Bul. Dept. Pl. Res. No. 36

PLANT RESOURCES

(A Scientific Publication)

Government of Nepal
Ministry of Forests and Soil Conservation
Department of Plant Resources
Thapathali, Kathmandu, Nepal
2014

ISSN 1995 - 8579

Bulletin of Department of Plant Resources No. 36

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N. of Copies: 500

Cover Photo: *Pedicularis integrifolia* Hook. f.
Photo by G. D. Bhatt

Date of Publication: April, 2014

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Citation:
Name of the author, year of publication. Title of the paper, *Bul. Dept. Pl. Res.* N. 36, N. of pages, Department of Plant Resources, Kathmandu, Nepal.

ISSN: 1995-8579

Published By:
Publicity and Documentation Section
Department of Plant Resources (DPR), Kathmandu, Nepal

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DEPARTMENT OF PLANT RESOURCES

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GRAM: VANSAPATI, KATHMANDU
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FOREWORD

I am pleased to put forward some of my thoughts into this publication of the Department. I commend the work of the scientists of this Department who have accomplished the work despite hardships of various natures including prolonged interruption of power supply and utilities related malfunctions. These limitations are being addressed in the current fiscal year. Laboratories are under up gradation and newer equipments have been procured. Scientific manpower of all levels is provided with training and exposure opportunities abroad. All these interventions are expected to facilitate research which is of immense value to carry out credible research and therefore harness the unlimited potential of our biodiversity sector towards economic and environmental prosperity.

We have initiated collaborative research of diverse nature a few of which is expected to trigger international trade in MAP sector. We are continually evolving our work plan based on the policy directives of the Government. It is also a matter of satisfaction for us that the process of drafting the Plant Resource Act was revived after a long gap since 2058. The process is in advance stage of consultation and once formalized it will provide legal basis for our mandate and will put our scientific workforce into proper perspective.

We need to build upon our research capabilities and the benchmarks established in the past and look forward to emerging and reemerging challenges faced by MAPs sector. The scope and quality of research should be oriented to resolve the problems and difficulties experienced in this sector. We need to strive for innovation and novelty. Such achievements should be owned and protected and the merit of publication should be considered based on impact factor in the sector. Scientific research are credible and desired if they are need-based and competitive nationally and internationally.

The Department is privileged in that the MOF&SC has approved a procedural guideline facilitating scientists to undertake research while in regular work. I am confident that the Department will become more and more oriented towards academic research and will contribute scientifically in the endeavor of nation building.

Finally I would like to thank the painstaking effort of all the paper contributors, editorial board members, publicity and documentation section to bring out the publication in this form.

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Yam Bahadur Thapa
Director General
April 2014

Editorial

We are pleased to bring out this issue of "Bull Dept Pl Res No 36", a continuation of our publication on plant resources. The issue carries a score of peer reviewed original scientific and review articles mostly based on the research undertaken by scientists within the Department of Plant Resources.

Since this publication speaks on the scope and objectives of our Department, we are aware that the publication should accommodate as many articles as possible so that it truly represents the work of our Department. And at the same time we are also aware of the need to preserve the scientific quality and integrity of the research articles.

19 articles have been incorporated in this issue under different categories like systematic botany, ethnobotanical study, floristic survey, ecology, biotechnology, review paper, chemical and biological analysis.

We encourage our scientists to pursue quality research and contribute to build scientific knowledge on MAPs sector of Nepal. We thank each and every contributor for their interest in publishing their valued work in this scientific publication and look forward to further cooperation and collaboration. We value the comments and opinion of our contributors and readers.

We apologize in advance for any lapses in this issue and at the same time promise to improve the future issues based on your valued input.

Addition and correction to the knowledge on edibility of wild mushrooms in Nepal: a discussion

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Abstract

This paper provides an updated list and information (with corrections, addition and nomenclature changes along with their occurrence, appearance frequency and market status) to the previous knowledge on wild edible mushrooms gathered and reported by various researchers in Nepal. Near about 335 species have been analysed (based on Nepalese reports and FAO compiled list from various sources) with critical notes about their edibility and collection concept in Nepal. The screening is based on various literatures published abroad. In total 131 (111 from previous list and 20 recent addition) species are recognised as edible ones without any hesitation, 66 species are controversially treated for their edibility, and 23 species (listed previously) are recorded poisonous or to be avoided. Rests of species are discussed separately about their edibility. All species need authentic identification or consultation with experts before eating or consumption.

Key words : Wild edible mushrooms, list, literature account, market, Nepal

Introduction

a. General

FAO (www.wildusefulfungi.org, 2004) provides merely a compiled list of near about 1130 wild species of fungi reported from various countries, which are said to be edible or used as food and with medicinal value. According to FAO paper, those records were taken from more than 140 sources, including papers, books, websites and other contacts, of which full details are held in a database established by the authors. The names of the species as they appear in the original publications are with the exception of obvious spelling mistakes, which are visualized necessary to provide the valid and synonym easily available to all. Moreover the mycological literatures do not always make it clear whether an "edible" fungus is simply eaten as vegetable and or used as "food". Recently Roman (2010) briefly provided a comparative account on wild edible species reported from different countries.

The term 'food', as listed in FAO paper, at present (in my) opinion, may have been applied, when the quantity of a fungus is used in large amount instead of or as substitute to food grains associated with daily consumption, which supply the necessary nutritional elements required to the body or to fill the stomach or belly. Moreover it depends on availability of the species, good flavor, delicious in eating and if there no alternative of food grains to eat. The term "edible" is used for the little amount of the fungus used as a supplement, as a vegetable, as a constituent or an ingredient in the food but not necessary for daily use. So, regarding the concept of edibility of a fungus it is very controversial. It depends up on some of the factors as noted below:

a. Altitudinal diversity and availability of species.
b. Altitude influencing phytogeographic conditions, local environment, type and nature of the substrate and soil texture.
c. Form, structure and color of the fungi, which differ in each species, individual and place. In Nepal mostly they fear to eat red forms as they think to be poisonous species excepting few.
d. Amount of availability of the species and appearance, growth, frequency of the species and or scarcity of food.
e. Concept on edibility of fungus, ethnomycophagus groups, traditional mycophagus society and mycophilians. Traditional method in use of fungi.

f. The physiology of person varies in each individual. So edibility depends upon physiology of a person/ethnic groups and ability to resist the toxicity of a fungus.

g. Nearness of collection, neatness of collector and poverty of collector. Method of collection, mixing of species, carriage time and nature or type of basket.

h. Storage of material, nature of storing material, time duration, days and method of drying.

i. Cooking methodology and the ingredients used to cook (what species you eat, how you eat, with what other species you mix during cooking and the quantity you eat).

b. Ayurvedic concept

The oriental use of fungi dates back to very early age as depicted by Ayurveda (an ancient science on human health), which principally originated from Rigveda and Yajurveda (Adhikari, 1981-2, 1999, 2000). The Ayurveda based classics such as Samhita (Charak, Shushrut, Kashyap) and Nighantus (Ratnakar, Bhavprakasgh, Madanpal, Chandra) though narrated in different ways have the same view. Charak (also known as Agnivesha tantra, written in 1500 BC) states that excepting the resupinate forms (which are attached to the substrate by stipe) rest is toxic to liver, heavy to digest and have sedative properties. They are, therefore, not suggested as edible ones. In Shushrut (written by Dhawnantari, 1000 to 1500 BC) the mushrooms are considered as vegetables. They are mild in taste and contain fat and protein. Those species which grow on straw are agreeable in taste. The mushrooms growing on sugar cane are bitter in taste and have sedative properties. The mushrooms cause cough, gastric trouble, arthritis, liver trouble, enhance urinary excretion, act as purgative and favour the multiplication of parasites in the body. The species growing on bamboos cause stomach disorder. The species growing on dung are bitter. They are responsible for causing sweating and arthritis. It is advised that mushroom are not to be eaten with milk (Adhikari, 2000). The regular eating of the mushrooms may cause or produce some abnormalities in human body structure or physiology, which can either be noticed or unnoticed. Some cases can be detected to have abnormal appearance. The cases can be studied in such areas where there is scarcity of food materials and the inhabitants have to rely mostly on the wild species.

Species in Nepal

a. Nepalese reports

The Nepalese literature review [Adhikari (1996, 2000ab, 2004, 2008, 2009abc, 2011), Adhikari & Adhikari (1996-97, 1999), Adhikari *et al.*, (1996), Adhikari & Devkota (2007), Adhikari, Devkota& Tiwari (2005), Adhikari & Durrieu (1996), Adhikari & Pokharel (1999), Adhikari & Watanabe (2009), Adhikari, Shrotriya & Durrieu (2003), Bhandary (2047BS, 2048BS, 1984, 1991), Bills & Cotter (1989), Bodo (2006), Christensen, Bhattarai, Devkota & Larsen (2008), Christensen, Devkota & Bhattarai (2008), Christensen& Larsen (2005), Giri & Rana (2007, 2008), Guzman & Kasuya (2004), Joshi & Joshi (1999), Kharel (1999), Kharel & Rajbhandary (2005), Pandey & Budathoki (2006, 2007ab), Pandey *et al. (2006)*, Rana & Giri (2008), Sacherer (1979), Schroeder & Guzman (1981), Singh (1966), Tulloss (1989), Tulloss & Bhandary (1992) and Zang & Doi (1995)] record numerous wild fungi or mushrooms found in the different phytogeographic regions Nepal. Very few papers with significant ethnomycological knowledge have been contributed by Bills & Cotter (1989), Adhikari & Durrieu (1996), Adhikari (2000) and Christensen *et al.*, (2008).

b. Ethnomycological knowledge

Among these literatures the previous record on wild edible species started from the works of Bhatt (1970: 4 species) and Singh (1966: 18 species). Since then Bhandary (1984) listed 107 species. Adhikari & Durrieu (1996) reported many species with their local names in "ethnomycologie nepalaise". Adhikari (2000) included 110 edible species. Adhikari, Devkota & Tiwari (2005) in ethnomycological knowledge from western Nepal

listed 24 species, among which 17 species were recorded for caulinary purposes. Giri, Rana & Shrestha (2005) provided a list of 25 taxa used in Khumbu region. Pandey & Budhthoki (2002, 2006) provided a list of 28 species among, which 20 species were said to be edible. Pandey & Budhthoki (2007) in a study of Chepang community listed 50 specimens among which 16 taxa (10 species identified) were found as edible ones. Pandey, Devkota, Christensen & Budhathoki (2006) provided the compiled list of 101 taxa (37 species, rest to generic level only) with addition used by Tamang community, Pandey *et al. (2006),* provides a list of 49 species of fungi used. Cristensen *et al.* (2008) records 228 species of mushrooms for consumption. It was interesting to note if Cristensen *et al.* (2008) would have provided the list of 228 species. But the list published by them tabulate only 68 species from Nepal. So it is useless to predict the number of edible fungi without providing the list of recorded species from the field. Adhikari & Adhikari (2011) during mycological studies and market survey in Kathmandu valley found 5 species of *Stereum* used in ceremonies of Newar community.

These information or records have been gathered by above authors from the collectors residing near by forests in diverse phytogeographic (tropical to alpine belts) regions of Nepal. Most of these include Magar, Tharu, Tamang, Chepangs, Newar, Rai, Yadav, Gurung, Limbu, Musahar, Sherpa, Rajbansi, Dhangar, Kusunda, Raute, Thakali, Bhote and Dhimal ethnic casts, who are engaged in either traditional concept of collection or collecting knowningly or unknowningly, trade and transit of wild mushrooms (Map 1 - distribution map of some ethnic groups in Nepal).

c. Recent approach

In this paper all the species, which were recorded previously to be the edible species in Nepal are also dealt along with some recent addition. Till now 1121 species (147 species of Ascomycota, 974 species of Basidiomycota) of wild mushrooms are recorded. Among them 140 species are said to be edible (Adhikari, 2012). This is the revised knowledge on edibility status of wild mushrooms recorded in Nepal.

While going through the FOA list near about 335 species occur in Nepal. Among them 201 species (65 + 46 + 31 + 35 + 23) to previous list are analysed for their edibility, while 101 species are screened based on FAO report, 20 species are added and 13 species discussed for edibility. The recent molecular phyllogenetic approach on taxonomic treatment and nomenclature of the fungi many species are merged under the synonyms.

Materials and methods

The information on the wild species gathered from the field or markets by the investigators (during their course of investigation) (see - Adhikari, 2000; Bhandary, 1984 and Christensen *et al.*, 2008, Pandey & Budathoki (2002, 2007b), Rana & Giri (2008), through collectors, mycophilians and sellers were listed as edible species, which show controversial opinion (Adhikari & Adhikari, 1996, Adhikari, 2000 and Christensen *et al.*, 2008), while going through the various literatures. So, in order to get recent concept or approach, make aware and to improve the concept of edibility the list is revised with addition and corrections to the previous knowledge by consulting the literatures like Lincoff (1981), Chaumaton *et al.*, (1985), Arora (1986), Imazeki, Otani & Hongo (1988), FAO (compiled list published as edible species of different countries), Courtecuisse & Duhem (1994), Courtecuisse (2000), Phillips (2006), Okuzawa (2007) and Eyssortier & Roux (2011). Moreover the list is revised on the basis of personal communication, observations and the Nepalese reports. The literatures cited here are abbreviated as follows, which are provided in parenthesis: Lincoff (Lcf.), Arora (Ar.), Imazeki, Otani & Hongo (IOH), Courtecuisse (Co), Phillips (Ph.), Okuzawa (Ok) and Eyssortier & Roux (ER). The symbol for the 'edible' and 'food' as suggested by FAO are denoted in parenthesis as (E) and (F). Dueto nomenclature changes some of the species are merge together. Let us see what the authors or experts say about the species. They are provided together with status of availability in nature.

Enumeration of species

To avoid the repeated citation of reports from Nepal in full form for each species, they are provided in parenthesis in abbreviated forms as Adhikari (A), Adhikari & Adhikari (AA), Adhikari & Durrieu (AD), Adhikari, Devkota & Tiwari (ADT), Bhatt (Bt), Bhandary (Bh), Bills & Cotter (BC), Christensen *et al.* (C), Guzman& Kasuya (GK), Kharel (K), Kharel & Rajbhandary (KR), Pandey & Budhathoki (PB), Pandey, Devakota, Christensen & Budhathoki (Pea), Rana & Giri (RG), Giri, Rana & Shrestha (GRS), Singh (S), Schroeder & Guzman (SG). Several wild mushrooms were found sold in the market or used in some of the hotels for edibility or hallucinogenic purposes. The list is revised to give more or less a complete picture of the species reported yet. The local names of the species concern can be seen in Adhikari (2012). The list is categorized in the following subheadings like

A. Edible and recommended by various literatures
   a. Most commonly gathered (65 species),
   b. Gathered in very few amount, seldom known or rarely collected (46 species)
B. Edibility controversial
   a. Edible but with care (31 species)
   b. Edible but not recommended (35 species)
C. Recorded poisonous /hallucinogenic (among the previously listed species) (23 species)
D. Recent additions (based on recent list 20 species).
E. Comments based on FAO list (101 species not known to Nepalese)

So, this is an attempt to provide an up dated list on the concept of edibility, though the people are accustomed for eating mushrooms in different parts of Nepalese territory. The citations of the authors providing the opinions are given in parenthesis. The species left without opinion are mostly listed as edible in Nepalese perspective. But still everyone must be careful before eating the wild species. The enumeration of the species is done in following manner:

Species [= synonym] – reports / literatures from Nepal, occurrence status, edibility concept or record of various literature and FAO, comments (market status and others).

A. Edible and recommended by various literatures

a. Most commonly gathered (61 species)

- **Amanita caesarea** (Scop.: Fr.) Pers. – (A, AA, Bh, PU, S, C) edible (IOH, Lcf, ER), if collected in large quantities used as food, sold in the market also. Subtropical to Teperate species. *Amanita chepangiana* Tulloss & Bhandary – (TB, ADT, C), edible, if collected in large quantities used as food. It is wide spread in tropical and subtropical belt. They are sacked in bags and carried to India even for sell. Their market price fluctuates in between 400 and 450 Rs. (NC). *Amanita hemibapha* (Berk. & Br.) Sacc. (A, AA, AD, RG, C, GRS) and its variety *hemibapha* and *similis* – (A, C) edible, if collected in large quantities used as food. It is subtropical to teparate pine inhabiting species. *Amanita javanica* (Corner & Bas) Oda, Tanaka & Tsuda – (A) edible, if collected in large quantities used as food. *Amanita caesarea*, *Amanita hemibapha* and *Amanita javanica* are mixed together and sold in market at the rate of Rs. 50/- kg.
- **Cantharellus cibarius** Fr. – (A, AA, AD, ADT, Bh, PU, C, GRS) common to frequent, edible (IOH, Ph, ER) (F), edible but with care (Lcf), causes gastric upsets and hallucinogenic effects (Ok). Most of the *Cantharellus* species, *Cantharellus odoratus* (Schw.: Fr.) Fr.- (A, C) (E), *Cantharellus subalbidus* Smith & Morse – (A) (E), *Cantharellus minor* Pk – (A), (F), *Cantharellus leucocomus* Bigelow – (A) (F) and *Cantharellus subcibarius* Corner – (A) (E)} are mixed together with other species of *Cantharellus* (S) and sold in the market at the rate of Rs. 60/-kg, (E). Subtropical to Teparate species. Most species are edible.
- **Clavulina amethystinoides** (Peck.) Corner [= *Clavulina amethystina* (Fr.) Donk.] – (A,E), edible (Lcf).
- **Craterellus tubaeformis** (Bull.:Fr.) Quel. [*Cantharellus tubaeformis* (Bull.) Fr., *Cantharellus infunbibuliformis* (Scop.) Fr.] - (A), edible(E)
- **Exobasidium butleri** P. & H. Sydow –(A,

ADT), juicy, edible in fresh condition and while climbing high altitudes to avoid dryness of throat, in Nepal only.

- **Favolus canadensis** Klotzsch. – (S, A), edible (Lcf).
- **Grifola frondosa** (Dick. & Fr.) S. F. Gray – (A, AA, ADT, Bh, KR, Pea, C), frequent, edible, gathered and sold in the market (Rs. 600- 700/- kg), it is used as food when the species is gatherd in large amount, (E).
- **Hericium abietis** (Weir ex Hubert) Harrison - (F); *Hericium clathroides* (Pall.: Fr.) Pers. [= *Hericium ramosum* (Bull.) Letell.]–(S, A), (E)*; Hericium erinaceus* (Bull.) Pers. – (A, AA, ADT, B, PU, Pea, C), frequent, edible (Lcf, Ph, IOH); rare in Europe, with care (ER), (F); *Hericium flagellum* (Scop.) Pers. [= *Hericium coralloides* (Scop.) Pers.]– (A, Bh), red data list, edible (Ph); rare, not edible (ER), (F); *Hericium laciniatum* (Leers.) Banker]–(E) are gathered mixed together. The species are controversially treated, though these species are commonly gathered for eating purposes and sold in the market. (A).
- **Hydnum repandum** L.:Fr. – (A, PU, C, GRS), (F) are sold in the market.
- **Hydnellum zonatum** (Fr.) Karst. [= *Hydnellum canescens* (Pers.) Banker *; Hydnellum velutinum (Bohm.:Fr.*) Karst. – (A),
- **Laccaria amethystina** (Huds.) Cooke – (A, Bh, PU), edible, collected in large quantities and sometimes used as food, (F). *Laccaria laccata* (Scop.) Cooke – (A, AA, ADT, Bh, PU, Pea, GRS), common to frequent, edible (IOH, Ph, ER); with care (Lcf,), gathered in large quantities for food and sometimes sold in the market, (F).
- **Lactarius thakalorum** Bills & Cotter – (BC, C), edible, collected in large quantities and sometimes used as food, named after the ethnic cast Thakali and the Thakkhola region.
- **Laetiporus sulphureus** (Fr.) Murr. – (S, A, ADT, Bh, PU, Pea, C), edible, but sometimes it is used as food when the species is gatherd in large amount, (F).
- **Lentaria macrospora** Corner – (A), edible.
- **Lentinula edodes** (Berk.) Pegler – (A, Bh, RG, C), edible, sometimes sold in the market, now a days cultivated.
- **Lentinus badius** (Berk.) Ber. – (A) edible; *Lentinus conchatus* (Bull.: Fr.) Schr.- (A), edible; *Lentinus polychrous* Lév. – (A), edible, sometimes sold in the market. Lentinus *velutinus* Fr.[= *Lentinus nepalensis* Berk. – (A, Bh), edible]; *Lentinus sajor-caju* (Rumph.: Fr.) Fr. – (A), edible but sometimes it is used as food when the species is gatherd in large amount, now a days cultivated (cultivar from abroad: sold at the rate between Rs. 80 - 200/ - kg.). *Lentinus tuber-regium* Fr. : Fr. - (A), edible.
- **Meripilus giganteus** (Fr.) Karst. – (A, Bh, C), common, edible (Lcf, Ph); frequent, edible but with care (ER), (F), sold at rate of Rs. 200 - 300/- kg.
- **Morchella elata** Fr. [= *Morchella conica* Pers.; *Morchella costata* (Vent.) Pers.; *Morchella deliciosa* Fr.;] – edible (Lcf, IOH, Ph, ER). *Morchella esculenta* (L.) Pers. – frequent to rare, edible (Lcf, IOH, Ph, ER), Morchella *smithiana* Cooke (SU, Bh)-not to be taken with alchoholic drinks, may cause gastric upsets. The species are gathered in huge amount (approx. 10 -12 tonnes per year and sold at the rate of 12,000 - 15,000/- kg, Adhikari, 2000) from west Nepal and sold in Indian market. They are used as food also (Bt, Bh, A, C).
- **Pleurotus circinatus** Fr. – (Bh, A), edible. *Pleurotus ostreatus* (Jacq.: Fr.) Kummer –(Bh, A, RG, Pea, C), common, edible (IOH, Ph, ER), (F). *Pleurotus ostreatus* var. *magnificus* Peck. – (A), edible, but sometimes it is used as food when the species is gatherd in large amount. Sold in Kathmandu market. Now a days it is cultivated also.
- **Polyporus arcularius** Batsch.:Fr. – (S, A, Bh), edible, sold Kathmandu market. *Polyporus nepalensis* Berk. – (A), edible; *Polyporus brekeleyi* – (S, Bh), edible.
- **Ramaria botrytis** (Pers.: Fr.) Ricken – (Bh,

A, ADT, PU, RG, Pea, C), edible, sold in Kathmandu and Jomsom market. *Ramaria botrytoides* (Peck.) Corner –(A), edible, sold in Kathmandu market. *Ramaria flaccida* (Fr.) Ricken –(A, ADT), edible.

- **Russula kathmanduensis** Adhikari – (A), edible.
- **Sarcodon imbricatus** (L.: Fr.) Karst. [=*Hydnum imbricatum* L.:Fr.]-(A), edible; *Sarcodon laevigatus* (Swartz.) Karst. – (A), edible (ER).
- **Scleroderma cepa** (Vailli.) Pers.: Pers. – (Bh, A, AA, Pea, C), edible, sold in Kathmandu market. *Scleroderma texens* Berk. – (A), edible, mostly gathered in large quantities to sell in the market also used as food, gathered mostly in western tarai belt of Nepal.
- **Termitomyces eurhizus** (Berk.) Heim.-all the tropical to subtropical species of *Termitomyces* [*Termitomyces albuminosus* (Berk.) Heim, *Termitomyces microcarpus* (Berk. & Br.) Heim, *Termitomyces striatus* (Beeli) Heim, *Termitomyces heimii* Natarajan, *Termitomyces robusts* (Beeli) Heim *Termitomyces auranticus* Heim, *Termitomyces clypeatus* Heim, *Termitomyces eurhizus, Termitomyces heimii* and *Termitomyces mammiformis*] are gathered in large amount from the forest for food and sold in the Nepalese and Indian markets also. These species are either mixed together or kept separate and sold in the market (400 - 600/- NRs) or used as food material (A, ADT, PU, C).
- **Volvariella volvacea** (Fr.) Singer (F) and *Volvariella bombycina* (Schaeff.:Fr.) Singer (E) are tropical to subtropical edible species. (F), cultivated (Bh, A, RG).

b. Gathered in very few amount, seldom known or rarely collected (46 species)

- **Agaricus campestris** L.: Fr. – (Bt, S, A, Bh, PU, C) common, edible. (Worldwide, F). *Agaricus subrufescens* (Peck.) Hobson & Stuntz – (A, Bh, F). *Agaricus sylvicola* (Vitt.) Peck. – (A, Bh) commonly found, edible, (F).
- **Albatrellus confluens** (Fr.) Koltz. & Pouz. – edible, (E).
- **Aleuria aurantia** (Fr.) Fuck. – (Bh), common, edible (Lcf, IOH, Ph, ER), (E).
- **Auricularia auricula-judae** (Bull.) Quel. – (A, ADT, Bh, PU, C), common, edible, (F); *Auricularia delicata* (Fr.) Henn. Apud Bres. – (A, PU)
- **Boletus edulis** Bull.: Fr. – (Bt, S,A, Bh, PU, GRS), common, edible, (ER, Lcf, F).
- **Bondarzewia berkeleyi** (Fr.) Bond & Singer – (A, C), (Lcf), edible. *Bondarzewia montana* (Quel.) Singer – (A), edible. rare in Europe, (Lcf, E).
- **Calvatia gigantea** (Batsch. : Pers.) Lloyd – (A, C), common to frequent, (ER, Lcf, E).
- **Cantharellus lateritius** (Berk.) Singer – (A), common, edible (Lcf).
- **Clavaria acuta** Sch. : Fr. – (A, PU) edible. *Clavaria fragilis* Holmsk [= *C. vermicularis* Swartz. : Fr.] – (A,Bh, PU), frequent, edible, (Lcf, ER, F).
- **Clavulina coralloides** (L.) Schroet. [=*C. cristata* (Fr.) Schroet.] – (A, Bh), common, edible (ER).
- **Coprinus comatus** (Mull.: Fr.) Pers. – (A, ADT, Bt, Bh, PU, C), common, edible when young (ER, Lcf).
- **Craterellus cornucopioides** (L.: Fr.) Pers. – (A, Bh, Pea, C), common to frequent, edible, (Lcf, ER, F).
- **Dacromyces palmatus** (Schw.) Bres.-(Bh), edible (Lcf), (E).
- **Dictyophora duplicata** (Bosc.) Fisch. – (PU), edible in egg but not choice (Ar, IOH)
- **Entoloma subcostatum** Atkinson –(A), edible, seldom gathered.
- **Favolus canadensis** Koltz. – (B); *Favolus tenniculus* P. Beauve–(C), edible.
- **Fistulina hepatica** (Schaeff.) Witt. –(A, Bh), common, edible, (Lcf, ER, F).
- **Flammulina velutipes** (Curt. : Fr.) Karsten – (A, Bh, C), common, edible, (Lcf, IOH, ER, F).
- **Gomphus clavatus** (Pers.: Fr.) S. F. Gray – (A, Ch, GRS), rarely gathered, edible, but with choice (Lcf), (F).
- **Laccaria vinaceoavellanea** Hongo –(C),

edible (IOH), rarely gathered.

- **Lactarius deliciosus** (L.:Fr.) Gray- (A, Bh, Pea, C), common to frequent (Lcf, IOH, Ph, ER), edible (Ph, ER) (F); *Lactarius indigo* (Schw.) Fr. – (A), edible (Lcf, IOH), (F). *Lactarius volemus* (Fr.) Fr. – (A, ADT, C), rare (Ph); frequent (ER), edible, (F).
- **Lentinus strigosus** (Schw.) Fr. – (A), edible (Ph).
- **Lycoperdon perlatum** Pers. : Pers. – (A, Bh), edible (IOH) (E)
- **Marasmius oreades** (Bolt.: Fr.) Fr. –(A, Bh, PU), common, edible (IOH, Ph, ER)
- **Morgenella pyriformis** (Schaeff.: Pres.) Kreisel & Kroger [= *Lycoperdon pyriforme* Schaeff. : Pers.] – (A), common, edible (IOH, Ph), (F).
- **Pholiota nameko** (Ito) Ito & Imai – (Bh, A), edible (IOH) (E), cultivated.
- **Phyllotopsis nidulans** (Pers.:Fr.) Singer [= *Pleurotus nepalensis* Corner] – (Bh, A), edible (IOH)
- **Pluteus polumbinus** (?) – (Bh)
- **Pleurotus cornucopiae** (Paul.) Rolland – (A, PU, C), common to frequent, edible (IOH, Ph, ER), (F).
- **Psathyrella piluliformis** (Bull.: Fr.) Orton – (A), common, edible (Ph, ER)
- **Ramaria stricta** (Pers.) Quel. - (C), gathered mixed with other *Ramaria* species.
- **Rhodocollybia butyracea** (Bull.: Fr.) Lennox [= *Collybia butyracea* (Bull. : Fr.) Kummer] – (A, B), common, edible (Lcf, ER).
- **Russula aurora** Krombh.[= *Russula rosacea* (Pers.) Gray; *Russula rosea*] – (A), rare, edible (Ph) (E). *Russula cyanoxantha* (Sch.) Fr. – (Bh, A), common, edible (IOH, Ph, ER), (F). *Russula galochroa* (Fr.) Fr.-(A), edible. *Russula heterophylla* (Fr.: Fr.) Fr. – (A), common to frequent, edible (Ph, ER), (F). *Russula vesca* Fr. – (S, Bh, A), common, edible (Ph, ER, (E). *Russula virescens* (Sch.) Fr. – (Bh, A, C), common to frequent, edible (IOH, Ph, ER)
- **Tricholoma terreum** (Schaeff.: Fr.) Kumm. – (Bh, E)

B. Ediblitity controversiel

a. Edible but with care (31 species)

- **Agaricus bitorquis** (Quel.) Sacc.-(A) frequently, edible (Lcf,), but with care (Ph, ER, (F); *Agaricus rhodmani* – (S, Bh).
- **Amanita fulva** (Schaeff.) Fr. – (A, Bh, C), common, edible (Ph); with care (Lcf, ER) (causes gastric upsets, Ok), (F). *Amanita rubescens* (Pers.:Fr.) Gray – (B), common, edible (Ph, ER); not recommended (IOH); causes gastric upsets, (Ok); *Amanita echinocephala* (Vitt.) Quel. [=*Amanita solitaria*] – (Bh) (ER).
- **Armillaria mellea** (Vahl.:Fr.) Kummer. – (A, Bh, PU, SN, C), common, edible (Ph), with care (IOH, Lcf, ER), causes gastric upsets (Ok). *Armillaria tabescens* (Scop.: Fr.) Emel. – (A, Bh), frequent, edible (Lcf, Ph); poisonous (IOH), causes gastric upsets (Ok), (F).
- **Astraeus koreanus** (Stanek) Kreisel [= *Astraeus hygrometricus* (Pers.: Pers.) Morgan] –(A, C) common, edible but with care (ER, Ph), Red date list – Europe, (E).
- **Auricularia mesenterica** (Dicks.) Pers. – (A), common, edible (IOH) but with care (ER, Ph), (E). .
- **Bjerkandera adusta** (Fr.) Karst. – (A), common, edible but with care (ER, Ph).
- **Boletus bicolor** Peck. – (C), edible (Lcf); with care, may cause gastric upsets (Ar)
- **Bovista plumbea** Pers.: Pers. – (A), common to frequent, edible (Ph); with care (ER), (E).
- **Coprinellus disseminates** (Pers.: Fr.) Lange – (Bh), common, edible (Lcf, Ph) (E), with care (ER). *Coprinellus micaceus* (Bull.:Fr.) Vil., Hop. & John.- common, edible (Lcf, Ph); not recommended (IOH, ER), (F).
- **Conocybe lactea** (Lang) Metrod – edible (Lcf) *; Concybe tenera* (Schaeff.) Fayod - (Bh), edible (Lcf).
- **Gymnopus confluens** (Pers.: Fr.) Antonin, Halling & Noor [= *Collybia confluens* (Pers.) Kummer – common, edible (Lcf, IOH, Ph); with care (ER). *Gymnopus dryophila* (Bull.: Fr.) Murr. [= *Collybia dryophila* (Bull.) Kummer] – common, edible (Lcf, IOH); with

care (ER), causes gastric upsets (Ok), (E). *Gymnopus acervata* (Fr.) Murrill.[= *Collybia acervata*] – edible (IOH).

- **Hypholoma capnoides** (Fr.) Kummer – (Pea, C), edible but with care (ER)
- **Lactarius piperatus** (L.: Fr.) S. F. Gray- (A, ADT, Bh, C) frequent, edible (Ph); with care (Lcf); common (ER), (F) *Lactarius subpiperatus* Hongo –(A, C), causes gastric upsets (Ok)
- **Lentinellusursinus** (Fr.:Fr.) Khuner –(A, K, KR, PU), edible but with care (ER)
- **Leucopaxillus giganteus** Massee – (C), edible (IOH); with care (ER); causes gastric upsets (Ok)
- **Noelentinus lepideus** (Fr.: Fr) Redhead & Ginns.– edible (IOH, Lcf); causes gastric upsets (Ok)
- **Parasola picatilis** (Curt.: Fr.) Redhead, Vilg. & Hopple - common, edible (Lcf, Ph); not recommended (IOH, ER).
- **Suillus granulatus** (L.) Rous. – (C), edible (Lcf, IOH); frequent (Ph); common, with care (ER), causes gastric upsets (Ok), (F). *Suillus placidus* (Bonord.) Singer – edible (Lcf); rare, with care (ER), causes gastric upsets (Ok), (E).
- **Volvariella bombycina** (Fr.) Singer – edible (Lcf, IOH, Ph); with care (ER), (F).
- **Xerula radicata** (Relban) Dorflet [= *Oudemansiella radicata* (Rehl.) Singer] – (Bh, A, ADT, PU, C), common, edble (IOH); inedible (ER), the species is roasted on fire or cooked for eating in Nepal.

b. Ediblebut not recommended (35 species)

- **Amanita vaginata** (Bull.) Fr.–(A, Bh, PU, C, GRS), causes gastric upsets and hallucinogenic effects, poisonous fungi in Japan, (Ok, IOH).
- *Auricularia polytricha* (Mont.) Sacc. – (A, Bh, PU, C, GRS), edible (IOH), causes coronary artery disease Lcf.), (E); *Auricularia stroma; Auricularia temperata* - (B)
- **Clavulina cinerea** (Bull.: Fr.) Schroet. – (A, Bh, C, GRS), common, edible (Ph); frequent, not recommended (ER), (F).
- **Clavulinopsis fusiformis** (Sow.) Corner – (A, ADT, Bh, C), edible (Lcf), inedible (IOH), (E), seldom gathered in Nepal.
- **Clitocybe diatreta** (Fr. : Fr.) Kummer – (A), frequent, ediblity not recommended (ER)
- **Hydnellum zonatum** (Fr.) Karst. [= *H. concrescens* (Pers.) Banker] – (A), frequent, not edible. Hydnellum *velutinum* (Bšhm. : Fr.) Karst. – (A), red data list, not edible (Ph).
- **Lactarius controversus** Pers.: Fr. – (A), common to rare, edible (Ph) (E), common, not edible (ER); *Lactarius lignyotus* Fr. – (A, Bh) edible (IOH), frequent, not edible (ER).
- **Lentinus tigrinus** Bull.: Fr. [= *Panus tigrinus* (Bull.: Fr.) Singer]– (Bh, A, C), edible (IOH, Co, FAO); frequent, inedible (ER)
- **Pholiota gummosa** (Lasch.: Fr.) Singer – common to frequent, not recommended (Ph, ER). *Pholiota limonella* (Pk.) Sacc. [= *Pholiota aurivella* (Batsch.) Kummer] – (Bh, A, C), edible (Lcf), with care (IOH), frequent, inedible (Ph, ER, E). *Pholiota squarrosa* (Mull.: Fr.) Kummer – (Bh, ADT, C), common to frequent, not recommended as edible (IOH, Ph, ER), (E).
- **Pleurotus dryinus** (Pers.: Fr.) Kummer –(A), frequent, not recommended as edible (ER), (F).
- **Pluteus cervinus** (Sch.: Fr.) Kummer – (S, Bh, A), common, edible (Lcf, IOH, Ph); inedible (ER), (F)
- **Polyporellus brumalis** (Fr.) Karst. – (Bh, A), common, not edible (Ph)
- **Polyporus badius** (Pers.) Schw. [= *Polyporus durus* (Timm.) Kreisel; *Polyporus picipes* Fr.]– (Bh, A, C), frequent, not edible (Ph, ER), (E). *Polyporus leptocephalus* (Jack.) Fr. [= *Polyporus varius* Fr.] – (A), common, not edible (Ph). *Polyporus squamosus* Michel.: Fr.–(Bh, A), common, edible (Ph) (E), frequent, not recommended as edible (ER)
- **Rhizopogon obtextus** (Spreng.) S. Rauchert. [= *Rhizopogon luteolus* Fr. & Nordholm] – (A, C), frequent, not edible (Ph), (E). *Rhizopogon roseolus* (Corda) Fr. – (A), common, not edible (ER), (E).
- **Russula atropurpurea** (Krombh.) Britz. [= *Russula undulata* Vel.] – common, edible (Ph) inedible (ER), (E). *Russula chloroides*

(Krombh.) Bres. – (A, ADT), edible (IOH); common, not edible (ER), (E). *Russula claroflava* Groov. – (A), edible (Lcf); frequent (Ph); not recommended (ER). *Russula delica* Fr. – (Bh, A, PU, C), common, edible (IOH, Ph), not recommended as edible (ER), (F). *Russula nigricans* (Bull.) Fr. – (A, C), not recommended as edible (IOH,ER); common, edible (Ph), causes gastric upsets (Ok), (F). *Russula puellaris* Fr. – (A), frequent, edible (Ph); not recommended as edible (ER). *Russula sanguinaria* (Schum.) Rausch. [= *Russula sanguinea*] – (A), common to frequent, not recommended as edible (Ph, ER), (F). *Russula velenovskyi* Melz. & Zvara – (A), common, edible (Ph); inedible (ER); *Russula xerampelina* – (Bh)

- **Sarcodon imbricatus** (L.:Fr.) Karsten [= *Hydnum imbricatus* L.] – frequent, not edible (ER), (F).
- **Schizophyllum commune** (Fr.) Fr. – (Bh, A, Pea, C), common, not recommended as edible (IOH, Ph, ER), food (FAO), used as ingredient of 'Panchgol' in Newar community.
- **Strobilomyces strobilaceus** (Scop.:Fr.) Berk. [= *Strobilomyces floccupus* (Vahl.: Fr.) Karst.- (Bh), red data list, edible (Ph); rare, inedible (ER), not edible in Nepal.

c. Recorded poisonous / hallucnoenic(23 species)

- **Auricularia mesenterica** (Dicks.) Pers. – (A), common inedible, causes coronary artery diseases (Lcf), (E).
- **Clitocybe gibba** (Pers.: Fr.) Kummer – (A, Bh), common, edible (IOH), hallucinogenic (Ok), (F).
- **Gomphus floccosus** (Schw.) Singer – (A, RG, GRS), inedible, poisonous (IOH), not recommended as it contains indigestible acid, sometimes sour and not palatable (Lcf), (F), causes gastric upsets and hallucinogenic effects (Ok).
- **Gyromitra infula** (Schaeff.) Quel. – (Cea), poisonous (Lcf, IOH, ER); not rcomended for edibility (Ok), mostly contains 'Gyromitrin' toxic substance, (F).
- **Hygrocybe conica** (Schaeff.) Kummer [=*Hygrocybe nigrescens* (Quel.) Kuhn.] –(A), common, edible with care (IOH, Ph) not edible (ER); poisonous (Lcf), (E). *Hygrocybe miniata* (Fr.) Kummer – (A), common to frequent, edible (Lcf); not edible (Ph, ER). *Hygrophorus coccinea* (Schaeff.) Kummer – (B), common, edible (IOH, Ph); frequent, not recommended (ER), edible (FAO), *Hygrocybe eburneus* (Bull.:Fr.) Fr.- (B), not edible in Nepal.
- **Omphalotus illudens** (Schw.) Bres. **[=** *Clitocybe illudens***] –**inedible
- **Omphalotus olearius** (De Cand.:Fr.) Fayod.**[=** *Clitocybe olearius; Omphalotus olivascens***]** (AD)
- **Paxillus involutus** (Batsch. : Fr.) Fr. – common, inedible, poisonous (IOH, ER)
- **Psilocybe coprophila** (Bull.) Kumm. [= *Deconica coprophila* (Bull.) Karst.]; *Psilocybecubensis* (Earle) Singer; *Psilocybe montana* (Pers : Fr.) Kumm.; *Psilocybe percevallii* (Berk. & Brown.) Orton; *Psilocybe pseudobullacea* (Petch.) Pegler; *Psilocybe subcubensis* Guzman – used for hallucinogenic purposes (GK, SG)
- **Ramaria aurea** (Sch.) Quel. – (A), poisonous (IOH); rare, edible (Ph), (F). *Ramaria flava* (Sch.: Fr.) Quel.-(A, C, GRS), poisonous (have laxative effect – IOH); rare, edible (Ph), (F). *Ramaria formosa* (Pers.: Fr.) Quel. –(A), poisonous (causes diahorrea – IOH, Ok, Lcf; rare - Ph) (E).
- **Scleroderma citrinum** Pers.: Pers. – (Bh, A, PU), common, poisonous (IOH), not recommended as edible (Ph, ER), (E), gathered and sold in the maket in Nepal. *Scleroderma verrucosum* (Bull.) Pers. –(A, Pea, C), common, poisonous (IOH) not recommended as edible (Ph, ER*)*, (E), gathered and sold mixed with other *Scleroderma* species.
- **Tylopilus eximius** (Peck.) Singer – (RG, GRS), poisonous (IOH)

C. Recent additions (Based on lieratures) (20 Edible)

- **Agaricus arvensis** Schaeff. – common to frequent, edible (Lcf, IOH, Ph, ER), (F).
- **Artomyces pyxidatus** (Pers.: Fr.) Jullich

[=*Clavicorona pyxidata* (Fr.) Doty] – edible (Lcf),

- **Chroogomphus rutilus** (Schaeff.: Fr.) Miller – frequent, edible (Lcf, Ph)
- **Clavariodelphus pistilaris** (Fr.) Donk – edible (Lcf), (F).
- **Clavulina amethystinoides** (Peck.) Corner – edible (Lcf), (E).
- **Clitocybe nuda** (Bull.:Fr.) Big. & A.H.S.; *Clitocybe odora* (Bull.) Kummer – common, edible
- **Concybe lactea** (Lange) Metrod – edible (Lcf)
- **Hohenbuehelia petaloides** (Bull.) Schul. – rare, (E).
- **Lactarius corrugis** Peck – (B), edible (Lcf), (F). *Lactarius hygrophoroides* Berk. & Curt. – edible (Lcf).
- **Oudemansiella mucida** (Schrad.) Hohn.- edible (IOH).
- **Pseudohydnum gelatinosum** (Scop.) Karst. – (Bh), common, edible (Lcf)
- **Ramariopsis kunzei** (Fr.) Donk. – edible (Lcf)
- **Russula xerampelina** (Schaeff.) Fr. – common, edible (Lcf, Ph, ER), (F).
- **Sarcodon asparatus** (Berk.) Ito – frequent, edible with care (IOH), (F), causes gastric upsets (Ok).
- **Sparasis crispa** (Wulfen) Fr. – frequent, edble (Lcf IOH, ER), (F).
- **Suillus cavipes** (Opat.) Sm. & Thiers – edible (Lcf); red data list (Ph),
- **Vascellum praatens** (Pers.) Kreisel – edible (Lcf, FAO). Common, edible (Ph); inedible (ER)
- **Verpa conica** (Mull.) Swartz. – edible (Lcf), (E).

Comments based on list prepared by FOA in Nepalese context.

It is very difficult to say wether the collection of mushrooms according to the edibility list of FOA is or can be done in each country or not as it depends on the criteria as noted above. In Nepal the following species are very little known or unknown to be edible. The comments on the list are noted below.

Morels, *Xerula radicata* and *Scleroderm*a species are roasted in fire and eaten, while some species (*Ophiocordyceps sinensis, Xerula radicata* and *Cantharellus cibarius*) are eaten row, which is suggested to avoid.

In Ascomycota

Meager knowledge has been found on the record of collection of Ascomycots for edible purpose. In Pezizales the species like: *Aleuria aurantia* (E), *Otidea onotica* (E), *Peziza badia* (F). *Peziza rependa* (Bh), *Peziza vesiculosa* (Bh, E), causes gastric upsets – Ok) and *Sarcoscypha coccinea* (F) are recorded edible by various literatures. The species of *Gyromitra* and *Helvella* [*Gyromitra esculenta* (E), *Gyromitra infula* (C, F) [= *Helvella infula* Fr.], *Helvella acetabulum* (F), *Helvella crispa* (B, C, F), *Helvella adipose* (F), *Helvella elastica* (B), *Helvella lacunose* (F)] and *Verpa conica* (E) are reported to cause gastric upsets and considerd as poisonous species (IOH, Ok) containing the toxic chemicals like Gyromitrin and Helvellic acids. So, none of the *Helvella* and *Peziza* species are edible (Lcf, Ar, IOH, ER). It is suggested not to eat morels (or any species) in large quantities, in raw or with alchoholic drinks (Lcf), which may cause gastric up sets or vomitting.

In Basidiomycota

In Tremellales *Tremella foliacea* (Pers.) Fr. [- edible (E)], *Tremella fusiformis* Berk. [- edible (E)], *Tremella lutescens* (E), *Tremella mesenterica*Retz.: Fr.[- edible (E)] and *Tremiscus helvelloides* (E) are not known as edible (Lcf, IOH) species to Nepalese.

In The lephorales the species like *Sarcodon aspratus* (F) and *Sarcodon imbricatus* (F) are seldom gathered for edible purposes.

The gasteroid groups [*Astraeus hygrometricus* (E), *Geastrum fimbriatum* (E) and *Geastrum triplex* (F)] are also not known to be edible in Nepal.The species like *Bovista plumbea* (E), *Calvatia gigantea, Calvatia cyathiformis* (F), *Calvatia utriformis* (E), *Calvatia caelata* (B), *Vascellum pretense* (E) *Phallus impudicus* (E) and *Lycoperdon pusilum* (Bh, E) are not known to be edible. *Scleroderma polyrhizum* Pers. and *Scleroderma sinnameriense* Mont. (C) are

rarely found gathered by people for eating.

In Boletales besides very few species [*Boletinus cavipes* (S, B), *Boletus edulis* (F)] rest are [*Boletus aereus* (E), *Boletus luridiformis* (E), *Boletus luridus* (E), *Boletellus ananas*(F), *Boletellus emodensis* (E), *Phylloporus rhodaxanthus* (Bh, E), *Strobilomyces floccopus* (F), *Suillus bovines* (E), *Suillus granulates* (F), *Suillus grevillei* (E), *Suillus placidus* (E), *Suillus sibiricus* (C), *Suillus viscidus* (E), *Leccinum versipelle* and *Strobilomyces strobilaceus* (Scop.:Fr.) Berk. are not known to be edible species in Nepal. Excepting very few rest of the *Boletus*, *Tylopilus* and *Suillus* species cause gastric upsets (Ok). *Psilocybe* are hallucinogenic.

In Gomphaceae the species like *Clavariadelphus pistillaris* (F), *Clavariadelphus truncates* (F) and *Gomphus clavatus* (F) are rare and not recorded as edible by Nepalese.

In Agaricaceae *Echinoderma asparum* [= *Lepiota acutsquamosa*] (Bh), *Lepiota aspera* (E), *Lepista nuda* (F), *Macrolepiota procera* (Bh, F) and *Macrolepiota rhacodes* (E) are also not found gathered as they causes gastric upsets (Ok). None of the *Lepiota* species are recommended as edible (Lcf).

In Coprinaceae [*Coprinus atramentarius* (E), *Coprinus comatus* (E), *Coprinus disseminates* (E), *Coprinus micaceus* (F), *Psathyrella candolleana* (F) and *Psathyrella pululiformis* (E) are not yet found gathered for edible purposes. Not recommended to take with alchoholic drinks (Ok).

In Pluteaceae excepting some *Amanita* species listed above all others [*Amanita ceciliae* (F), *Amanita constricta* (E), *Amanita gemmata* (E), *Amanita inaurata* (F)] are not gathered for edible purposes. The traditional collectors think to be the poisonous species. Most of them causehallucinogenic effects, gastric upsets (Ok) and ultimately death if not taken proper care at time.

In Tricholomataceae mushrooms like *Cystoderma amianthinum* (E), *Hygrocybe coccinea* (E), *Hygrocybe conica* [-cause gastric upsets (Ok) (E)], *Hygrocybe psittacina* [-cause gastric upsets (Ok)(E)], *Hygrophorus camarophyllus* (E), *Hygrophorus eburneus* (E), *Hygrophorus niveus* (F), *Nyctalis agaricoides* (E), *Tricholoma caligatum* [- edible (IOH, Ar) (E)], *Tricholoma saponaceum* [- edible (IOH) (E)], *Tricholoma sulphureum* (F) and *Tricholoma terreum* (E) are till now not gathered as edible species.

In Russulaceae also most of the *Russula* and *Lactarius* species cause gastric upsets. The mycophilus casts have not been found togather *Lactarius corruguis* (B, F), *Lactarius deterrimus* (E), *Lactarius indigo* (F), *Lactarius rufus* – not recommended (ER) (E), *Lactarius subdulcis* (B), *Lactarius scrobiculatus* – not recommended (ER) (F), *Lactarius subdulcis* (E), *Lactarius torminosus* – not recommended (ER) (E), *Lactarius vellereus* – not recommended (ER) (E), *Lactarius volemus* (F), *Russula adusta* – (Bh, C) not recommended (ER) (E), *Russula aeruginea* – not recommended (ER) (F), *Russula albonigra* – not recommended (ER) (E), *Russula alutacea* (F), *Russula aurata* (E), *Russula brevipes* (F), *Russula consobrina* (E), *Russula emetica*– not recommended (ER) (E),*Russula foetens* – not recommended (ER) (F), *Russula fragilis* – not recommended (ER) (E), *Russula lepida* – not recommended (ER) (F), *Russula mariae* (F), *Russula nitida* – not recommended (ER) (E), *Russula ochroleuca* (E), *Russula olivacea* (F), *Russula praetervisa* [= *Russula pectinatoides*]– not recommended (ER) (E),*Russula rubra* – not recommended (ER) (E) and *Russula xerampelina* (F), for edible purposes. For example the species like *Russula adusta* (Pers.) Fr. [edible (Ph, FAO), not edible (ER)], *Russula aeruginea* Lind. [edible (Lcf, Ph), not recommended (ER) (F], *Russula densifolia* (Secr.) Gill. [not recommended as edible (IOH, ER, F), causes gastric upsets (Ok), (F)] and *Russula olivacea* (Schaeff.) Fr. [not recommended as edible (IOH, ER), edible (Ph), (F)] are controversially treated and not known as edible species in Nepal.

In Ramariaceae it seems that **Ramaria aurea*, ***R. flava* and **R. formosa* (Thakre chyau); [*Considered inedible (Imazeki *et al.*, 1988); **Some consider edible and others inedible (Dickinson & Lucas, 1979;

Lang & Hora, 1978; Phillips, 1981] are not well distinguished by local people as the mushrooms are more or less similar to one another in layman's eyes (Adhikari & Adhikari, 1966-67, Adhikari, 2000).

In Polyporaceae *Microporus affinis* (Blume & Nees) Kuntze [(A), inedible, edible (FAO)], *Microporus vernicipes* (Berk.) Kunt. (A), *Microporusxanthopus* (Fr.) Kuntze (A) and *Trametes versicolor* (A, E) though reported edible are not gathered as edible species in Nepal.

The species like *Pholiota adiposa* (A, E), *Pholiota nameko* (A, E), *Pholiota squarrosa* (A, E), *Neolentinus lepideus* (E), *Oudemansiella mucida*(E). *Paxillus atrotomentosus* (E), *Chlorophyllum molybdites* (E), *Dacrymyces palmatus* (E), *Hohenbuehelia petaloides* (E), *Agrocybe pediades* (E), *Kobayasia nipponica* (E), *Laccaria bicolor* (F) and *Lacrymaria velutina* (E) are not yet known to be gathered for edible purposes by Nepalese.

Discussion and conclusion

Though, there are some Myxomycetes, Ascomycetes and members of *Ustilago* listed by FAO, very few species are known either edible or not known to be edible species.

In Nepalese context, for example, the species of *Termitomyces, Scleroderma texens* and *Amanita chepangiana* found in the tropical *Shorea robusta* forest and *Amanita hemibapha* in subtropical pine forests are gathered in large quantities, used as food and sold in the markets.

Likewise Morels, in western development region are also gathered in large quantities. In the temperate region the species of *Hericium* and *Cantharellus* are gathered in small quantities and used as edible ones, while *Laetiporus sulphureus* and *Meripilus gianteus*are gathered in large quantities for food. Here, it is also interesting to note that the inedible species like*Stereum hirsutum* (Willd.) Gray, *Stereum ostrea*(Blume. & Nees.) Fr., *Stereum rugosum* Pers.: Fr., *Stereum striatum* (Fr.) Fr. *Stereum sanguinlentum* (Alb. & Schw.: Fr.) Fr.), *Stereum gausapatum* (Fr.: Fr.) Fr. and *Schizophyllum commune* Fr.: Fr. are found mixed together and sold in the markets of Kathmandu and Patan as an important ingredient or spices in curriesin the ceremonies of Newar ethnic cast (Adhikari & Adhikari, 2011). None of the *Stereum* species are edible (Lcf, Ar, IOH, ER).

Now a day the wild species are seldom found sold in Kathmandu markets (Asan, Indrachowk, Khichapokhari, Ranmukteswar) in their 'in season' as the cultivated species has taken its wide coverage. Very few collectors hunt for wild edible species, where ever possible. Most of the villagers have now started cultivating theexotic strains of species like: *Agaricus bisporus* (Lange) Imbach. (A) (400 – 600/- kg.-common), *Lentinula edodes* (Berk.) Pegler (A) (400 – 600/- kg.- common), *Lentinus sajor-caju* (Rumph.: Fr.) Fr. (120 – 300/- kg.- common), *Pleurotus ostreatus* (Jacq.: Fr.) Cumm.(120 – 300/- kg.- common), *Pleurotus florida*, *Pleurotus eryngii* (DC.:Fr.) Quel (200 – 300/- kg.- common) and *Volvariella volvacea* (Bull. : Fr.) Singer (400 – 600/- kg.- common). Recently *Coprinus comatus* (Mull.) Pers. is cultivated and sold (400/-kg.) in Lagankhel, Lalitpur. The wild Nepalese species like *Pholiota nameko* (Ito) Ito & Imai, *Flammulina velutipes* (Curt. : Fr.) Karst. and *Ganoderma lucidum* (Fr.) Karst.are under experimental cultivation.

So lastly it is recommended not to eat mushrooms until the species is well identified. The government is requested to moniter the wild mushrooms sold in the market. The organizations concerned are requested to make aware in time to time about the edibility, nutrition value of wild and cultivated species and toxicity, conduct seminar, symposium, mushroom fairs and publish books, booklets and brochures. Institutes are requested to carry on training programs for identification wild species. The educational institutes should inforce and include courses about the mycology up to higher lavel. The planners should be aware of making a definite policy to control, certify, utilize, cultivate and conserve the wild species.

Here it is very difficult to say that these wild mushrooms can immedietly uplift the socioeconomic status of poor rural Nepalese people until and unless the government can take a strong step towards the

development of mycology, technocommercial cultivation of indigenous species, maketing management of both wild and cultivated species,

Acknowledgement

The author is thankful to Prof. Dr. Guy Durreiu, UPS and Prof. J. P. Girolami, Toulouse, France, Dr. K. Watanabe, Senior volunteer, JICA, Ms. K. S. Adhikari and G. Adhikari for their kind help.

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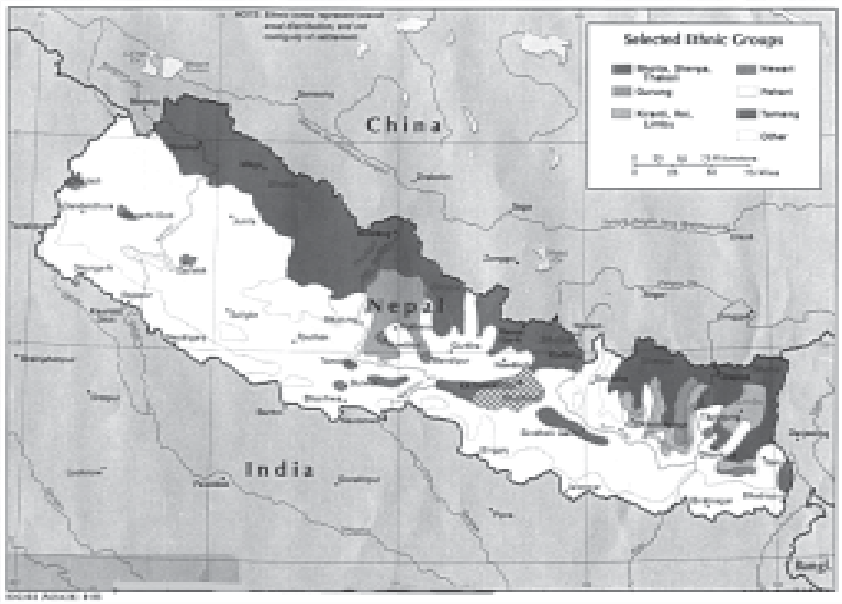

Map 1 - (Distribution map of some ethnic groups in Nepal)

Preliminary enumeration of Flora of Parsa Wildlife Reserve, Central Nepal

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Abstract

This paper aims to enumerate the vascular flora of the Parsa Wildlife Reserve, Central Nepal. Altogether 127 vascular plant species were collected from the study area belonging to 47 families and 103 genera. Out of 127 species reported from the study area, 50 species have medicinal uses, 25 species are fodder plants, eight species are fodder and medicinally important, seven species are used for fuel wood and four species as timber. One species was found endemic, one commercially threatened and one vulnerable. The study moreover reveals that the plant collection time (December) is most favorable for botanical exploration of leguminous plants and some other families like Asteraceae, Labiatae etc.

Key words: Parsa Wildlife Reserve, useful plants, vascular flora

Introduction

Nepal is situated between the latitudes 26^0 22' and 30^0 27' N and the longitudes $80^0$40' and 88^0 12' E. About 86 % of the total land area is covered by hills and high mountains, and the remaining 14 % are flat lands of Terai. The altitude ranges from 60 m (Kechana kolan, Jhapa) to 8848 m (Top of the world, Mt. Everest). The climate is broadly classified into cold Arctic/Nival (above 3000 m), cold temperate (2000-3000 m), warm temperate (1500-2000 m), subtropical (1000-1500m) and tropical (below 1000m). Nepal is divided into 7 physiographical regions which occur in the following order from south to north: Terai, Siwaliks, Mahabharat lekh, Midhills, Himalayas, Inner Himalayas and The Tibetan Marginal Mountain Range (Hagen, 1998).

The Department of National Parks and Wildlife Conservation (DNPWC) is a government organization committed to the conservation, management, and regulation of the protected areas and biodiversity in Nepal. It has a network of protected areas that include 10 national parks, 3 wildlife reserves, 6 conservation areas, 1 hunting reserve, and 12 buffer zone areas. These protected areas cover 34,185.62 sq. km (23.23%) of the total geographical area of the country (Majupuria 1998).

Parsa Wildlife Reserve was established in 1984, located in the Inner Terai lowlands of south-central Nepal. It covers an area of 499 km^2 in Parsa district, Makwanpur, Bara and Chitwan Districts and is the largest wildlife reserve in the country (Majupuria 1998) . In altitude, it ranges from 435 m Terai to 950 m asl in the Siwalik Hills. The typical vegetation of the park is tropical and subtropical forest types with *Shorea robusta* (Sal) forest constituting about 90% of the vegetation. *Pinus roxburghii* (Chirpine) grows in the Churia Hills. *Acacia catechu* (Khair), *Dalbergia sissoo* (Sissoo) and *Bombax ceiba* (Silk cotton) trees occur along riverside. *Eulalia bipinnata* (Sabai grass) grows well on the southern face of the Churia hills. An estimated 919 species of flora have been recorded including 298 vascular plants, 234 dicots, 58 monocots, five pteridophytes and one Gymnosperm in the Parsa Wildlife Reserve (Majupuria 1998). A total of 720 species of vascular plants including Pteridophytes, Gymnosperms and Angiosperms have been recorded from wetlands and their adjoining ecosystems of Terai (Siwakoti 2006). There is less known information on flora of this area. Thus, this study aims to enumerate the vascular flora of this area.

Materials and methods

The study sites Aadhabhar, Bhata Post and Amlekhgang Hattisar were selected randomly. Within a site, a circled sampling was carried out in the centre and within the periphery of 1 km making five different patches (Fig 2). Field survey was carried out during December 2013 for the collection of plant specimens from the study sites.

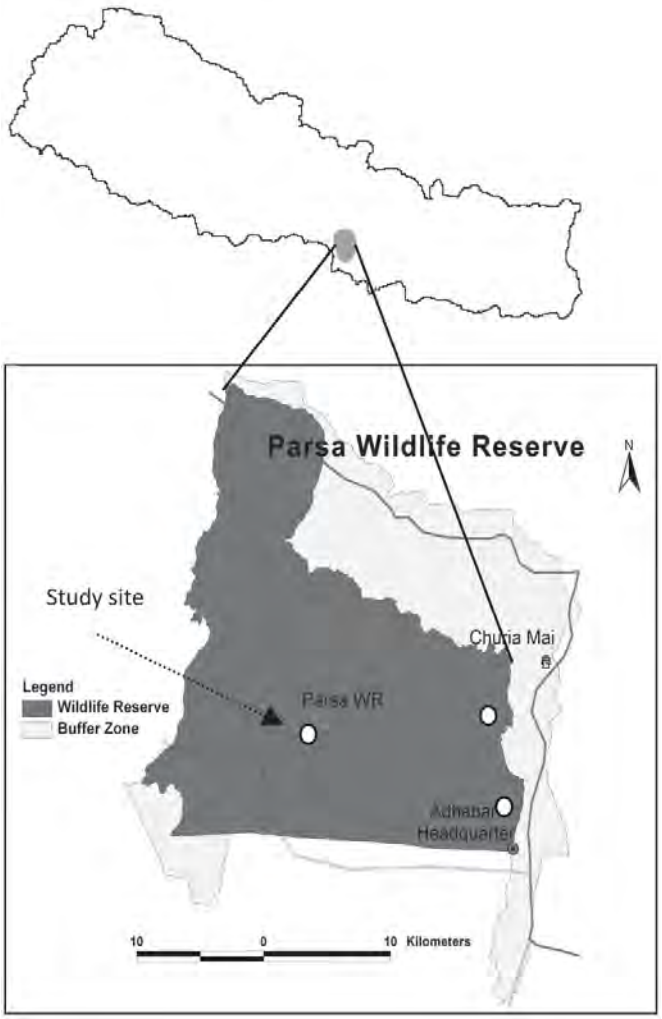

Fig 1: Map of Parsa Wildlife Reserve. (Source:www.nepaltravelandtour.com/ www.himalayanfootsteps.com)

The collected plants were identified at National Herbarium and Plant Laboratories (NHPL, KATH), Godawari, Lalitpur All collected samples are under the process of deposition at 'KATH' Herbarium. The nomenclature were followed by Thapa (2002) for Pteridophytes and Press *et. al,* (2000) for Angiosperms. The medicinal uses of plants were collected from local communities during field visit and from different literatures Manandhar (2002); Baral and Kurmi, (2006); DPR (2007).

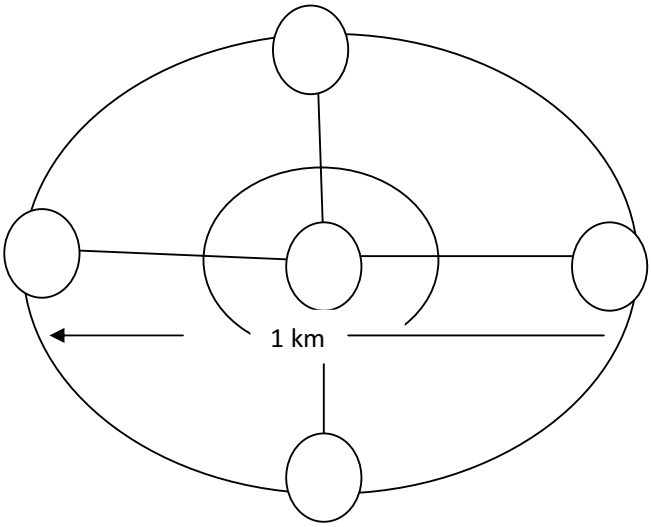

Fig 2: Sampling method (design) at the study area.

Results and Discussion

Altogether 127 vascular plant species were reported from the study area belonging to 47 families and 103 genera (Appendix I). Among them, 111 species i.e 87.40% are angiosperms (101 Dicots and 10 monocots), and 16 i.e 12.60% of Pteridophytes. While comparing family wise distribution of angiosperms (Table 1), Leguminosae was found dominant with 18.90% followed by Asteraceae 11.2% and Poaceae 4.72%. The other common families were Acanthaceae (3.93%), Labiatae (3.93%), Euphorbiaceae, Rhamnaceae and Malvaceae 3.14% in each. Among Pteridophytes, Pteridaceae represented the largest family with 4.72% followed by Dryopteridaceae with 2.3%. The list of species with their family, local name, locality and uses is provided in (Appendix I). Out of 127 species reported from the study area, 52 species are of medicinal importance, 25 species are fodder plants, eight species have multiple uses, seven species were found to be used for fuel wood and four species as timber (Appendix I). Endemic *Hypericum cordifolium,* Commercilally Threatened *Acacia catechu* and Vulnerable *Dalbergia latifolia* were also found on the study area. One of the

important findings of this research is the addition of number of vascular plants in the previous list. While comparing with Nepal Bio- diversity Resource book (Bhuju *et .al* 2007), seventy six vascular plants (53 dicots, 8 monocots and 15 fern species are added in the list of flora of Parsa Wildlife Reserve. This study also reveals that the area has huge potential for medicinally important plants (Appendix I).

Table 1: Larger ten families reported from the study area.

S.N.	Family	Total Number of species	Percentage (%)
1	Leguminosae	24	18.90
2	Asteraceae	14	11.02
3	Poaceae	6	4.72
4	Pteridaceae	6	4.72
5	Acanthaceae	5	3.93
6	Labiatae	5	3.93
7	Euphorbiaceae	4	3.14
8	Malvaceae	4	3.14
9	Rhamnaceae	4	3.14
10	Dryopteridaceae	3	2.3

Conclusion

From this study it can be concluded that the Terai (Parsa Wildilife Reserve) region is rich but less botanized area because in this study we have focused only for flowering and fruiting species on this particular season. But further emphasis should be given to explore the whole area extensively at different seasons. Besides the inventory of the tropical seasonal plants, this study also reveals that the study time (December) is most favorable for Leguminous plants and some other families like Asteraceae, Labiatae and so on. Additionally, this gives appropriate ideas for botanical exploration in Terai region and family based plant collection. Many plant species were left unrecorded hence further study to document more floristic list is needes.

Acknowledgement

The authors are thankful to Mr. Yam Bahadur Thapa, Director General and Ms. Sushma Upadhya, Deputy Director General, Deputy Director General, Thapathali, Kathmandu for their encouragement and support. We are also obliged to Dr. Keshab Raj Rajbhandari, Mr. Dhan Raj Kandel and Mr. Rajendra Acharya for their remarkable help during identification of plants. Thanks are also to Department of National Park and Wildlife Conservation (DNPWC) and all staff of NHPL and Parsa wildlife Reserve, Aadhabhar, Bara for necessary help.

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Appendix I: Plants collected from Parsa Wildlife Reserve.

S.N.	Coll. Number	Scientific Name	Family	Common Name	Uses	Locality/altitude
1	1312110	*Andrographis paniculata* (Burm. f.) Wall. ex Nees	Acanthaceae	Kalamnath Kalamedh Green Chiretta	M	Near Hattisar, Amlekhganj/ 430 m
2	131224	*Asystasia macrocrapa* Nees in Wall.	Acanthaceae			Bhata Post, PWR/ 550 m
3	131225	*Barleria cristata* L.	Acanthaceae	Bhede Kuro	M	Bhata Post, Parsa wildlife Reserve
4	131216	*Barleria strigosa* Willd.	Acanthaceae		M	Bhata Post, PWR
5	131295	*Thunbergia grandiflora* Roxb.	Acanthaceae	Kagchuche		Churia Hills,
6	131209	*Achyranthes aspera* Linn.	Amaranthaceae	Apamarga Dattiwan	M	Bhata Post, PWR
7	1312103	*Achyranthes bidentata* Blume	Amaranthaceae	Rato apamarga		Near Hattisar, Amlekhganj
8	131280	*Calotropis gigantia (*L.) Dryand	Asclepiadiaceae	Aank	M	Near Hattisar, Amlekhganj
9	131263	*Holarhena pubescens* (Buch.-Ham.) Wall. ex G. Don	Apocynaceae	Indrajau Kurchee	M	Near Aadhavar, PWR
10	1312107	*Asparagus racemosus* Willd.	Liliaceae	Kurilo Satawari	M	Mahadev post, Parsa
11	1312104	*Acmella calva* (DC.) R.K. Jansen	Asteraceae	Marathi	M	Bhata Post, PWR
12	131203	*Ageratum conyzoides* L.	Asteraceae	Gandhe Jhar	M	Bhata Post , PWR
13	131257	*Anaphalis adnata* Wall. ex DC.	Asteraceae	Bukiphool	M	Near Churia hill /600 m
14	131214	*Bidens pilosa L.*	Asteraceae	Kalo Kuro		Bhata Post, PWR
15	131202	*Chromolaena odoratum* (L.) R. King & H. Robinson	Asteraceae	Banmara		Bhata Post, PWR
16	131244	*Eclipta alba* (L.) Hassk.	Asteraceae	Bhrigaraaj	M	Amlekhgang, Hattisar
17	131299	*Elephantopus scaber* L.	Asteraceae	Buteejhaar Gomukhee	M	Amlekhgang, Hattisar
18	131259	*Emilia sonchifolia* (L.) DC.	Asteraceae	Hirankhuri		Bhata Post, PWR
19	131223	*Innula cappa* (Buch.-Ham. ex D. Don) DC.	Asteraceae	Kanpate		Bhata Post, PWR
20	1312122	*Inula sp.*	Asteraceae			Bhata post, PWR
21	1312123	*Inula sp.*	Asteraceae			Bhata post, PWR, 550 m
22	1312124	*Mikania micrantha* Kunth	Asteraceae	Lahare Banmara		Bhata Post, PWR
23	1312125	*Vernonia squarrosa* (D. Don) Less.	Asteraceae	Phule jhar	M	Bhatta post
24	131233	*Vernonia cinerea* (L.) Less.	Asteraceae	Marcha jhar	M	Bhatta post
25	131290	*Garuga pinnata* Roxb.	Burseraceae	Dabdabe	F/Fu	Near Hattisar, Amlekhgang
26	131271	*Cannabis sativa* L.	Cannabaceae	Ganja	M	Churia, along roadside
27	1312109	*Cerastium glomeratum* Thuill.	Caryophyllaceae			Near Hattisar, Amlekhganj
28	131277	*Celastrus paniculatus* Willd.	Celastraceae	Jyotismati		Near Churia Temple
29	131275	*Terminalia bellerica* (Gaertn.) Roxb.	Combretaceae	Barro	M/F	Near Aadhavar,PWR
30	131291	*Terminalia chebula* Retz.	Combretaceae	Harro	M/F	Near Aadhavar,PWR
31	131296	*Porana grandiflora* Wall.	Convolvulaceae	Chamero laharo		Bhatta post, PWR
32	1312114	*Rivea ornata* (Roxb.)	Convolvulaceae			Churia hills

		Choisy				
33	131286	*Coccinea grandis* (L.) Voigt	Cucurbitaceae	Golkakri	M	Bhatta post, PWR
34	131264	*Cucumis melo* L.	Cucurbitaceae	Ban Kaankri	M	Base of Churia hill
35	131245	*Dillenia pentagyna* Roxb.	Dilleniaceae	Tatari	F	Near Aadhavar,PWR
36	131289	*Bridelia retusa* (L.) Spreng.	Euphorbiaceae	Gayo	F	Near Churia Temple
37	131287	*Bridelia stipularis* (L.)	Euphorbiaceae	Lahare gayo	F	Near Kamini Daha
38	131262	*Mallotus philippensis* (Lam.) Muell. - Arg.	Euphorbiaceae	Rihini, sindure	F/M	Bhata Post, PWR
39	131272	*Ricinus communis* L.	Euphorbiaceae	Adel, Andir	F	Near Churia Temple
40	131238	*Flacourtia indica* (Burm.f.) Merr. Brutelle	Flacourtiaceae	Kandel		Bhata Post, PWR
41	131254	*Swertia nervosa* (G. Don) C. B. Clarke	Gentianaceae	Chiriata	M	Near Churia Hill
42	1312117	**Hypericum cordifolium* Choisy in Dc.	Hypericaceae	Khareto	M	Churia , Makwanpur
43	1312116	*Curculigo orchioides* Gaertn.	Hypoxidaceae	Kalo musli	M	PWR, Near Mahadevsthan
44	1312121	*Anisomeles indica* (L.) Kuntze	Labiatae	Rato charpate	M	Between Aadhabhar and Mahadevsthan
45	131298	*Plectranthus barbatus* Andrews	Labiatae			Near Churia Hill
46	131248	*Colebrookea oppositifolia* Sm.	Labiatae	Dhusure	M	Between Aadhabhar and Mahadevsthan
47	131240	*Craniotome sp. Versicolor Rechens*	Labiatae	Silaya Jhar, Bose jhar	M	Bhata Post, PWR
48	131234	*Leucas lanata* Benth. in Wall.	Labiatae	Dronapuspi	M	Bhata Post, PWR
49	131270	*Careya arborea* Roxb.	Lecythidaceae	Kumbhi	F	Bhata Post, PWR
50	131207	*Leea asiatica* (L.)C.E. Ridsdale	Leeaceae			Bhata Post, PWR
51	131205	*Lablab purpureus* (L.) Sweet (cultivated)	Leguminosae	Raaj Simi	C	Bhata post Near forest
52	131237	*Acacia catechu* (L.f.) Willd.	Leguminosae	Khayar	T	Bhata Post, PWR
53	131242	*Bauhinia purpurea* L.	Leguminosae	Tanki	F	Bhata Post, PWR
54	131276	*Bauhinia vahlii* Wight & Arn.	Leguminosae	Bhorlo	F	Aadhabhar, PWR
55	131226	*Bauhinia variegata* L.	Leguminosae	Koiralo	F	Bhatta post, Parsa Wildlife Reserve
56	1312102	*Butea minor* Buch.-Ham. ex Baker	Leguminosae	Palans	M	Churia VDC, Makwanpur
57	131292	*Caesalpinia decapetala* (Roth) Alston	Leguminosae	Ulte kanda		Near Stream, Kamini Daha
58	131249	*Senna tora* L.	Leguminosae	Tapre	M	Bhata Post, PWR
59	131211	*Crotalaria albida* Heyne ex Roth	Leguminosae	Putaliphool,Bhendiphool		Bhata Post, PWR
60	131283	*Crotalaria humifusa* Grah.ex.Benth.	Leguminosae			Near Churia Temple
61	131241	*Crotalaria spectabilis* Roth	Leguminosae	Chhinchhine Bis		Bhata Post, PWR
62	131228	*Dalbergia sissoo* Roxb.	Leguminosae	Sissoo	T/Fu	Bhata Post, PWR
63	131282	*Dalbergia latifolia* Roxb.	Leguminosae	Satisal	T/M/Fu	Amlekhgang, Hattisar
64	131273	*Desmodium microphyllum* (Thunb.)DC.	Leguminosae	Bakhre Ghans	F	Near Amlekhgang
65	131227	*Desmodium multiflorum* DC.	Leguminosae		F	Bhata Post, PWR

66	131243	*Desmodium oojeinense* (Roxb.) Ohashi	Leguminosae	Sadhan	F/Fu	Bhata Post, PWR
67	131284	*Desmodium triangulare* (Retz.) Merr.	Leguminosae			Near Kamini Daha, PWR
68	131231	*Dolichos sp.*	Leguminosae			Bhata Post, PWR
69	131212	*Flemingia macrophylla* (Willd.) Merr.	Leguminosae	Bhatwasi		Bhata Post, PWR
70	131288	*Millettia auriculata* Baker ex Brandis	Leguminosae		F	Aadhabhar, PWR
71	131208	*Mimosa pudica* L.	Leguminosae	Lajjawati		Bhata Post, PWR
72	131267	*Senna occidentalis* (L.)	Leguminosae	Panwaar, Kasaudi	M	Churia hill, along roadside
73	131279	*Spatholobus parviflorus* (Roxb.) Kuntze	Leguminosae	Debre lahara	F	Near Kamini Daha,
74	131230	*Vigna sp.*	Leguminosae		M	Bhata Post, PWR
75	1312113	*Reinwardtia cicanoba* (Buch. – Ham. ex D. Don) Hara	Linaceae	Pyaauli		Near Churia Temple
76	1312118	*Reinwardtia indica* Dumort.	Linaceae	Pyaauli		Bhata Post, PWR
77	131222	*Lagestromia parviflora* Roxb.	Lythraceae	Budho dhairo	Fu	Bhata Post, PWR
78	131204	*Sida cordata* (Burm. f.) Borss. Waalk.	Malvaceae	Balu	M	Bhata Post, PWR
79	1312112	*Sida spinosa* Linn.	Malvaceae	Balu, Gulsakaaree	M	Bhata Post, PWR
80	131285	*Thespesia lampas* (Cav.) Dalz. & Gib.	Malvaceae	Ban Kapas		Aadhabhar, PWR
81	131201	*Urena lobata* L.	Malvaceae	Balujhar		Bhata Post, Parsa wildlife Reserve
82	1312115	*Ficus semicordata* Buch.-Ham.	Moraceae	Khanyu	F	Churia hills, small tree
83	131266	*Ficus sp.*	Moraceae			Bhata post, PWR
84	131250	*Maesa chisia* Buch.-Ham. ex D.Don	Myrsinaceae	Bilaune	F	Churia VDC, Near Churia Temple
85	131251	*Maesa macrophylla* (Wall.) A.DC.	Myrsinaceae	Paha, Phagata		Churia VDC, Near Churia Temple
86	131268	*Myrsine semiserrata* Wall.	Myrsinaceae	Kalikath	F	Churia VDC, Near Churia Temple
87	1312105	*Boerhavia diffusa* L.	Nyctaginaceae	Punarnawa	M	Bhata Post, PWR
88	131221	*Nycanthes arbor-tristris* Linn.	Nyctaginaceae	Parijat	M	Bhata Post, PWR
89	131294	*Pluambago zeylanica* L.	Plumbaginaceae	Chitu	M	Aadhabhar, PWR
90	131236	*Apluda mutica* L.	Poaceae	Dhalkejhar, Dhalke khar		Bhata Post, PWR
91	131260	*Capillipedium assimile* (Steudel) A.	Poaceae			Bhatta Post, PWR
92	131218	*Neyrandia reynaudiana* (Kunth) Keng. ex. A. S. Hitche	Poaceae			Bhata Post, PWR
93	131260	*Oplismenus composites* (L.) Beauvois	Poaceae			Bhatta Post, PWR
94	131218	*Phragmites australis* (Cav.) Trin. ex. Steudel	Poaceae			Bhatta Post, PWR
95	131217	*Cyrtococcum accrescens* (Trin.) Stapf	Poaceae			Bhata Post, PWR
96	131220	*Persicaria pubescens* (Blume) Hara	Polygonaceae	Lato pire,		Bhata Post, PWR
97	131219	*Persicaria posumbu* (Buch.- Ham.ex D.Don)	Polygonaceae	seto pire	M	Bhata Post, PWR
98	131265	*Clematis buchananiana*	Ranunculaceae	Junge Lahara		Near Churia Hill

		DC.				
99	1312101	*Zizyphus nummularia* (Burm.f.) wight & Arn	Rhamnaceae	Bayer	F/M	Mahadevsthan, PWR
100	1312120	*Zizyphus mauritiana* Lam.	Rhamnaceae	Hade Bayer	F/M	Bhata Post, PWR
101	131239	*Zizyphus incurva* Roxb.	Rhamnaceae	Bayer	F/M	Bhata Post, PWR
102	1312119	*Zizyphus oenoplia* (L.) Mill.	Rhamnaceae	Aule Bayer	F/M	Bhata Post, PWR
103	131278	*Haldina cordifolia* (Wild. ex. Roxb.) Benth. & Hook.f.ex. Brandis	Rubiaceae	Karma	T/Fu	Aadhabhar PWR
104	131215	*Tamilandia uliginosa* (Retz.) Tirv. & Sastre	Rubiaceae	Pidar	Fu	Bhata Post, PWR
105	131247	*Lindenbergia grandiflora* (Buch.- Ham. ex. D.Don)	Scrophulariaceae	Bhediphool		Along the trail, Near Kamini Daha
106	131235	*Scoparia dulcis* Linn.	Scrophulariaceae	Mitha jhar		Bhata Post, PWR
107	131269	*Smilax ovalifolia* Roxb.	Smilacaceae	Kukurdaino	M	Amlekhganj, Hattisar
108	131206	*Corchorus acutangulus* Lam.	Tilliaceae			Bhata Post, PWR
109	131210	*Boehmeria rotundifolia* D.Don.	Urticaceae		F	Amlekhganj, Hattisar
110	1312100	*Vitex nigundo* L.	Verbenaceae	Simali	F/M	Nera Hattisar, Amlekhganj
111	131261	*Hedychium spicatum* Smith	Zingiberaceae	Pankhaphool	M	Hattisar, in moist forest

Pteridophytes

112	1312131	*Dryopteris cochleata* (Ham.ex D.Don)	Dryopteridaceae	Danthe Niuro	M	Bhatta post
113	131232	*Polystichum lentum* (D.Don)T. Moore	Dryopteridaceae			Bhata Post, PWR
114	1312132	*Tectaria coadunata* (Wall.ex.J.Sm.) C. Chr.	Dryopteridaceae	Kalo Unyu	M	Aadhabhar, PWR
115	131229	*Sphenomeris chinensis* (L.) Maxon	Lindsaeaceae			Between Amlekhgang and Churiya
116	131253	*Cheilanthes bicolor* (Robx. In Griff.) Griff. ex Fras.-jenk	Pteridaceae	Ranisinki	M	Bhata Post, PWR
117	1312111	*Colysis elliptica* (Thunb.) Ching	Polypodiaceae			Mahadevsthan, PWR
118	131213	*Lygopodium flexuosum* (L.) Sw.	Lycopodiaceae		M	Bhata Post, PWR
119	131255	*Onychium siliculosum* (Desv.) C.Chr.	Pteridaceae	Seto sinki	M	Churia VDC, on forest margin
120	131274	*Pityrogramma calomelanos* (L.)	Pteridaceae			Mahadevsthan, PWR, 435 m
121	1312130	*Pteridium revolutum* (Bl.) Nakai,	Pteridaceae		M	Churia VDC, on forest margin
122	1312129	*Pteris biaurita* L.	Pteridaceae	Hade Unyu	M	On sal forest, Bhatta post PWR
123	1312128	*Pteris vittata* L.	Pteridaceae			Churia VDC, on forest margin
124	1312108	*Selaginella bryopteris* (L.) Bak.	Selaginellaceae			Near Hattisar, Amlekhganj
125	131297	*Thelypteris jaculosa* (Christ) Panighari	Thelypteridaceae			Amlekhganj, Hattisar
126	131252	*Athyrium pectinatum* (Wall.ex.Mett.)T. Moore	Woodsiaceae			Near mahadevsthan
127	131256	*Diplazium esculentum (Retz.)Sw.*	Woodsiaceae			Between Amlekhganj and Churia

(For abbreviation: M= Medicinal, T= Timber, F= Fodder, Fu= Fuel wood, C= Cereal, endemic is denoted by*)

Violaceae in Nepal

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Abstract

Viola L. is the only genus under the family Violaceae found in Nepal and the species under this genus are studied and reported in this paper. In total 18 species have been recorded and among them Viola biflora, V. canescens, V. thomsonii and V. wallichiana are found distributed in all the three botanical provinces (i.e. west, central and east) of Nepal while others (V. betonicifolia, V. bulbosa, V. diffusa, V. glaucescens, V. hamiltoniana, V. hookeri, V. kunawarensis, V. mandshurica, V. odorata, V. paravaginata, V. pilosa, V. pogonantha, V. sikkimensis, and V. tricolor) have sparse to restricted distribution in their preferential habitats. A key to the species for authentic identification have been worked out. Full description of the species with ecological information also has been provided.

Key words: Violaceae, Viola, Nepal

Introduction

Violaceae Batsch

Violaceae is a medium sized family of dicotyledons (sub-class Magnoliopsida, order Malpighiales), comprising 24 genera and 700 species (Mabberley, 2007), distributed worldwide, and more confined in the temperate regions. The number of genera may be as many as 29 and 900 respectively (Takhtajan, 1980, 1987). The members of the family Violaceae are either annual or perennial herbs, climbers are poorly represented, some are shrubs, or rarely small trees. The flowers of viola remarkably show great variation of color from primitive white and yellow to light red, purple or blue. The seeds of viola are generally dispersed by squeezing mechanism, as a characteristic of the family. The family has great commercial value in floriculture. There are several species of the family, which are generally grown in the gardens of temperate regions of the world. Many of its genera have medicinal value.

The authentic literature for the record of Violaceae in Nepal are Koba *et al.* (1994) and Press *et al.* (2000) which listed 14 species of Viola as previously mentioned by Hara *et al.* (1979). Along with the study of herbarium specimens housed in National Herbarium (KATH) and Tribhuban University Central Herbarium (TUCH) (Dani and Shrestha 2004, Banarjee and Pramanik, 1983) 18 species of *Viola* L. has been reported in the present study from Nepal.

General characters of Violaceae

Herbs, shrubs or undershrubs, small trees, rarely lianas. Leaves alternate, rarely opposite, simple, entire or toothed, rarely lobed; stipules minute or leafy. Flowers bisexual or unisexual, rarely plant polygamous or dioecious, hypogynous or slightly perigynous, medianly zygomorphic or actinomorphic, solitary or in axillary or in terminal racemes, spikes or panicles, often bracteolate. Sepals 5, free or slightly connate, persistent, imbricate, often ciliate. Petals 5, free, or shortly connate, generally sessile, imbricate, unequal, the lowermost often gibbous or spurred and larger than others and differentially shaped. Stamens 5, mostly hypogynous; filaments free or connate, alternate with petals, closely connivent around pistil; anthers 2-loculed, basifixed or adnate, introrse, one of them often spurred, dehiscence by longitudinal slits, connective produced apically; 2 abaxial anthers sometimes spurred. Ovary superior, sessile, subglobose, unilocular with generally 3-5 carpels, placentae parietal with1-2 or numerous ovules on each; ovules bitegmic, crassinucellar, anatropous; style simple, mostly sigmoid or thickened above; stigma various, usually truncate lobed, beaked or

simple. Fruit usually a loculicidal 3-valved capsule, or a berry or nut. Seeds numerous, smooth or rough, rarely tomentose, often arillate, sometimes winged in woody lianas; embryo straight; cotyledons thin, wider than radicle; endosperm moderate or copious, rarely scanty, fleshy.

Cosmopolitan, tropical and temperate regions; ca 22 genera and ca 900 species, 1 genus and 18 species in Nepal.

Viola L.

Herbs, annual or perennial, often suffruticose, rarely shrubby; rhizomes present or absent; stem mostly present**.** Leaves alternate, entire to pinnatisect, ovate-triangular or reniform, cordate, serrate or crenate; petioles sometimes winged; stipules persistent, free or adnate to petiole, lanceolate-ovate, entire, dentate or fimbriate. Flowers irregular, 1-2 on long axillary bibracteolate, non-articulate peduncles, often dimorphic with normal and cleistogamous flowers. Sepals persistent. Petals erect or spreading, flat unequal; lateral ones larger than others; lowermost spurred. Anthers 2 loculed, sub-sessile, connivent around ovary, each tipped with a small triangular appendage; connectives of lower 2 often produced into spurs within the spur of corolla. Ovary sessile; style much-variable, straight or curved, often geniculate at base, filiform to clavate; stigma variable, truncate or obtuse, lobed or triangular, straight or beaked. Fruit 3-valved loculicidal capsule; seeds rounded-ovoid, shiny.

Cosmopolitan, distributed chiefly in the temperate regions throughout the world; ca 500 species, 18 species in Nepal, distributed mostly in the northern temperate and alpine areas; a few confined to the lower hills.

Key to the species

1a. Stipules more or less adnate to petiole, generally winged petioles 2
1b. Stipules free from petioles, generally wingless petioles 6
2a. Leaves not cordate or scarcely cordate at base, obtuse, apex acute to accuminate stipules adnate more than half of the petiole 3
2b. Leaves deeply to shallowly cordate base, apex reniform to abruptly acute, and stipule adnate at base only 5
3a. Leaves ovate-oblong to orbicular, cuneate to attenuate base margin entire, ovate to apex obtuse ..... *V. kunawarensis*
3b. Leaves triangular, cuneate to scarcely cordate base, margin crenate to serrate, and apex acute to obtuse 4
4a. Leaves linear lanceolate to triangular-hastate or irregular ovate, shallowly cordate base, glabrous or sparsely pubescent, much widely divergent basal lobes ..... *V. betonicifolia*
4b. Leaves linear-lanceolate to triangular lanceolate, cuneate to scarcely cordate base, completely glabrous crenate to serrate margin, apex acute to obtuse, not much widely divergent basal lobes .... *V. mandshurica*
5a. Leaves with abruptly acute apex, deep cordate base, rhizome thin, rather stout, flower rose red to purple ..... *V. paravaginata*
5b. Leaves obtuse to reniform, shallowly cordate base, rhizome thick, rather soft, flower usually white ..... *V. bulbosa*
6a. Stipules at least the upper parts pinnatified or palmatified, style globose at apex. Lateral petals directed towards the top of the flower. *V. tricolor*
6b. Stipules entire to fimbriate. style not as above, lateral petals spreading horizontally 7
7a. Stigma not beaked, leaves reniform to rotundate, style conspicuously two lobed 8
7b. Stigma beaked, leaves not as above, style not lobed 9
8a. Spur 2mm long, round, sepals lanceolate, oblong or acute ..... *V. biflora*
8b. Spur 5-6x1mm long, acute, sepals subulate, acute ..... *V. wallichiana*
9a. Stipules entire or with few short teeth, stigma with two lateral patent lobes 10
9b. Stipules fimbriate or with long teeth, stigma without lateral patent lobes 11

10a. Leaves cordate - reniform, petioles not or scarcely winged ..... *V. hamiltoniana*
10b. Leaves elliptic ovate to oblanceolate, petioles conspicously winged ..... *V. diffusa*
11a. Leaves ovate to oblong-ovate, deep cordate base 12
11b. Leaves ovate orbicular, base weekly cordate (basal lobes nearer) 15
12a. Style clavate or subclavate distally or filiform. 13
12b. Style clavate distally, usually hooked or decurved ..... *V. odorata*
13a. Leaves-ovate, reniform, cordate, apex obtuse to acute, thickish, canescent pilose, petioles retrosely pubescent, capsule hairy, stipules long fimbriate ..... *V. canescens*
13b. Leaves- cordate , broad lanceolate to triangular lanceolate, apex acuminate to prolonged acuminate, thin, white pilose or glabrous, petioles pubescent or glabrous, Capsules glabrous or pubescent, stipules shortly fimbriate 14
14a. Spur ca 3mm long, leaves apex acute to acuminate, deeply cordate at base ..... *V. pilosa*
14b. Spur 2-3 mm long, leaves apex prolonged acuminate, shallowly or widely cordate at base ..... *V. pogonantha*
15a. Bracteoles below the middle peduncles .... *V. glaucescens*
15b. Bracteoles more or less in the middle of the peduncle 16
16a. Spur 2-3mm long, stigma marginate ..... *V. thomsonii*
16b. Spur 1-3 mm long, stigma not marginate ... 17
17a. Lamina silvery white beneath, veins raised below, spur 3-4 mm long ..... *V. sikkimensis*
17b. Lamina not silvery white beneath, veins not raised below, spur 1-3 mm long ..... *V. hookeri*

Viola betonicifolia Sm.

Herbs perennial, 7-8 cm high. Root slender, unbranched. Stem absent. Leaves in rosette, variable, linear lanceolate to triangular-hastate or irregular-ovate, cuneate, truncate or widely shallowly cordate at base, usually decurrent_petiole, shallowly and distinctly crenate, sometimes dentate on basal lobes or rarely serrate, acute or sometimes roundish obtuse at apex, 1.5-4.5 x 1.5-3cm, glabrous; petioles usually longer than lamina, 1.5-13 cm long, winged above, glabrous; stipules ovate-lanceolate, acuminate, 2-15mm long, ca 1mm wide, short fimbriate, adnate to petiole, up to middle point . Peduncles equaling or shorter than leaves, 4.5 – 10cm long, glabrous. Flowers 2cm across, white to purple or light blue with darker veins; bracteoles opposite, lanceolate, acute, entire. Sepals ovate lanceolate to oblong lanceolate, acute or acuminate, 4.8mm long, 1-2.5 mm wide, glabrous or ciliate, green with scarious margins. Petals oblong ovate, up to 15mm, lateral ones usually bearded at base; spur cylindrical, straight or slightly upcurved, 2-6mm long. Style almost geniculate at base, clavate above, up to 3mm long. Capsule ellipsoid to oblong, up to 9mm long, glabrous.

key to sub species

1a. Lamina linear lanceolate to triangular or ovate, not cordate; flower smaller, about 1.5 cm across, spur short, 2.4 mm, straight. - ssp. **betonicifolia**

1b. Lamina oblong to ovate to broadly lanceolate, sometimes shallowly cordate at base; flower larger, about 2 cm across, spur longer, 4-6 mm, slightly upcurved. - ssp. **jaunsariensis**

Viola betonicifolia ssp. **betonicifolia** Sm in Bot. Jahr. 54 Beib. 120 (1917); D. M. Moore in Fedde. Repert. **68**:81 (1963); Banarjee in J. Nat. Hist. Soc. **81**:522 (1964); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. **2**:47 (1979); Banarjee & Pramanik in Fl. Ind. **12**: 15 (1983); Grierson in Grierson & Long, Fl. Bhutan 2(1):223 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola patrini var. *nepalensis* DC., Prod. **1**: 293 (1824); Wall.

Cat. 39 n. 1445 (1829).

Viola caespitosa D. Don., Prodr. Fl. Nep. 205 (1825).

Viola patrini auct. non. DC., Hook f. & Thomson, Fl. Br. Ind. **1**:183 (1872); Banarjee in J. Nat. Hist. Soc. **51**:552 (1953);

Viola betonicifolia ssp. *nepalensis* (DC) W. Becker in Beih. Jahrb. 54 (Beibl. 120) 166 (1917); H. Hara

in Hara & Williams, Enum. Fl. Pl. Nep. **2**:47 (1979).

Leaves linear lanceolate to deltoid ovate or triangular, 3.5-7.5 x 1.5-2 cm. margin distally crenate, often basal lobes more distally crenate, sub cordate to truncate at base, apex obtuse, glabrous on both side; petioles 2-7.5 cm long, winged above, glabrous or sparsely pubescent. Peduncles 9-18 cm long, exceeding the leaves; bibracteolate, usually below the middle. Flower 1-1.2 cm across, white, light blue or purple, or violet. Sepal lanceolate, 4.6 mm long. petal oblong, obovate, up to 1 cm long, lateral bearded, upper beardless; spur 2-3 mm long, cylindrical, round.

Distribution: Afghanistan to Bhutan, Burma, China (Taiwan), Australia, Japan, Malaysia, Nepal, Sri-Lanka.

Ecology: On shady place; amongst stones, road sides, dry areas of higher mountains; between 1500-3100m.

Flowering: Apr. -June. Fruiting: Mar. - July - Aug.

SPECIMEN EXAMINED:

West Nepal: Sumduwa, Dolpa, 2960m, 11.06.1987, N.K. Bhattarai & M. N. Subedi, 87/66 (KATH); Wangri, 3100m, 13.06.1980, P. R. Shakya & B. Roy, 5641 (KATH).

Central Nepal: Kali Gandaki Valley, Dhaulagiri, Mustang (Dhampus, 2450-Tukuche, 2590m), 29.08.1988, M. Suzuki, T. Maeda, N. Naruhashi, R. Watanabe, M.N. Subedi, M. Minaki, S. Noshiro and H. Ikeda, 88815190 (KATH); RBG, Godavari, 1515m, 12.04.2003,N. Joshi, 503 (KATH); Godavari, 5500', 3.12.2022 B.S. (= 16.03.1968), P. Pradhan, 4252 (KATH)

Viola betonicifolia Sm. ssp. **Jaunsariensis** (W. Becker) Hara in J. Jap. Bot. **49**:133 (1974); Banarjee & Pramanik in Fl. Ind. **12**: 15 (1983); Banarjee in J. Nat. Hist. Soc. 8**1**:524 (1984); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. **2**:47(1979); Press *et al*., Ann. Check. Fl. Pl. Nep. 326(2000).

Viola patrinii var. *suaveolens* G. Watt. in J. Linn. S. B. **18**:379 (1881).

Viola prionantha Bunge ssp. *jaunsariensis* W. Becker in B. Jahrb. 54 (Behibl. 120) : 181 (1979).

Leaves ovate- oblong to broadly lanceolate, hirsute, truncate, 2-4.5 x 1-2 cm, base sub cordate to cordate, margin crenate to serrate, apex obtuse to acute; petioles 3-8 (1-2cm) cm long, winged above; stipules oblong, 9-10 mm long (free part) 1-1.5cm long, membranous, apex acuminate, shortly dentate, glabrous or slightly pubescent. flowers 2cm across, violet, sepals 4.6mm long Peduncles 9-13 cm long, bibracteolate or at slightly below middle. Petal oblong, obovate, 1.5 cm long, lateral bearded inside; spur 4-6 mm long spur 5-6mm long, cylindrical, round slightly up curved.

Key to varieties:

1a. Leaves linear, lanceolate, triangular, cuneate at base, petiole winged above, spurs 4-6 mm long, straight, cylindrical -var. **jaunsariensis**

1b. Leaves oval, shallowly cordate at base, distinctly winged, spur 4-5 mm long, distally up curved - var. **cordifolia**

Viola betonicifolia Sm. ssp. **jaunsariensis** (W. Becker) Hara var. **cordifolia** H. Hara in J. Jap. Bot. **49**:133 (1974); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. **2**:47 (1979); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Perennial herb up to 10cm tall. Rhizome short ca 1cm. Leaves variable, shallowly cordate at base, margin dentate or slightly serrate, roundish obtuse at apex, 1.5-3.5 x 0.8-2.5cm, glabrous, petioles up to 6cm long, stipules shorter, anterior 4 mm free, pubescent. Peduncles almost equaling to the leaves, up to 7 cm long. Flowers purplish pink or white, 1.5cm across. Sepals 5 mm long, 2 mm broad, apex obtuse or sub acute; appendage shorter 1 mm long, round. Petal 1.2 cm long; spur 4-5 mm long, distally up curved, round.

Distribution: Nepal

Ecology: Marginal lands of agricultural field between 930m-2120m (=3070'-7000')

Flowering: Apr.- May **Fruiting**: June-Aug.

SPECIMEN EXAMINED:

Central Nepal: Gorkha, Jaubari, 930m, 11.05.1987, N. P. Manadhar and L. P. Kattel, 11619 (KATH); Nagarjun, Kathmandu, 45-7000', 2024.01.13 B.S. (= 26.04.1968), P. Pradhan and S. Gurung, 8544 (KATH).

Viola betonicifolia Sm. ssp. **Jaunsariensis** (W. Becker) Hara var. **Jaunsariensis** H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. **2**:47 (1979); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Leaves linear, lanceolate, triangular, cuneate at base, petiole longer 3-8 cm, winged above, stipules longer, anterior free 8 mm, glabrous or pubescent. Flower 1.5-2 cm across, peduncles 9-13 cm long. Sepals 9 mm long, 2mm broad, apex acute; appendage longer 2mm long, round. Petal 1.5 cm long; spurs 4-6 mm long, straight, cylindrical, round.

-var. **jaunsariensis**

Distribution: Nepal

Ecology: 2700m

Flowering: April **Fruiting**: May- June

SPECIMEN EXAMINED:

West Nepal: Suli Gad (29˚02'N, 82˚55'E), Dolpa, 2700m, 27.04.1974, J. F. Dobremez & N. P. Manandhar, 2802 (JFD), 74/431 (NPM) (KATH).

Viola biflora L., Sp. Pl. 936(1753); Hook. F. Thomson, Fl. Br. Ind. 1:182 (1872) p.p.; H. Hara, Fl. East. Him. 212 (1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nepal 2: 47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Grierson in Grierson & Long, Fl. Bhutan 2(1):223 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola manaslensis F. Maekawa, in Kihara, Fauna and Fl. Nep. Him. 181 (1955); Banarjee in Rec. Bot. Surv. India 19(2):24 (1966).

Herbs annual or perennial, glabrous or pubescent, up to 35 cm high. Stem slender, erect or decumbent; rhizome horizontal or oblique, more or less stout. Leaves reniform to broadly ovate, cordate at base, crenate or slightly crenate along margins, 1-3.5 x 1.2-4.5cm, glabrous or hirsute along margins and nerves above, 5-7 nerved, petioles glabrous, slender, up to 11 cm long, stipules ovate acute, up to 5 mm long, entire, sometimes leafy. Peduncles slender up to 8 cm long, exceeding leaves, bibracteolate above the middle, bracteoles opposite or sub-opposite, membranous. Flowers solitary, up to 1.5 cm across, yellow with 5-7 brownish purple to dark violet stripes in lower petals. Sepals 4-6 x 0.5-12mm, lanceolate, apex acute, tri-nerved. Petal 6-7 x 3-4mm, yellow, obovate to oblong; basal longer, apex round, strongly purple streaked; lateral and upper usually beardless and sharply reflexed; spur 1-2mm long, round or obtuse, equaling or slightly exceeding calcyline appendage. Style 1.2-1.7mm long, clavate distally, geniculate at base; stigma bilamellate, lobes spreading, bilobed at top with no stigmatic beak. Capsule ovoid or ellipsoid, 5-6mm long, glabrous, apiculate. Seed ovoid, ca 2mm long, smooth.

Distribution: Afghanistan to Bhutan, North-East Asia, Russia, Temperate Europe, N. America.

Ecology: Wide range of habitats- shady moist place, mossy stones, rock crevices, forests of oak, birch, fir; amongst herbs like *Sedum*, *Juncus*, *Artemisia*, etc; more common on W facing cliff; between 2200-4500m.

Flowering: June-Sep. **Fruiting**: July –Oct.

Uses: Root used as emetic; flower as emollient pectoral, antiseptic and diaphoretic; leaves as emollient and laxative (Chopra et al. 1956).

SPECIMEN EXAMINED:

West Nepal: Mugu, 8.07.1980, P.R. Shakya & B. Boy, 5553 (KATH); Chimang Lekh, Humla, 3385m, 13.04.2021 B. S. (=28.07.1964), T. B. Shrestha & M. S. Bista, 2152 (KATH); Maure pass, Jumla, 3200mk, 28.06.1987, N. K. Bhattarai & M. N. Subedi, 87/224 (KATH); Jangla Bhanjyang, 3800m, 14.06.1973, Polunin, Sykes and Williams, 619 (KATH); Rara, 2900 m, 10.08.1981, N. P. Manandhar & D.P. Joshi, 7000 (KATH); Chankheli lekh, Mugu, 3250 m,13.08.1985, P. R. Shakya, M. N. Subedi and R. K. Uprety 8605 (KATH); Mugu, 3400 m, 8.06 1980, P. R. Shakya & B. Roy, 5553 (KATH); Bajhang-Ghodilekh, 4000 m, 17.08.1972, M. S. Bista & D. P. Joshi 539 (KATH); Chankheli Lagana, 3350 m, 25.07.1979, K. R. Rajbhandari & B. Roy, 3830 (KATH); Surma Sarowar Lekh, 3800 m, 9.07.1981, P. R. Shakya, L. R. Sharma and K.R. Amatya 6365 (KATH); Pandal, Dolpa,4100 m, 8.07.1980, P. R. Shakya & B. Roy, 6097 (KATH); Chaudhabisekhola, 3550 m, 18.06.1980, P. R. Shakya & B. Roy, 5791 (KATH); Nilgatti-Nayaodar, Bajhang, 3460 m, 27.07.1984, P. R. Shakya, M. K. Adhikari and M. N. Subedi 8252 (KATH); Marghor Lekh, Humla, 31.07.1979, K. R. Rajbhandari & B.

Roy, 4199 (KATH); Khaptad Lekh,2400m, 1.07.1981, P. R. Shakya, L. R. Sharma and K. R. Amatya 6238 (KATH); Deula Deuli, Jumla, 3510m, 20.02.1996, M. Minaki, K. K. Joshi, Y. Kadota, H. Sugita, A. Takahashi, S. Tsuda, H. Yagi and C. Yonebayashi, 9107013 (KATH); Chankheli Lagana, 3450m, 25.07.1979, K. R. Rajbhandari & B. Roy, 3896 (KATH); Bhabsen-Mabu Pass, Dailekh, 2600m, 6.07.1979, K. R. Rajbhandari & B. Roy, 2945 (KATH); Rikula-Chuyadhara, 2850m, 7.08.1976, H. Tabata, K. R. Rajbhandari and K. Tsuchiya, 1030 (KATH); Suiren, 3900m, 9.05.1974, J. F. Dobremez & N. P. Manandhar, 2929 (KATH).

Central Nepal: Parbati Kunda-Yure Kharka, Rasuwa, 3200 m, 25.07.1994, F. Miyamoto, K. R. Rajbhandari, S. Akiyama, M. Amano, H. Ikeda and H. Tsukaya 9440021 (KATH); Banthanti-Ghodepani, 2650- 3170m, 12.07.1983, H. Ohba, H. Kanai, M. Wakabayasi, M. Suzuki and S. Akiyama, 8330386 (KATH); Parbati Kunda-Yure Kharka, Rasuwa, 3000 m, 25.07.1994, F. Miyamoto, K. R. Rajbhandari , S. Akiyama, M. Amano, H. Ikeda and H. Tsukaya 9400027 (KATH); Rasuwa, Lipchet Kharka 2580 m. Makgan Kharka 2750m-Guinsi Kharka 2200 m, 16.08.1994, F. Miyamoto, K. R. Rajbhandari, S. Akiyama, M. Amano, H. Ikeda and H. Tsukaya 94220291 (KATH); Khare Khola-Patale Pokhari 4000 m- a pass 4200 m-Phedi kharka 2100 m, H. Ohba, M. Wakabayasi, M. Suzuki and S. Akiyama, 83332068 (KATH); Thorung Phedi, Mustang, 4050 m, 15.07.2000, M. N. Subedi, 00400117 (KATH); Shivapuri, Kathmandu, 2400m, 14.06.2000, R. S. Dani (TUCH); Langtang valley, 13000', 25.06.65, Schilling, Sayers and Bista, 410(KATH); Charikot-Kalinchok, Dolakha, 8500', 16.09.1994, Banarjee, Shrestha and Upadhyaya, 2771 (KATH); Chandanbari, Rasuwa, 9500', 13.06.1969, Dr. Saman & Mr. Bista 13091(KATH); Domje Chauki, Rasuwa, 2840 m, 20.07.1983, M. N. Subedi, 29E (KATH); Lamche Danda, 3100 m, 25.06.1970, J. F. Dobremez, 251 (KATH); Dolkha, 2950 m, 19.06.1994, I. Sharma, M. N. Subedi and P. P. Kurmi, 7/94 (KATH); Chimang Lekh, 11000', 13.04.2021 B.S. (= 28.07.1964),T.B. Shrestha & M. S. Bista, 2152 (KATH); Laurivinayak, Rasuwa, 12500', 27.07.1968, S. B. Malla, 9236 (KATH); Helambu, Sindhupalchok, 12000', 5.08.1972, Collector ? H.9 (KATH); Samar, Mustang, 3800 m, 29.07.1974, D. P. Joshi & T. K. Bhattacharya, 74/2106 (KATH); Kangrang La, 12000', 17.06.1969, Collector ?, 15750 (KATH); Helambu, Sindhupalchok, 2987 m, John & Naomi Bishop 1.06.1972, WF 3 (KATH); Muktinath, Mustang, 11000', 11.04.2021 B.S. (= 26.07.1964),T. B. Shrestha & M. S. Bista, 1493 (KATH); Phe, Manang, 4500 m, D. P. Joshi & T. K. Bhattacharya, 74/2337 (KATH); Langtang, Rasuwa, 12500', 27.07.1967, S. B. Malla, 9236 (KATH).

East Nepal: Jor Sale, Solukhumbu ($27^0$47'21"N, $86^0$43'06"E), 2900m, 12.09.2006, M.F.Watson, K. R. Rajbhandari, K. K. Shrestha, D. Knott, C. A. Pendry, S. K. Acharya, U. Koirala, L. N. Mandar, N. MaCheyne, R. C. Paudel, S. Rajbhandari and S. Vaidya, DNEP 3-BX 30 (KATH); Kendju, Solukhumbu, 3600 m, 2.06.2004, N. Joshi & C. H. Young NJ833 (KATH); Reu Kharka – Gurensadanda, Makalu barun National Park, 3050 m, 18.06.1994, P. R. Shakya & K. K. Dongol, 10180 (KATH); Ghunsa-Rampuk Kharka, Taplejung, 3300-3660 m, 7.06.1992, S. Noshiro, S. Akiyama and N. Acharya, 9240639 (KATH); Kalapaththar, Solukhumbu, 2800m, 19.08.2051 B. S. (= 5.12. 1994), Baba Shrestha 2(TUCH); Phedung Danda-gairi Kharka,, Panchthar, 3720-3270 m, 20.061992, S. Noshiro, S. Akiyama and N. Acharya, 9240938 (KATH); Chairam-Dorongden, Taplejung, 3720-2890 m, 11.06.1992, S. Noshiro, S. Akiyama and N. Acharya, 9240721 (KATH); Ghongma-Thulopokhari, Sankhuwasabha, 3650m, 7.09.1986, T. B. Shrestha & P. R. Shakya, 8989 (KATH); Gidde-Jaljale, 11500', 12.07.1971, T. B. Shrestha & D. P. Joshi, 238 (KATH); Tinjure, Sankhuwasabha ?, 9000', 17.07.1971, T. B. Shrestha & D. P. Joshi , 107 (KATH).

Vila bulbosa Maxim. in Bull. Acad. sci. St-Pet. 23; 334 (1877); H. Hara, Fl. E. Him. 3:83 (1975); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:47 (1979); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola tuberifera Franch in Bull. S.B. Fr. 33:410 (1886); H. Hara, Fl. E. Him. 2:82 (1971).

Viola bulbosa ssp. *tuberifera* (Franch.) W. Becker in Beih B. Centralbl. 34(2): 418 (1917); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993).

Herbs, perennial. Rhizome erect to ascending; rootstock with globose scaly bulb, minute rooting from the bulb, estoloniferous. Stem 4-5 cm long erect, glabrous. Leaves 1.5-2 x 2-4 cm, usually wider than length, thicker, ovate, margin crenate to dentate, glabrous or sparsely pubescent on both surfaces, apex obtuse to rounded, base cordate to shallowly cordate; petioles2-5 cm long, long winged, glabrous; stipules 6-7 x 1.5 cm, membranous lanceolate, slightly adnate at the base, apex acuminate, margin dentate. Peduncles 5-9 cm long, equals or exceeding petioles; bracteole linear, 3-4 mm long, oppositely inserted at the middle. Flower 0.6-1 cm across, pale yellow to almost white, no distinct veins on lower petals. Sepals lanceolate, 4-6 x 1-3 mm, entire, glabrous, apex acuminate, appendages 2 mm long, apex acute, slightly curved. Petal 7-8 mm long; lower petal streaked with purple veins, glabrous within; spur reduced, 1-2 mm long, apex rounded. Style 2 mm long, geniculate at base, clavate distally; stigma not lobed, minutely beaked. Capsules 4 mm in diameter, sub-globose.

Distribution: Bhutan, China, India, Nepal

Ecology: 2800-3600m

Flowering: May-June **Fruiting**: June-Aug.

SPECIMEN EXAMINED:

West Nepal: Near Chaudhabisekhola, Jumla, 9300', 12.05.1952, O. Polunin, W. R. Sykes and L. H. J. Williams, 2023(KATH);

East Nepal: Ghunsa (3500m)- Rampuk kharka (3660m)- Ghunsa (3500m), Taplejung, 7.06.1992, S. Noshiro, S. Akiyama and N. Acharya, 9240609(KATH).

Viola canescens Wall. In Roxb, Fl. Ind. 2:450 (1824); Burkill in Rec. B. Surv. Ind. 4:98 (1910); Banarjee in Rec. B. Surv. Ind. 19(2): 24 (1966); H. Hara, Fl.E. Him. 3:83 (1975); H. Hara in Hara &Williams, Enum. Fl. Pl. Nep. 2:47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Press *et. al.* Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola serpens Wall. var. *canescens* (Wall.) Hook. f. & Thomson, Fl. Br. Ind. 1:184 (1872) p.p. excl.syn..

Viola serpens Wall in Roxb., Fl. Ind. 2:449 (1824) (excl. var. *glabra* and *confusa*)

Viola wightiana Wall. Cat. 4021.

Viola royleana Wall. Cat. 1778.

Viola griffithiana Boiss., Fl. Orient 1:456 (1867)

Herbs, prostrate, pubescent or sub-glabrous. Stem absent or producing runners instead of leafy stems. Roots long, cylindrical. Leaves ovate-cordate to sub-reniform, obtuse to acute, serrate-crenate, 1-5.5 x 1-4.5cm, 5 nerved beneath, tinged with purple; petioles 1.4-10cm long, pubescent; stipules free, lanceolate, deeply fimbriate, up to 1cm long, reddish at base. Peduncle 3-4.5cm long, exceeding or equaling the leaves, pilose or pubescent; bracteoles linear, 5-8mm long, oppositely inserted at middle or below. Flowers ca 1.3cm across, pale violet, pinkish, pale purple to almost white or light blue, streaked with fewer veins. Sepals linear up to 5mm long, reddish green, apex acute; appendages ca 2mm long, margin entire, apex acute. Petal ovate- oblong, 8-10 x 2-3.5mm, bearded inside; upper two cuneate; lateral two rather narrower, apex obtuse; lower oblong, shorter than rest, little bearded inside, dark purple veined; spur 3mm long, apex obtuse. Ovary villous. Style 2mm long, slightly geniculate at base, clavate distally; stigma truncate, slightly oblique. Capsule 4mm long, sub-globose, pubescent, many seeded.

Distribution: China, India, Nepal

Ecology: Crevices of rock, shady and open place, eroded soil, under cedar and oak forest, etc.; between 790-3300m.

Flowering: January-July **Fruiting**: Apr-Aug

SPECIMEN EXAMINED:

West Nepal: Lipna, Dadeldhura, 1080m; 13.04.1981, L. P. Kattel & K. J. Malla, 255 (KATH); Kirmadi, Dadeldhura, 1600m; 27.12.1980, L. P. Kattel , 155 (KATH); Nagma, Tila village, Jumla,7000',17.04.1952, Polunin, Sykes & Williams, 3909 (KATH); Lohari, Dailekh, 780m, 27.02. 1991, N. P. Manandhar, 503/91 (KATH); Gaivari, Dailekh, 900m, 25.02. 1991, N. P. Manandhar, 381/91 (KATH); Ghanteswar,

Dadeldhura, 2680m, 3.05, 1971, P. R. Shakya & D.P. Joshi, 452 (KATH); Kaigaon, Dolpa, 10,000', 4.06.1966, T. B. Shrestha, 5079 (KATH); Chutrabeshi, Arghakhanchi, 880m, 4.03.1976, N. P. Manandhar & P. M. Regmi, 158 (KATH); Harnok, Dang, 1300m, 7.03.1976, N. P. Manandhar & P. M. Regmi, 249 (KATH); Suli Gad, Dolpa, 2900m, 28.04.1974, J. F. Dobremez & N. P. Manandhar, 2813 (JFD), 74/422 (NPM)(KATH); Basari Khola, Palpa,1680m, 1.03.1976, N. P. Manandhar & P. M. Regmi, 55 (KATH).

Central : Dhunche, Rasuwa, 1950m, 7.11.2000, Y. P. Khatiwada, 25 (TUCH); Godavari, 5500', 3.12.2022 B.S. (=16.03.1966), P.Pradhan, 4252 (KATH); Chitlang (S/W of Kathmandu), Makwanpur, 1800m, 11.01.1975, Joshi, Rajbhandari & Ghimire, 75-271 (KATH); Mandanda, Palpa, 1400m, 4.03.1974, D. P. Joshi & M. M. Amatya, 74/1421(KATH); Larjung, Mustang, 2550m, 25.07.1974, D. P. Joshi & T. K. Bhattacharya, 74/ 2035 (KATH); Tistung, Makwanpur, 6000', 16.01.2020 B.S. (=29.04.1964), Dr. Suwal & Shrestha, 989 (KATH); Muktinath, Mustang, 11000', 11.04.2021 B.S. (=26.07.1964), T. B. Shrestha & M. S. Bista, 1493 (KATH); Pharping-Champi, Kathmandu, 5100-5600', 17.03.1973, M. M. Amatya & T. K. Bhattacharya, 73/92 (KATH); Nagarjun, 4500-7000', 22.03.1968, P. Pradhan & S. Gurung, 8545 (KATH); Dhunche-Deurali, Rasuwa, 2350m, 28.04.2001, M. Ghimire, V. Manandhar and L. Joshi , 20022 (KATH); RBG, Godavari, Lalitpur, 1500m, 17.12.2061 B.S. (=30.03.2005), B. D. Neupane, 1 (KATH); Kakani, Kathmandu, 1676m, 11.05.1976, V. L. Gurung, R. Kayastha and P. M. Regmi, 44 (KATH); Mangtewa VDC, Tamle (Locality to be confirmed), 1500m, 2052.07.14 B.S. (= 31.10.1995), M. S. Rai, B.M., 185 (KATH); Sanga Bhanjyang, Bhaktapur, 1570m, 9.03.1975, D. P. Joshi & K. R. Rajbhandari, 75/360 (KATH); Around Lokpa, Gorkha , 1880m, 25.07.1994, M. Suzuki, N. Acharya, N. Fujii, L. Joshi, T. Kajita, N. Kondo, M. Mikage, S. Noshiro and K. Yoda, 9470194 (KATH); Godavari, Lalitpur, 5500', 3.12.2022 B.S. (= 16.03.1966), P. Pradhan, 4252 (KATH); Phulchoki, Lalitpur, 1700m, 2.11.2049 B. S. (=13.02.1993), Prabhat s.n. (TUCH); Dhunche, Rasuwa, 1950m, 7.11.2000, Y. P. Khatiwada, 25 (TUCH); Dhunche, Rasuwa, 1950m, 7.11.2000, R. Tripathee, 247 (TUCH); Deurali, Rasuwa, 2500m, 5.11.2000, L. Karki 3 (TUCH); Dhungekharka, Kabhre, 2200m, 12.11.2000m, G. P. Bhattarai, 70 (TUCH).

East Nepal: Lukla, Solukhumbu, 9000', 24.04.1997, Govinda, s.n. (TUCH).

Viola diffusa Ging ex. DC., Prodr. 1: 298 (1824); Hook. f. & Thomson, Fl. Br. India 1:183 (1872); H. Hara, Fl. E. Him. 212 (1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Grierson in Grierson & Long, Fl. Bhutan 2(1):224 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola tenuis Benth. In Hook. Lond. J. B. 1:482 (1842).

Annual or perennial. Stolon up to 10cm long, protruding dense rosette of leaves and flowers and procumbent rooting stems, rhizome vertical, fibrillose. Leaves sub-orbicular, elliptic ovate to oblanceolate, obtuse at the apex, crenate serrate to serrate, 1-3 x 1-2.5cm, decurrent, hirsute; petioles 1-4cm long; stipules free, lanceolate, acute, dentate to fimbriate, 6-10mm long, ca 1.5mm wide. Peduncles 1-4cm long, bibracteate at the middle, long winged, usually exceeding the leaves, pubescent; bracteole small and weak,4-5mm long, oppositely inserted at the middle, margin usually ciliated. Flowers 1cm across, pale purple to nearly white. Sepal linear lanceolate,3-4 x 1mm, apex acuminate slightly pubescent, margin fimbrio-ciliate; appendage reduced, 2-5mm long, apex round, margin usually ciliate. Petal ob-ovate oblong, 4-7 x 2-3mm; basal shortest, apex acute, not bearded; lateral longest, apex obtuse or round, bearded inside or rarely glabrous; spurs 0.5-1mm long, apex obtuse. Style 1.1mm long, geniculate at base, clavate distally; stigma bilobed, with stigmatic beak anteriorly. Capsule globose, 4-6 mm long, glabrous. Seeds ovoid, less than 1mm broad, smooth.

Distribution: Bhutan, Burma, China, India, Japan, Malaysia, Philippines, Nepal, New Guinea

Ecology: 925-2000m.

Flowering: June-August **Fruiting**: Oct.-November

SPECIMEN EXAMINED:

East Nepal: Near Chyangthapu-Birwa, Panchthar, 27.11.1963, H. Kanai, G. Murata and M. Togashi, 6304532 (KATH).

Viola glaucescens Oudem. In Miq. Ann. Mus. Bot. Lugd.-Bat. 3:74. 1867. H.Hara, Fl.E. Him. 212 (1966); H. Hara in Hara &Williams, Enum. Fl. Pl. Nep. 2:47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Rootstock articulated, stolons up to 25cm long. Leaves hairy with short bristles, orbicular-cordate, acute to sub-acuminate, 1.2-4 x 1.6-3.8cm, basal sinus moderately wide, margin broadly and evenly crenate, glabrous or sparsely hispid above, petioles up to 6cm long, stipules ovate oblong, lacerate or fimbriate, up to 1.3cm long. Peduncles up to 9cm long, glabrous, equaling or shorter than leaves; bracteoles linear, short, up to 5mm long, inserted oppositely below or at the middle point. Flowers 1.2cm across, purplish white or rose purple. Sepals lanceolate, 4-6 x 1-1.5mm, margin distinctly ciliate, glabrous, apex acute; appendage 1.5-2 x 1mm, apex acute. Petals orbicular-obovate, 1cm long, lateral bearded within; spur 3-4 x 1mm, saccate, exceeding calycine appendage. Style geniculate at base, clavate distally; stigma terminal, beaked. Capsules oblong, apiculate, ca 1cm long. Seeds globose, light brown.

Distribution: Bhutan, India, Malaysia, Nepal

Ecology: Herb on moist shady place, 1500-3300m

Flowering: March-July **Fruiting**: June-Oct.

SPECIMEN EXAMINED:

Central Nepal: Tharupati Pass, Sindhupalchok, 3300m, 24.05.1993, N.P.Manandhar, 140-93 (KATH); Lele Bhanjyang, lalitpur, 1500m, 25.04.1963, H. Kanai & M. S. Bista, 11064 (KATH).

East Nepal: Murhay (Mude)-Sinduwa-Chitre-Bilbatebhajyang 24.10.1963, H.Hara, H.Kanai, S.Kurosawa, G. Murata, M Togashi and T. Tuyama, 6306623 (KATH); Chyangthapu, Birwa, 12.10.1963, H. Hara *et al*. 6306623 (KATH).

Viola hamiltoniana D. Don., Prodr. Fl. Nep. 206 (Feb. 1825); H. Hara, Fl. E. Him. 212 (1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Grierson in Grierson & Long, Fl. Bhutan 2(1):228 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola arcuta Blume, Bijdr. 58 (June-Dec. 1825); Jacob & Moorein Fl. Males 7: 205(1971); Hashimoto in Acta. Phyt. Geobot. 25: 109(1973).

Viola repens Wall. Cat. 39n.1441(1829) nom. Nud.

Viola notoniana Wall. Cat. 39n. 1449(1829) nom. Nud.

Viola distans Wall. [Cat. 142, n. 4022(1831] nom. Nud.] in Trans. Med. Phys. S. Calc 7:727 (1835); Hook. f. &Thomson, Fl. Br. Ind. 1:183(1872) p.p.; Banarjee in Bombay Nat. Hist. S. 51:552 (1953); et Rec. Bot. Surv. Ind. 19(2): 24 (1953).

Viola serpens var. *hamiltoniana* (D. Don). Hook. f. &Thomson ex Boissieu in Bull. S. B. Fr. 57: 259 (1910).

Herbs perennial. Stems or stolons trailing up to 3.5cm long, slender, procumbent or ascending, rooting at lower nodes. Leaves ovate to reniform – cordate, usually as broad as long with broad basal sinus, obtuse or rather acute at apex, crenate-serrate, 1.7-3.5 x 1.5-3.2cm, glabrous or hirsute; petioles curved upwards, 1.5cm long, glabrous; stipules lanceolate, acute, subentire to fimbriate, 5-10 x 1-3mm, glabrous, white to purple. Peduncles 1.5-7cm, fimbriate, bibracteolate above middle. Flowers 1cm across, white to light violet, purplish pink to bluish pink. Sepals broad lanceolate,3-5 x 1-2mm, acute, entire, glabrous or sparsely pubescent, appendages 1-2mm long, apex acute, entire or slightly dentate. Petals oblong to oblanceolate; lateral bearded, ca 10mm long; lower shortest, emerginate at apex; spur 2-3mm long, equaling or slightly exceeding calycine appendage, cylindrical, obtuse. Styles 1.2-1.4mm long, geniculate at base, clavate distally; stigma with two lateral lobes with conspicuous anterior stigmatic beak. Capsules oblong, up to 9mm long, usually glabrous. Seeds 1.2-1.5mm long, ovoid, with inconspicuous elaiosome.

Distribution: China, India, Nepal

Ecology: Shady and marshy place, stream bank, 1450-1600m

Flowering: Feb. -May **Fruiting**: May-June

SPECIMEN EXAMINED:

Central Nepal: Education Garden, Royal Botanical Garden, Godavari , Lalitpur, 1515m, 12.04.2003, N. Joshi, 504 (KATH); Godavari , Lalitpur, 5300', i.d. 1974 No, Indira, Murari and Madhavi, 74-11(KATH); Jiri-Shivalaya, Ramechhap, 1800m, 2.02.1996, M. Suzuki, N. Kurosaki and S. K. Wu, 8571656 (KATH); Thulo Seem, District?, 5000', 15.05.1968, Miss Manandhar & Party, 10508 (KATH); Godavari, Lalitpur, 1600m, 6.11.1978, G. Amatya s.n. (TUCH); Phulchoki, lalitpur, 1600m, 20.11.2000, M. Bhattarai, P19 (TUCH); Hattiban, Lalitpur, 1450m, 11.12.2055 B. S. (= 25.03.1998), Sunita s. n. (TUCH).

Viola hookeri Thomson ex Hook. f. & Thomson, Fl. Br. Ind. 1:183 (1872) p.p.; H. Hara, Fl. East. Him. 213(1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nepal 2: 47 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Grierson in Grierson & Long, Fl.Bhutan 2(1):226 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Herbs perennial, glabrous or young parts pilose. Rootstock warted, stems or stolons short, stems multibracteate. Leaves broadly obovate, rounded at apex, rarely subacute, broadly crenate, 1.5-4 x 1.5-3cm, basal sinus deep, lobes touching or overlapping, glabrous; petioles up to 4.5cm long, toothed or lacerate, glandular at tip. Stipules lanceolate, accuminate, toothed or lacerate, glandular at top, Peduncles up to 7cm long, equaling or exceeding the leaves, bibracteate, more or less in the middle, 5-7mm long, entire , glabrous. Flowers 1cm across, white with purple veins. Sepals lanceolate, 4-5mm long, apex rounded, glabrous. Petals up to 10mm long; spurs 1-3mm long, apex obtuse. Style 2.5mm long, slightly geniculate at base, sub-clavate or narrowed downwards from the obscurely beak stigma. Capsules 5mm long, oblong, valve apiculate, glandular.

Distribution: Bhutan, India, Nepal

Ecology: Herb along the trail; between 1800-3600m.

Flowering: May-Oct. **Fruiting:** June-Nov.

SPECIMEN EXAMINED:

East Nepal: Thakma Khola-Banduke,Taplejung, 14.11.1963, H. Hara, S. Kurosawa and T. Tuyama, 6306628 (KATH); Thakma Khola-Banduke-Yamphudin, Taplejung, 17.11.1963, H. Kanai, G. Murata and M. Togashi, 06306627 (KATH); Tamku, Sankhuwasabha, 1800m, 2052.06.05 B.S. (=21.09.1995), M. S. Rai, B. M., 20 (KATH); Sewaden-Mewa Khola bridge-Topke Gola, Taplejung, 2490-2830-3590m, 15.05.1992, M. Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9240124 (KATH); Upper Salaim Khola ($27^0$44' N, $87^0$18' E), Sankhuwasabha, 2770m, 12.10.1991, D. G. Long, R. J. D. McBeath , D. R. McKeen, D. A. H. Rae and N. K. Bhattarai, 719 (KATH).

Viola kunawarensis Royle, Ill. B. Him. 75 t 18. F. 3 (1834); Hook. f. & Thomson, Fl.Br. India 1:185 (1872); H. Hara in Hara &Williams, Enum. Fl. Pl. Nep. 2:48 (1979); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); Grierson in Grierson & Long, Fl. Bhutan 2(1):224 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Herbs perennial, up to 7cm high, acaulescent, glabrous. Rootstock slender, branched, stolon absent. Leaves tufted, ovate-oblong to orbicular, subentire, cuneate, attenuate at base sometimes, 1-1.5 x 0.3-0.5cm, glabrous; petioles 1-2cm long; stipules 2.3mm long, adnate to a part above the middle, lanceolate, acuminate, shortly glandulose, fimbriate, membranaceous. Peduncles up to 4cm long, sparsely pubescent, bracteoles linear, 2-3mm long, oppositely inserted in the middle. Flowers 1cm across, purple or violet. Sepals ovate lanceolate, up to 4mm long, apex obtuse or subacute, margin entire, glabrous; appendage very short, 0.5-1mm long. Petals obovate to oblanceolate, up to 8mm long, purple with dark veins, yellow at base; lateral ones usually bearded; the basal shortest, apex emerginate or truncate; spurs up to 3mm, saccate, apex rounded. Style 1-2mm long, geniculate at base, shortly incurved, clavate distally; stigma bilobed, sub-horizontal, prominent anterior stigmatic beak. Capsules up to 5mm in diameter, ovoid to globose, sparsely pubescent. Seeds 2mm long, ellipsoid.

Distribution: China, India, Nepal, Turkistan

Ecology: 3800-4000m

Flowering: May **Fruiting**: June-Aug

SPECIMEN EXAMINED

West Nepal: Tingyu (29^0 14' N, 83^0 17'E), 4000m, 9.05.1974, J. F. Dobremez & N. P. Manandhar, n 3021/74-650 (KATH); Tingyu, 3800m, 9.05.1974, J. F. Dobremez & N. P. Manandhar (8936 JFD, 74.565NPM) (KATH); Tetang ($28^0$53' N, $83^0$50'E), 3800m, 18.05.1974, J. F. Dobremez & N. P. Manandhar (3021 JFD, 74.650NPM) (KATH); Ghiling ($29^0$00' N, 83^0 52'E), 4000m, 17.05.1974, J. F. Dobremez & N. P. Manandhar (2993 JFD, 74.622 NPM) (KATH).

Viola mandshurica W. Becker in Bot. Jahrb. 54, Beibl. **120:**179 (1917); Wang in F. Reip. Pop. Sin. **51:** 67 (1991).

Viola mandshurica W. Becker var. *ciliata* Nakai et var. *glabra* Nakai **1** c **36:** 60 (1922).

Herbs annual, rarely perennial. Rhizome erect to ascending, rather stout. Stem absent. Leaves basal; petiole 2-3(-11) cm long, glabrous, long winged(almost whole length); leaf blade linear-lanceolate to triangular lanceolate, 2-3 x 0.7-1.2 cm, base truncate, apex acute to obtuse, margin shallowly crenate, sometimes dentate to basal lobes, glabrous, chartaceous to subcoriaceous; stipules adnate to petiole more than half, lanceolate, 5-8 x 0.5-2 mm, upper 3-4 mm free, apex acuminate, margin entire or sparsely denticulate to ciliate. Flowers 6-9 mm across, usually dark purple to violet. Peduncles 2-7.5 cm long, equaling or exceeding leaves, glabrous; bracteoles linear, 4-5 mm long, oppositely inserted near base. Sepal lanceolate to ovate-lanceolate, 4-5 x 1-15 mm, apex acute, glabrous, margin entire; appendage 1-1.5 mm long, apex squarish to rounded. Petal oblanceolate to obovate, 6-7.5 x 2-3.5 mm, margin entire to undulate; laterals bearded; the basal apex truncate to emerginate; spurs 3-4 x 1-2 mm, apex rounded. Styles 2 mm long, slightly geniculate at base, clavate distally; stigma distinctly 3 lobed, terminal, with distinct anterior stigmatic beak.

Note: This species shows some similarities with V. *betonicifolia* however, it can be distinguished by its complete glabrous habit, shorter stipules, smaller flower (6-9 mm across), shorter peduncles, oppositely inserted bracteoles near the base, shorter spur (3-4 mm long), stigma distinctly 3 lobed.

Distribution: China, Nepal

Ecology: 1400-1700m,

Flowering: Mar-May **Fruiting**: May-Jun

SPECIMEN EXAMINED

Central Nepal:

Kirtipur-Jalbinayak, Kathmandu, 1450m, 29.02.2000, R.S. Dani, 202 (TUCH); Chobhar, Kirtipur, Kathmandu, 1500m, 17.03, 2000, R.S. Dani, 226 (TUCH).

Viola odorata L., Sp. Pl. 933 (1753). Hook f. & Thomson in Hook. f., Fl. Brit. Ind. **1**:184 (1872) p.p.; Banarjee & Pramanik in Fasc. Fl. Ind. **12**:29 (1983); Wang in Fl. Reip. Pop. Sin. **51**:20 (1991).

Viola odorata L.

Herbs annual. Rhizome erect to prostrate, rooting from rhizome and producing dense rosettes of leaves and flowers, stoloniferous. Stem absent. Leaves basal; petioles 7-14 cm long, shortly winged, glabrous; leaf blade broader ovate, 2-5 x 2.5-6 cm, base deeply cordate, acute apex, margin dentate, glabrous or sparsely pubescent; stipules almost free, membranous, 8-11 x 3-4 mm, margin shortly fimbriate. Flowers 1.5-2 mm across, dark purple with yellowish white at base. Peduncle 5-7 mm long, not exceeding the leaves, glabrous; bracteoles linear, 4-5 mm long, oppositely inserted below the middle, margin dentate, glabrous. Sepal broader lanceolate, 11 x 4 mm, acute apex; lateral broader than other; appendage 2 mm long, upper two smaller with entire margin, apex dentate. petal obovate to orbicular, 17

x 9 mm, yellowish white spot on inner neck; lateral bearded; spur 5 mm long, cylindrical, apex obtuse. Style 3 mm long, geniculate at base, clavate distally; stigma hooked with a conspicuous anterior stigmatic beak. Capsule 5mm in diameter, globose, hirsute.

Distribution: China, India, Nepal, N - W Asia, N Africa.

Ecology: On moist and shady place. Cultivated in gardens, sometimes escaped from the garden; 1400-1500m

Flowering: Mar. - May **Fruiting**: Jun - Aug

Uses: The plant is used as antipyretic and diaphoretic. The corolla is valued as a diuretic and expectorant. (Chopra et al. 1956, Watt, 1893).

SPECIMEN EXAMINED

West Nepal: Mulpani Botanical Garden, Kapurkot, Salyan, 1400m, 18.08.2067 B.S. (= 4.12.2010), M. N. Subedi, 2-2010 (KATH).

Central Nepal: Chobhar-Jalvinayak**,** Kathmandu, 1450m, 29.02.2000, R.S. Dani, 206 (TUCH); Coronation Garden, Kirtipur, Kathmandu, 1500m, 29.02.2000, R.S. Dani, 207 (TUCH).

Viola paravaginata Hara in J. Jap. Bot. B. 43: 47 (1968); H. Hara, Fl.E. Him. 2:82 (1971) et in Fl.E. Him. 3:83(1975); et Bull. Univ. Mus. Tokyo 8: 83 (1975); Banarjee & Pramanik in Fl. Ind. 2: 342-379 (1993); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:48 (1979); Grierson in Grierson & Long, Fl. Bhutan 2(1):226 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Herbs perennial. Rootstock 2 to 7cm long, 2-6mm thick, articulated; stem or stolon absent. Leaves rotundate to ovate-cordate, deeply cordate to cordate at base, 3-7 x 2.5-6cm, pilose above, only on nerves beneath, 3-13cm long; stipules oblong- ovate, long-attenuate, up to 1cm long, glandulose, ciliate, brown. Peduncles- 5-12cm long glabrous; bracteoles linear, small, delicate, 10 x 4mm, inserted oppositely at the middle, apex acuminate, glabrous. Flower 1cm across, white to purplish with purple streaks. Sepal lanceolate, up to 4mm long , apex acute, margin crenate;appendage1-2mm long, apex rounded, glabrous. Petal oblong to obovate, up to1mm long ; lateral petal usually beardless; lower petal streaked; spur 2mm long, apex round to obtuse. Style 1-2mm long, geniculate at base, clavate distally; stigma beaked. Capsule oblong-ovate, up to 5mm long, apiculate, glabrous, purple spotted. Seeds: yellowish brown.

Distribution: Bhutan, India, Nepal.

Ecology: Stream sides, grassy slopes; forest environs of *Rhododendron, Betula, Acer*, etc; between 700-3500m.

Flowering: Apr.-June **Fruiting**: June-Oct.

SPECIMEN EXAMINED

West Nepal: Ranimatta-Dungeswar, Dailekh, 2170-720m, 31.07.1991, M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K. R. Rajbhandari, H. Takayama and K. Terada, 9160105 (KATH).

East Nepal: Above Tashigaon, Sankhuwasabha, 3030m, 31.07.1988, M. Suzuki, N. Naruhashi, N. Kurosaki, Y. Kadota, M. N. Subedi, M. Minaki, S. Noshiro and H. Ikeda, 8850743 (KATH); Bhainsikharka-Khongma, Sankhuwasabha, 2540-3500m, 15.07.1988, M. Suzuki, N. Naruhashi, N. Kurosaki, Y. Kadota, M. N. Subedi, M. Minaki, S. Noshiro and H. Ikeda, 8820468 (KATH); Minohin Dhap-Mul Pokhari, Near Taplejung, 29.10.1963, H. Hara, H. Kanai, S. Kurosawa, G. Murata, M. Togashi and T. Tuyama, 6305463 (KATH); Bilbatey, Tinjure, 2700m, 27.10.1963, H. Hara, H. Kanai, S. Kurosawa, G. Murata, M. Togashi and T. Tuyama, 6305464 (KATH).

Viola pilosa Blume; H. Hara, Fl. E. Him. 2:82 (1971) et in Fl. E. Him. 3:83 (1975); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:48 (1979); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 30 (1983); Grierson in Grierson & Long, Fl. Bhutan 2(1):228 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola serpens Wall ex Ging., DC. Prodr. **1**:296 (1824); Wall. In Roxb., Fl. Ind. **2**: 449 (1824); Hook. F. & Thomson, Fl. Br. Ind. **1** : 184 (1872) (excl. var. *canescens, glabra & confusa*).

Viola serpens var. *glabra* Hook. F. & Thomson, Fl. Br. Ind. **1** : 184 (1872) excl. syn.

Viola pilossa Blume

Herbs, prostrate to sub-prostrate. Stems or stolons usually long, leafy. Leaves ovate to deltoid, shallowly cordate at base 1.5- 4 x 1-3cm, serrate; petioles 2-5cm long, pubescent. Stipules ovate-accuminate, sub- entire to serrate or dentate, 3-5mm long. Peduncles 3-7cm long, pilose; bracts 2, placed above the middle, linear lanceolate, entire, ca 4mm long. Flowers white or pale violet, purplish blue to deep mauve. Sepals linear lanceolate, acute, entire or denticulate, 4-8 x 1-2mm, standing erect when fruiting; appendage ca 3mm long, pointed. Petals obovate-oblong, 2-4 times as long as broad, 1-2cm long; basal one obovate, slightly bearded; lateral ones oblanceolate, bearded at base; Spur ca 3mm long, relatively large, obtusely cylindrical. Stamen and anther white to light orange. Style subclavate, subtruncate and shortly beaked at apex, 1.5-3mm long. Capsules ellipsoid, ca 5mm long, glabrous or sparsely pubescent.

Note: There is wide variation in shape and size of this species needing further research. Sometimes it is confused with *V. canescens* which is distinguished by its ovate-cordate-lanceolate leaves with acuminate to long acuminate apex, shortly fimbriated stipules, bearded petals and glabrous capsules.

Distribution: Afghanistan to Bhutan, Burma, China, Java, Malaysia, Nepal, Sri-Lanka, Thailand.

Ecology: Moist and shady places, open woodlands, rock crevices, open dry slope; forest environs of Pine, Rhododendron, Oak, *Schima-Castanopsis*, etc.; common between 900-2800m.

Local name: Ghatte Ghans

Flowering: April-Dec. Fruiting: Sept.-Feb.

Uses: The root or the whole plant is prescribed for stomachic pains and several gastric disorders.

SPECIMEN EXAMINED

West Nepal: Padmara, N/E of Jumla, 9000', 11.05.1952, O. Polunin, W. R. Sykes & L. H. J. Williams, 4039 (KATH); Rikegaon (3270m)-Rachi (2990m), 8.10.1991, M. Minaki, K. K. Joshi , M. Kadota, H. Sugita, A. Takahashi, S. Tsuda, H. Yagi & C. Yonebayashi , 9104426 (KATH); Dyola, Baitadi, 2350m, 16.04.1994, P. Pradhan, R. K. Upreti, N. Pradhan & N. Dawadee, 1326 (KATH); Bhartha Lagna, 8500', 23.04.1952, O. Polunin, W. R. Sykes & L. H. J. Williams, 1941 (KATH).

Central Nepal: Mali, Dolkha, 1750m, 7.04.1996, I. Sharma, M. N. Subedi & M. Pudasaini, 11/96 (KATH); Ghodepani, Myagdi, 2800m (28^0 22' N 83^0 44' E), 24.05.1974, J. F. Dobemez & N. P. Manandhar, 82076/74-835 (KATH); Thuneri, Gorkha, 1420m, 10.05.1987, N. P. Manandhar, 11581 (KATH); Thalajung, Gorkha, 1400m, 9.05.1987, N. P. Manandhar & L. P. Kattel , 11530 (KATH); Peepal tari, Parbat, 1050m, 5.09.1991, N. P. Manandhar, 824-91 (KATH); Jhorbang, Dhading, 1550m, 5.11.1989, N. P. Manandhar, 12966(KATH); Simigaon, Dolkha, 1860m, 21.05.1979, N. P. Manandhar & M. K. Adhikari , 1655 (KATH); Syabru-Lama Hotel, 2123m, 4.08.1985, H. Van T. & Irene S. Cotter, G. Staples, P. K. Rai & S. Tamang, N 156 (KATH); Bajrajogini, Kath, 1627m, 17.05.1976, M. M. Amatya, I. Sharma & R. Shrestha, 31/76 (KATH); Boksing, Dhading, 920m, 3.12.1988, N. P. Manandhar, 12791 (KATH); Siklis, Kaski, 2000m, 7.07.1986, N. P. Manandhar & L. P. Kattel, 11185 (KATH); near Chhokang, Dhading, ca 10000', 8.12.1972, David Lichter, 12 (KATH); Near Dhorpatan, 9000', 29.04.1954, Stainton, Sykes & Williams, 2650 (Kath); Dhunche-Bharkhu, Rasuwa, 1800m, 19.05.1977, H. K. Sainju & P. M. Amatya, 923 (KATH); Near Kalika Mandir, Gorkha, 1900m, R. S. Dani, 137 (TUCH); Godavari, Lalitpur, 1530m, 13.04.1998, S. Karki, 30 (TUCH); Sankhu, Kathmandu, 1500m, 12.06.2051 B. S. (=28.09.1994), N. Baniya S5(TUCH); Tistung, Makawanpur, 6500', 16.01.2020 B.S. (= 29.04.1963), Dr. Suwal & Shrestha, 989 (KATH); Langtang, 8450', 23.07.1972, John & Naomi Bishop, TBA 17 (KATH); Hattiban, Lalitpur, 1450m,

18.01.2055 B. S.(=24.04.1998), S. Maharjan, 4(TUCH); Lamjung, S. R. Misra, s.n. (TUCH); Dhunche-Deurali, 2300m, 28.04.2001, M. Ghimire, V. Manandhar & L. Joshi, 20021 (KATH); Helambu, Sindhupalchok, 9700', 1.05.1972, John & Naomi Bishop, TAE 16 (KATH); Helambu, Sindhupalchok, 8600', 20.05.1972, John & Naomi Bishop, TAA 9(KATH); Ghodepani (2830m)-Ranibas (2520m), 2700m, 25.08.1988, M. Suzuki, T. Maeda, N. Naruhashi, R. Watanabe, M. N. Subedi , M. Minaki, S. Noshiro and H. Ikeda, 8812029 (KATH); Education Garden, NBG, Godavari, 1515m, 12.04.2000, N. Joshi, 447 (KATH); Godavari, Lalitpur, 1500-1700m, 5.04.1969, H. Kanai, 9897 (KATH); Godavari, Lalitpur, 1500-1700m, 5.04.1969, H. Kanai, 9898 (KATH); Shivapuri, Kathmandu, 6000', 11.12.2020 B. S. (= 24.04.1963), Ramola Thapa, 4340 (KATH); Shivapuri, Kathmandu, 8000', 24.11.1966, T. B. Shrestha, 6521(KATH); Okhreni, Shivapuri, Kathmandu, 6400', 6.3.1973, M. M. Amatya & T. K. Bhattacharya, 13977 (KATH); Bagdwar, Shivapuri, Kathmandu, 2500-2600m, 26.3.1969, H. Kanai, 11137 (KATH); Bajrabarahi, Kathmandu, 19.03.1973, Ramola & Vidya, 8797 (KATH); Fish Pond, Godavari, Lalitpur, 1520m, 23.03.1961, P. N. Suwal & Party, 108 (KATH); Paharedanda, Sundarijal, Kathmandu, 1700m, 20.03.1975, D. P. Joshi & K. R. Rajbhandari, 75/764 (KATH); Manichur Herbal Farm, 6500', 19.03.1967, B. B. Basukala, 5977 (KATH); Phulchoki, ca 7000', 2023.01.30 B. S. (=12.05.1966), Dr Banarjee & P. R. Shakya, 4519(KATH); Chhampai-Pharping, Kathmandu, 4600-5100', 17.03.1973, M. M. Amatya & Bhattacharya, 73-92 (KATH); Manichurdanda, Kathmandu, 7400', 18.05.1976, M. M. Amatya, I. Sharma and I. Shrestha, 73/76 (KATH); Swayambhu, Kathmandu, 1400m, 12.04.1986, P. R. Shakya, 8827 (KATH); Sheopuri, Kathmandu, 2400m, 23.11.1966, D. H. Nicolson, 2727 (KATH).

East Nepal: Beyond Mai Pokhari, Ilam, 2300m, 7.04.1967, D. H. Nicolson, 3171 (KATH); Sewaden (2490m)-Topkegola (3590m), 15.05.1992, M. Suzuki , N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9240114 (KATH); Jongim (2550m)-Suketar (Tamur Bridge) (2020m), 2.06.1992, M. Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9240488 (KATH); Phakdin (Namche-Lukla), 27^0 44' 11" N, 86^0 42' 44" E, 2690m, M. F. Watson, K. R. Rajbhandari, D. Knott, A. G. Miller, B. Adhikari, K. Maden, V. Manadhar and R. K. Uprety, DNEP1 317 (KATH); Matewa VDC 1, 1500m, 2052.07.15 B.S. (=1.11.1995), B. P. Rai, B D 11, (KATH); Matewa VDC 1, 1300m, 2052.02.3 B.S. (ca 17.05.1995), Dil P. Rai, B. D. 149, (KATH); Budhabare, Jhapa, 6000', 25.05.1969, T. B. Shrestha, 15192/W192(KATH); Dhankuta-pakhribas, Dhankuta, 3000', 11.04.1965, Dr Banarjee, A.V. Upadhyaya and Basukala, 3155 (KATH); Chhintapu, Panchthar, 9000', 8.06.1969, T. B. Shrestha, 15505/W.461, (KATH); Guphapokhari-Milke, 2940m, 10.06.1972, H. Kanai, H. Ohashi , K. Iwatsuki , H. Ohba, Z. Iwatsuki and P. R. Shakya, 1433 (KATH).

Viola pogonantha W. W. Sm. in Notes Roy. Bot. Gard. Edin. 12: 228 (1920); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 32 (1983).

Herbs perennial. Rhizome short, articulate distally, bearing dense brown roots, stoloniferous, stolon up to 17 cm long, with dark brown scales. Stem 2 - 10 cm long. Leaves basal and on stem; petioles not winged, 4-9 cm long, glabrous; leaf blade broad lanceolate to triangular lanceolate, 2.5-5.5 x 1.5-2 cm, base shallowly cordate, apex acuminate to long acuminate, sparsely pubescent on upper, glabrous on lower surface, margin serrate, minutely serrate at basal lobes, distally serrate at anterior parts; stipules free, 9-13 x 3-4 mm, apex acuminate, margin shortly fimbriate, glabrous , brown. Peduncles 2.5-7 cm long, not exceeding the leaves, glabrous; bracteoles linear, 3-4 mm long, usually alternately inserted above and below middle, sometimes oppositely inserted above the middle. Flowers 7-11 mm across, white, fewer faint purple veins on lower petals. Sepal linear, lanceolate, 4-5 x 1 mm, apex acuminate, glabrous; appendage 1-2 mm long, apex round to obtuse, glabrous, margin entire. Petal obovate to ovate, all bearded usually; spurs 2-3 x 1.5-2 mm, apex rounded. Styles 1-1.5 mm long, slightly geniculate at base, not clavate distally;

stigma truncate, filiform. Capsules ellipsoid, glabrous. Seed smooth.

Note: This species is closely related with V. *pilosa* and V. *thomsonii*, however, it can be distinguished by its prolonged acuminate leaves, obtuse basal lobes, peduncles not exceeding the leaves, bearded all petals.

Distribution: China, India, Nepal.

Ecology: 1400-1700m

Flowering: Apr. - May **Fruiting**: Mar. - May.

SPECIMEN EXAMINED

Central Nepal: Thuneri, Gorkha, 1420m, 10.05.1987, N. P. Manandhar, 11581 (KATH); Bhargu, Dhunche, Rasuwa, 1800m, 6.02. 2034 B. S. (=19.05.1977), H. K. Sainju & P. M. Amatya, 923 (KATH); Chovar, Kathmandu, 1400m, S. Rajbhandari, 25 (TUCH); Laxmi Danda, Kabhre, 1740m, 13.05.1994, S. Shrestha, 11K (TUCH); Phulchoki, Lalitpur, 1975m, 15.04.1995, S. Malla, 156 (TUCH); Godavari, Lalitpur, 1700m, 10.05.1958, B. D. Padey, s.n. (TUCH); Phulchoki, Lalitpur, 2200m, 15.04.1995, P. Mandal, 33-95 (TUCH); Patleban, Phulchoki, Lalitpur, 1600m, 15.02.2048 B.S. (=29.05.1991) B. K. Sharma, 74 (TUCH); Godavari, Lalitpur, 1700-2200m, 24.04.2000, R. S. Dani, 140 (TUCH); Chisapani, Makwanpur, 1650m, 22.04.2000, R. S. Dani, 124 (TUCH).

Viola sikkimensis W. Becker in Beih. Bot. Centrabl. 34. 11.260 (1916); H. Hara in Fl. E. Him. 213 (1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. **2**:48 (1979); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 34 (1983); Grierson in Grierson & Long, Fl. Bhutan 2(1):228 (1991); Press et al., Ann. Check. Fl. Pl. Nep. 326 (2000).

Herbs perennial; rootstock woody, erect, densely articulated; Stolons up to 20cm long. Leaves ovate-orbicular, cordate with broad sinus at the base, acute, crenate, 1.5-4 x 1.5-3 cm, 3-5 nerved at base, glabrous, silvery white beneath, petioles up to 7.5 cm long, not winged; Stipules lanceolate, subulate, acuminate, up to 1 cm long, fimbriate, scarious. Peduncles up to 7cm long, equaling or exceeding the petioles, glabrous; bracteoles linear, up to 8mm long, nearly opposite in arrangement above the middle, with few soft hairs. Flowers not sufficient or absent for study. Flowers 1.2cm across, yellow with few darker veins, on lower petal. Sepal lanceolate, up to 5mm long, narrow, margin entire, glabrous; appendages very short or less distinct. Petal obovate to ovate, 6 x 2mm, apex obtuse; lower petal smaller, apex acute; upper two usually reflected upwards; lateral ones usually beardless; spur 3-4mm long, exceeding calycine appendage, cylindrical, apex obtuse or rounded. Style straight to horizontal, 2-3mm long, sub-clavate distally; stigma obscurely 3 lobed with distinct anterior stigmatic beak. Capsule elliptic, 5mm long, glabrous.

Distribution: China, India, Indonesia, Nepal.

Ecology: Occasional along the path in broad-leaved forest with Rhododendrons; usually between 2800-2900m.

Flowering: July **Fruiting:** Aug-Sept.

SPECIMEN EXAMINED

East Nepal: Bhaisikharka-Dandakharka, Sankhuwasabha, 2820m, 15.07.1988, M. Suzuki, N. Naruhashi, S. Kurosaki, Y. Kadota, M. N. Subedi, M. Minaki, S. Noshiro and H. Ikeda, 8860191(KATH).

Viola thomsonii Oudem. In Miq. Ann. Mus. Bot. Lugd.-Bat. 3:74. 1867. in H. Hara in Fl. E. Him. 213 (1966); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:48 (1979); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 34 (1983); Grierson in Grierson & Long, Fl. Bhutan 2(1):228 (1991); Press et al., Ann. Check. Fl. Pl. Nep. 326 (2000).

Rootstock articulated, stolons up to 6 cm long; Leaves ovate-crenate, acute, 1-4 x 0.8-3 cm, serrate–crenate, glabrous to sparsely strigose; petioles 1.5-6 cm long, glabrous; stipules lanceolate, up to 1.5 cm long, deeply fimbriate; peduncles up to 9 cm long, sometimes extending above leaves, bracteoles linear, acuminate with a few teeth along the margin, up to 1 cm long. Peduncles up to 9cm long, exceeding or equaling to leaves, glabrous; bracteoles linear, 8-14mm long, oppositely inserted at or above the middle, few hairs on margins. Flowers 1.5 cm across, purple to yellow with reddish venation on lower petals. Sepals lanceolate, 5-8 x 1-1.5mm, apex acute,

margin entire, glabrous; appendages 2-3mm long, nearly equal to spurs, apex acute. Petals ovate-oblong, 1.5cm long, geniculate at base; stigma shortly beaked. Capsule 1cm long, apiculate, glabrous. Seed smooth.

Distribution: Bhutan, Burma, India, Nepal.

Ecology: 800-2300m

Flowering: Mar.-April **Fruiting**: April-Sept.

SPECIMEN EXAMINED

West Nepal: Dailaekh, Lohari, 790m, 27.02.1991, N. P. Manandhar, 503.91(KATH).

Central Nepal: Manichur Herbal farm, Kathmandu, 6500', B. Basukala, 5977 (KATH); South of Godavari, Lalitpur, 1500-1700m, 5.04.1969, H. Kanai, 9898 (KATH); Hattiban, Lalitpur, 1450m, 20.12.2054 B. S. (=2.04.1958), R. Piya, s.n.(TUCH); Nagadhol, Lalitpur, 6000', 19.01.2024 B. S. (=2.05.1967), R. Manandhar et al. 6857 (KATH); Phulchoki, Lalitpur, 1500m, 28.02.2057 B. S. (=10.06.2000), K. P. Pokhrel (TUCH); On the way to Tarke, 6700', 6.04.1967, S. B. Malla, 7836 (KATH).

East Nepal: Arun Valley, 7500', 24.04.1956, J. D. A. Stainton, 111 (KATH); way to Sektim, 1000m, 25.10.2050 B. S. (=7.02.1994), P. Rai s.n. (TUCH); Seduwa, 7000', 4.05.1965, Banarjee *et al*. 3356 (KATH); mai Pokhari,Ilam, 6.04.1967, D. H. Nicolson, 3151 (KATH); Manebhanjyang-Batasi, Taplejung, 2000m, 1.05.1960, H. Kanai *et al*. 2936 (KATH); Seduwa, 2100m, 24.10.1963, H. Hara *et al*. 6306633(KATH); Papung(1940m)-Dongen (2260m) -Mewa Khola bridge (2050m)-Sewaden (2490m), 14.05.1992, M. Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9240089 (KATH).

Viola tricolor L., Sp. Pl. 935 (1935); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 29 (1983);

Herbs annual. Rhizome erect, rather short, estoloniferous. Stem up to 15 cm long, branched. Leaves basal on stem; petioles short winged, 2-2.5 cm long, glabrous; leaf blade broad-lanceolate to elliptic to sub-orbicular, 2-5 x 1.5-2.5 cm, base cuneate, apex sub-acute to rounded or obtuse, margin shallowly crenate, glabrous, herbaceous; stipules free, leafy, pinnatifid or palmatifid, broad lanceolate, 1.2-1.7 x 5mm, apex acute, margin sparsely ciliated, glabrous. Peduncles up to 9 cm long, exceeding the leaves; bracteoles linear delicate, 2-4 mm long, oppositely inserted near the flower. Flowers 2.5-3.5 cm across, variously coloured usually dark violet, red, yellow, white, pink, etc. with almost yellowish white colours deeply streaked on lower petals with various colours; Sepal green, linear lanceolate, margin entire; upper 2 smaller and narrower than rest, 12 x 3.5 mm with 4 mm long appendage; rest sepal 14 x 4.5 mm with 5 mm long appendages. Petal upper pair longer than lateral, usually beardless, 21 x 21 mm; lateral shorter, 20 x 18 mm, densely bearded; lower petal much broader, 22 x 24 mm, margin slightly crenate; spur 7-8 mm long, round, densely bearded. Style 3mm long, geniculate at base, capitate distally; stigma terminal with anterior stigmatic beak, pubescent. Capsules1.4cm long, ellipsoid, glabrous. Seed ovoid.

Distribution: American continent, China, Europe, India, Nepal.

Ecology: Cultivated at 12000'altitude.

Local name: The English common name 'Pansy' used for this species is accepted as 'Pyanji' in Nepali.

Flowering: Jan.-Mar. **Fruiting**: March-June

Uses: The herb is credited with stimulant, diaphoretic and diuretic properties (CSIR 1976, Chopra *et el.* 1956).

SPECIMEN EXAMINED

Central Nepal: Mu Gumba, Dhading, 12000ft, 20.08.1973, David Litcher, 115 (KATH); T.C. Garden, Kathmandu, 1400m, 15.02.2039 B.S. (=29.05.1982), B. N. Upadhyaya s.n. (TUCH); Maitighar Traffic Island, Kathmandu, 1400m, 1.03.2000, R. S. Dani, 206 (TUCH); Godavari Garden, Lalitpur, 1700m, 1.03.2000, R. S. Dani, 205 (TUCH) .

Viola wallichiana Ging ex DC; D. Don, Prod. Fl. Nep. 206 (1825) H. Hara in Fl. E. Him. 3: 84 (1975); H. Hara in Hara & Williams, Enum. Fl. Pl. Nep. 2:48 (1979); Banarjee & Pramanik in Fasc. Fl. Ind. 12: 37 (1983); Grierson in Grierson & Long, Fl. Bhutan 2(1):255 (1991); Press *et al*., Ann. Check. Fl. Pl. Nep. 326 (2000).

Viola biflora auct. non L., Hook. F. & Thomson, Fl. Br. Ind. **1**: 182 (1872) p.p.

Herbs perennial. Rhizome erect to prostrate, procumbent rooting, more or less stout, estoloniferous. Stem 4-17 cm, erect or decumbent. Leaves cauline; reniform to rotundate, rounded-crenate along margins, 0.7-3 x 0.5-3 cm, glabrous. Petioles 0.5-5.5 cm long. Stipules ovate, denticulate, ca 3mm long. Peduncles 1-5 cm long, bibracteolate above the middle, usually exceeding the leaves, sparsely pubescent or completely glabrous, bracteoles linear,1-3mm long, oppositely inserted at the middle. Flowers 1.2cm across, yellow. Sepals broad subulate or lanceolate, 5-9 x 1-2mm, apex acute or acuminate, shortly ciliate or glabrous; appendage reduced, 0.5mm long, apex round. Petal ovate or oblong, 5-8 x 3-5mm, yellowish white or yellow, basal longest, apex round

Viola wallichiana Ging ex DC

to ovate, glabrous; upper 4 reflexed upward; spur 5-6 x 1mm, apex acute, always exceeding the calycine appendage. Style1.5mm long, geniculate at base, clavate distally, stigma bilamellate, lobes spreading, obliquely bilobed. Capsule 4mm in diameter, oblong, apiculate.

Note: This species shows some similarities with *V. biflora* but it can be distinguished by its long slender and acuminate spur, broad thick and glabrous leaves and long lanceolate sepals.

Distribution: India, Nepal

Ecology: By the side of forest path in an evergreen broadleaved forest and also among the rocks; usually found between 1800-3700m.

Flowering: May-July **Fruiting**: July-Sept.

SPECIMEN EXAMINED

West Nepal: Nilkatti-Naya Odar, Bajhang, 3460m, 27.06.1984, P.R. Shakya, M. K. Adhikari and M. N. Subedi, 8252 (KATH).

Central Nepal: Bhulu Danda, 2300m, 3.02.2023 B. S. (=16.05.1996), Banarjee & P. R. Shakya, 5578(KATH); Charikot-Kalinchok, Dolakha, 2580m, 16.09.1964, Banarjee *et al*., 2771 (KATH); Lamobagar-Hum, Dolakha, 2000m, 16.07.1977, K. R. Rajbhandri & B. Roy, 1549 (KATH); Dovan Phokte, 3000m, 25.07.1978, P. Pradhan *et al.*, 4852 (KATH); Sardukhola, Gorkha, 1800m, 26.07.1994, M.Suzuki *et. al.*, 9485161 (KATH); Sardukhola, Gorkha, 1810m, 26.07.1994, M. Suzuki *et. al*., 9485162 (KATH); Sardukhola, Ripche, Gorkha, 2300m, 27.07.1994, M.Suzuki *et. al.*, 9470220 (KATH); Bagdwar, Shivapuri, Kathmandu, 2700m, 14.06.1969, H. Kanai, 623286 (KATH); Shivapuri Base, Kathmandu, 2000m, 14.06.2000, R. S. Dani, 142 (TUCH); Shivapuri Top, Kathmandu, 2400m, 14.06.2000, R. S. Dani, 143 (TUCH); Kavre, 2400m, 23.06.1970, J. F. Dobremez, 236 (KATH); Kutung Chang, 2550m, 22.08.1969, S.B.Malla, 16090 (KATH); Langtang gorge, 2940m, 21.07.1971, Shakya & Adhikari, TH 7,548 (KATH); Chame, Manang, 2680m, 12.08.1983, N. P. Manandhar, 9749 (KATH); Betrabati, Rasuwa, 13.07.1978, Ramola *et. al*., 205 (KATH); Chandanbari, Langtang, Rasuwa, 2762m, 13.06.1969, S. B. Rajbhandari & M.S. Bista, 13091(KATH); Lama Hotel –Chumna Lodge, 2550m, 12.07.1992, H. Takayama, K. Arai, H. Hatta,, T. Hoshino, F. Miyamoto, M. N. Subedi and S. Takatsuki, 9233054 (KATH); Chayulle Kharka, Rasuwa, 3600m, 12.08.1994, F. Miyamoto *et. al.* , 9430119 (KATH); Dhunche, Rasuwa, 6050', 4.06.1977, N. P. Manandhar, 54 (KATH); Langtang, Rasuwa, 3350m, 12.07.1984, H. K. Sainju & B. Roy27 (KATH); Near Lama Hotel, Rasuwa, 2514m, 25.06.1985, H. V. T. et.al., N 82 (KATH); Tarkeghyang, Sindhupalchok, 2500m, 5.10.1984, N. K. Bhattarai, 84/644a (KATH); Tsedang Pokhari, 3000m, 22.08.1969, Malla & Kanai, 674640 (KATH).

East Nepal: Jongim (2550m) - Suketar (Tamur bridge) (2020m), 2200-2400m, 2.06.1992, M.

Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9240486 (KATH); Gnaula (3245m), 2890m, Solukhumbu, 21.07.1995, F. Miyamoto, M. Amano, H. Ikeda, C. M. Joshi, K. Arai, Bhanduke, Panchthar, 2600-2800m, 25.06.1992, S. Noshiro, S. Akiyama and N. Acharya, 9241064 (KATH); Pankongma (2800m)-Pankongma (3100m), 2880m, 3.08.1997, M. Wakabayashi, M. Amano, M. Mori, K. R. Rajbhandari and K. Shinozaki, 9720104 (KATH); Gidde-Jaljale, 3690m, 22.07.1971, T. B. Shrestha & D. P. Joshi, 251 (KATH); Siringdham, 3076m, 15.06.1969, T. B. Shrestha, 15621/W597 (KATH); Chakela Kharka, Namche Kharka, Solukhumbu, 2440m, 1.06.1994, P. R. Shakya & K. K. Dangol, 10048 (KATH); Mewa Khola, Tamur valley, 2615m, 18.05.1956, J. D. A. Stainton, 356 (KATH); Tinjure Danda, Taplejung, 2830m, 29.08.1989, C. Grey-Wilson, D. G. Long, M. Sinnot, H. Noltie, R. McBeath, S. Zmartzy and M. Subedi, 65 (KATH).

Acknowledgement

The authors are highly grateful to the chief of National Herbarium (KATH) and Tribhuban University Central Herbarium (TUCH) for giving permission to study the specimens and other necessary supports. They also would like to thank Dr. K. R. Rajbhandari for critically reading the manuscript and providing necessary suggestions.

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Documentation of medicinal plants conserved in National Botanical Garden, Godawari Lalitpur

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Abstract

This paper documents *ex situ* and *in situ* conserved medicinal plants in National Botanical Garden, Godawari, Lalitpur. The present study documented 138 species belonging to 75 families, of which three species are endangered MAPs for Nepal, vulnerable seven species, four species threatened and rare one species. Likewise Leguminosae, Solanaceae, Zingiberaceae, Moraceae and Liliaceae are dominant families. There are different landscape garden such as Physic garden, Tropical house, Fern garden, Lily garden, Conservation and educational garden for scientific research, conservation, display and education. Of these, 105 species are conserved in Physic garden (PH), Tropical house (TH) 17 species, Shade house (SH) 5 species, Poly house (PH) 6 species, and 5 species in Conservation and education garden. Thus the National Botanical Garden is one of the hotspots for *ex situ* conservation of medicinal and aromatic plants.

Key words: Botanical garden, Conservation status, *Ex situ* conservation, *In situ* conservation

Introduction

National Botanical Garden (NBG), established in 1962 A. D. is a government institution holding documented collection of living plants for the purpose of scientific research, conservation, display and education. It is located at an altitude of 1515m and lies in between $27^0$33'N- $27^0$36'N latitude and $85^0$22'E- $85^0$23'E longitude. The temperature in summer ranges from 20- 30^0C while in winter it is 0- 18^0C and average total rainfall is 18863.5mm (Sharma, 2003). It is surrounded by evergreen natural forests. More than 550 species including ferns, gymnosperms, cactus and succulents, orchids, medicinal and ornamental plants are conserved in NBG (Sharma, 2003). The garden spreads over an area of about 82 ha of varying topography and exposures of which 35 hectare has been developed into various garden units for scientific research, conservation, display and education, such as: Physic Garden, Special Garden, Rock Garden, Rose Garden, Lily Garden, Fern Garden, Terrace Garden, Water Garden, Japanese Style Garden, VVIP Plantation Area, Tropical House, Coronation Pond, Orchid House and Conservation and Education Garden. Among these, Physic Garden, Conservation and Education garden, Orchid House and Tropical House have more MAPS. The aim of this study is to document the medicinal and aromatic plants conserved in each landscape gardens.

Materials and methods

Ex situ and ***In situ*** conserved wild and cultivated medicinal plants were recorded from different landscape gardens such as. Demo Plot of Physic Garden (DPPG), Demo Plot of Conservation and Education Garden (DPEG), Tropical House (TH), Poly House (PH), and Shade House (SH) (photo 1). To maintain their population different types of propagation techniques *viz*. cutting, budding, grafting, layering, sowing seeds etc. have been carried out. For awareness and information, all medicinal plants are tagged.

Existing medicinal plants of NBG and conserved medicinal plants collected from different sites of Nepal and their medicinal uses were identified by staff of NBG, relevant literatures (Joshi, 2008, and Bulletin No. 28, DPR, 2007) and voucher specimens of the species deposited at KATH Herbarium, Godawari, Lalitpur. For documentation, awareness and information, medicinal plants were labeled with following formats such as scientific name, family, ocal name, distribution, uses, propagation.

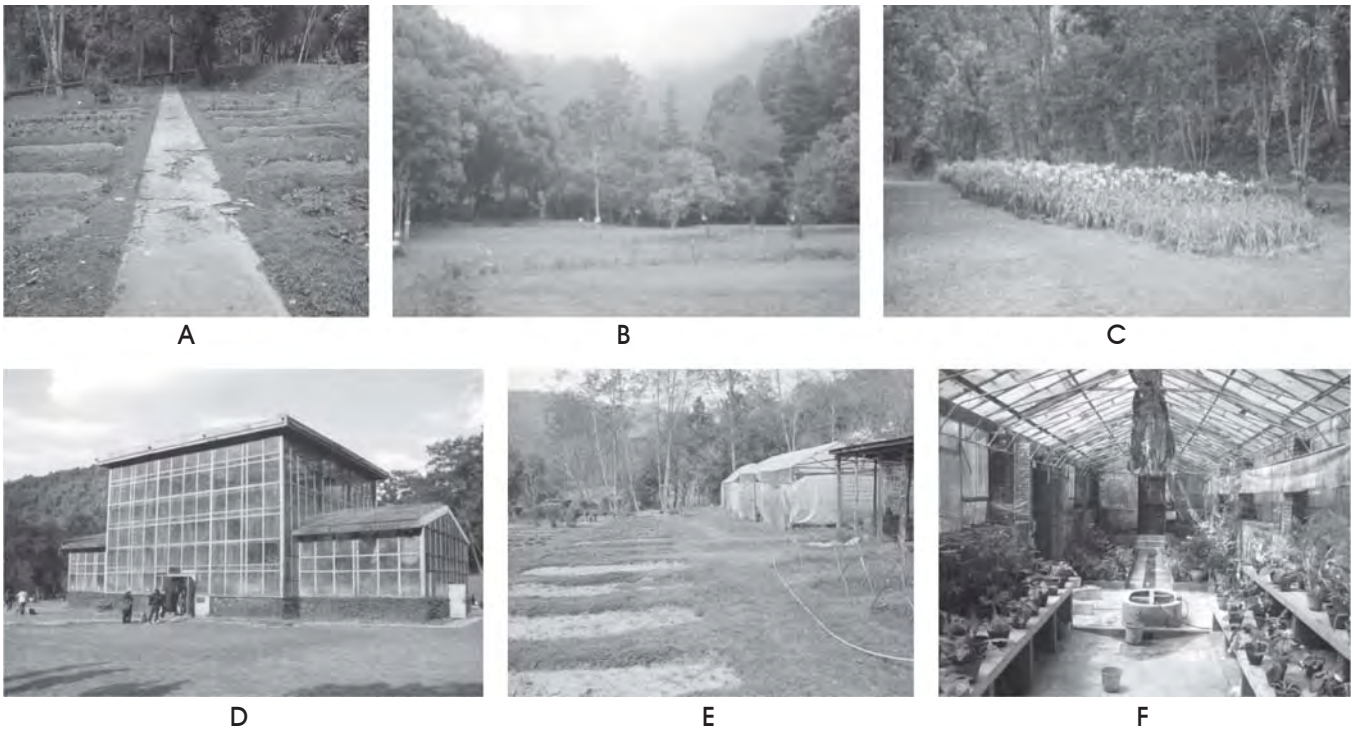

Photo 1: Different landscape gardens conserving MAPs *viz*. A= Physic garden, B= VVIP garden, C= Lily garden, D= Tropical house, E= Conservation & Educational garden & F= Poly house.

Results and Discussion

Diversity

According to Plants of Nepal, Fact-Sheet (2012), total number of medicinal plants conserved in different topographric regions of Nepal are 701 spp. while in NBG, there are 138 spp (19.8%) and according to The World Conservstion Union Nepal (IUCN) 2003, total medicinal plants in NBG were 125 spp., but our research shows that number of medicinal plants are increased which are conserved in different sites *viz.* Demo Plot of Physic Garden (DPPG), Tropical House (TH), Poly House (PH) and Shade House (SH). The study enlisted 121 genera of 138 species of medicinal plants (Annex-I). These 138 species represent different life forms: trees (51 spp.), shrubs (30 spp.), and herbs (57 spp.) and among total 75 families; leguminoceae, solanaceae, zingiberaceae, and Liliaceae are the dominant families (Figure. 1).

Threaten Category

IUCN and CAMP (2012) categorized 17 species of MAPs as Endangered, 26 species as Vulnerable, 7 species as Threatened and 6 species as Rare in Nepal. Our study showed that, in NBG out of 138 species, 3 species (17.6%) are as Endangered, 7 species are (26%) vulnerable, 4 species are (57.1%) Threatened and 2 species are (33.33%) Rare (Annex-I and Figure 2).

Prioritized for Research and agro-technology Development

According to Plants of Nepal, Fact-Sheet (2012), total number of medicinal plants prioritized for research & development and agro-technology development are 30 species and 12 species, respectively. Among them, 19 species (63.33%) and 9 species (75%) are found respectively in different sites of NBG (Table 1 &Table 2).

Conservation Site

In general, amongst all medicinal plants, conservation technology *i.e. ex-situ (*plantation on green house, poly house, shade house, tagging) 117 species and *in-situ* 21 species are known. Medicinal plants are conserved in different sites of NBG *viz.* Demo Plot of Physic Garden (DPPG) comprises 105

species, Tropical house (TH) 17 species, Demo Plot of Conservation and Education Garden (DPEG) 5 species, Shade House (SH) 5 species and Poly House (PH) 6 species.

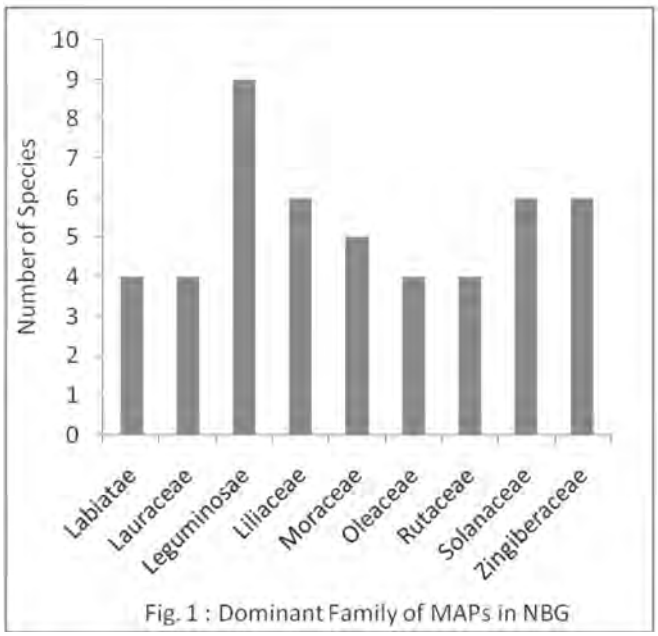

Fig. 1 : Dominant Family of MAPs in NBG

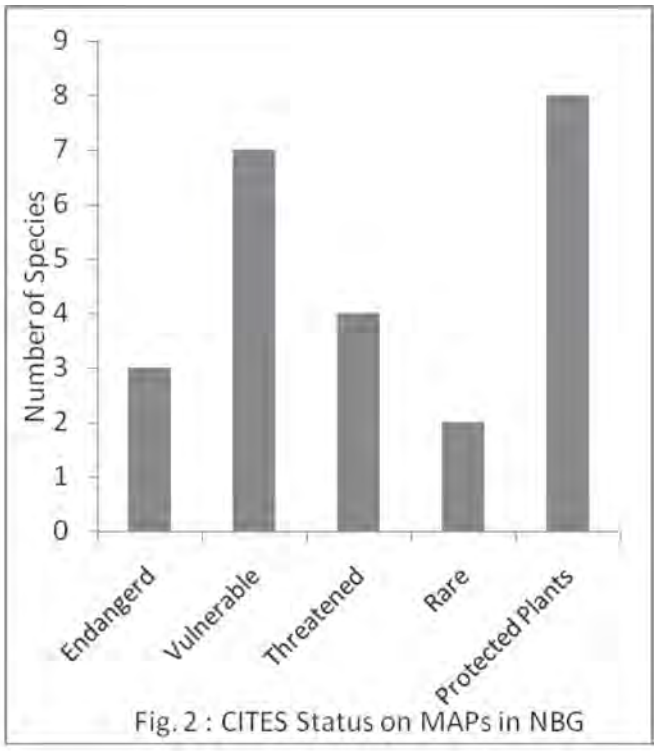

Fig. 2 : CITES Status on MAPs in NBG

Table 1: Medicinal plants prioritized for research and development

S.N.	Scientific Name	Family	Nepali Name
1	*Aconitum spicatum* (Bruhl) Stapf	Ranunculaceae	Vis
2	*Acorus calamus* L.	Araceae	Banjho
3	*Asparagus racemosus* Wild.	Liliaceae	Satavari
4	*Bergenia ciliate* (Haw.) Sternb.	Saxifragaceae	Pasanbhed
5	*Cinnamomum glaucescens* (Nees) Hand.-Mazz.	Lauraceae	Sugandhakokila
6	*Cinnamomum tamala* (Buch-Ham.) Nees & Eberm.	Lauraceae	Tejpat
7	*Dioscorea deltoidea* Wall.	Dioscoreaceae	Bhyakur
8	*Gaultheria fragrantissima* Wall.	Ericaceae	Dhasingre
9	*Juglans regia* L.	Juglandaceae	Okhar
10	*Phyllanthus emblica* L.	Euphorbiaceae	Amala
11	*Piper longum* L.	Piperaceae	Pipala
12	*Podophyllum hexandrum* Royle	Podocarpaceae	Laghupatra
13	*Rauvolfia serpentine* (L.) Benth. Ex Kurz	Apocynaceae	Sarpagandha
14	*Sapindus mukorossi* Gaertn.	Sapindaceae	Rittha
15	*Swertia chirayita* (Roxb. Ex Fleming) Karsten	Gentianaceae	Chiraito
16	*Taxus wallichiana* Zucc.	Taxaceae	Lauthsalla
17	*Tinospora sinensis* (Lour.) Merr.	Menispermaceae	Gurjo
18	*Valeriana jatamansii* Jones	Valerianaceae	Sugandhaval
19	*Zanthoxylum armatum* DC.	Rutaceae	Timur

Table 2: Medicinal plants prioritized for agro-technology development

S.N.	Scientific Name	Family	Nepali Name
1	*Asparagus racemosus* Wild.	Liliaceae	Satavari
2	*Cinnamomum glaucescens* (Nees) Hand.-Mazz.	Lauraceae	Sugandhakokila
3	*Piper longum* L.	Piperaceae	Pipala
4	*Rauvolfia serpentine* (L.) Benth. Ex Kurz	Apocynaceae	Sarpagandha
5	*Swertia chirayita* (Roxb. Ex Fleming) Karsten	Gentianaceae	Chiraito
6	*Taxus wallichiana* Zucc.	Taxaceae	Lauthsalla
7	*Tinospora sinensis* (Lour.) Merr.	Menispermaceae	Gurjo
8	*Valeriana jatamansii* Jones	Valerianaceae	Sugandhaval
9	*Zanthoxylum armatum* DC.	Rutaceae	Timur

Conclusion

The study enlisted 138 species of medicinal plants, among them leguminosae, solanaceae, liliaceae, moraceae and zingiberaceae are dominant families. 3 speices are catogorised as Endangered, 7 species Vulnerable, 4 species Threatened, 2 species rare and 8 species are protected plants of Nepal. Similarly medicinal plants priortized for research & development and agrotechnology development are 19 species and 9 species respectively. Likewise 117 species of plants are conserved ex-situ and 21 species are conserved in-situ.

Still, there are many other commercially viable, threatened economically important plants whose conservation technologies are yet to be standarised. Development of conservation technologies of medicinal plants will not only help in promoting mass cultivation in fields but also help in reducing pressure on wild stock.

Moreover the present study has only focused on the medicinal plants of National Botanical Garden but many other species also faces high degree of pressure and calls an urgent need for adequate conservation and management.

This paper provides comprehensive information on diversity, utilization pattern, conservation site and status of medicinal plants conserved in National Botanical Garden.

Acknowledgement

The authors are thankful to **Mr. Yam Bahadur Thapa**, Director General, Department of Plant Resources and staff of National Botanical Garden, Godawari, Lalitpur.

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Annex-I

S.N.	Scientific name	Family	Habit	Local name	Distribution	Part used	Usses	Convt. status	Conservation sites
1	*Achyranthes bidentata* Blume	Amaranthaceae	Hb	Datiwan	600-1800m WCE	WP	Purgative, diuretic,dropsy, piles,snake bites		DPPG
2	*Aconitum spicatum* (Bruehl.)stapf	Ranunculaceae	Hb	Bikh	2000-4200m WCE	WP	Antipyretic, analgesic	T (IUCN)	DPPG
3	*Acorus calamus* L.	Aracea	Hb	Bojho	500-2300m WCE	Rh.	Aromatic,carminative,emetic		DPPG
4	*Alnus nepalensis* D.Don.	Betulaceae	Tr	Uttis	900-2700m WCE	RBL	Diarrhea,cutts & wounds		DPPG
5	*Aloe vera* (L.) Burm. f.	Liliaceae	Hb	Ghiu kumari	Cult.	WP	Cooling,anthelmintic,burning sensation		DPPG
6	*Amomum subulatum* Roxb.	Zingiberaceae	Hb	Alainchi	1200-1800m E	Fr.	Stomachic, gonorrhia, appetizer,snake bites		DPPG
7	*Artemisia indica* Willd.	Compositae	Hb	Titepati	300-2400m WCE	LS	Stomachic, purgative, itching, emorrhage		DPPG
8	*Asparagus racemosus* Willd.	Liliaceae	Hb	Sataa wari	1000-2100m WCE	WP	Tonic, diuretic, cough, bronchitis,appetizer	V (CAMP)	DPPG
9	*Astilbe rivularis* Buch-Ham. ex D.Don	Saxifragaceae	Hb	Budho aushadhi	2000-3600m WCE	Rh.	Tonic in pre &post pregnancy		DPPG
10	*Atropa beladona* L.	Solanaceae	Hb	Beladona	Cult.	RL	Narcotic,sedative,diuretic,neuralgia		DPPG
11	*Bauhinia purpurea* L.	Leguminoiceae	Tr	Taki	300-1600m WCE	RB	Astringent,carminative		DPPG
12	*Bauhinia variegata* L.	Leguminoiceae	Tr	koiralo	150-1900m WCE	RB	Tonic,blood purifier,diarrhia		DPPG
13	*Berberis asiatica* Rox.ex.DC.	Berberidaceae	Sh	Chutro	1200-2500m WCE	B	Astringent,diaphoretic,antiperiodic		DPPG
14	*Berginia ciliata* (Haw.) Sternb.	Saxifragaceae	Hb	Pakhan ved	1000-3200m WCE	R	Cooling, piles, tumors,heart & lung disease	T (IUCN)	DPPG
15	*Buddleja asiatica* Lour.	Logoniaceae	Tr	Bhimsenpati	350-2000m WCE	WP	Boils,headache,,skin complains		DPPG
16	*Camellia sinensis* (L.) Kuntze	Theaceae	Sh	Chiya	Cult.	L	Astringent,stimulant,diuretic,digestive		DPPG
17	*Cherospondias axillaris* (Roxb) Burk& Hill.	Anacardiaceae	Tr	Lapsi	1200-1500m CE	Fr.	Good source of vit. C		DPEG
18	*Cannabis sativa* L.	cannabaceae	Hb	Bhang	200-2700m WCE	SLFl.	Headache,migrane,asthma,dysentry		DPPG
19	*Cassia fistula* L.	Leguminoceae	Tr	Rajbrikshya	150-1000m WCE	WP	Tonic, skin diseases, snake bites		DPPG

20	*Catharanthus roseus* (L.) G.Don	Apocynaceae	Hb	Sadabahar	150-1500m WCE	WP	Menorrhagia,tonic,stomachic, cancer		DPPG
21	*Cinnamomum camphora* (L.) J.Presl	Lauraceae	Tr	Kapur	1300-1500m WCE	WP	Antispasmodic,diaphoretic,stimulant, carminative		DPPG
22	*Cinnamomum glaucacescens* (Ness) Hand-Mazz	Lauraceae	Tr	Sugand kokila	1000-1500m WCE	Sd.	Muscular swelling	PP	DPPG
23	*Cinnamomum tamala* (Buch.–Ham.) Ness & Eberm.	Lauraceae	Tr	Tejpat	450-2000m WCE	LB	Carminative,disentry,spices		DPPG
24	*Cistrus aurantifolia* (L.) Brum. f.	Rutaceae	Tr	Jyamir	Cultd.	Fr.	Digestive, carminative,disentry, refrigerant, scurvy		DPPG
25	*Costus speciosus* (Koeing)Smith	Zingiberaceae	Hb	Betlauri	400-700m WCE	Rh.	Astringent,purgative, stimulant, snake bite		DPPG
26	*Curcuma aromatica* Salisb.	Zingiberaceae	Hb	Ban haledo	700-1100m CE	Rh.	Carminative, appetizer, tonic,cough, bronchitis		DPPG
27	*Curcuma zedoaria* Rosc.	Zingiberaceae	Hb	Kachur	300-1900m	Rh.	Stomachic, diuretic, cooling, aromatic		DPPG
28	*Cymbopogon flexuosus* (Nees ex Steudel) W.Waston	Gramineae	Hb	Lemon grass	Cultd.	WP	Aromatic, stimulant, diaphoretic, oil		DPPG
29	*Dalbergia sissoo* Roxb.	Leguminaceae	Tr	Sesau	200-1400m WCE	RL	Stimulant, gonorrhea, leprosy, boils		DPPG
30	*Datura stramonium* L.	Solanaceae	Hb	Daturo	200-2200m WCE	LFlFr	Antispasmodic, drug, bronchitis, asthma		DPPG
31	*Dichroa febrifuge* Luor.	Hydrangeaceae	Sh	Bhaasak	900-2400m WCE	RL	Emetic & febrifuse		DPPG
32	*Digitalis purpurea* L.	Scrophulareaceae	Hb	Digitalis	Cultd.	L	Heart disease and tonic		DPPG
33	*Dioscorea deltoidea* Wall.	Diascoreaceae	Hb	Bhyakur	450-3000m WCE	R	Fish poison, wash cloth	T (IUCN)	DPPG
34	*Dispacus innermis* Wall.	Dipsacaceae	Hb	Banmula	1500-2200m CE	R	abortifacient		DPPG
35	*Dryopteris cochleata* L.	Dryopteridaceae	Hb	Unyau	1200-2700m WCE	Rh	anthelmintic		DPPG
36	*Drymaria cordata* (L.) Willed. ex Roem.	Caryophylaceae	Hb	Abijalo	2200-4300m WCE	WP	Fever, indigestion, headche		DPPG
37	*Elaeocarpus sphaericus* (Gaerth.) K. Shum.	Elaeocarpaceae	Tr	Rudra kshya	700-1700m CE	Fr.Sd	Liver tonic,epilepsy,mental disorder		DPPG
38	*Ephedra intermedia* Schrenk & Meyer.	Ephedraceae	Hb	Somlata	2400-5000m WCE	WP	Asthma, cardiac, bronchitis	En (CAMP)	DPPG
38	*Equisetum devile* Roxb.	Equisetaceae	Hb	Kurkure jhar	1000-2500m WCE	WP	Cooling, gonorrhea		DPPG

40	*Ficus lacor* Buch.-Ham.	Moraceae	Tr	Kavro	100-500m WCE	WP	Ulcer, leucorrhea, scabies, boils, leprosy		DPPG
41	*Ficus religiosa* L.	Moraceae	Tr	Pipal	200-1800m WCE	WP	Astringent, gonorrhea, purgative, cooling		DPPG
42	*Gaultheria fragrantissima* Wall.	Ericaceae	Sh	Dhasingre	1200-2600m WCE	SL	Aromatic, stimulant, carminative,antiseptic		DPPG
43	*Geranium nepalense* Sweet	Geraniaceae	Hb	Chunitroghansh	1500-4000m WCE	WP	Astringent, renal disease, coloring		DPPG
44	*Ginko bibola* L.	Ginkgoaceae	Tr	Ginkgo	Cultd.	L	Tonic, stimulant		DPPG
45	*Hedera nepalensis* K. Koch.	Araliaceae	Sh	Pipal pate/dudelaa	2000-3200m WCE	L Fr.	Stimulant, diaphoretic,cathartic		DPPG
46	*Hedychium spicatum* Buch.-Ham.ex D.Don	Zingiberaceae	Hb	PANI SARO	1500-2100m WCE	Rh.	Astringent, stomachic, tonic,fragrant		DPPG
47	*Houttuyania cordata* Thunb.	Saururaceae	Hb	Gane	1300-2500 CE	WP	Cooling, gonorrhea, skin disease, disentry		DPPG
48	*Hypericum uralum* Buch.-Ham.ex D.Don	Hypericaceae	Sh	Khareto/urilo	1200-3600m WCE	Sd.	Aromatic, stimulant		DPPG
49	*Juglans regia* L.	Juglandaceae	Tr	Hade okhar	1200-2100m WCE	LBFr.	Astringent, anthelmintic, rheumatism	PP	DPPG
50	*Justicia adhatoda* L.	Acanthaceae	Sh	Asuro	150-1600m WCE	LF	Cough, bronchitis, asthma, phthisis		DPPG
51	*Lilium nepalense* D.Don.	liliaceae	Hb	Khiraule	2300-3500m WCE	Bulb.	Aromatic & tonic		DPPG
52	*Maesa chisia* Buch.-Ham ex.D.Don	Myrsinaceae	Sh	Bilaune	1200-2600m Wce	RBFr.	Anthelmintic, ringworm, scabies		DPPG
53	*Mahonia nepoulensis* (Lam.) Mull.-Arg.	Berberidaceae	Sh	Jamane mandro	200-2900m WCE	BFr.	Antidisentric, antidiorrheatic		DPPG
54	*Mallotus philippensis* (Lam.) Mull.-Arg.	Euphorbiaceae	Tr	Sindure	150-1800m WCE	WP	Skin disease, cuts, wounds		DPPG
55	*Melia azedarach* L.	Meliaceae	Tr	Bakaino	700-2700m WCE	WP	Anthelmintic, leprosy, skin disease, hysteria		DPPG
56	*Mentha arvensis* L.	Labiatae	Hb	Pudina	1200-2000m WC	L	Aromatic, antispasmodic, stomachic, refrigerant		DPPG
57	*Mentha spicata* L.	Libiatae	Hb	Pudina	1800-2700m WC	LFr.	Aromatic, stimulant, stomachic, carminative		DPPG
58	*Mimosa pudica* L.	Leguminasae	Hb	Lajjawati	200-1200m CE	LR	Kidney, piles, fistula, asthma, cough, fever		DPPG
59	*Morus macroura* Miq.	Moraceae	Tr	Kimbu	1200-1700m WCE	BFr.	Anthelmintic, fever, dyopepsia, melancholia		DPPG
60	*Murraya koenigii* (L.)	Rutaceae	Tr	Mithaneem	150-1450	WP	Tonic, stomachic, stimulant, piles		DPPG

	Spreng.								
61	*Myrica esculenta* Buch.-Ham.ex.D.Don	Myricaceae	Tr	Kaphal	1200-2300m WCE	B	Astringent, diuretic, dipepsia, cough,asthma		DPPG
62	*Nerium indicum* Mill.	Oleaceae	Sh	Karabir	600-1000m WCE	RL	Astringent, diuretic, swelling oil		DPPG
63	*Nyctanthes arbortrisis* L.	Oleaceae	Sh	Parijat	200-1200m WCE	WP	Anthelmintic, diuretic, duspepsia, cough, asthma		DPPG
64	*Origanum vulgare* L.	Libiatae	Hb	Ramtulsi	1500-3600m WCE	L	Wounds, diarrhea, hysteria		DPPG
65	*Oxalis corniculata* L.	Oxalidaceae	Hb	Chari amilo	300-2900m WCE	WP	Astringent, tonic, stomachic, scurvy		DPPG
66	*Paris polyphylla* Smith.	Liliaceae	Hb	Satuwa	2000-3000m WCE	Rh.	Anthelmintic and tonic	V (IUCN)	DPPG
67	*Phyllanthus emblica* L.	Euphorbiaceae	Sh	Amala	150-1400m WCE	WP	Cooling, diuretic, jaundice, vitamin C		DPPG
68	*Phytolacca acinosa* Roxb.	Phytolaccaceae	Sh	Jaringo	200-3200m WCE	WP	Narcotic, purgative		DPPG
69	*Piper longum* L.	Piperceae	Hb	Pipla	200-800m WCE	RFr.	Carminative, bronchitis, asthma, cough, cold		DPPG
70	*Podophyllum hexandrum* Royle	Berberidaceae	Sh	Laghu patra	3000-4500m WCE	RFRh.	Hepatic, stimulant, purgative, ulcer, cuts	V (IUCN)	DPPG
71	*Rauvolfia serpetina* (L.) Benth.ex Kurz	Apocynaceae	Sh	Sarpa gandha	100-900m WCE	RB	Blood pressure, hypnotic, bowel disorder, fever	En (IUCN),PP	DPPG
72	*Rauvolfia verticilata* L.	Apocynaceae	Sh	Sarpa gandha	100-900m WCE	RB	Blood pressure, hypnotic, fever		DPPG
73	*Rhododendron arboreum* Smith	Ericaceae	Tr	Laligurans	1500-3300m WCE	BFr.	Cough, menstrual disorder, fish bone dissolution		DPPG
74	*Rhus succedanea* L.	Anacardiaceae	Tr	Ranibhalayo	1300-2400m WCE	LFr.	Skin disorder, phthisin, disentry		DPPG
75	*Ricinus communis* L.	Euphorbiaceae	Sh	Ander	150-2000m WCE	WP	Astringent, diuretic, aphrodisiac,antipyretic		DPPG
76	*Roscoea purpurea* Smith.	Zingiberaceae	Hb	Rasgari	2500-4000m WCE	WP	Astringent, anthelmintic, depurative, ulcers		DPPG
77	*Rubia manjith* Roxb. ex Fleming	Rubiaceae	Hb	Manjitho	1200-2700m WCE	R	Tonic, astringent, paralysis, ulcers	V (CAMP)	DPPG
78	*Rubus ellipticus* Smith	Rosaceae	Sh	Ainselu	1700-2300m WCE	WP	Astringent, tonic, coolong		DPPG
79	*Rumex nepalensis* Spreng.	Polygonaceae	Hb	Halhale	1200-4200m WCE	R	Purgative, venereal disease, ulcers		DPPG

80	*Salvia officinalis* L.	Libiatae	Hb	Baabari	170-1100m WC	Sd.	Gonorrhea and monorrhagia		DPPG
81	*Santalum album* L.	Santalaceae	Tr	Srikhanda	200-800m WCE	Ht-w	Aromatic, refrigerant, diuretic, fever		DPPG
82	*Sapindus mukorossi* Gaertn.	Sapindaceae	Tr	Rittha	1000-1200m WCE	F	Salivation, chorosis, epilepsy		DPPG
83	*Schima wallichii* (DC) Korth.	Theaceae	Tr	Chilaune	900-2100m WCE	BL	Anthelmintic, rubifacient, fever		DPPG
84	*Smilax aspera* Linn	Liliaceae	Hb	Kukurdaino	1200-2500m WCE	Rh.	Blood purifier, skin diseases		DPPG
85	*Solanum caopsicoides* All.	Solanaceae	Hb	Kantakari	300-900m WCE	RL	Cough, asthma, fever, chest pain		DPPG
86	*Solanum nigrum* L.	Solanaceae	Hb	Kaligedi	900-2900m WCE	WP	Diuretic, tonic, heart disease		DPPG
87	*Sambucus canadensis* L.	Sambucaceae	Sh	Kanike phool	1000-1600m CE	RFL	Fever, cold, arthritis, epilepsy		DPPG
88	*Solanum torvum* Swartz	Solanaceae	Hb	Thulo bihi	250-750m CE	Fl.Fr.	Headache, migraine, dropsy, gonorrea		DPPG
89	*Stephania glandulifera* Miers.	Menispermaceae	Hb	Gurje lahare	1000-2500m CE	R	Pulmonary TB, asthma, disentry,fever		DPPG
90	*Spilanthes calva* DC.	Compositae	Hb	Latoghans	1100m W	WP	Snake bite, toothache,stomach pain		DPPG
91	*Taxus wallichiana* Zucc.	Taxaceae	Tr	Lauth salla	2300-3400m WCE	BL	Antitumor, asthma, bronchitis	En (CAMP),PP	DPPG
92	*Thalictrum foliolosum* DC.	Ranunculaceae	Hb	Dampate	1200-2400m WCE	R	Tonic, purgative, diuretic, febrifuse		DPPG
93	*Tinospora sinensis* (Lour.) Merr.	Menispermaceae	Hb	Gurjoo	150-500m WCE	SLR	Gout, asthma, leprosy, bronchitis	V (CAMP)	DPPG
94	*Toona cilita* Roem.	Meliaceae	Tr	Tooni	200-1700m WCE	BFl.	Astringent, tonic, ulcer, disentry		DPPG
95	*Urtica diocia* L.	Urticaceae	Hb	Sisnoo	1500-3000m WCE	WP	Uterine haemorrhage, nose bleeding, diuretic		DPPG
96	*Valeriana jatamansii* Jones	Valerianaceae	Hb	Sugandhawal	1500-3300m WCE	Rh.	Hysteria, liver and nervous disorder	V (CAMP)PP	DPPG
97	*Vetiveria zizanoides* (L.) Nash	Gramineae	Hb	Khas khas	100-200m WCE	R	Refrigerant, aromatic, febrifuse, stomachic		DPPG
98	*Zanthoxylum armatum* DC.	Rutaceae	Sh	Timur	1500-2400m WCE	SB	Tonic, cholera, dyspepsia, stomachic		DPPG
99	*Belamcanda chinensis* (L)Redoute	Iridaceae	Hb	Padam pushkar	1300-2300m WCE	Rh.	Blood purifier, pulmonary complains		DPPG
100	*Plumbago zeylanica* L.	Plumbaginaceae	Sh	Chitu	100-1300m	R	Astringent, appetizer, digestive, piles,		DPPG

					WCE		paralysis		
101	*Ficus benghalensis* Linn	Moraceae	Tr	Bar	200-2000m WCE	BLSd.	Diabetes, disentry, cooling, tonic		DPPG
102	*Hydrocotyle nepalensis* Hook	Umbelliferae	Hb	Ghod Tapre	1000-2500m WCE	WP	Anthelmintic, improve mamory power		DPPG
103	*Pinus wallichiana* A. B.Jackson	Pinaceae	Tr	Gobresallo	1800-4100m WCE	Rn	Plaster for bone fracture, pain reliever		DPPG
104	*Podocarpus neriifolius* D. Don	Podocarpaceae	Tr	Gunsi	1800-4100m CE	S	Diarrhea, leprosy, rheumatism, gout, tonic, cough	R (IUCN)	DPPG
105	*Fraxinus floribunda* Wall.	Oleaceae	Tr	Lankuri	380-1100m WCE	S. Rn	Juice and resin are laxative		DPPG
106	*Michelia champaca* Linn	Magnoliaceae	Tr	Sun chanp	600-1300m WCE	WP	Astringent, stimulant, tonic, stomachic	En (IUCN) PP	DPPG
107	*Hydrangea aspera* D. Don	Hydrangeaceae	Sh	Hansraj	1600-2600m C	WP	Antispasmodic, narcotic, bronchitis		DPPG
108	*Phoenix sylvestris* Roxb. Fam.	Palmae	Tr	Khajur	150-1500m WCE	RFr.	Tonic, cooling, fever, malaria		TH
109	*Chlorophytum nepalense* (Lindl.) Baker Fam.	Liliaceae	Hb	Musali	500-1200m CE	Tb.	Tonic, fruit has galactoglucan		TH
110	*Dalbergia latifolia* Roxb. Fam.	Fabaceae	Tr	Satisaal	100-1000m WCE	S	Tonic, stomachic, leprosy, abesity	V (IUCN)PP	TH
111	*Litchi chinensis* Sonner	Sapindaceae	Tr	Lichi	900-2000m WCE	LFr.	Tonic, bites of animal		TH
112	*Saureria nepaulensis* DC. Fam.	Saureriaceae	Tr	Gogan	750-2100m WCE	BFr.	Cough, cold, paultice		TH
113	*Celtis australis* L. Fam.	Ulmaceae	Tr	Khari	1300-2200m C	Fr.	Amenorrhea, coleic, fatty oil		TH
114	*Psidium guajava* L. Fam.	Myrtaceae	Tr	Amba	600-2500m WCE	LFr.	Wound, vomiting, ulcer, diorrhea		TH
115	*Litsea monopetala* (Roxb.) Prs.	Lauraceae	Tr	Kutmero	1200m WCE	B	Astringent, diabetes,pain		TH
116	*Aegel marmelos* (L.) Correa	Rutaceae	Tr	Bel	150-1000m WCE	RLFr.	Aromatic, diabete, dyspepsia, disentry		TH
117	*Bombax cieba* L.	Bombacaceae	Tr	Simal	200-900m WCE	RLFr.	Disentry, TB, influenza	PP	TH
118	*Acasia catechu* (L.f.) Wild.	Leguminoceae	Tr	khayar	200-1400m WCE	B	Itching, bronchitis, ulcers, boils, inflamations	T (IUCN) PP	TH
119	*Musa paradisiaca* L.	Musaceae	Hb	Kera	Cultd.	RFr.	Diarrhea, dysentery, diabetes, nephritis		TH
120	*Sizigium cumini* (L.) Skeels	Myrtaceae	Tr	Jamun	300-1200m WCE	BFr Sd.	Astringent, bronchitis, ulcer, asthma		TH

121	*Crateva unilocularis* Buch. Ham.	Capparaceae	Tr	Siplikan	100-1800m WCE	LB	Rheumatism, kidney & bladder stones, tonic	R (IUCN)	TH
122	*Morus ustralis* Poir	Maraceae	Tr	Kimbu	900-2400m WCE	RBFr.	Aromatic,cooling, gingivitis		TH
123	*Opuntia monacantha* (Willd.) Haw.	Cactaceae	Sh	Pate siudi	700-1800m WCE	Fr. Latex	Astringent, refrigerant, purgative		TH
124	*Nikotiana tabacum* L.	Solanaceae	Hb	Surti	Cultd.	L	Narcotic, emetic, antispasmodic		TH
125	*Juniperus indica* Bertol	Cupressaceae	Sh	Dhupi	800-4500m WCE	Fr. S	Anthelmintic, carminative, tumor, piles		DPEG
126	*Ardisia solanacea* Roxb.	Myrsinaceae	Sh	Damaifal	200-1100m CE	WP	Stimulant, carminative, blood purifier		SH
127	*Hedera nepalensis* K.Koch	Aralaceae	Sh	Dudelo	200-3200m WCE	LFr.	Cathartic, diaphoretic, stimulant		SH
128	*Jusminum humile* L.	Oleaceae	Sh	Sanojai	1600-3400m WCE	RFl.	Astringent, fistular, ringworm		SH
129	*Albizia procera* (Roxb) Benth.	Leguminoceae	Tr	Sirish	300-1100m WCE	L	Febrifuse, ulcer, insectiside		DPEG
130	*Swertia chirayita* (Roxb. Ex Flem)Karsten	Gentianaceae	Hb	Chiraito	1500-2500m CE	WP	Skindisease, worm, fever, inflamation	V (IUCN)	PH
131	*Aesculus indica* (Colebr.ex cambess.)Hook	Hippocastanaceae	Tr	Lekpangra	1900-2400m WC	Fr.	Rheumatism, skin diseases		DPEG
132	*Hauttuynia cordata* Thunb.	Saurauiaceae	Hb	Gande	1300-2500m WC	WP	Digestion, gonorrhea, eye trouble		PH
133	*Pterocarpus santalinus* L.f.	Leguminoceae	Tr	Raktachandan	Cultd.	Ht-w, Fr	Jaundice, constipating, febrifuse, ophthalmic, tonic		SH
134	*Daphne papyracea* Wall.ex steud.	Thymalaceae	Sh	Lokta	1500-2300m CE	WP	Purgative, febrifuse		SH
135	*Jatropa curus* L.	Euphorbiaceae	Sh	Sanjiwan	500-1200m WCE	LFr.	Purgativ, convultion, neuralgia, dropsy		PH
136	*Diploknema butyracea* (Roxb.)Lam	Sapotaceae	Tr	Chiuri	200-1500m WCE	Fr.	Rheumatism, refreshing		PH
137	*Acacia nilotika* (L.)Wilid.ex.Del	Leguminoceae	Sh	Babul	Cultd.	B	Astringent, aphrodisiac, emetic		PH
138	*Terminalia bellerica* (Gaertn) Roxb.	Combretaceae	Tr	Barro	300-1100m WCE	Fr.	Diarrhea, piles, leprosy, fever		PH

Acronyms

NBG - National Botanical Garden
MAPs - Medicinal and Aromatic Plants
DPPG - Demo-plot of Physic Garden
DPEG - Demo plot of Education Garden
TH - Tropical house
SH - Shade house
PH - Poly house
W - West
C - Centre
E - East
WP - Whole plant
R - Root
Rh. - Rhizome
Fr. - Fruit
Fl. - Flower
Ht-w - Heart wood
Rn - Resin
L - Leaf
S - Stem
B - Bark
Sd. - Seed
Tb. - Tuber
Tr - Tree
Sh - Shrub
Hb - Herb
T - Threatened
V - Vulnerable
Rr - Rare
En - Endangered
PP - Protected plants of Nepal
IUCN - International Union for Conservation of Nature and Natural Resources
CAMP - Conservation Assessment and Management Planning

In vitro Propagation of *Dendrobium amoenum* Wall. ex Lindl. from shoot-tip Culture

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Abstract

Dendrobium amoenum collected from Dhumpus area of Kaski district were planted in green house of National Herbarium and Plant Laboratoies, Godawari. The sprouted shoots were used as explants. The shoot-tips after sterilization were cultured on agar gelled MS medium supplemented with different concentration of Benzyl Amino Purine, Kinetin and Napthalene Acetic Acid.. The medium supplemented with BAP 1mg/l and NAA (0.01-0.1mg/l) and medium with BAP 1mg/l and kinetin 1.5mg/l were best for culture establishment. These regenerated microshoots and PLBs were subcultured on MS medium with different hormone concentration for further multiplication of microshoots and PLBs. The medium supplemented with 1mg/l BAP, 1.5 mg/l Kinetin and 10% Coconut milk and 1mg/l BAP, 1mg/l NAA and 10% Coconut milk were most suitable condition for multiplication of PLBs and healthy microshoots regeneration. The microshoots thus obtained were transferred on the medium with 0.5mg/l NAA to regenerate roots and for further growth. The seedlings thus obtained were washed thoroughly by water and transferred in mosses substrate for further growth of seedlings. This protocol would be helpful for production and conservation of this species.

Key words: *Dendrobium amoenum,* Protocorm like bodies (PLBs), Growth hormone, Culture and subculture.

Introduction

Plant tissue culture is a commercially successful aspect of biotechnology in plant propagation and breeding. Orchid is the first horticultural plant cloned by tissue culture method on commercial scale (Griesbach, 1986). In nature, the orchid seeds do not grow in absence of appropriate host. Symbiotic germination of orchid seeds was first developed by Noel Bernard. He successfully isolated a number of fungi and used them in the germination of orchid seeds between 1900 to 1911 (Breddy, 1991) Later, Hans Burgeff (1909) demonstrated the association of fungal mycelia with orchid root structure and their role in orchid seed germination (Arditti, 1979). He also stressed on the need for symbiotic germination. Knudson (1922) showed that orchid seed germination was possible on simple nutrient medium containing minerals and sugars without the help of any mycorrhiza. His discovery was used in the germination of many species of orchid including many hybrids. This became a standard procedure for germinating orchids. Further, Moral (1964) developed the method of tissue culture by using meristem culture technique. It created a sensation among orchid growers and completely changed the traditional concept of orchid culture. It developed a multimillion dollar orchid industry. Since then, the numbers of genera and hybrids are multiplied by means of this method. Most of the orchids are disappearing from their natural habitat due to extensive collection by orchid enthusiasts, deforestation and natural calamities. Orchids are placed in CITES appendix II except *Paphiopedilum* species.

Most of these plants are exported from Nepal through unsustainable collecting practices from natural habitats and not from their cultivation. The resource evaluation of *Dendrobiums* in nature had not been thoroughly studied yet now. Thus tissue culture is an alternative method to propagate these plants for commercial cultivation. The present paper deals with the protocol for *in vitro* propagation of *Dendrobium amoenum* by using its shoot tips for their subsequent development into seedling.

Dendrobium amoenum is an epiphytic orchid and grows clustered as pendulous five to six slender stems. It flowers during May- July. The flowers flourish on older stems in clusters of two to three per node. The flower is delightfully perfumed. It is found common in temperate forests and is distributed to Western Himalaya to Sikkim, Darjeeling, Bhutan, Meghalaya and Burma (Sharma and White, 2000). The plant is called as "Amlaphung" in Limbu community and is very popular species used for various kinds of cultural ceremony. It is used to prepare a fringe which is used as a symbol of love (Raskoti, 2009). Its stems have antibacterial properties (Vaidya et. al).

Materials and methods

The plants of *Dendrobium amoenum* were collected from Dhampus area of Kaski district and planted in the green house of National Herbarium Plant Laboratories, Godawari. The sprouting shoot tips (1-2cm) from these plants were detached from mother plants. Then these shoot tips were washed in running tap water for one hour and teepol for five minutes and washed with distilled water. These shoot tip explants were sterilized with 0.1% mercuric chloride solution for 5 minutes and washed with sterilized distilled water for five times. Aseptically, unnecessary parts from these explants were cut down by sharp sterilized blade into small shoot tips (1-2mm). These were then cultured in MS medium with different concentration of hormones**.** The medium was also fortified with 0.1% Casein hydrolysate, 3% sucrose and 8% agar for solidification of medium. The pH of the medium was adjusted to 5.5 before autoclaving. The cultures were then incubated at 25±2°C under 16 hour photoperiod.

Protocorm like bodies (PLBs) and microshoots regenerated from primary shoot tip cultures were again subcultured on MS medium supplemented with different concentration of hormone (BAP, Kinetin and NAA). The medium was also fortified with 10% coconut milk for multiplication of microshoots.

The regenerated microshoots on different concentration of hormones were separated into smaller and larger sizes. The smaller size microshoots with PLBs were subcultured on MS medium either containing BAP, Kinetin and 10% coconut milk or BAP,NAA and 10% Coconut milk for further multiplication and larger sized microshoots (2-2.5cm long) were subcultured in MS medium supplemented with NAA.

Result and Discussion

The shoot tip explants responded initially in all concentrations but after three to four weeks, they responded differently in different hormone concentrations. The shoot tip explants cultured in medium containing BAP 1mg/l and NAA 1mg/l and the medium containing BAP1mg/l and Kinetin 1.5mg/l proved ideal condition for the establishment of explants(Table 1) .

The microshoots and protocorms thus obtained were subcultured in MS medium supplemented with different concentrations of BAP, NAA and Kinetin (Table-2). Among these concentrations, the MS medium supplemented with 1mg/l BAP, 1.5mg/l Kinetin and 10% Coconut milk and the medium supplemented with 1mg/l BAP, 1mg/l NAA and 10% coconut milk were found to be best for differentiation of PLBs and microshoots (Table2, Fig 3&4). The seedling growth and multiplication is promoted when the medium is supplemented with Coconut milk in *Cymbidium aloifolium* (Bopaiah and Jorapur, 1986). The PLBs and small microshoots were again subcultured in a medium enriched with 1mg/l BAP, 1.5mg/l Kinetin and 10% coconut milk or in a medium with 1mg/l BAP, 1mg/l NAA and 10% coconut milk to obtained protocorms and microshoots at an interval of 6 to 8 weeks (Fig, 2&3). In every subculture, the long microshoots were subcultured in MS medium containing 0.5mg/l NAA for further growth and development of roots.The smaller microsoots and PLBs were again subcultured in the same medium as above to continue multiplication. Vij et al (1984) reported that the best result with the seedling leaves of *Rhyncotsylis retusa* was obtained in medium containing Kinetin and NAA also. Chaturbedi and Sharma (1986) reported that the young leaves and roots differentiated into

Table:1 Growth responses of explants on MS medium with different concentrations of NAA, BAP and Kinetin.

S.No.	Concentration of hormone ,mg/l NAA	BAP	Kn	Growth responses by protocorms
1	0.1	0.1		No multiplication,explants remain green
2	o.1	0.5		No multiplication,explants remain green and grow upto1.5cm
3	0.1	1		Multiplication of few(2-3) microshoots with few PLBs.
4	0.01	1		Multiplication of few microshoots with (4-5)PLBs.
5		1	1	Multiplication of (6-8) microshoots and10-15 PLBs
6		1	1.5	Multiplication of microshoots(8-10) and 12-15PLBs.

Table: 2 Growth responses by microshoots and PLBs on the medium with different concentrations of BAP, NAA, Kinetin and Adenine sulphate with 10% Coconut milk.

S. No.	Concentration of hormone ,mg/l NAA	BAP	Kn		Growth responses
		1	1.5		15-20microshoots with PLBs
		1	1.5	1mg/l casein hydrolysate	,,
	0.01	1		50mg/l Adenine sulphate	Not so good for multiplication
	1	1			15-20 microshoots with more PLBs

Table: 3 Microshoots on MS medium with different NAA concentrations

S.No.	Conc of NAA	Rooting condition
1	Medium without auxin	Weak roots Regenerated
2	Medium with 0.5mg/l NAA	Best roots Regenerated
3	Medium with 0.5mg/l NAA +Charcoal 0.5mg/l	Week roots Regenerated

PLBs in modified VW medium supplemented with 1mg/l BAP, 1mg/l IAA and 200mg/l casein hydrolysate. Depending upon the medium and growth promoters used, the callus phase can be maintained or organogenesis can be induced. The differentiation in callus and subsequent developmental changes then lead to plantlets formation (Rao, 1963).

The microshoots 3-4cm long (fig 5), were kept in the culture bottles for 2-3 weeks in green house for acclimatization. The seedlings were taken out by forceps, washed with clean tap water and the roots were wrapped by mosses for further growth. Seedlings generally grew better in groups than singly, so seedlings were kept in group in community pots. After a few months, these plantlets were kept in clay pots with tree fern roots, charcoal, dry cow dung and brick pieces as potting medium.

Conclusion

The present study provides the protocol for production of millions of *Dendrobium amoenum* plants through tissue culture.

Acknowledgement

The author is grateful to Mr. Puspa Raj Shrestha, former Director General, Department of Plant Resources and Dr. S. R. Baral, then Chief of National Herbarium and Plant Laboratories for providing facilities for this work. The author is also thankful to Mr. G. D. Bhatt in helping during this work.

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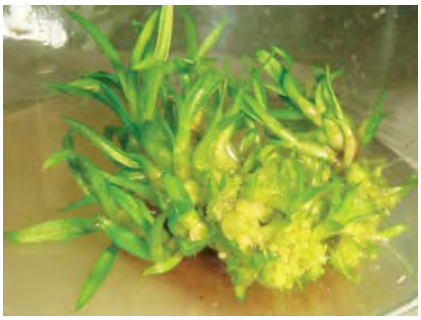
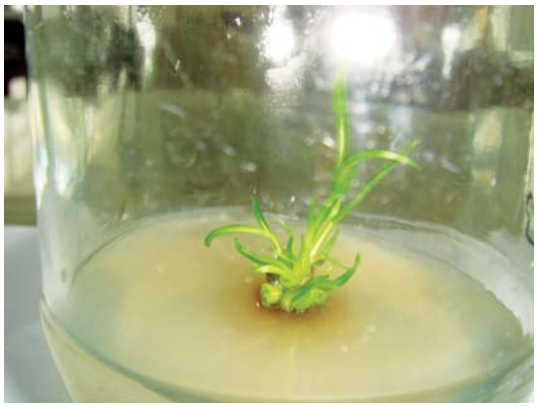
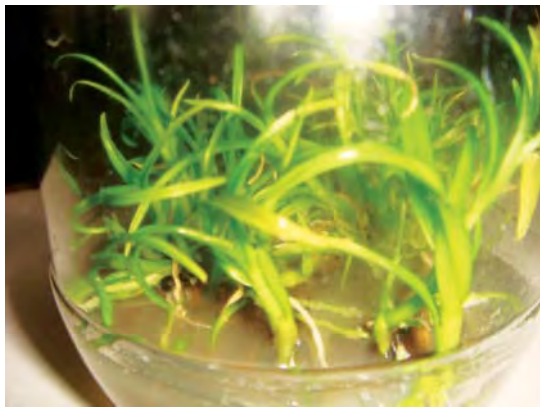
Flower of *Dendrobium amoenum*



Microshoots and protocorms



Explant proliferating protocorms and microshoots



Seedlings on MS medium

Clonal propagation of *Paulownia tomentosa* Steud. for commercial production

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Abstract

Nodal explants were used for clonal propagation of *Paulownia tomentosa* by manipulating the cytokinin and auxinon MS media. Shoot bud proliferation was achieved from nodal explants derived from green house plant of *Paulownia tomentosa* on MS medium supplemented with 1.0 mg/l BAP and 0.1 mg/l NAA. The number of shoot proliferation was enhanced by changing concentration of growth hormone BAP. The mature culture bottles were acclimatized for a week. *In-vitro* grown shoot were successfully rooted *ex - vitro* in non sterile sand. The rooted plants were then transferred in polybags.

Keywords: Nodal explants, growth hormones, shoot proliferation, micro propagation

Introduction

Paulownia tomentosa is a deciduous tree in the genus *Paulownia*. It belongs to the family Scrophulariacea. *Paulownia* is native to central and western China . It grows upto 40-50 ft with large heart-shaped and five-lobed leaves 15-40 cm across, arranged in opposite pairs on the stem.. The flowers are flourished before the leaves in early spring, on panicles 10-30 cm long, with a tubular purple corolla 4-6 cm long resembling a foxglove flower. The flowers are colorful and beautiful in spring and the trees are green and shady in summer. *Paulownia* species are therefore very suitable for beautifying and enriching the environment. The fruit is a dry egg-shaped capsule 3-4 cm long, containing numerous tiny seeds. The seeds are winged and disperse by wind and water. It is tolerant toward pollution and is not fussy about soil type. For this reason it functions ecologically as a pioneer plant. *Paulownia* timber is a hardwood, very light, fine-grained, soft, and warp-resistant and is used for making chests, boxes, and clogs. Its low silica content reduces dulling of blades, making it a preferred wood for boxes to hold fine Japanese edge tools. The leaves and flowers are rich in nitrogen and therefore serve as good fertilizer and fodder. They are also equally suitable for landscaping of urban and industrial areas. The wood is burned to make charcoal for sketching and powder for fireworks, and the leaves are used in vermicide preparations. Recently, *Paulownia* has received a great deal of interest for its environmental properties and has been put forward as a potential solution to the global deforestation problem which lies at the heart of the climate change debate. *Paulownia* trees were grown in plantations for the production of high quality timber. *Paulownia* could be propagated by seeds and root cuttings [Rao et al. 1996, Ozaslan et al. 2005]. Conventionally production of planting material is not sufficient for large scale cultivation. To overcome this problem, *in vitro* multiplication of *Paulownia* by nodal cutting is a tool for fulfilling the large scale production of planting materials. The micro propagation seems to be a prospective method of mass-production of valuable plants. Due to multiple applications of *Paulownia tomentosa*, not only in foreign countries, but in Nepal also people were interested for commercial plantation for its timber and other purpose. Recently 6000 tissue cultured *Paulownia* plants were planted in Gorkha district. Hence the present investigation was launched, to maximize micro propagation rate of *Paulownia tomentosa* for commercial production by using different concentration of growth hormones.

Paulownia have been cultivated in China for at least 2000 years. In recent decades, agroforestry plantings have increased in China, to shelter crops and provide firewood and timber. It is estimated that 2.5 million

hectares of Chinese farm land now has *Paulownia* shelter belts planted on it, from which up to 10 million cubic meters of logs may be produced each year. Within Asia, Paulownia is grown in Taiwan, Vietnam, Cambodia, Laos, Korea and Japan. Elsewhere, Paulownia is grown commercially in South America and the United States, where it has naturalized in Appalachian forests. Commercial development has been attempted in Australia, New Zealand and South Africa. (http://www.agric.wa.gov.au/PC_92536.html)

Materials and methods

Plant material and explants sterilization

The plant material was collected from ICIMOD, Godawari and grown in Biotechnology nursery at DPR, Thapathali. Stem apex explants with two or three nodes were taken from year-old juvenile shoots of *Paulownia tomentosa*. For the surface sterilization, the shoots were kept in running tap water for about one hour with few drops of liquid detergent Tween 20. After washing with detergent the explants were thoroughly rinsed with distilled water for 4-5 times to remove any traces of detergent remaining in explants. After these treatments, explants were taken inside the laminar air flow for further sterilization. Explants were surface sterilized with freshly prepared 0.1% w/v aqueous solution of Mercuric chloride for 10 minutes. Then again explants were thoroughly rinsed for 3-4 times with sterilize distilled water to remove any traces of Mercuric chloride.

Culture medium

Single or double nodal explants were inoculated onto MS basal (Murashige and Skoog, 1962) medium supplemented with different concentration of plant growth regulators Benzyl amino purine (0.5 mg/l ,1.0mg/l , 2.0 mg/l, 2.5 mg/l and 5.0mg/l) and Naphthalene acetic acid (0.1 mg/l) for bud break and shoot proliferation. Sucrose 3% was used as carbon sources and media were adjusted to pH 5.8 using Sodium hydroxide (NaOH) before autoclaving. The media were solidified with 0.8% agar and were autoclaved at 121 C.

Inoculation of explants

Before inoculation, explants were transferred to sterilized Petridis with the help of sterile forceps under strict aseptic conditions. The leaves were removed and single node about 0.5 to 1.0 cm long was transferred to culture bottles containing MS medium with different concentration of growth hormone, BAP and NAA. After successful initiation of the shoot, newly formed shoots were excised and again leaf were trimmed and nodal cutting with 1-2 node were sub cultured on the media with increasing the concentration of BAP with same concentration of NAA. After four weeks the proliferated shoots with 3-4 node were again transferred in the medium with reduced hormone level (BAP 2.5 to 1.0 mg/L) The cultures were incubated under 16 h photoperiod with light intensity of 3000 lux florescent tube light and temperature of 25± 2^{o}C.

Result

Shoot proliferation

After four weeks of inoculation, explants started to show signs of shoot initiation. 2-4 new shoots were produced from the both side of the nodal explant. The micro shoot with 4-5 node were subculture onto the same basal medium with increasing growth hormone BAP (2.5 mg/L) supported maximum number of bud break. After two weeks of third subculture, the nodal cuttings were transferred into the media with reducing concentration of BAP 1.0 mg/l. During subculture 8-10 pieces of single nodal cutting were placed in culture bottle. 20-25 number of shoots were formed in a single culture bottle. The culture was maintained by regular sub culturing at 4 week of intervals to fresh medium with the same composition. Among all combination of growth hormone BAP and NAA, 1.0 mg/l BAP and 0.1 mg/l NAA gave highest number of shoot proliferation than other hormone concentration (Table 1).

Table 1 : Effect of different concentration of AP and NAA on shoot proliferation of *Paulownia tomentosa* after 4 and 6 weeks

S.N.	MS + Growth Hormone mg/l		Explant showing shoot formation	Average number of shoot per single nodal explants		Condition of shoots	Remarks
	BAP	NAA		after 4 weeks	after 6 weeks		
1	0.5	0.1	responded	1-2	Remain same	Satisfactory	
2	1.0	0.1	responded	2-4	4-6	Good	
3	2.0	0.1	responded	1-2	Remain same	Satisfactory	
4	2.5	0.1	responded	1-2	Remain same	Very weak	
5	5.0	0.1	responded	1-2	Remain same	Not good	

This table shows that the explants responded to all media. In BAP 1.0 mg/l and NAA 0.1 mg/l show best for shoot initiation from nodal explant. Each nodal explant with single node gives rise 4-6 shoots only. When subcultured in high concentration of BAP 2.5 mg/l showed optimum number of bud break in nodal explants. But the micro shoot obtained from high concentration was very soft and weak. It was difficult for rooting. So in third subculture the concentration of BAP was decreased to 1.0 mg/l BAP. In this concentration micro shoots were hard in nature. In single culture bottle 8-10 piece of nodal cutting were placed, from which 20-25 microshoots were obtained. The best concentration for shoot multiplication was found to be 1.0 mg/l BAP and 0.1 mg/l NAA. In this composition, micro shoots were very healthy and strong.

Sand Rooting

Mature plantlets were shifted to greenhouse for acclimatization for 7-10 days. The plantlets were taken out carefully with the help of forceps and washed with water to remove the media. Plants were thoroughly watered and covered with polythene hood having 80% humidity and 30°C temperature for rooting in sand. After 2 weeks of transplantion, plantlets initiated to give rise to roots. 80-90 % of plants gave rise to roots. After 6 weeks of sand rooting, the plants were transferred to soil. Micro propagated plants showed an excellent growth in the field attaining a height of 12-15 feet in one and half year.

Discussion

Paulownia sp. have been cultured *in vitro* by various researchers for mass propagation. Bergmann, Ben A.; Moon, Heung-Kyu. reported adventitious shoot formation was obtained from petioles and laminae of *Paulownia elongata, P. fortunei*. Fully expanded, dark green, thick, older leaves were healthier and exhibited greater callus and shoot production than young leaves. The growth regulator concentrations required for maximal shoot production differed among clones, but all required 0.2 or 0.5 mg/l naphtahlene acetic acid and 5.0 or 7.0 mg/l benzyl adenine. The average adventitious shoot production after 4 weeks in culture for the two most prolific genotypes was 63 shoots per leaf from P. 'Henan 1' and 48 shoots per leaf from *P. elongata*. In this experiment, nodal explant is best for micropropagation of *Paulownia tomentosa.* Ozaslan M., Can C., Aytekin T., 2005 study effect of explant source on *in vitro* propagation of *Paulownia tomentosa* Steud. They used different explant such as leaf, petiole shoot tip and nodal cutting. Among them they found nodal explant is best for propagation of paulownia. Ipekci Z., Altinkut A., Kazan K., Bajrovic K., Gozukirmizi N., 2001 obtained high frequency plant regeneration from nodal explants of *Paulownia elongata*. In our cases we also used nodal explant for shoot proliferation in *paulownia tomentosa.* Bergmann B.A., Heung-Kyu M., 1997 research on *In vitro* adventitious shoot production in *Paulownia* using nodal explant.Most of the researcher used nodal explant for shoot proliferation. E.corredoira, A. Ballestar, A.M. Vieitez used growth hormone Thidiazuron for inducing high frequency of plant. They used leaf explant in their research work. We used BAP and NAA for multiple propagation of plant. Rout G.R., Reddy G.M., Das P. 2001 also studied *in vitro* clonal propagation of *Paulownia tomentosa* using nodal explant. They also used growth hormone BAP and NAA.

Marcotrigiano M., Stimart D. P., 1983 research on *in vitro* organogenesis and shoot proliferation of *Paulownia tomentosa* using nodal explant . Kumar P.P., Rao C.D., Goh C.J., 1998 used petiole and lamina as an explant for adventitious shoot initiation of *Paulownia fortunei*. Venkateswarlu B, Mukhopadhyay J, Sreenivasan E, Kumar VM also used nodal cutting as an explants for micropropagation of *Paulownia fortunii*.

Most of the researchers produced *in vitro* rooting plantlets using auxin NAA and IBA. The *in vitro* rooting was economically expensive and takes one more step in tissue culture process. In our research work, micro shoots were transferred in sand for initiation of roots. Once plantlets were established, rapid multiplication was observed in sub culture on same concentration of growth hormone BAP and NAA. Single culture bottle contain 20-25 plantlets after third subculture. The best media for shoot initiation was MS media supplemented with 1.0 mg/l BAP and NAA 0.1 mg/l NAA.

Conclusion

Paulownia tomentosa is a commercially important plant, which is cultivated in many countries due to its high demand. Its demand is increasing day by day in Nepal also. Due to its high demand for commercial cultivation, tissue culture is only the best tool for plant production. The objective of this present research work was to maximize the number of microshoots per culture bottle manipulating the appropriate concentration of growth hormones. We found Benzyl amino purine (BAP) 1.0 mg/l and Naphthalene acetic acid (NAA) 0.1 mg /l promoted higher frequency of shoot proliferation.

Acknowledgement

It is our pride privilege to express our sincere thanks and deep sense of gratitude to Dr. Annapurna Nanda Das then Director General, DPR for facilitating our lab making it suitable to conduct this research successfully.

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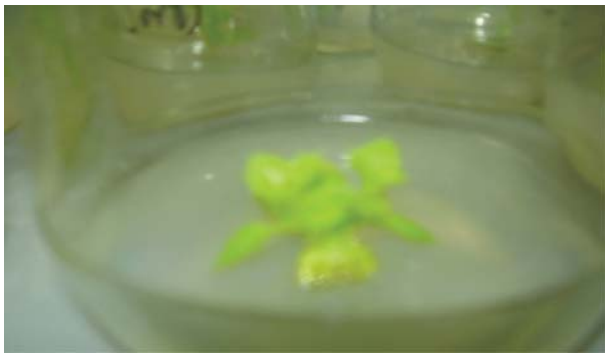

Shoot proliferation from nodal explant after 4 weeks

Shoot elongation with 4-5 node after 4 weeks

Subculture in media with BAP and NAA

Sand Rooting

A single plant

Rooted plant in polybags

6 weeks old plant

6 month old paulownia plant (8-9 feet)

In vitro seed germination and seedling development of *Cymbidium devonianum* Paxton (Orchidaceae)

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Abstract

***Cymbidium devonianum* Paxton**, an epiphytic orchid native to Nepal having high ornamental and medicinal values is found at elevations of 1500-2000 m asl. *In vitro* seed germination and seedling development of the orchid was carried out on 0.8% (w/v) agar solidified Murashige and Skoog (MS) medium and the medium supplemented with different combinations of 6-Benzylaminopurine (BAP) and á-Naphthalene acetic acid (NAA). The germination of seed started after 10 weeks of culture in different combinations of the medium. The medium supplemented with 2mg/l BAP and 0.5 mg/l NAA was found to be the most effective where protocorm like bodies (PLBs) were obtained after 11 weeks and shoot initiation after 23 weeks of culture. Developing shoots started to become achlorophyllous after 32 weeks of culture. Well-developed shoots were obtained from the primary culture of chlorophyllous PLBs on the MS medium supplemented with 1 mg/l BAP, 1.5 mg/l Kinetin and 10%coconut milk followed by the medium supplemented with 2mg/l BAP and 0.5 mg/l NAA.

Key words: *Cymbidium devonianum*, *in vitro*, seed, PLBs, MS.

Introduction

Nepal, the nature's paradise, harbors 437 species of orchids belonging to 104 genera (Rokaya *et al*. 2013). Orchids as a whole are cited under Appendix II of CITES except *Paphiopedilum insigne* and *Paphiopedilum venustrum* (Appendix I). They are important aesthetically, medicinally and also regarded as ecological indicator (Joshi *et al*. 2009). They are very popular in every corner of the world due to their various shape, size, habit, habitat, colourful flowers, long lasting bloom, shinning green leaves and variously shaped pseudobulbs. A total of 90 species of orchids of Nepal have been reported to have medicinal value by Pant and Raskoti (2013). Whole plants as well as their different parts, viz., roots, rhizomes, pseudobulbs, stems and leaves are used as medicine. These are used for treatment of different diseases such as general debility, stomachache, bone fractures, colds, wound healing, general weakness and to cure various other diseases.

Cymbidium devonianum occurs as an epiphyte on tree trunks or lithophytes on mossy rocks at elevations of 1500-2000 m asl (Rajbhandari and Bhattarai 2001). It has high aesthetic value so is used as an ornamental plant in different gardens, nurseries, hotels, etc. Its medicinal value is due to paste of its root which is applied to treat boils and concentrated decoction of the plant is taken in case of cough and cold (Manandhar 2002). Its high market price in the national and international markets has led to its rampant collection from its natural habitat and is restricted to very narrow pocket areas.

Orchid seeds lack functional endosperm so the germination of seeds requires an aid of suitable fungus. The germination rate of orchid seeds in nature isonly 2-5% (Rao1977) even if they do so, the seeds take a long time for their germination and any disturbance in the habitat or physical environment destroys the whole population. Also, the seedlings take 12 years to become an adult plant (Basker and Narmatha Bai 2006). Vegetative propagation of orchids through division of clumps of rhizomes, bulbs or by the rooting of off-shoots is slow and difficult to obtain desired number of orchids. These difficulties in natural germination and vegetative propagation drives some of the indigenous species to extinction. Hence, tissue culture provides the best alternative for the large scale propagation and ultimately for the conservation of rare and endangered orchids.

Materials and Methods

An immature capsule of *Cymbidium devonianum* Paxton collected from the orchid house of National Botanical Garden, Godawari, Kathmandu was used for this research.

The capsule of *C. devonianum* was sterilized by washing under running tap water besides 2-3 drops of between 20 for 50 minutes until the water became totally clear and transparent. The capsule was then rinsed in 70% ethyl alcohol for 2 minutes and 1% solution of sodium hypochlorite for 10 minutes. Finally it was rinsed with sterile water for five times.

Murashige and Skoog (MS) medium, basal medium, was used alone and in different combinations of 6-Benzylaminopurine and á-Naphthalene acetic acid for seed germination (as given in Table 1). The MS medium supplemented with BAP (1 mg/l), Kinetin (1.5 mg/l) and 10% coconut milk was also used. The medium was supplemented with 3% sucrose. The pH of the medium was adjusted to 5.8 before autoclaving and solidified with 0.8% (w/v) agar. The medium was autoclaved at 15 psi for 15 minutes.

The sterilized capsule was then dissected longitudinally using sterile surgical blade inside pre-sterilized laminar air flow cabinet. The seeds were then inoculated on the surface of MS medium alone and in different combinations of BAP and NAA using sterile forceps. The cultures were incubated at 25± 2°C under photoperiod of 16/8 hours light/ dark cycle.After the initiation of germination data was taken at regular intervals of one week. The photographs of distinct phases of germination and their growth and development were also taken accordingly. The protocorm like bodies (PLBs) obtained were thinned by culturing in the above combinations of the medium in addition to the MS medium supplemented with BAP (1 mg/l), Kinetin (1.5 mg/l) and 10% coconut milk and incubated.

Results and Discussion

In the present study, hormone free MS medium and the medium supplemented with different combinations of hormones were found to be efficient for the germination of immature seeds up to the development of protocorms like bodies (PLBs). Immature capsule was selected for this research as it shows better germination response and saves time (Pant 2006). The most effective germination response for *C. devonianum* was found to be on MS medium supplemented with BAP (2 mg/l) and NAA (0.5 mg/l). The quantity and nature of growth regulators have significant effect on the germination of orchid seeds (Arditti 1992).

The most appropriate medium was selected on the basis of time taken for germination of seeds and their growth and development. Initiation of seed germination was observed after 10 weeks of culture. It was also similar with the findings of Pradhan and Pant (2009) on the seed germination of *Cymbidium elegans* and Shibu *et al*. (2012) on *Coelogyne nervosa* and *Porpax reticulata*. PLBs were obtained after 11 weeks of culture and the PLBs formed on different media were chlorophyllous and globular. Similar finding was also reported by Pradhan and Pant (2009) in PLBs formation of *Cymbidium elegans*.

The first shoot initial was obtained after 23 weeks of culture but the further differentiation into seedlings ceased and it started to become achlorophyllous after 32 weeks of culture. This result showed that the additional organic supplements were needed for the effective germination and development of seedlings. Therefore, the chlorophyllous PLBs were inoculated on fresh MS medium supplemented with 1 mg/l BAP, 1.5 mg/l Kinetin and 10% coconut milk in addition to the different combinations of MS medium mentioned in the table 1. Subsequently well-developed shoots were obtained after 10 weeks of primary culture of PLBs on MS medium supplemented with BAP (1 mg/l), Kinetin (1.5 mg/l) and 10% coconut milk followed by medium supplemented with BAP (2 mg/ l) and NAA (0.5 mg/l). Arditti *et al*.,(1981) reported that the improvement in the nutritional status of the basal medium with additives likes vitamins, amino acids and hormones promote seed germination in many orchids.

Table 1: Effect of growth hormones supplemented to MS medium on seed germination and seedling development of *Cymbidium devonianum* Paxton

Medium	Growth hormones	Concentration of hormones (mg/l)	Observation taken in weeks		
			Initiation of germination	PLBs formation	1st shoot formation
MS	-	-	10	12	27
MS	BAP	0.5	14	20	
MS	BAP	1	13	14	
MS	BAP	1.5	14	21	
MS	BAP	2	13	14	
MS	NAA	0.5	10	12	
MS	BAP+NAA	0.5+0.5	11	13	25
MS	BAP+NAA	1+0.5	10	12	24
MS	BAP+NAA	1.5+0.5	11	13	25
MS	BAP+NAA	2+0.5	10	11	23
MS	NAA	1	12	13	25
MS	BAP+NAA	0.5+1	12	13	25
MS	BAP+NAA	1+1	11	12	24
MS	BAP+NAA	1.5+1	11	12	24
MS	BAP+NAA	2+1	12	13	24

Culture conditions: 25± 2˚C, 40 weeks, 16 hours photoperiod and 6 replicates were used in each combination.

Conclusion

MS medium supplemented with BAP (2mg/l) and NAA (0.5 mg/l) was found to be the best for *in vitro* seed germination and seedlings growth of *Cymbidium devonianum* Paxton suggesting that the phytohormones BAP and NAA both are necessary for its fast growth and development. Similarly, MS medium supplemented with BAP (1 mg/l), Kinetin (1.5 mg/l) and 10% coconut milk was found to be most effective for PLBs culture.

Acknowledgement

The author would like to express sincere gratitude to Dr. Sushim Ranjan Baral, former Head- and Dr. Khem Raj Bhattarai, Head, National Herbarium and Plant Laboratories, Godawari for providing necessary laboratory facilities for this research. I would also like to thank National Botanical Garden, Godawari for providing the orchid capsule for the research.

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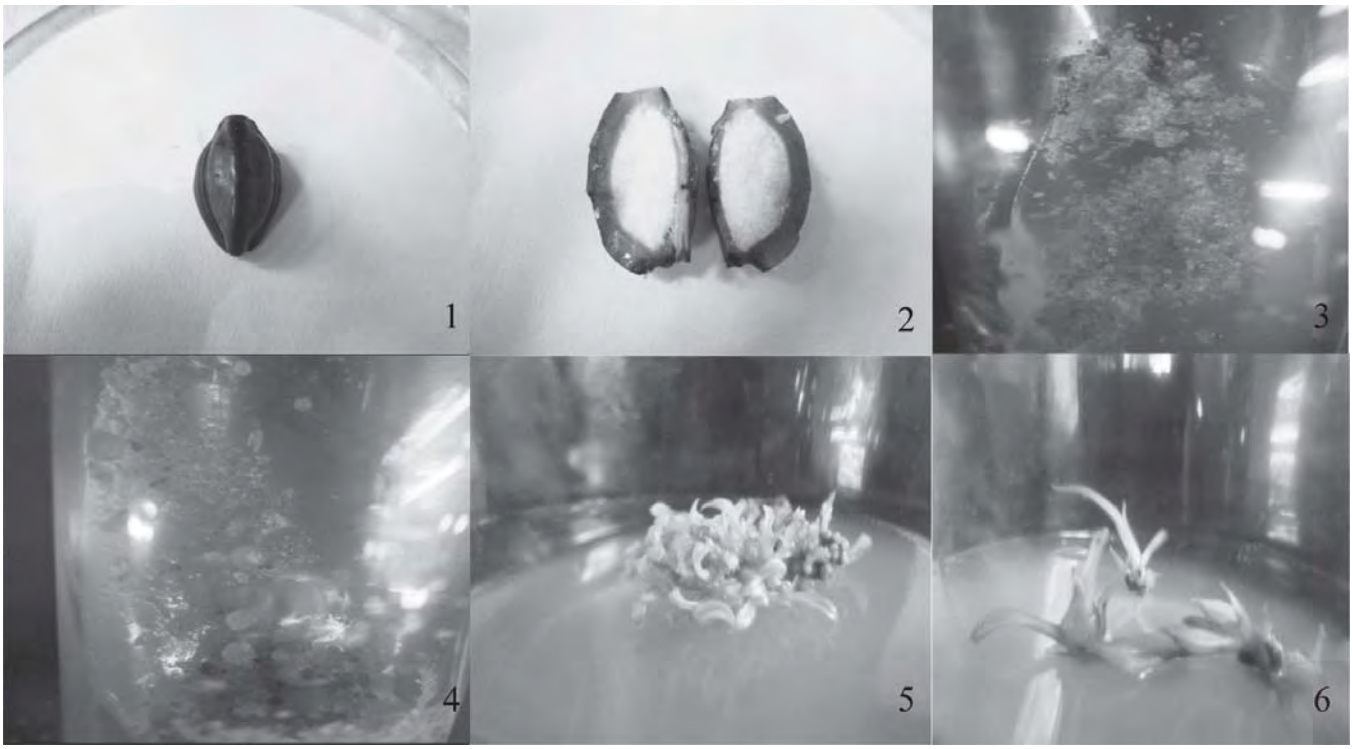

Figures : (1) An immature capsule of *Cymbidium devonianum*Paxton; (2) Capsule cut longitudinally into two halves; (3) Protocorm like bodies (PLBs) on hormone freeMS medium after 12 weeks of culture; (4) Swelling of PLBs on MS medium supplemented with 0.5 mg/l BAP and 0.5 mg/l NAA after 15 weeks of culture; (5) Development of shoots on MS medium supplemented with 2mg/l BAP and 0.5 mg/l NAA after 25 weeks of culture; (6) Development of shoots onMS mediumsupplemented with BAP (1 mg/l), Kinetin (1.5 mg/l) and 10% coconut milk.

Vegetative propagation technology of *Rosa moschata* Milli. at different conditions in National Botanical Garden, Godawari

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Abstract

Study on cuttings behaviour of Rosa moschata Milli. was carried out in different conditions in National Botanical Garden. Data were collected by random sampling method. Phenotypic traits like height of plant, total number of adventitious roots and branch numbers were taken as indicators in 12 different individuals out of total 25 populations. Observed morphological data showed range of variation in cutting of Rosa moschata. On the basis of characters like height of plant, total number of adventitious roots and branch numbers, cuttings grown inside Glass-House where temperature is found highest among other sites showed superior population. Survival rate of cuttings is found highest in Glass-House site.

Key words: Variation in cutting behavoiur, vegetative propagation technology, best condition for cuttings, Survival rate, *Rosa moschata*.

Introduction

Angiosperms are the most developed and advanced among the plants community. They all bear flowers and fruits through which they reproduce sexually and they also can perform the vegetative propagation. These can perform natural vegetative reproduction by rhizome, corm, bulb, tuber, runner, sucker, offset, stolen, leaf and root as well. In horticulture, identical offspring with rapid multiplication rate is required for proper plantlet. So people use the artificial technique of vegetative propagation for several plants according to their different purpose. Various artificial technique of vegetative propagation like cutting, grafting, layering, budding, tissue culture *etc*. can be applied for plant improvement. Cutting is commonly used process of vegetative propagation. In this technique, a short segment of stem is cut and planed in soil with suitable conditions. Adventitious roots and leaves start to develop and independent plant is formed. Hormone, rootex, can be applied for fast result. Natural population of plant shows intricate pattern of variation (Briggs and Walters, 1997). Intra and inter population variation in nature are nearly of quantitative rather than discontinuous kind (Falconer, 1981). Variation in the phenotypic traits may be due to environmental or genetic control to which it is exposed (Joshi and Joshi, 1998). Significant variation between progenies derived from a single maternal parent have been taken to indicate that a significant heritable component exist for measured characters (Jones, 1971).

Rosa moschata (Family: Rosaceae, Local Name; Bhaisi Kanda or Jangali Gulaf) is ornamental plant and its domestication is going on without proper knowledge on its cultivation. Study of cuttings at different environmental conditions help for the selection of proper behavior condition for its cultivation. Therefore, present study carried out to assess the morphological variation among cuttings of *Rosa moschata* with the aim to select appropriate environmental condition for domestication. Rose is one of the nature's beautiful creations and is universally acclaimed as the queen of flower (Yadav *et. al*. 1989). Roses are symbol of beauty, fragrance and are used to convey the message of love. Gardens are not considered complete without roses (Arora, 2007). In the global pretex, Rose is the first ranked cut flower launched by Floriculture Association Nepal (FAN) for multi location trails and has become quite successful (Pun, 2004). Roses are found growing from plains to the suitable hilly region and come to bloom in different seasons Adhikari, Devraj).

Rosa moschata is distributed in C. & W. Himalaya (Afghanistan to Nepal). It is common on open and sunny place as well as shady place of east, central and west Nepal with suitable environment. The flowering season is April and fruiting in August to October. *Rosa moschata* is a prickly scan dent glabrous shrub. Leaves alternate, stipulate, pinnately compound, 9- 15 cm long, leaf-lets 5- 9, elliptic lanceolate,3-5 cm long and 1- 2 cm broad, serrate, acute or acuminate, base rounded, glabrous. Inflorescence is terminal corymbs, 9 cm long and 10 cm broad. Flowers pedicellate, bracteates, white. Calyx-tube obovoid, lobes -5, lanceolate,caudate-acuminate, entire, deciduous. Petals- 5, 2 cm long, 1.5 cm broad, obovate, obtuse, entire, white.Stamen numerous inserted on the disc, anther bilobed, dorsifixed. Carpels numerous, inserted in the lower portion, sessile. Style united in a column producing far above the calyx-mouth. Fruit- globose,red (Flora of Kathmandu valley and Flora of Phulchoki and Godavari).

Materials and methods

Cuttings of *Rosa moschata* were planted in different conditions (*i.e*. Open- field, Glass- House, Shade-House and Poly- House) in Jan 18, 2012 without using any growth regulators. Twenty five cuttings of *Rosa moschata* were planted in each site. Mature and healthy 12 plants were randomly selected from each site after four months. Height, total number of adventitious roots and branch numbers were measured for each plant. The temperatures for each site were noted in every week up to four months. The numbers of survival cuttings were also observed.

Materials required: Secateurs, Beaker, Thermometer, healthy twig of *Rosa moschata* Milli.

Result

Survival rate of cuttings

80 % cuttings are survived inside Glass-house (where temp. is 26^{0}C) while on the open-Field (where temp. is 18^{0}C) this percentage is found only 44%. Here survival rate increases with the increasing of temperature (Table-I).

Variation of cuttings at different condition

Total numbers of branches, adventitious roots and height of shoots are found maximum in cuttings grown inside Glass House while the cuttings grown on open field these characters are found minimum. Thus plants developed at different conditions show variation (Table-II).

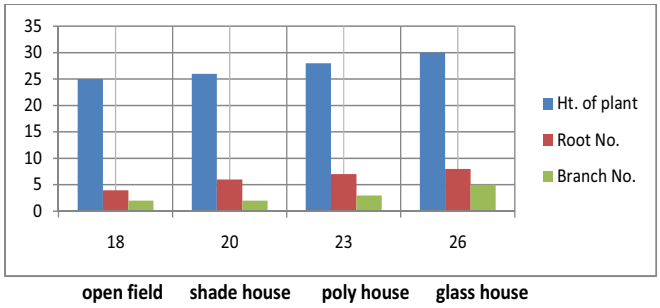

Figure-1: variation of height, root No. & branch No. with Temp.

Conclusion

Total number of branches, adventitious roots, height and survival rate found maximum in plant grown inside glass house showed that warm condition is best for cuttings of *Rosa moschata*. Morphological traits are controlled by environmental factor or some gene. For the confirmatory test, it is suggested to progeny test, reciprocal transplant practice as well as study on molecular level.

Acknowledgement

I express my sincere gratitude to Mr. Yam Bahadur Thapa, Director General of Department of Plant Resources, Mr Dipak Lamichhane, Senior Garden Officer of National Botanical Garden and Mr. Bindeshwor Roy for valuable suggestions. I would like to acknowledge Mr. Dammar Bahadur Karki and all National Botanical Garden family.

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Table-I, Survival rate of cuttings

SN	Site	No. of plants for cutting	Survived & rooted	% of survival
1	Glass-house	25	20	80
2	Poly-house	25	18	72
3	shade-house	25	15	60
4	Open-field	25	14	44

Table-II, Phenotypic variations of *Rosa moschata* in different sites

Sites	Temperature (in ^{0}C)	Height of Plant(in cm)	Number of Roots	Number of Branches
Glass-House	26	30	8	5
Poly-House	23	28	7	3
Shade-House	20	26	6	2
Open-Field	18	25	4	2

Some photographs

Cuttings on Open- Field

Cuttings inside Poly- House

Cuttings inside Glass-House

Branching of *R.moschata*

longest plant of *R. moschata*

Roots of *R. moschata*

Study of traditional medicinal practice in Bridhim VDC of Rasuwa District, Central Nepal

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Abstract

Study of traditional medicinal practice was carried out in Bridhim VDC of Rasuwa District, Central Nepal. The use of 20 different important medicinal plants was documented using Ethnobotanical approach.

Background

Ethnobotany is the relationship of people and plant. It aims to document the knowledge acquired by the indigenous people traditionally from their ancestors. The knowledge acquired by these people is accumulated to themselves only having little or no use. The precious knowledge on plants acquired by these people is being diminished due to peoples lure towards the modern technology. After some years, hardly some people having the traditional knowledge about plants would be left. So it is very necessary to explore and document the existing knowledge of the plant which can be a very important information tool for the future.

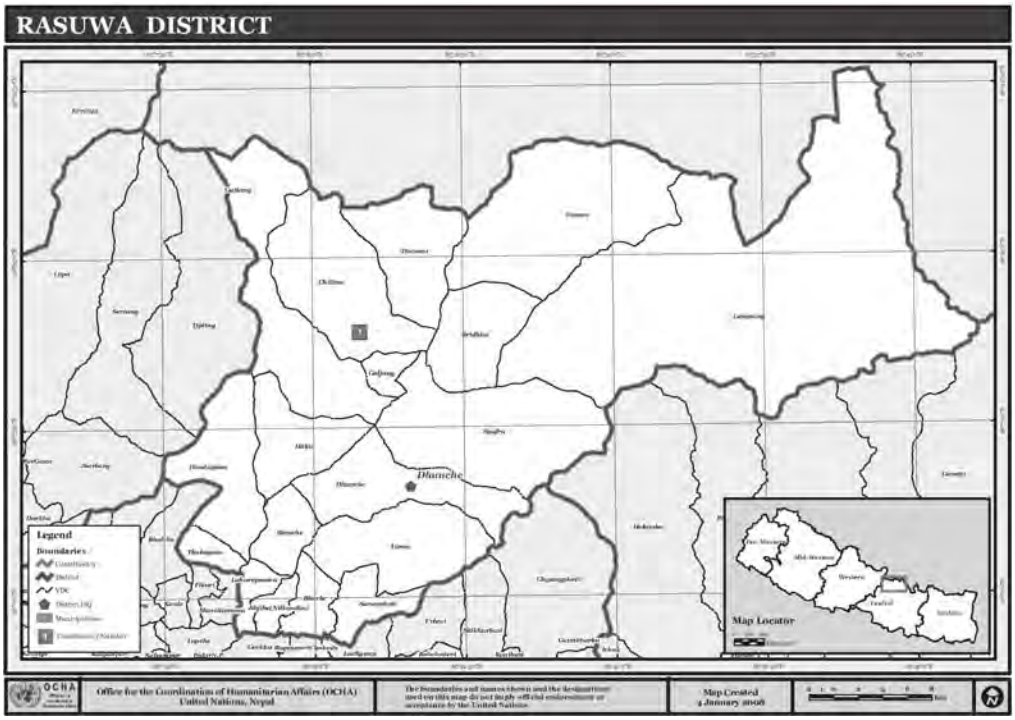
Traditional medicinal practice is one of the very important branches to be explored. It deals with the use of some plants as medicines. The practice differs according to the tradition, geography, vegetation, etc of the place. It is a well-known fact that some modern medicines have been formulated from the herbal plants through an Ethnobotanical approach.

Ethnobotany reveals historical and present plant use to fulfill a wide variety of human needs. Documenting indigenous knowledge through the ethnobiological approach is important for species conservation and sustainable resource use. Furthermore such studies are often significant in revealing locally important plant species, sometimes leading to the discovery of crude drugs or contributing to economic development. Globally, millions of people in the developing world rely on medicinal plants for primary health care, income generation and livelihood improvement. Indigenous people living on their traditional territory largely rely on medicinal plants for healthcare and they are therefore rich in ethnopharmacological knowledge. Scientific research is needed to determine the active principles of traditional medicinal recipes and to evaluate their effectiveness, so that benefits could be equally shared among local peoples in the spirit of the Convention on Biological Diversity. Medicinal plants play vital role in the Nepalese livelihood and the use of medicinal plants is frequent in several Nepalese regions. It is estimated that only 15-20% of the population of Nepal living in and around urban areas has access to modern medicinal facilities, whereas the rest depend on traditional medicines. Several ethnopharmacological studies have been conducted in Nepal, but many parts of the country remain unexplored.

Study area

A field study was carried out in Bridhim VDC of Rasuwa district of Central Nepal. The district lies between 27° 2’ and 27° 10’ N and 84° 45’ and 85° 88’ E, with altitude ranging from 792 to 7245 m above sea level. The district presents some of the best examples of graded climatic conditions in Central Himalaya. Pronounced altitudinal gradients, coupled with complex Tamang indigenous people, which comprises 98% of the total Bridhim VDC population. People from the Tamang ethnic group have a rich culture and possess sound traditional knowledge. However, they are economically and socially marginalized and far from having their basic needs fulfilled. Topography and geology have resulted in a rich biodiversity and unique vegetation

patchwork. Therefore, the district harbors a rich diversity of medicinal plants. The Bridhim VDC lies in the central part of the district.



Materials and Methods

Ethnopharmacological data was collected by conducting interviews and focus group discussions with local people from Briddhim VDC of Rasuwa district. Participants were purposively selected to include key informants like plant collectors, medicinal plant cultivators & traditional healers. Respondents were all from the Tamang ethnic group, predominant (65%) in Rasuwa district. Prior informed consent was obtained with the help of community workers that also facilitated interviews and discussions with the local people. Consent was granted by the local people for the dissemination of their traditional knowledge. Guidelines for the interviews and group discussions were developed to facilitate the collection of information. Interviews and group discussions were conducted to gather information on plant uses, parts used, and modes of utilization. A checklist was developed and used to determine what species were used to treat what kinds of diseases/disorders. Herbarium specimens were collected for those species for which field identification was not certain and brought back to the lab to facilitate identification using reference collections.

Key Informants

1. Mipsang Lama
2. Kinjo Ghaisen
3. General public or villagers

Results

The ethnobotanical survey identified a total of 20 medicinal plant species used to prepare a wide variety of remedies (Table 1) in Traditional medicinal system of Bridhim VDC of Rasuwa district, Central Nepal.

Conclusion

The Tamang people of Rasuwa district Central Nepal possess rich ethnopharmacological knowledge and therefore use several medicinal plant species in their traditional healthcare delivery system. Medicinal plants provide huge opportunities for community development and livelihood improvement. However, local people are often deprived of the benefits from these resources. Proper management of high-value and high-priority medicinal plants could serve as a sustainable income source for the communities. This would in turn help generate incentives for biodiversity conservation, thus ensuring the long-term availability of medicinal plants for indigenous and commercial uses. Documentation of the indigenous knowledge is an urgent need of the country for the purpose of Bio-prospecting and Patenting of our natural resources.

Table 1 : List of medicinal plants used in traditional medicinal practice in Bridhim.

S.No.	Scientific Name	Family Name	Local Name	Part used	Uses
1.	*Acorus calamus* Linn.	Araceae	Chutaka Su dag nagpo	Rhizome	Paste of rhizome is use to heal wound
2.	*Aconitum naviculare* (Brunl) staf.	Ranunculaceae	Bongkar	Root tubers	Tuber paste used as anti poisonous in may types of poisoning
3.	*Aconitum spicatum* (Buuehl) Stapf	Rananculaceae	Ganumen Bongnak	Tuber	Tuber juice given in stomachic, gastritis, gout, constipation
4.	*Allium wallichii* Kanth	Amaryllidaceae	Ruicpa yang	Leaves	Leaves are used to treat altitude sickness.
5.	*Artemisia indica* willd	Compositae	Chhaphung	Leaf	Leaf juice given to children 2/3 times a day to treat fever.
6.	*Berberis aristata* DC.	Berberidaceae	Kerpa kyumsa	Root	Root paste obtained by boiling the pieces in water is applied to treat sinusitis
7.	*Datura stramonium* Linn.	Solanaceae	Mdak rda-rdu-ra	Seeds	The dense smoke made by boiling its seeds with edible oil kills the germs of the teeth.
8.	*Gentiana capitata* Buch-Ham ex.D.Don	Gentianaceae	Pangyenmbu	Flower	Flower juice is given 2/3 time a day to treat cold & fever in small children & infants.
9.	*Geranium pretense* L.	Geraniaceae	Sangemimen ligadur ngonpo	Leaves	Leaf juice mixed with water applied on eyes drop by drop to treat eye infections.
10.	*Hedera nepalensis* K. Koch	Araliaceae	Cantarmundo khan	Whole plant	Head wrapped with this plant relieves headache.
11.	*Malva verticillata* Linn.	Malvaceae	Chytalama champalenmu campa	Leaves	Leaf paste is applied to the swelling parts of the body 2/3 time a day to take out water.
12.	*Penus roxburghii* Songent	Pinaceae	Thamsingdong selta	Resin	Resin mixed in Luke worm water administered to children to treat cough
13.	*Potentilla fulgens* Wall ex.Hook	Rosaceae	Dholo sengezilpa	Root	Root juice mixed with hot/cold water given 2/3 time a day is dysentery.
14.	*Princepia utiles* Royle	Rosaceae	Migung Melingo Tescha	Oil extracted From ripe fruit	To sooth throat To heal wounds 2/3 times a day
15.	*Rhoidodendron arboreum* Sm.	Ericaceae	Mendro tog dar mpo	Flower petals.	Flower petals juice is applied in stinging throat
16.	*Roscoea purpurea* Smith	Zingiberaceae	Phase	Root tubers	Tuber paste used in cold & fever
17.	*Sphaeranthus indica* Linn	Compositae	Wanla	Root	Root paste is taken with milk as tonic for week person.
18 .	*Swertia chirayita* (Roxb.ex Flem) Karsten	Gentianaceae	Tigta	Whole plant	Whole plant juice given 2/3 times a day in fever.
19.	*Thlaspi arvensis* Linn.	Cruciferaceae	Khaktichyoma cambree brega	Seeds	Seed power given 1/2 time a day to get ride of stomach worms.
20.	*Zanthoxylum armatum* D.C	Rutaceae	Gyerma	Seeds	Seeds used to maintain blood level

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A preliminary screening of some Nepalese medicinal plants for antimicrobial activity

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Abstract

The alcoholic extracts of 31 medicinal plants were tested for antimicrobial activity againt seven species of bacteria (*Bacillus subtilis, Eshcherichia coli, Enterococcus faecalis, Klebsiella pneumoniae, Salmonella typhii, Shigella dysenteriae, Staphylococcus aureus*) and two species of fungi (*Candida albicans* and *Saccharomyces cerevisiae*). Among these, 50% ethanolic extracts of two plants, viz. *Chlorophytum arundinaceum* and *Tagetes minuta*, were found to be moderately active against bacteria *Enterococcus faecalis* and *Salmonella typhii* respectively while methanolic extract of *Punica granatum* showed encouraging activity against *Escherichia coli*, *Staphylococcus aureus*, *Shigella dysenteriae* and *Enterococcus faecalis*. Similarly, *Allium humile*, *Trillidium govanianum*, *Rudbekia* spp. showed only weak activity againt bacteria *Enterococcus faecalis*.

Key words: Antimicrobial activity, plant extract, bacteria, fungi

Introduction

Plants are the richest resource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Hammer *et al.*, 1999).Medicinal plants have been used for centuries before the advent of orthodox medicine (Sharma *et al.*, 2010). Herbal medicine is still the mainstay of about 75 - 80% of the whole population, and the major part of traditional therapy involves the use of plant extract and their active constituents (Akerele, 1993).

Among the 7,000 species of medicinal plants recognized all over the world, more than 900 types of precious medicinal plants are said to be found in Nepal (Manandhar, 2000). About 1500 plants are systematically used in indigenous system of medicine, like Ayurveda, Unani and Siddha (Joshi *et al*, 2010). However, the scientists are constantly still in search of medicinal efficacy of plants and their phytochemicals. Herbal and natural products have been used in folk medicine for centuries throughout the world, but there are relatively lower incidences of adverse reactions to plant preparations compared to modern conventional pharmaceuticals. This coupled with their reduced cost, is encouraging for both the consuming public and national health care institutions to consider plant medicines as alternatives to synthetic drugs (Nair et al., 2005).

In the recent years, the development of resistance of pathogens against antibiotics has become a difficult issue caused by the indiscriminate use of modern antibiotics (Kunin, 1993). Resistance to antimicrobial agents is recognized at present as a major global public health problem. In the industrialized nations, despite the progess made in the understanding of microorganisms and their control, incidences of epidemics due to drug resistant microorganisms and the emergence of hitherto unknown disease causing microbes, pose enormous public health concerns (Iwu *et al*., 1999). In the wake of emergence of multiple drug resistance in many microbes of general health concern, it is only highly pertinent that the scientific world look into different potential sources of neo drugs which can be effective against these challenging maladies. Plants have traditionally been proven and are being used to cure several diseases from time immemorial. Further, drugs such as sulphanilamides, butylscopolamine, hyosyamine, methyl salicylic acid, quinine etc, which are being used in allopathic medicine, have been extracted, derived or fabricated from different plants. This is a non-deniable evidence of plant biodiversity being the most important potential source of such new antimicrobial drugs from plants. Thus screening of plant extracts and secondary metabolites may provide an important lead to the discovery of highly efficient ideal drug.

Materials and Methods

Preparation of Extracts: The test plant materials were air dried then powdered in grinder. Extraction was carried out in percolator with methanol or 50% ethyl alcohol. The extract was concentrated in rotary vacuum evaporator at 60°C under reduced pressure and finally dried in water bath. The extracts so obtained were sealed inside a sterilized 20 ml culture tubes and stored in a refrigerator at 2-8°C.

Assessment of antimicrobial properties: Agar Disc diffusion method was used to assess the antimicrobial activity of the obtained extracts (Cheesbrough, 1989). Solution of the extract (0.1 $g.ml^{-1}$) was prepared in methanol or 50% ethanol. Sterile 6 mm discs of Whatman no.1 filter paper were prepared and were saturated with the extract solution. The saturated discs were dried in an incubator at 37±2°C overnight then stored in a refrigerator at 2-8°C. Streptomycin sulphate discs (50 ìg/disc) were used as control.

Microorganisms used for screening: The plants were tested for antimicrobial activity against seven species of bacteria viz. *Bacillus subtilis*, *Eshcherichia coli, Enterococcus faecalis, Klebsiella pneumonia, Salmonella typhii, Shigella dysenteriae* and *Staphylococcus aureus*, and two species of fungi viz. *Candida albicans* and *Saccharomyces cerevisiae*. These standard organisms had been obtained from National Chemical Laboratory, Industrial Microbiology Unit, Pune-4110008.

Seeding of culture media and incubation: 0.5 ml of 0.5 McFarland standard concentrated test organisms were inoculated into 10 ml melted and cooled sterilized Muller Hinton Agar (for bacteria) and Sabouraud Dextrose Agar (for Fungi). The plates were dried for five minutes at 37±2°C. The discs of antibiotic (positive-streptomycin), extract (Test plant extract) and control (blank- pure solvent containing disc) were placed aseptically on the inoculated agar surface. The plates for bacteria were incubated at 37±2°C for 24 hours and for fungi were incubated at 25±2°C for 24-28 hours.

Reading: Inhibition of the growth was indicated by a clear area (zone of inhibition) around the disc. The diameter of the zone of inhibition was measured in millimeters with the help of vernier calipers.

Result and discussion

Among the 30 plant extracts screened for antimicrobial activity, 8 showed antimicrobial activities. Seven extracts showed antibacterial activities while only one showed antifungal activity. However, strong antibacterial activity was expressed only by methanolic extract of *Punica granatum* against *Escherichia coli, Staphylococcus aureus, Shigella dysenteriae* and *Enterococcus faecalis*. Similarly, *Chlorophytum arundinaceum* showed weak antimicrobial activity against *Staphylococcus aureus* and *Salmonella typhii*, and moderate activity against *Enterococcus faecalis*. Likewise *Rudbekia* spp. showed weak activity against *Escherichia coli*, *Staphylococcus aureus*, *Shigella dysenteriae*, *Klebsiella pneumonia* (Table 1).

Ahmad and Beg (2001) have reported that alcohol extracts of pomegranate fruits showed antibacterial activity when tested against *Staphylococcus aureus, Escherichia coli* and *Shigella dysenteriae*. Parashanth *et al*. (2001) also reported methanolic extacts of pomegranate fruit rind to be active against all microorganisms tested in their study. Mathabe *et al*. (2005) showed that methanol, ethanol, acetone and water extracts obtained from pomegranate rind were active and effective against the tested microorganisms (*Staphylococcus aureus, Escherichia coli, Salmonella typhii, Vibrio cholera, Shigella dysenteriae, S. sonnei, S. flexneri and S. boydii*). Dahham *et al.* (2010) studied antimicrobial activity of extracts from different parts of pomegranate including pomegranate Juice, pomegranate seed oil, pomegranate pericarp (peel, rind), pomegranate leaves, pomegranate flower and pomegranate roots, and reported that extract from promegranate rind had highest antimicrobial activity in comparison to other extracts particularly against *Staphylococcus aureus* and *Aspergillus niger*. Ahmet *et al*. (2009) also reported the *in vitro* antibacterial activity of extracts obtained from six pomegranate cultivators against the bacteria *Bacillus megaterium, Pseudomonas aeruginosa,* against *Candida albicans, Staphyloccus aureus, Escherichia coli* and *Enterococcus faecalis,* showing inhibition zones ranging from 13-26 mm.

Valya *et al.* (2009) reported that the root extracts of *Chlorophytum arundinaceum* in solvents like petroleum ether, benzene, ethyl acetate, hydro-alcohol, methanol and chloroform showed moderate antimicrobial activity whereas the aqueous root extract expressed no antimicrobial activity.

According to Jafari Marandi *et al*. (2010), the methanol and ethanol extracts of *Rudbeckia hirta* had greater inhibitory effect on microorganisms including *Kelebsiella pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Bacillus anthracis* and *Streptococcus pyogenes* in comparison to aqueous extract.

Hence, from this study, it could be concluded that plants can be important source of effective antimicrobial drugs. Methanolic extract of *Punica granatum* was found to have significant antibacterial activity. Further researches need to be carried out to identify, quantify and verify its active components, MIC, MBC, suitable dose, high yielding variety, administration method etc. This study was mostly carried out using 50% ethanolic extracts of the plants. Since previous studies have shown that extraction with other solvents may also yield antimicrobially active extract, screening of extracts using other solvents seems necessary.

Acknowledgement

We would like to express our sincere gratitude to Mr. Yam Bahadur Thapa, Director General, Department of Plant Resources, Thapathali for providing us excellent opportunity to carry out this research. Thanks are also due to Natural Products Research Laboratory, Thapathali for providing us the extracts of the plant materials for the screening.

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Table 1 : Antimicrobial activities of the plant extracts screened plant extracts

S.no.	Name of Plants	Local name	Parts of Plants	Bacteria							Fungi	
				Bacillus subtilis	*Escherichia coli*	*Staphylococcus aureus*	*Shigella dysenteriae*	*Salmonella typhii*	*Klebsiella pneumoniae*	*Enterococcus faecalis*	*Saccharomyces cerevisciae*	*Candida albicans*
1.	*Allium humile* Kunth.	Ban jimmu	Bulb	-	-	-	-	-	-	+	-	-
2.	*Alstonia scholaris*	Chatiwan	Bark	-	-	-	-	-	-	-	-	-
3.	*Anaphalis triplinervis*	Buki phul	Whole plant	-	-	-	-	-	-	-	-	-
4.	*Anisodus loridus*		Aerial branch	-	-	-	-	-	-	-	-	-
5.	*Asparagus currilus*	Kurilo	tuberous root	-	+	-	-	-	-	-	-	-
6.	*Astibul rivularis*	Budo awakhati	Rhizome	-	-	-	-	-	-	-	-	-
7.	*Bobax ceiba*	Simal	Flower	-	-	-	-	-	-	-	-	-
8.	*Bryophyllum* spp.		leaf	-	-	-	-	-	-	-	-	-
9.	*Buddleja* spp.	Bhimsen pati	Whole plant	-	-	-	-	-	-	-	-	-
10.	*Catharanthus roseus*	Barhamase phool	leaves	-	-	-	-	-	-	-	-	-
11.	*Ceropegia pubescens*	Ban simi	bark	-	-	-	-	-	-	-	-	-
12.	*Chlorophytum arundinaceum*		Bulb	-	-	+	-	+	-	++	-	-
13.	*Dioscorea bulbifera*	Gittha	tuber	-	-	-	-	-	-	-	-	-
14.	*Dioscorea deltoidea*	Vyakur	Rhizome	-	-	-	-	-	-	-	-	-
15.	*Flemingia chappar*	Bhatmas lahara	Whole plant	-	-	-	-	-	-	-	-	-
16.	*Gaultheria fragrantissima*	Dhasingre	Leaves	-	-	-	-	-	-	-	-	-
17.	*Gentiana depressa*		Whole plant	-	-	-	-	-	-	-	-	-
18.	*Lyonia ovalifolia*	Angeri	leaves	-	-	-	-	-	-	-	-	-
19.	*Moringa olifera*	Sovanjan	leaves	-	-	-	-	-	-	-	-	-
20.	*Morus* spp.	Kimbu	leaves	-	-	-	-	-	-	-	-	-
21.	*Pieris formosa*	Timaal	Flowering branch, twig	-	-	-	-	-	-	-	-	+
22.	*Punica granatum* (50% ethanol)	Anar	rind	-	+++	+++	+++	-	-	+++	-	-
23.	*Punica granatum* (hexane)	Anar	rind	-	-	-	-	-	-	-	-	-
24.	*Quercus lanuginose*	Khasru	Branch, twig	-	-	-	-	-	-	-	-	-
25.	*Quercus lanuginosus*	Khasru	seed	-	-	-	-	-	-	-	-	-
26.	*Rudbekia* spp.	Mitho aalu	Rhizome	-	+	+	+	-	+	+	-	-
27.	*Stephania gracilenta*	Biral gano	Tuberous root	-	-	-	-	-	-	-	-	-
28.	*Tagetes minuta* (Ilam)	Jungali sayapatri	Whole plant	-	-	-	-	++	-	-	-	-
29.	*Tagetes minuta* (Jumla)	Jungali sayapatri	Whole plant	-	-	-	-	-	-	-	-	-
30.	*Trillidium govanianum*		Rhizome	-	+	-	-	-	+	+	-	-
31.	*Verbascum thapsus* L.	Bandarpuchhre	Whole plant	-	-	-	-	-	-	-	-	-

Legend:

Symbol	Antimicrobial activity	ZOI range
+	Weak	6-10 mm
++	Moderate	10-14 mm
+++	Encouraging	14-18 mm
++++	Highly encouraging	above 18 mm

Seasonal variation of the essential oil of *Nardostachys grandiflora* DC.

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Abstract

Due to variation in geoclimatic conditions the constituents in essential oil may vary with seasons and altitude. The essential oil obtained by hydro distillation of rhizome of *Nardostachys grandiflora* DC. collected From Lauribina area of Gosaikunda in three different seasons was analyzed by GC/MS identified in GC/MS library by the mass fragments matching procedure to find out the seasonal variation in chemical composition.

Key words: GCMS analysis, essential oil, *Nardostachus grandiflora*, seasonal variation.

Introduction

The herbaceous plant *Nardostachys grandiflora* DC. (family V*alerianaceae*), known in Nepal by the name of Jatamansi, is found from east to west at the range of 3200-5200m elevation in the high mountain, having a slope of 25-45 degree in alpine and subalpine zones of the Himalayas of Nepal. [1][2][3]. It is also found in locations of similar elevation of Sikkim, Punjab, Bhutan, Tibet and west China. It is listed in CITES Appendix II. It also known by the name of *N. jatamashi* DC and country of origin is Nepal. [4][5] It is an aromatic, perennial herb having underground rhizome which posses a characteristic smell. Upon hydro-distillation, essential oil is obtained at a yield of around 1-2%. This is of greenish color and has an unpleasant odor which is similar to expensive musk.[4] In Ayurveda, *N. grandiflora* is used for Madhya (brain tonic) Rasayan (rejuvenative to the mind) Nidrajana (promote sleep) pachan (promote digestion) and many other diseases [2]. The medicinal properties reported in recent days are anti-inflammatory, anti-aging, sedative, anti-spasmodic, astringent, cardio-tonic, antifungal, antibacterial and hepato-protective [3][4]. Due to these various properties, it has high value in trade and is a major exported herb from Nepal [6]. The essential oil is present on the hairy scale of rhizome which contains patchouli alcohol, virdiflorol, spathulenol, gammadione, maaliol, seychelene, aristolene, B-gurjenene, card-4-en-10-ol, intermediol, and jatamansone as major compounds [4].

Materials and Methods

A. Sample collection

Samples were collected from Lauribina area of Gosaikunda around 3900 m at three different seasons. One sampling was done on last week of Kartik of 2069 and other two were done on third week of Ashad and last week of Ashoj 2070 B.S. After digging, the rhizome was washed with water and dried for a week in shadow. The plant was identified at Natural Products Research Laboratory of DPR.

B. Extraction of essential oil

Each sample of (100 gram of chopped rhizomes) of three different seasons was submitted to hydro distillation for 8 hrs using Clevenger type apparatus. The oil obtained by decantation were dried over anhydrous sodium sulphate and stored at 4^{o}C till the GC analysis.

C. Analysis of essential oil samples

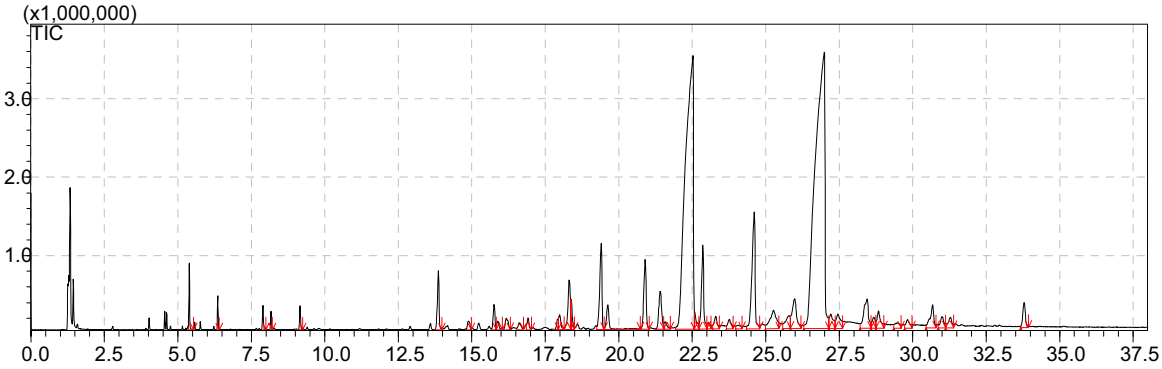
The essential oil was analyzed on a Shimadzu gas chromatograph (GC 2010) with Rtx-5MS column (25mX0.25mmX0.25micrometer). 0.5 micro liter

of undiluted essential oil was injected into the GC inlet after fixing the split ratio at 95. The initial temperature of the column was set to 50 degree centigrade programmed to rise up to 108, 180 and 250 degrees centigrade with the increase rates at 10, 2 and 15 deg centigrade/minute and the final temperature was held constant for 5 minutes.

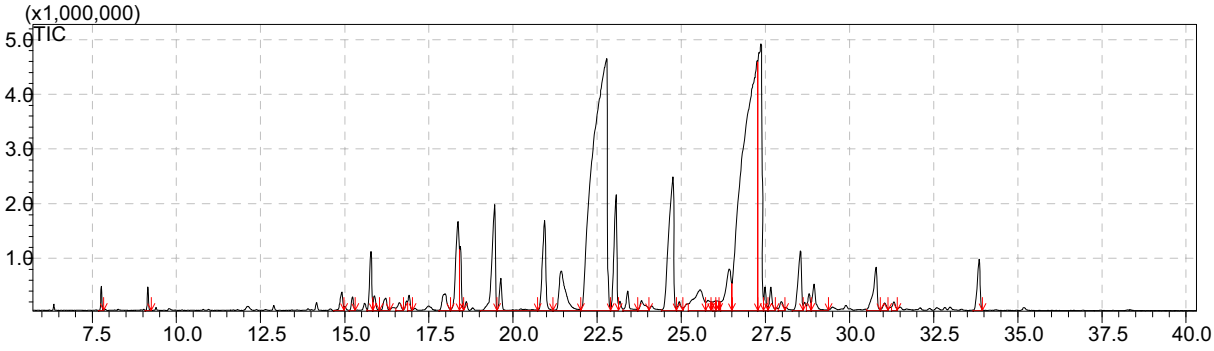
D. GCMS analysis

GCMS analysis was carried out in a Shimadzu GCMS-QP 2010. During the analysis the interface temperature was set at 250 degree centigrade and the column flow rate at 188.6 ml per minutes. The purge flow was 3.0 ml, the ion source temperature was 200 degree centigrade and the detector gain was 0.7 kV; the detector start speed was 2500 scanning range of M/z was 40-1090. The MS library used in analysis was NIST 05.

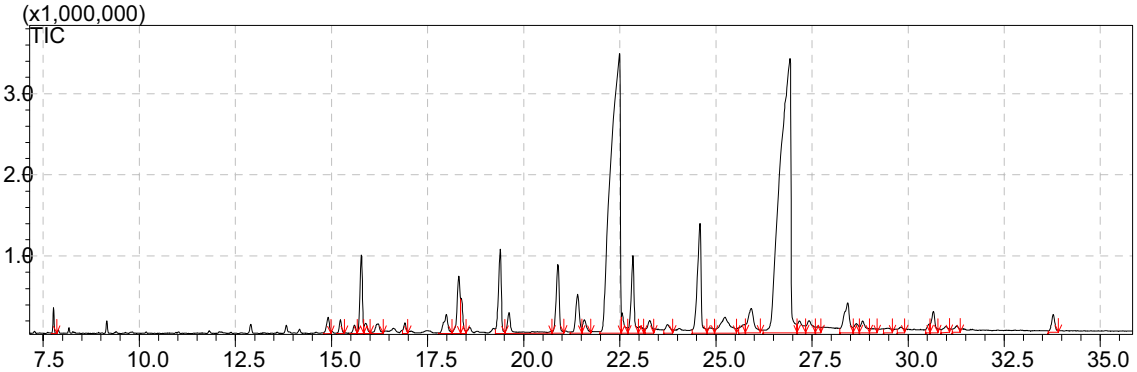
Chromatograms



Chromatogram of essential oil of Jatamashi collected in the last week of Ashoj of 2070



Chromatogram of essential oil of Jatamashi collected in the third week of Ashad 2070



Chromatogram of essential oil of Jatamashi collected in the last week of Kartik2069

Result

SN	oil percentage and major chemical constituents	last week of Kartik of 2069	3rd week of Ashad 2070	last week of Ashoj 2070	Remarks
1	oil percentage	0.87	2.1	2.0	
2	jatamansone	32.88	36.47	35	Compounds were identified with the help of MS. The numerical value in the table of major constituents is the peak area in chromatogram without considering correction factors.
	cardin-4-en-10-ol	37.19	32.19	34	
	viridiflorol	3.4	3.15	3.15	
	patchouli alcohol	3.0	3.0	2.0	
	intermedeol	1.12	0.38	0.74	
	muurolene	not observed	2.55	not observed	
	(-)-alpha pnasinaen	2.65	2.91	2.5	
	1-ethyl-4,4-dimethyl-cyclohex-2-en-1-ol	2.37	2.46	2.14	

Yield of essential oil percentage found varies 0.87 to 2.1 and highest percentage is found in third week of Ashad of 2070. Similarly the percentage of jatamanson is maximum in the same time but cardin-4-en-10-ol, one of the major constituent, has found maximum in last week of kartik of 2069.

Conclusion

Many other factors besides seasonal factor can influence the percentage and characteristics of the oil. In this study, result is based on the analysis of a single sample from each sampling time in one particular year only, so age and topographic factor are not considered here. Research on either cultivated plant specimen or choosing the proper wild plant specimen that represents the proper sampling along with considering topographic factor, would overcome the shortcoming of this study.

Aknowledgement

We would like to express our sincere thanks to Ms. Susma Upadhyaya (DDG, DPR), Jyoti Joshi, Chief, NPRL Kalpana Shrestha Samjana Pradhan, Parash Mani Yadav, NPRL and Rabindra Budha and Sishir Panthi, DPR.

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Pharmacognostic and phytochemical analysis of *Asparagus racemosus* Willd. from Makwanpur and Kailai districts of Nepal

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Abstract

Asparagus racemosus Willd. (Wild Asparagus) is one of the prioritized medicinal plants of Nepal. It is used medicinally for different purposes in different combinations. Nepalese Satavar (Pili Satavar) is considered as best quality drug in the Indian market in relation to its efficacy. The present study provides taxonomy, pharmacognostic and physico-chemical properties of the species from two districts, Makwampur and Kailali. It will help to standardize their purity and drug efficacy. Samples from Dhangadhi Kailai were found to have quality characteristics as demanded in trade and fetch high price as well. The samples from sukhad Dhangadhi shows the value nearest to standard value while other samples also found out to be fine according to standard value from Indian Pharmacopaea. The TLC analysis of samples from Kailai shows characteristics Rf value as 0.41 as indicated for shatavarin in Quality Standards of Indian Medicinal Plants (Gupta *et.al* 2003).

Keywords: *Aspargus racemosus*, phytochemical analysis, pharmacognostic properties, TLC analysis, quality standards.

Introduction

Of the 300 species of *Asparagus* found worldwide, Nepal harbors 7 species viz. *Asparagus lycopodineas, Asparagus adscendens, Asparagus curillus, Asparagus filicinus (var. brevipes & var. filicinus,), Asparagus penicillatus* H. Hara (Endemic species from Dolpa), *Asparagus racemosus (var. racemosus, & var. subacerosus*), and *Asparagus tibeticus* (New record from Mustang), in the wild stata. Among them *Asparagus racemosus* (Kurilo, Satavari) is one of the top ten most traded high value MAP species having therapeutical and nutraceutical importance (Tiwari *et.al.* 2004). It is also one of the prioritized species for conservation viz. Vulnerable (IUCN 2004, Bhattarai *et.al.* 2002); Cultivation Priority (GoN/MOFSC/DPR 2005) and Under Important Medicinal Plants Area (IPA, 2006).

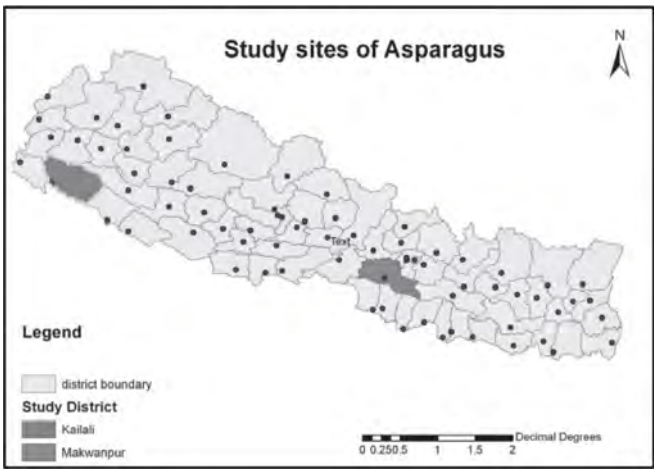
In international market, *Asparagus racemosus* is used medicinally as a refrigerant, demulcent, diuretic, aphrodisiac and anti dysenteric (Kirtikar and Basu, 1993), galactogogue, bitter-sweet, emollient, cooling, nervine tonic, constipating, and antiseptic (Chaudhary and Kar, 1992). Locally the plant is used for different medicinal purposes as a folk medicine. The roots have a good medicinal value and used to make the crude drugs and ayurvedic products. Tender shoots are cooked as vegetable, and squeezed roots are used for washing clothes. Locally the root is also used to control fleas, and candy is prepared from tubers (Manandhar, 2000; Baral and Kurmi, 2001; GoN 2007). Trade volume of Kurilo in Mid Far Western Development Region in the last five years is about 200 metric tons (MT). According to ITC record of 2004, annual export of Asparagus from whole Nepal is found to be 300 MT. So it is highly preferred species in low altitude areas of Nepal (Maraseni, 2007).

The content of biological active compound of the medicinal plant species varies depending upon the genotype, micro and macro environment and developmental stage of plant. Such variations existed in population along phyto-geographical gradient can provide basis for planning and conservation management program (Pant and Bimb 2005).

Nepalese Satavar (Pili Satavar) is considered as best quality drug in the Indian market in relation to its efficacy. But its pharmacognostic study and phytochemical screening of different traits from different ecological habitats is still lacking. Hence this paper tries to elucidate physico chemical quality of wild Asparagus from two districts where it is extensively cultivated commercially. The standardization of crude drugs has become very important for identification and authentication of a drug. But due to certain problems the importance was not up to the mark.

Materials and Methods

Study sites: Field-based studies were conducted in two districts representing central and western regions. Proposed study sites are **Makawanpur** (with medium precipitation/rainfall area of Nepal) and **Kailali** (with low precipitation area of Nepal.



Collection of Samples: The selected plant samples and voucher specimens were collected from study sites – Makwanpur, Dhangadhi and Kailali and the voucher specimens of these species were identified properly & deposited at KATH Herbarium, Godawari. Root tubers of each and every sample were also collected for phytochemical analysis.

Pharmacognostic study as well as preliminary phytochemical screening was done for the collected samples in laboratory of Natural Products Research Laboratory, DPR. Methodologies were followed as described by Prof. Dr. I Ciulei in his book "Methods for studying vegetable drugs". Micro-morphological variation were studied and correlated with chemical variations of the traits as whenever possible.

Result and Discussion

In Nepal, Asparagus is produced especially in Banke, Bardia, Kailali, Kanchanpur, Surkhet, Dang, and Pyuthan districts in Mid and Western Regions, while in Central region, it is produced in Makwanpur, Bara, Parsa, Rautahat, Dhanusha, Sarlahi, Saptari and Chitwan. Most of the farmers collect Asparagus for household as well as commercial purposes. A total of 4000-5000 households are involved in Kurilo production in the cluster of these districts (Dang, Kailali, Kanchanpur and Banke districts) (Acharya, 2010).

Standardization is an essential measurement for ensuring the quality control of the herbal drugs.

Morphological description: The samples collected also showed variation in morphology (Table 1, Plate 1 a, b). Generally the plant is a climber, climbs upto 1-3 m high. It is an extensively scandent, spinous, much branched undershrub. Roots are numerous, fusiform, succulent and tuberous with a diameter of 0.5 to 1.5 cm and arise as a cluster from the basal end of the stem. Stem is woody, sparsely covered with recurved spines. Leaves are reduced to small scales called as cladode, which are in tufts of 2-6 in a node, finely accuminate, falcate divaricate and constitute the main photosynthetic organs. Inflorescence is a branched raceme. Flowers are white, fragrant, solitary or fascicles having a width of 0.3-0.4 cm. Berries are globose or obscurely 3 lobed. Seeds are black in color and hard with brittle testa.

The macroscopic characters (height, weight, thickness, color) as well as microscopic characters (T.S of root tuber, powdery microscopy) of the roots were observed Table 1, 2, Plate 2, 3).

Table 1 : Morphological variation among root tubers.

S.N.	Sample site	Length cm	Thickness cm	Color	Texture
1	Maghi, Chaumala, Kailai	13.505	0.6675	Healthy bright yellow	Brittle ribbed
2	Sukhad, darakh, Kailai	11.825	0.665	Brown	Smooth not much ribbed
3	Mangalpur, Kailali	10.575	0.6625	Yellowish brown	ribbed
4	Phaparbari, Makwanpur	13.3	0.54	Dark yellow	ribbed
5	Raigaon, Makwanpur	10.295	0.5225	Blackish yellow	
6	Hadikhola, Makwanpur	10.635	0.5175	Dull brown	

Table 2 : Measurement of root tubers of collected samples

Sample code no.	collection sources	collection date	measurement	df	Mean	S.D.	t value
WND 1/067	Maghi Chaumala VDC, Kailali	2087/12/13	weight	19	3.7622	1.2003	2.093
			Length		13.505	2.5763	2.093
			Breadth		0.6725	0.1006	2.093
WND 2/067	Sukhhad. Darakh Kailai	2067/12/13	weight	19	3.6428	1.2263	2.093
			Length		11.825	1.8481	2.093
			Breadth		0.665	0.947	2.093
WND 3/067	Darakh, kailali	2067/12/14	weight	7	3.3289	1.3108	0.6625
			Length		10.575	1.6272	2.6347
			Breadth		0.6625	0.1126	2.3647
CNM 1/067	Phaparbari, Makwanpur	2067/10/24	weight	19	2.6579	1.1532	2.093
			Length		13.3	2.4257	2.093
			Breadth		0.54	0.1324	2.093
CNM 2/067	Raigaon, Makwanpur	2067/10/24	weight	19	2.0417	0.8662	2.093
			Length		10.295	2.4723	2.093
			Breadth		0.5225	0.0966	2.093
CNM 3/067	Hadikhola, Makwanpur	2067/10/25	weight	19	2.0481	0.8404	2.093
			Length		10.635	2.2015	2.093
			Breadth		0.5175	0.1115	2.093

Microscopic features reveals the following tissues from outside within: compactly arranged, uniseriate, polygonal to radially elongated, thick-walled cells represent the outermost piliferous layer. Immediately lying below the epidermis is extensively developed, several layers of thick cortex made up of parenchymatous cells. The cortex is clearly distinguished into outer lignified cortex and inner parenchymatous cortex. The cortical cells contain rhapide bundles. The innermost 1 or 2 layers of cortex immediately outside the endodermis comprise thick-walled cells, with numerous circular or oval pits on their wall. Endodermis is composed of a single layer of compactly arranged, barrel-shaped, parenchymatous cells. Inner to endodermis is a single layer of thin-walled, parenchymatous cells, constituting the pericylce in the form of a ring, surrounding a central stele. Phloem and Xylem groups are arranged on alternate radii and form a ring. Phloem is mostly undifferentiated and consists of thin walled polygonal cells. Vessel elements possess spiral, scalariform and pitted thickenings. Pith wide, composed of thin-walled rounded or angular cells.

Physico-chemical parameters

The powdered drug was evaluated for its physico-chemical parameters like Ash values: Acid Insoluble ash, water soluble ash, water insoluble ash, extractive values (Alcohol and water soluble values), and loss on drying and foreign matter. All the results are tabulated below with comparison with Indian pharmacopaea (Gupta *et.al.* 2003) and findings of Kundu *et.al*. 2011 (Table 3, 4, 5).

Table 3: Physical constant values

Sample sites	Moisture %	Total ash	Acid insoluble ash	Water soluble ash	Crude fibre	Crude fat
Standard value (Gupta *et.al*. 2003)	11.4	< 6	< 1	not available	< 23	< 1
Kundu *et. al.* 2011	3.94	7.67	1.02	2.53	-	-
Sample 1 (choumala, Maghi)	8.15	1.53	0.23	0.42	2.6025	2.9
Sample 2 (Raya Gaun, Makawanpur)	7.35	1.99	0.37	1.04	27.59	2.9
Sample 3 (Sukhad, Dhangadi)	12.84	1.08	0.15	0.38	24.26	2.4
Sample 4 (Chaumala,Mangalpur)	14.71	1.55	0.23	0.8	2.885	3.1
Sample5 (Phaparwari,Makwanpur)	13.32	2.05	0.27	0.45	22.67	4
Sample 6 (hadi khola)	13.43	2.16	0.38	0.7	19.95	3.3

Table 4 : Extract Values examined

Samples	solvent	% of extractive values	Standard value (DPR)	Standard value (indian pharmacopaea)
Sample 1 (choumala, Maghi)	Ethanol	65	> 15	> 9
Sample 2 (Raya Gaun, Makawanpur)	Ethanol	64.47		
Sample 3 (Sukhad, Dhangadi)	Ethanol	72.43		
Sample 4 (Chaumala,Mangalpur)	Ethanol	65.48		
Sample5 (Phaparwari,Makwanpur)	Ethanol	67.60		
Sample 6 (hadi khola)	Ethanol	63.60		
Sample 1 (choumala, Maghi)	Water	65.74	> 34	> 34
Sample 2 (Raya Gaun, Makawanpur)	Water	68.15		
Sample 3 (Sukhad, Dhangadi)	Water	75.67		
Sample 4 (Chaumala,Mangalpur)	Water	65.56		
Sample5 (Phaparwari,Makwanpur)	Water	72.03		
Sample 6 (hadi khola)	Water	66.01		

Table 5: TLC Test results of alcoholic extract on Silica Gel using n- butanol:acetic acid:water (4:1:5) v/v on exposure to iodine vapors

Sample	R.f values	Color
1	0.41	Yellow
2	0.41	Yellow
3	0.41	Yellow
4	0.36	Yellow
5	0.37	Yellow
6	0.37	Yellow
Standard sample of **satavarin IV**	0.41	Yellow (Gupta et al 2003)

Conclusion

Asparagus racemosus Willd. (Wild Asparagus) is one of the prioritized medicinal plants of Nepal among 30 prioritized NTFPs (GON 2005). As per estimate, nearly 4000 tons of Asparagus dry roots are required to meet the demand of Ayurvedic and Unani industries in India. Regarding the trade value, Asparagus needed by Indian Pharmaceutical Industries was estimated to be c. 500 tons of which 50% from wild and 50% from cultivation (Subrat, 2002). It was found distributed from East to western Himalayas of Nepal from 100-1900m altitude.

Asparagus racemosus is a rich source of saponin, and also contains alkaloids, proteins, starch, tannin, mucilage and diosgenin. *A. racemosus* found in South India have saponin - A4 fraction but not in North Indian plants (Parveen *et. al*. 2009). This study tried to study such variation in *Asparagus racemosus*

Willd (wild Asparagus) from different altitudes and climates. Samples from Dhangadhi, Kailai were found to have quality characteristics as demanded in trade and fetch high price as well. Similarly phytochemical analysis also shows variation slightly. The samples from Sukhad Dhangadhi shows the value nearest to standard value while other samples also found out to be fine according to standard value from Indian Pharmacopaea. Thus preliminary physicochemical and TLC analysis of this species from 2 different regions (west central) and altitudinal gradient of 100, 500, 1000m showed some variation and near to standard value.

Further work will be continued for phytochemical analysis for the same species to find out the best traits of Asparagus from Nepal which will be referred for commercial mass production. The result will be contributed in trade promotion, in-situ, ex-situ conservation & sustainable management.

Acknowledgement

Mr. Yam Bahadur Thapa, Director General DPR is greatly acknowledged for initiating, providing inspiration for this publication. Sincere thanks also go to Ms. Sushma Upadhaya, Deputy Director General, for her valuable advice. Ms. Jyoti Joshi, Chief of Natural Product Research Laboratories (NPRL), and Rajeswor Ranjitkar, NPRL, deserve special appreciation for their valuable cooperation for phytochemical analysis of the samples.

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Plate 1 : Morphological Characteristics


a. Asparagus sample from Maghi chaumala Ws1


aa. Roots from Maghi chaumala WS1


b. Asparagus samplle no ws2


bb. roots from Sukhad WS2


c. Asparagus smple No ws3a


cc. root from Managalpur WS3


dd. As root CN1

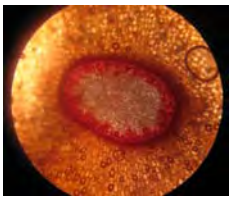

e. Asparagus from Phaperbari CN2

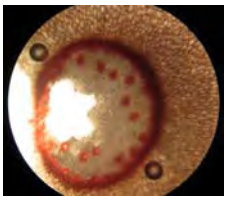

ee. As root CN2e

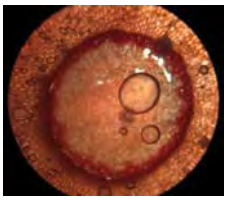

f. Asparagus from Hadiokhola CN3


ff. As root CN3

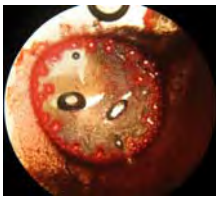
Plate 2 Anatomical characteristics


T.S. root-CN1


T.S. root-CN2


T.S. root-CN3


T.S. root-WS1


T.S. root-WS2

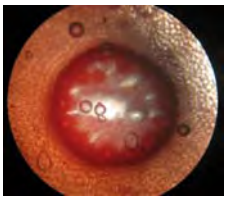
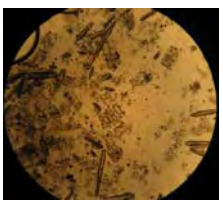
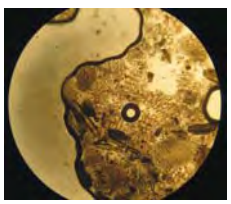
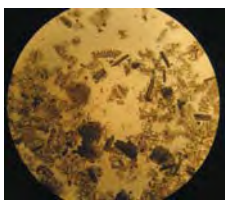
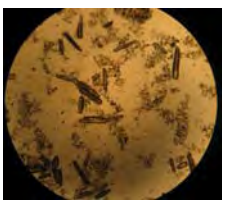

T.S. root-WS3

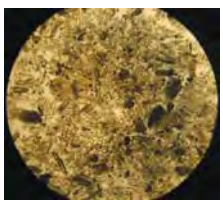
Plate 3 Powder Microscopy

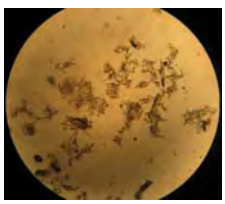

powder sample a. WS1


Powder sample b. WS2


Powder Sample c. WS3


Powder Sample d. CN1


Powder Sample e. CN2


Powder Sample f. CN3

Annex 1

Morphological variation of *Asparagus racemosus* from Makwanpur and Kailali district

S.No.	Sample site	Altitude (m)	Plant height (m)	Root tuber length X breadth (cm)	Cladodes No. (size)	es spine size cm	Flower
1	*Maghi, Chaumala, Kailali WS1*	180	Shrub 1-2m	10-25 X 0.3-1.5	1-5, (1-2 cm)	0.5-1	White
2	*Sukhad Darakh, Kailali WS2*	180	Shrub 1-3 m	8-16 X 0.6-1 smooth more or less translucent	3- 5 (0.8-1.0)	0.3-0.6 leaf scale like	white
3	*Mangal pur Kailali* WS3	180	Shrub ca. 1m	8-20 X 0.6-1.5	4-6 (0.3-0.8)	0.5-0.8	white
4	*Phaperbari, Makwanpur*	250	Herb , 1-1.5m	7-15x 0.6-1	1-5 (1-1.5 cm)	4-5mm	white, 5-6 no in simple panicle
5	*Raigaon Makwanpur*	66	Shrub, 1-1.2m	6-13 X 0.5-0.8	1-4 (0.3-0.5)	0.3-0.7	white 5-6 no in simple panicle
6	*Hadikhola, Makwanpur*	450	robust shrub 1.5-2	10-20 X 0.3-1	2-5 (0.5-1.5)	0.1-0.4 in branches 1-1.5 cm in main stems	white 2-5 cm panicles 4-12 flowers

Analysis of *Tagetes minuta* L. : A potential medicinal herb

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Abstract

Tagetes minuta, an annual ornamental plant, has been identified as a potential medicinal herb. The phytochemical analysis of aerial parts of the plant exhibited the presence of essential oils, saponins, terpenoids, tannins and flavonoids. Ethanol extract exhibited LD50 value of 1000mg/kg. Its pharmacognostical, physico-chemical parameters and pharmacological results will help to identify and quantify the plant and plant products.

Key words: LD50, essential oils, medicinal plant, *Tagetes minuta*.

Introduction

Tagetes minuta is a very important member of the genus *Tagetes* belonging to Asteraceae family. It has been identified as a potential medicinal plant as it contains allelochemicals and essential oils that have multi-dimensional uses and applications such as weedicides, germicides, nematocides, insecticides, fungicides etc. A comprehensive research is needed to explore other aspects and uses of this beneficial plant in future. The objective of this study is to prepare the quality standard of Nepalese Medicinal Plants for exploitation and change its status from weed to underutilized minor crop.

Description

It is an annual plant about 50-150 cm tall. It has glabrous, erect and branched stem with opposite branches (Fig.1). Its leaves are opposite and pinnately parted but the upper leaves are alternate. Length and width of *Tagetes* leaves is 4 to 8 cm and 3 to 4.5 cm respectively. Margins of leaves are acute and serrate. It has corymbiform dense inflorescence at the end of branches. Phyllaries forming a cylindric tube is naked at base and 7 to 10 mm long. It has 3 florets that are ligulate, dark brown or lemon-colored and 2.5 to 3 mm long. Tubular florets are orange and 3 mm long. Achenes are 5 to 6.5 mm (excluding pappus) long and 0.5 mm wide. Color of achene is dark-brown and is covered with appressed hairs (Naqinzhad and Mehrvarz, 2007).

Fig. 1: Flowering branch of *T. minuta*

Materials and methods

Sample collection

The fresh flowers of *Tagetes minuta* were collected from Jumla District, Western Nepal.

Pharmacognosy

Medicinal plant materials were categorized according to sensory, macroscopic and microscopic

characteristics. An examination to determine these characteristics is the first step toward establishing the identity and degree of purity of such materials. Firstly morphology of plant was studied. The sample was tested in terms of colour, odour and taste etc.

Its shape, size, colour, surface characteristics, texture was examined macroscopically. Microscopic study of powder analysis and histochemical detection was done (Trease & Evans, 2002).

Extraction of essential oil

500gm of fresh flower of the *T. minuta* was taken in RB flask, 1.2 L of water was added and subjected to hydro-distillation in Clevenger apparatus. The distillation was carried out for 5hr.

Preparation of extract

Flower of T*agetes minuta* (150 g) were dried at 40 °C for 10 days and pulverised. The powder was cold percolated into 50% ethanol for overnight. This process was repeated 2-3 times. Thus obtained extracts were mixed together and the solvent was removed by distillation on a boiling water-bath at atmospheric pressure and then under reduced pressure below 60^0C in a rotary evaporator. Before administration, the extract was reconstituted by dissolving in 0.5% gum acacia solution.

Test animals

Albino mice (20 – 30 g) and Wistar albino rats (180–200 g) of both sexes, bred in the Animal House of NPRL, Thapathali, Kath, were maintained at room temperature 25 ± 2 °C.

Phytochemistry

The flower of *Tagetes minuta* was shade dried, grinded, powdered and extracted with solvents petroleum ether→Ethyl alcohol→water using Soxlet – apparatus for phytochemical screening to detect different group of compounds. The tests were done as per the method of I. Ciulei (1982)

Standardization

Medicinal plants are used throughout the world as home remedies, over the counter drug product and raw materials for the pharmaceutical industries. It is therefore essential to standardize for assessing their quality. The test parameter applied here are according to the guidelines of "Quality control method for medicinal plant materials" Published by WHO. Parameters studied were Total ash, Total extractable matter and moisture content.

Pharmacology

Acute toxicity: The aim of the acute toxicity test is to establish the therapeutic index, i.e. the ratio between the pharmacologically effective dose and the lethal dose on the same strain and species (LD50/ ED50). The greater the index, the safer is the compound. The LD50 is the dose that will kill 50% of the animals.

Acute toxicity test was performed on mice. The extract was administered once intra-peritoneally at various dose levels to group of 4-6 mice of both sexes (fasted overnight about 18 hrs.) The injected mice were observed continuously for 2 hrs and then occasionally for further 6 hrs. By observing the behavior of the injected animals carefully, valuable indications of the action of the extract were noted. The LD50 value was estimated from the mean of the logarithms of the smallest effective dose and the largest ineffective dose. The LD50 value is expressed in terms of mg/kg.

Anti-fertility activity of the extract was done as per the method

Anti-fertility Test

Anti fertility test of Khanna and Chaudhary 1986 was followed.Female rats of proven fertility were used. Oestrous cycle of rats was determined before mating. Adult female albino rats weighing between 150-200 gms showing regular 4-5 days of ostrous cycles were divided into groups. Young males of known reproductive vigor were kept with female rats during night and examined on the next morning for the presence of sperm. The day on which thick clumps of spermatozoa were detected in the vaginal smear was termed as day 1 of pregnancy. The extracts were fed for day 1 to day 5. Control group receives only 0.5% gum acacia. On the 10^{th} day, laparatomy

was performed under light anesthesia and uterine horns were examined for number and size of implants. Then the abdominal cavity was sutured and the rats were allowed to deliver at full term . After delivery, the pubs were examined for any macroscopic teratogenic effect of the extract.

Effect on spontaneous locomotory activity open field Test

2 groups of 4 mice each were used. Each mouse was placed in an open field 50x50cm surface surrounded by 30 cm high enclosure devoid of a cover and subdivided for scoring 25 squares. The number of squares cross by each mouse over a period of 3 minute was recorded. The sample was given intrapetoneolly at the dose of 500 and 250 mg/kg. The locomotor activities of each animal was recorded after half an hour of the administration and compare to the controlled group, treated with 0.5% gum acacia(Altaman *et al.*, 1975).

Effect on acetic acid induced writhing: For this test, groups of 4 mice were used. The first group received sample, the second group received 0.5% gum acacia. After 2 hours of treatment, each mouse was injected with 0.2 ml of 3% acetic acid ip and the number of writhes in the following 20 minutes was recorded (Koster R. *et al.*, 1959) .

Microbiological Test

Antimicrobial test: The study was done as per a standardized filter paper disc-agar diffusion procedure, known as the Kirby-Bouer method. The antimicrobial susceptibility of the plant extract was determined by measuring the diameter of the zone of inhibition that result from diffusion of the agent into the medium surrounding the disc. A measurement of the diameter of the zone of inhibition in millimeters was made and its potency was compared with a standard antibiotic (streptomycin). The test culture microorganisms were *Salmonella typhii*, *Escherichia coli*, *Staphylococcus aereus* and *Shighella dysentrica.*

Results

Pharmacognostic Characters

Morphological characters

Strongly smelling glabrous annual herb. Leaves compound, leaflets acuminate, attenuate at base, serrate, with rounded oil glands near margin at base of each tooth, others scattered near midrib. Capitula in compact corymbs. Corolla lemon yellow.

Organoleptic properties

Color : Yellowish green
Odor : Characteristic
Taste : Bitter

Microscopic characters

Powder

Presence of volatile oil, spiny spherical pollen grains, long covering trichomes, bunch of sclerenchyma fibre, lignified spiral vessels, pitted parenchyma (polygonal), few reticulate vessels, spherical parenchyma.

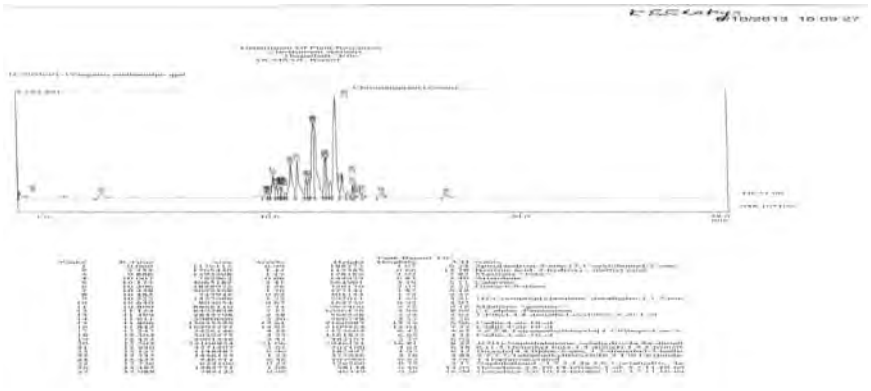
Chemical Constituents

Major: â-phelandrene, limonene, â-ocimene, dihydrotagetone, tagetone and tagetenone.

Other

GLC Identification Test

Gas Chromatographic Mass Spectoscopy (GC-MS) analysis of essential oil. The essential oil obtained was analyzed qualitatively and quantitatively by means of gas chromatography (GC-MS). The quantitative data were determinated from the peak-percentage areas without correction factors. A



Shimadzu GC-2010 gas chromatograph. The column was programmed as follows: 50ºC during 5 minutes, increased to 200°C at 10°C/min. Injector temperature was 180°C and pressure 36.9 kPa.

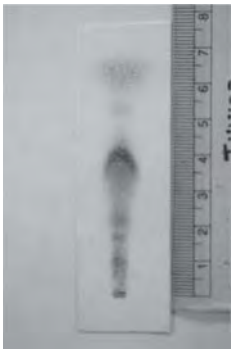
Standardization

The quantitative standard values estimated in air dried powdered materials are tabulated below.

Water soluble extractive	1.86%
Ethanol soluble extractive	0.49%
Total Ash	0.005%
Sp.gr.@ 25°C	0.596
Refractive Index @ 25°C	1.58
Oil %	1.4%

TLC

Rf=0.14(Pink), Rf=0.24(Light Pink), Rf=0.31(Brown), Rf=0.49(Orange), Rf=0.57(Dark Blue), Rf=0.79(Light Dark), Rf=0.93(Red)
Adsorbent: Silica gel
Sample: 0.1gm extract in 5ml methanol
Solvent: Toluene:Ethyal acetate:Methanol:Acetic acid(2.7:6.0:1.0:0.3)
Detection: Spray Anisaldehide –heated 100.c



Phytochemical screening

In the analysis of different solvent extract of *T. minuta*, following group of principal constituent were seen positive test, which are tabulated below.

Name of the plant	*Tagetes minuta*					
Parts used	Flower					
Ether extract		**Alcohol extract**		**Aqueous extract**		
Volatile Oil	+++	Anthracene glycoside	-	Polyurenoids	+	
Alkaloid	-	Coumarin	-	Reducing compound	++	
Carotenoid	-	Flavonoid	-	Polyoses	-	
Steroid	-	Steroid	-	Saponin	+	
Triterpenes	-	Triterpenoid	-	Gallic tannin	-	
Coumarine	-	Gallic tannin	-	Catecholic tannin	-	
Flavonoid	-	Catecholic tannin	++	Alkaloid	-	
Emodine	+	Reducing compound	++			
Alkaloid	-	Alkaloid	-			
		Anthocyanadine glycoside	-			

Pharmacological Test

The ethanol extract of *Tagetes minuta* showed non-toxic in LD50=1000 mg/kg i.p. dose in mice. It showed significant inhibition of G.I. mortility on charcoal movement test. It showed effect on analgesic and Diuretic.

The pharmacological test results are tabulated in below

S.N.	Material	Part	Test	Result
1.	*Tagetes minuta* 50% alcoholic Extract	flower	- Acute toxicity (LD50) Isolated tissue - Locomotors activity test - Analgesic test - Diuretic test -Anti-fertility test -Anti-implantation	1000-mg/kg i.p. no effect High High 25% 35%

Microbiological Test

The 50% alcoholic extract (dried) of *Tagetes minuta* showed remarkable inhibition of growth of some microorganisms. The test results are tabulated below.

S.N.	Material	Part	E. Coli	S. aerous	S. dysentrica	S. typhi
1	*Tagetes minuta*	Flower	-	-	-	++

note : + = weak effect (zone of inhibition 6-10 mm)
++ = Moderate effect (zone of inhibition 10-14 mm)
+++ = Encouraging affect (Zone of inhibition 14-20 mm)

Uses

Medicinal uses: *Tagetes minuta* leaves paste is typically used for wound healing, has anti-inflammatory, bronchodilatory (Abbasi *et al.*, 2010). Entire plant is used as a condiment, diaphoretic, diuretic, purgative, stomach strengthener, hysteria remedy, menstrual stimulant and for flavoring to milk and cheese (Neher, 1968). Its flowers are also used as mild laxative, insect repellent, for gastritis, indigestion (Neher, 1968). Leaves are also used locally to repel safari ants and mosquitoes and to kill mosquitos' larvae. Oil obtained from leaves is more toxic to mosquitos' larvae than DDT (Macedo *et al.*, 1997). Its flowers are used for ornamental purposes (Hamayun *et al.*, 2006). *Tagetes* roots have fungicidal and nematocidal characteristics (Batish *et al.*, 2007; Osman *et al.*, 2008).

Other uses: The oil obtained from seeds, leaves and flowers of *Tagetes minuta* strongly repels the blowflies and is also useful for blowfly dressing (Jacobson, 1983). Its oil is also used for perfume production, treatment of smallpox, earache and colds and to reduce fevers (Shahzadi *et al.*, 2010). Volatile *Tagetes* oil is highly suppressing against Plants, animals and humans pathogens and micro-organisms. It is also used as flavoring agent in food industry and in perfumes (Mohamed *et al.*, 1999).

Discussion

The aim of the study is to find out the medicinal value of *Tagetes minuta* and to determine the standard value for better quality assurance. By studying its pharmacological, biochemical and microbiological test, a lot of medicinal properties were found such as analgesic, antimicrobial, antifertility and diuretic effect. However, this study is not enough to say that *Tagetes* can be used as a medicine because there are many other biological tests that should be carried out before establishing it as a safe medicine. Further research work has to be done including isolation, identification and quantification of active compound/s. Pharmacognostical, phytochemical and standardization were estimated, which will be helpful for identifying the plant and plant products.

Conclusion

Tagetes minuta, being a potential medicinal plant and containing high amount of essential oils, should be planted commercially and efforts for doing so should be initiated. The MAPS suppliers of Nepalese business community should explore its market potential in the West. It it is available only in wild state so the Department of Plant Resources should initiate to produce this plant on a mass scale by using tissue culture technique or other relevant technology.

Acknowledgement

The authors are thankful to Mr. Yam Bahadur Thapa, Director General, Ms. Sushma Upadhaya, Deputy Director General and Ms. Ramila Pradhan, Scientific Officer, Department of Plant Resources, for their encouragement. We are thankful to the chief, Department of Plant Resources Office, Jumla for providing the plant material. We would also like to thank Keshab Poudel, K. K. Shrestha, Paras Mani Yadav, Bisho Karki, Anuradha Gyanwali and Rajendra Sharma for their various help.

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Phytochemical study of *Termitomyces robustus* (Beeli) R. Heim in Nepal

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Abstract

This paper reports on the qualitative phytochemical study of *Termitomyces robustus* (Beeli) R. Heim, family Tricholomataceae found in Terai, Siwaliks and Midhills of Nepal. Screening revealed the presence of alkaloid, carotenoid, steroid, triterpenoids, fatty acid, emodins, flavonoid, coumarin, anthracene glycoside, anthocyanadine glycoside, tannins, saponins, glycosides, polyurenoid and polyoses in the ethereal, methanolic and aqueous extracts. There were significant differences in the phytochemical composition of the samples collected from east, center and west eco-zones and tropical, subtropical and temperate climatic regions. There was a definite co-relation between the traditional application of Termite's mushrooms and possession of secondary metabolites, which supports the scientific basis for the traditional medicinal system. Results showed that the consumption of wild edible mushroom that act as a good dietary supplement and it may be valuable in drug development.

Key words: Termite's mushrooms, *Termitomyces robustus*, Phytochemicals.

Introduction

Phytochemicals are the natural substance of vegetable origin, which provide a range of drugs for a number of diseases. It gives useful information to promote sustainable use of biodiversity for food security and health and wellness (Evelyn *et al*. 2006). These are the major bioactive compounds and that make food functional (Klimczak 2007).

Seventy-three medicinal mushroom species have been reported from Nepal (Adhikari 2009). Medicinal plants are an integral part of the diverse traditional medical practices in Nepal and are codified in traditional medical systems such as Chinese, Ayurveda, Unani, Siddha, Homeopathy, Amchi, etc. (Manandhar 2002). Crude-drugs are commonly given in the form of powder, decoctions, and infusions or in ointment forms. *T. robustus* is not only an important source of food for local people but this also uses them for medicinal purpose for treatment for different types of disease and ailments (Table 1). *Termitomyces* species has ability to suppress postprandial hyperglycemia caused by prolonged high blood glucose level associated with diabetes (Moordian and Thurman 1999, Matsuura *et al*. 2000).

Hence, the preparation of monographs of wild edible mushroom *T. robustus* that would provide a systematic account on their phytochemical profiles is in urgent need for standardization of the traditional medicinal herbs, therapeutic benefits and their possible toxic effects. This study aimed to provide information on secondary metabolites of the *T. robustus* of Nepal.

Materials and Methods

Sample collection

Surveys were under taken and specimens collected from 1st to 31st May and from 1st June to 31st October in 2010"2012 respectively, from the termite nest of the forests in west, center and east of tropical, subtropical and temperate regions (Table 3) between 26º 44' 08" and 29º 06' 32" N latitude and 80º 18' 02" and 88º 08' 27" E longitude of Nepal (Fig. 1). The local names of the species along with its traditional uses by local people were noted on the

spot (Table 1). The collected specimens were brought to the laboratory of Central Department of Botany, Tribhuvan University, Kathmandu, Nepal, for identification.

Identification

The samples were identified using Heim 1977, Rawla *et al.* 1983, Leelavathy *et al.* 1985, Piearce 1987, Van der Weasthuisen & Eicker 1990, Pegler & Vanhaecke 1994 and Website: Index fungorum. Voucher specimens are deposited in Natural History Museum, Swayambhu, Kathmandu, Tribhuvan University. Accession No. NHM TU 2-2-1672.

Processing

The mushrooms were uprooted, washed and were oven dried for 48 hours at 40°C. They were turned repeatedly to avoid microbial growth. The samples were pulverized using a manual blender and stored in a labeled air-tight container before analysis.

Phytochemical Screening

The experiment was carried out in Laboratory of Department of Plant Resource, Thapathali, Kathmandu. It was conducted according to the standard methods described by Ciulei, 1982 (Table 2). Briefly, 10gm. of powdered sample from each site was first extracted with petroleum ether using Soxhlet extractor until 6 hrs, then with ethyl alcohol and finally with water. The obtained solutions in each extraction process were filtered through Whatman filter paper no.1 and concentrated up to 20-25 ml using rotary evaporator at 40ºC.

Result

In the present investigation, three samples were analyzed from each region (Table 3), and fourteen major chemical constituents have been found, where volatile oil and steroid are completely absent. Frequency of high concentration on north-south gradients of alkaloids, saponins, tannin and glycoside are highest in Midhills and gradually decreases from Siwaliks to Terai range. Whereas triterpenoids and carotenoid are almost equal in the entire eco-zone. Similarly frequency of high concentration on east-west gradients of saponins and glycoside are highest in west and gradually decrease center to east. Whereas in triterpenoids, carotenoid, fatty acid, emodine, flavonoid, anthocyanadine, anthracene, tannin and saponins are almost equal in the entire eco zone. During investigation they were found that, coumarin and polyoses were completely absent in center and equal in east and west eco-zone. The emodine, flavonoid, polyurenoid, was found moderate concentration in the entire region.

Likewise, there was significant difference in fatty acid, emodine, flavonoid, anthocyanadine, anthracene and polyurenoid among the tested sample of three different eco-zones of east-west gradients of tropical to temperate region of Nepal (Table 4). Similarly significant difference was found in alkaloid, fatty acid, emodine, flavonoid, coumarin, anthocyanadine, anthracene, saponins, tannins, glycoside, polyurenoid and polyoses of three different eco-zones of north-south gradients (Table 5). Variation of concentration of individual chemical compounds in east, center and west Nepal was tested using chi square test (Table-4). Similarly those variations were tested among the sample of tarai, siwalik and midhill range, using same test, by Pearson's (1990), chi square test (Table-5). Difference were considered to be significant at $p<0.05$.

Discussion

The present study shows that the content of fat was absent or negligible (Table 3). Similar result was also found by Okwulehie & Odunze (2004) and Oso (1977). Loganathan *et al.* (2010) reported, alkaloid, steroid, triterpenoids, flavonoid, anthracene, saponins, tannins and glycosides in Termite's mushroom (*T. reticulatus*). Similarly, Aryal and Budhathoki, (2013) also reported volatile oil, alkaloid, carotenoid, steroid, triterpenoids, fatty acid, emodins, flavonoid, coumarin, anthracene glycoside, anthocyanadine glycoside, tannins, saponins, glycosides, polyurenoid and polyoses in Termite's mushroom (*T. microcarpus*). Likewise, fatty acids found in *T. clypeatus* (Baraza *et al.* 2007) and *T. letestui* (Arasmus 1995). Because of it, they are

recommended as good source of food supplement for mankind (Wasser 2002; Lindequist *et al*. 2005). Wasser & Weis 1999 and Yang *et. al*. 2002 reported that, mushroom produces a wide range of secondary metabolites having high therapeutic value and immunomodulating properties. Hence it is a potential source of useful drugs. Many health promoting properties of mushrooms are still unknown. This is because there is still no information about these *Termitomyces* and their medicinal potential in Nepal. Phytochemicals are responsible for their nutritional and therapeutic uses. These results therefore not only make these wild edible mushrooms *T. robustus* popular to consume as food sources but may also be valuable in drug development.

Conclusion

Based on the result, *T. robustus* have high concentration of diverse phytochemicals and are of potential medicinal value. The species contain different chemical concentration of bioactive compounds even in same ecological zone. Concentration of chemicals may be affected by climatic variation. There was co-relation between the traditional application of mushrooms and possession of secondary metabolites. This result may be useful to future workers to select a group of plants having similar chemical constituents to isolate biologically active principle or prepare remedies for particular case. Bioactive compounds with antibacterial properties can also be sourced from this underutilized termite's mushrooms present in wild state. Hence it is necessary to identify the biological and pharmacological potential this wild edible mushrooms, which are collected indigenously. So that, more research should be required for identifying and isolating different species of mushrooms having nutraceutical and medicinal properties to commercialize. Its production in large scale level would create a lot of employment opportunities especially in economically deprived rural area.

Acknowledgement

The authors would like to acknowledge Nepal Academy of Science and Technology for providing research grant for this piece of research. The Central Department of Botany, Tribhuvan University and Department of Plant Resource, Government of Nepal, deserve thanks for providing the laboratory facilities. Institute of Science and Technology is thankful for granting my study leave. Last but not least, sincere thanks are extended to local people of the study area for necessary help and providing information.

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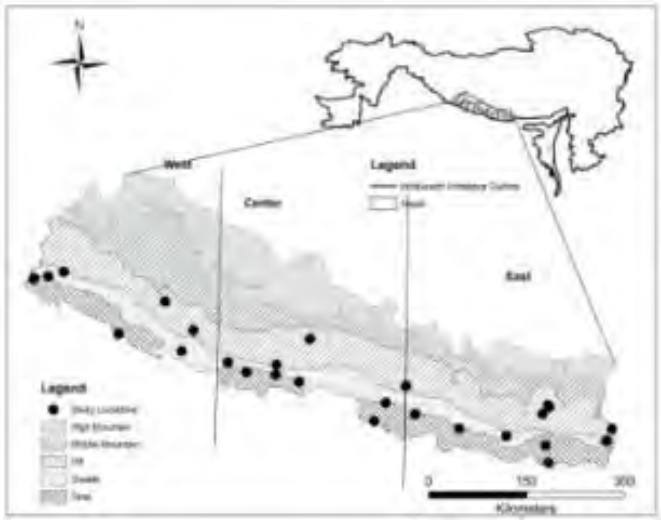

Figure 1 : Sample collection sites

Table 1 : Place of collection, Pronounce and Traditional use of *T. robustus* for the treatment of different types of disease and ailments by the different ethnic groups in the studies area.

S N	Pathological Conditions	Mode of Preparation and administration	Region	Local Name	Ethnic Group
1	Bleeding constipation, Wounds, Itching, Eczema etc.	For curing, its powder is used with mustard oil (in Santhal and Limbu tribe in Morang District)/water (in Tharu tribe in Nawalparasi District). Parts of fruiting bodies are mashed fresh with water for several times to form a uniform paste. The paste is consumed orally after dinner for 2/3 days.	ET ES CT CS	Bemtee Dewale Vavnethi, Rai	Santhal Limbu Tharu
2	Fever	Dried powder and Black salt (Birenun) are used with hot water, twice a day up to recovery (in Khuna tribe Banke district). Similarly it makes soup and drink (Tajpuriya, Bantar and Santhal communities in Morang, Jhapa, Saptari and Newar in Ilam district).	WT WS ET EM	Sangraino Chuchina Dhamire Dewale	Thami, Khash-chhetri, Khuna, Bote Tajpuriya, Bantar, Santhal Newar Rai
3	Cut wound	Fresh extract powder/paste of fruiting bodies is used for wound healing. [(In Kumhal-Khuna tribe in Kusum-Banke, Tharu in Bardiya, Sanyasi in Salyan, Magar in Gulmi District)].	WT WM CM	Vend Chhanii Bagale-Mugan	Khuna, Kumhal, Tharu Sanyasi, Magar

Where SN= Serial number, T=Tarai, S=Siwalik, M=Midhill, E=East, C=Centre and W=West

Table 2 : Methodology of phytochemical screening

SN	Chemical constituents	Test
1	Volatile oil	2 ml petroleum extract dissolved in diethyl ether evaporated to dryness. Pleasant smell or aromatic smell indicates presence of volatile oil.
2	Alkaloids	0.5 ml of extract + 1.5 ml HCl + Mayer' reagent, if it gives whitish- yellow ppt. and 0.5 ml of extract + 1.5 ml HCl + Bertrand reagent gives white ppt. indicates the presence of alkaloids.
3	Steroid & Triterpenes	15 ml of extract + 1.5 ml of 10% KOH + 0.5 ml acetic anhydride + 0.5 ml chloroform + Liebermann-Brofad's reagent. At the contact zone of test tube two layers were formed, the upper became green of steroid and lower of violet of triterpenes respectively.
4	Carotenoid	15 ml extract evaporated to dryness. Addition of 1 ml of antimony trichloride first became blue then red in colour. After addition of 1 ml conc. H_2SO_4, it became deep blue, indicates the presence of carotenoid.
5	Fatty acids	Spot persists on filter paper after dropping the 0.5 ml concentrated extract.
6	Emodins	2 ml of extract + 1 ml of 25% NH_4OH. It became red in colour.
7	Flavonoid	2 ml extract evaporated to dryness. Addition of 1 ml of methanol + piece of Mg + 0.5 ml of conc. HCl. It became orange in colour.
8	Coumarin	Addition of 2ml d/w in conc. extract + 10% NH_3. The occurrence of intense fluorescence under UV light indicates the presence of coumarin.
9	Anthracene glycoside	4 ml of ethanolic extract + 2 ml 25% NH_4OH. It became cherry red in colour.
10	Anthocyanadine glycoside	10/10 ml methanolic extract + 10% HCl + H_2O + 5 ml ether. The solution became red and turns neither to violet at a neutral pH, nor to green or blue in an alkaline medium, indicate the presence of anthocyanadine.
11	Tannins	20 ml of aqueous extract + 0.5 ml of 0.1% $FeCl_3$. The blue black precipitate were observed, indicate the presence of tannins.
12	Saponins	2.5 ml of aqueous extract + 10 ml of hot water. Persistence of froth, after shaken vigorously.
13	Glycosides	2/2 ml of semi dried aqueous extract + Fehling Solution (I & II). It gave brick red in colour, after heating.
14	Polyurenoids	2 ml of aqueous extract + 10 ml acetone + 1 ml Hematoxylin. The occurrence of a violet ppt. after centrifugation.
15	Polyoses	1 ml of aqueous extract + 0.5 ml H_2SO_4 + 1 ml methanol + Molisch's reagent gives red colour indicates the presence of polyoses.

Table 3 : Qualitative analysis of Phytochemicals in the different ecological zone of *T. robustus* in Nepal

SN	Region	V	A	S	T	C	F	E	Fl	Co	An	Ant	Sa	Ta	G	P	Po
1	West Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
2	West Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
3	West Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
4	Central Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	+	-	-	-
5	Central Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	+	-	-	-
6	Central Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	+	-	-	-
7	East Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
8	East Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
9	East Tarai	-	+	-	+++	+++	-	-	-	-	-	-	++	-	-	-	-
10	West Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	++	+++	+	+
11	West Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	++	+++	+	+
12	West Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	++	+++	+	+
13	Central Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	-	-	++	+
14	Central Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	-	-	++	+
15	Central Siwalik	-	+	-	+++	+++	+	+	+	+	+	+	+++	-	-	++	+
16	East Siwalik	-	++	-	+++	+++	+	+	+	+	+	+	++	++	++	+	+
17	East Siwalik	-	++	-	+++	+++	+	+	+	+	+	+	++	++	++	+	+
18	East Siwalik	-	++	-	+++	+++	+	+	+	+	+	+	++	++	++	+	+
19	West Midhill	-	++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++
20	West Midhill	-	++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++
21	West Midhill	-	++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++
22	Central Midhill	-	+++	-	+++	+++	+	++	++	+	+	+	+++	+++	+++	+	+
23	Central Midhill	-	+++	-	+++	+++	+	++	++	+	+	+	+++	+++	+++	+	+
24	Central Midhill	-	+++	-	+++	+++	+	++	++	+	+	+	+++	+++	+++	+	+
25	East Midhill	-	+++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++
26	East Midhill	-	+++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++
27	East Midhill	-	+++	-	+++	+++	+	++	++	++	+	+	+++	+++	+++	++	++

Note: + indicate, presence of chemicals in trace amount; ++ for moderate amount; +++ for high amount and - for absence. Here, V= Volatile oil, A= Alkaloid, S= Steroid, T= Triterpenoid, C= Carotenoid, F=Fatty acid, E= Emodine, Fl= Flavonoid, Co= Coumarin, An= Anthracene, glycoside, Ant= Anthocyanadine glycoside Sa= Saponins, Ta= Tannins, G= Glycoside, P= Polyurenoids, Po= Polyoses.

Table 4 : Results of P and X^2 on the variation of phytochemicals along with Phytogeographic east-west gradients (East, Central and West Region) with its frequency of each chemical at different Eco zone.

East west gradient (East, Central and West Region)

Alkaloid	Carotenoid	Triterpenoid	Fatty Acid	Emodine	Flavonoid	Coumarin	Anthocyanadine	Anthracene	Tannins	Saponins	Glycoside	Polyurenoid	Polyoses	N
0.126	3	3	0.0001	0.0001	0.0001	0.343	0.001	0.001	0.174	0.259	0.174	0.001	0.343	27
(7.2)	(3)	(3)	(1)	(1)	(1)	(4.5)	(1)	(1)	(9)	(2.7)	(9)	(1)	(4.5)	

Table 5 : Results of P and X^2 on the variation of phytochemicals along with Phytogeographic north-south gradients (Terai, Siwaliks and Mahabharata Region) with its frequency of each chemical at different Eco zone

North-South gradient (Terai, Siwalik and Mahabharata)

Alkaloid	Carotenoid	Triterpenoid	Fatty Acid	Emodine	Flavonoid	Coumarin	Anthocyanadine	Anthracene	Tannins	Saponins	Glycoside	Polyurenoid	Polyoses	N
0.001	3	3	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	27
(23.4)	(3)	(3)	(27)	(54)	(54)	(40.5)	(27)	(27)	(42)	(18.9)	(27)	(30)	(40.5)	

Phytochemical screening of *Hypericum cordifolium* Choicy ex DC.

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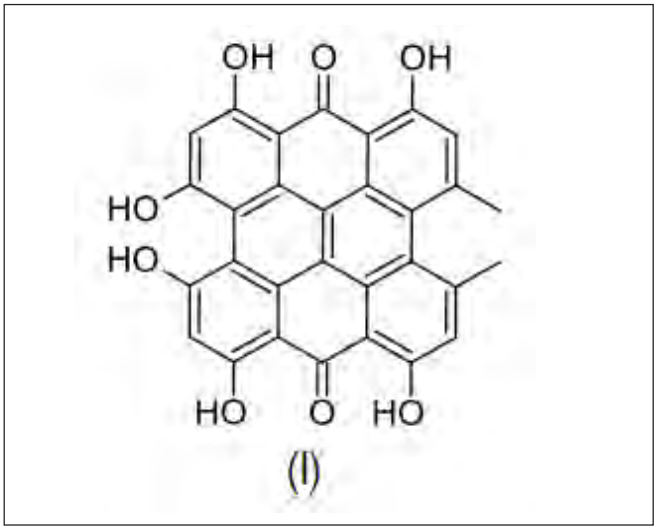
Abstract

Hypericum cordifolium Choicy ex DC, an endemic species, was subjected to preliminary phytochemical study. The whole aerial part of the plant was extracted with chloroform followed by methanol. The chloroform extract was found to have flavonoids, reducing compounds while methanol extract showed the positive test for the presence of the terpenoids, flavonoids, tannins, reducing compounds and proteins.

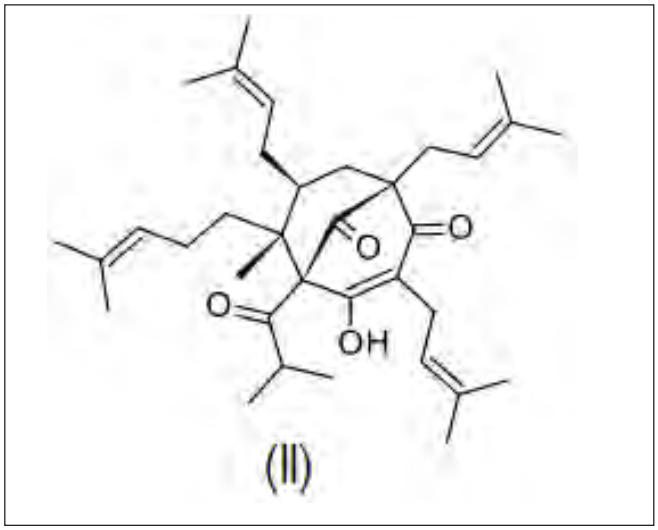
Introduction

Fifteen species of the genues *Hypericum* are reported from Nepal.[1] Among these, *Hypericum caodifolium* is reported as endemic to Nepal.[2] *Hypericum cordifolium* is also known as Areli in Nepal. This species is also reported to have medicinal propeties and valued for its beautiful yellow flower. Juice of plant is given for menstrual disorders, juice of the bark mixed with juice of *Diplokenma butyracea*, is applied in case of backache and dislocation of bone, juice of the root is given to treat diarrhea and dysentery, young leaves are poisons to cattle.[3]

Hypericin (I) and Hyperforin (II) are reported from several species of the genus *Hypericum* including the most traded species *H. perforatum*.[4] that has anti-depressant and many pharmacological activities. [6 & 7]



(I)



(II)

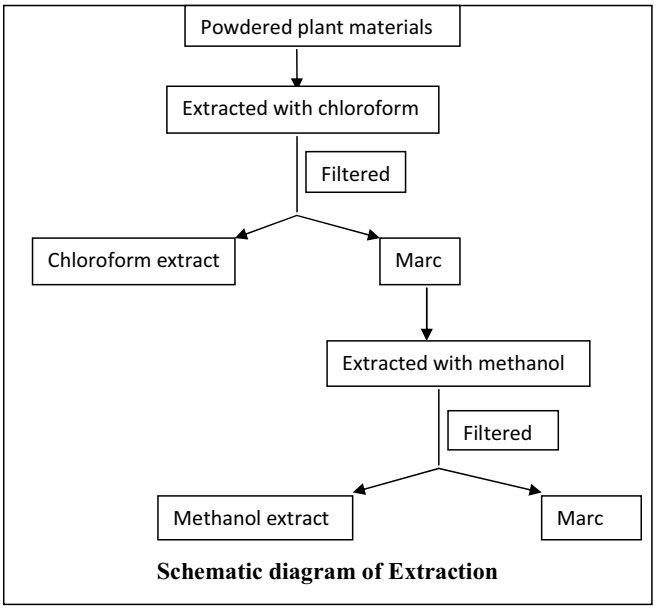
In continuation of exploring the Nepalese plant resources, preliminary phytochemical study of this endemic plant species was carried in present work.

Materials and Methods

Collection of Plant material: Plant materials were collected at flowering time of the species from the Fulchoki, Lalitpur area. Plants were collected and identified by Dr. S. R. Baral (then Chief of National Herbarium and Plant Laboratory, Godawari) and his colleagues. Collected plant material (whole aerial part) was shed dried, powdered and extracted.

Extraction of plant material: Dried plant material was extracted with chloroform and methanol. For chloroform extraction, 50 grams of powder was soaked in 300 ml of chloroform and shaken for 1

hour, then kept for 48 hours at room temperature. The mixture was filtered over Whatman No. 1 filter paper, the filtrate was concentrated on water bath subjected for phytochemical screening tests and marc was separately soaked in 300 ml methanol, shaken for 1 hour and kept for 24 hour and then again shaken and filtered. The filtrate was concentrated and subjected for phytochemical screening.



Schematic diagram of Extraction

Phytochemical screening: The chloroform and methanol extracts were examined for the presence of phytochemical compound groups as per Methodology for Analysis of Vegetable Drugs.[5]

Result

Both, Chloroform and Methanol extract were tested for the presence of phytochemical groups of compounds. Analysis shows the presence of flavonoids, and Reducing Sugar in both extract, while Terpenoids, Tannin and Protiens only in Methonolic extract. Result is tabulated in Table 1.

Discussion and Conclusion

Presence of terpenoids is an indication of possibility for the presence of Hyperforin (II) or similar compounds, which is founds in many species of *Hypericum* genus, which indicates the trade and medicinal value of *H. cordifolium.*

Results of this preliminary study indicate the presence of some pharmacological active compounds as in *H. perforatum*. So, Detail phytochemical and pharmacological study of *H. cordifolium* is also needed.

Acknowledgement

We are grateful to Hope International College, Pharmacy wing and Prof. K. D. Joshi, HOD for providing necessary facilities for the present work. We would like to thanks Dr. S. R. Baral (then chief), Ms Nirmala Phuyal, Assistant Scientific Officer and Mr. Diwakar Dawadi, Assistant Botanist of National Herbarium and Plant Laboratory for collecting and identifying the Plant materials. We would like to express our special gratitude to all friends and colleagues for their help during this work.

Table 1

S.No	Test compounds	Results (+ = presence; -- = absence)	
		Chloroform extract	Methanol extract
1	Alkaloids	--	--
2	Terpenoids and steroids	--	+
3	Glycoside	--	--
4	Saponins	--	--
5	Flavonoids	+	+
6	Tannins	-	+
7	Coumarins	--	--
8	carbohydrate	--	--
9	Reducing sugar	+	+
10	Proteins (Millon's test)	--	+

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Phenology of selected herbaceous angiosperm species found in the Botanical Garden of the Central Department of Botany, Tribhuvan University, Kathmandu, Nepal

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Abstract

Phenological behavior exhibited by flowering plant is periodically recurring natural phenomenon which is influenced greatly by environmental factors, season and photoperiod. Information on different phenophases of selected herbaceous angiosperm species found in the Botanical Garden of the Central Department of Botany, Tribhuvan Uinversity, Kathmandu, was collected in 2005. Peak season for the vegetative stage, flowering, fruiting and seed formation was found within 2-3 month period. The difference in period of different phenophases like vegetative growth, flowering & fruiting among plant species growing in the same habitat and distribution pattern of the plant species in a community reflects their vegetative growth pattern that may reduced the competition among them and make possible for them to co-exist. Phenological information of herbaceous species can be helpful for sustainable harvesting of medicinal plants and grassland management.

Key words: phenophase, sustainable harvesting, CDB Garden

Introduction

Season-wise distribution of different phases of plant life cycle such as leaf flushing, leaf expansion, leaf fall, flowering, fruiting, etc. (i.e. periodic biological events) is referred to as phenology. These seasonal events in the life cycle of plant are influenced to the greatest extent by temperature, photoperiod and precipitation (Keatley, 2000). Phenology is an important natural phenomenon recurring periodically with respect to the change of season and physical environment (Gupta, 2005) and is generally regarded as an art of observing life cycle phases or activities of plants in their temporal occurrence throughout the year (Leith, 1974). It is the study of relationship between climatic factor and seasonal biological phenomenon i.e. phenophases (Barbour *et al*., 1999). The US/IBP (United States, International Biological Programme) phenology committee defines phenology, as the study of timing of recurring biological events, the cause of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species.

Different phenophases of the plant like flowering, fruiting, seed germination and seedling establishment and their interrelation among phases of the same or different species are important for ecosystem dynamics. Leaf life span not only controls nutrient dynamics it also has phylogenetic significance. Plant phenological observation provides a background for information on functional rhythms of plant and plant community (Ralhan *et al*., 1985). The main purpose of phenology given by Linnaeous (1751) was to compile plant calendar of leafing, flowering, fruiting and leaf fall together with climatological observations. Phenology is important because of its relation to process and factor such as plant growth, periodicity, flowering, fruiting, plant water stress, leaf gas exchange and longevity, plant herbivore interaction and ecosystem proportion. It may be quite useful to understand the community structure and ecosystem function. Thus in the same microclimate, different plant species as well as the individuals of same species may occur in different

phenophases to minimize competition for the common resource such as light, temperature, nutrients, water, etc. Using phenological data climate change may be detect (as a biological indicator) according to plants' response to changing climate in their natural habitat (Root *et al*., 2003). Phenological records of the dates on which seasonal phenomena occur provide important information on how climate change affects ecosystem overtime. Ancient Chinese and Romans used phenological calendar to guide agricultural activities. In addition to agriculture, phenological observations are widely applicable in many fields such as forestry, applied botany, range management, silviculture, modeling garden and forest fire protection (Wielgolaski, 1974; Karki, 1999). Some sporadic work on phenological study (Joshi, 1997; Karki, 1999; Pandey, 2001; Shrestha, 2001; Thapa & Jha, 2002; Thapa 2005; Maharjan, 2006) has been carried out therefore there is not much published information on phenological research work which may minimize the information gap in the related field thereby a reliable background will be formed for such research work. The main objective of present study is to acquire the knowledge on phenology of some dicot/monocot herbaceous species found inside the Garden of Central Department of Botany (CDB Garden); which may help to predict the seasonal flowering/fruiting behavior of plants and the preference of their growing habitat/habitat utilization i.e. distribution pattern of the plant species in a community, which generally help to know the community structure.

Materials and Method

Study Area: Present study was carried in the Botanical Garden of the Central Department of Botany (CDB Garden), Tribhuvan University, Kirtipur, Kathmandu (27° 40' N, 85 17' E, 1300 m asl). It lies in subtropical region with characteristic monsoon rainfall and three distinct seasons: hot and dry summer (February to May), hot and moist rainy season (June to September) and cold and dry winter (October to January). Maximum temperature ranges from 30 to 33C in summer and 13 to 22C in winter and minimum temperature from 20 to 23°C in summer and -3 to 0°C in winter (recorded at Tribhuwan International Airport weather station (27 42' N, 85 22' E, alt. 1336 m), Kathmandu in 2003 (Source: Department of Hydrology and Meteorology/GoN). Soil in this area is silty loam and very suitable for paddy growing (Manandhar *et al*., 2007). CDB Garden is mostly dominated by herbaceous species such as *Trifolium repens*, *Centella asiatica, Imperata cylindrica*, *Cynodon dactylon, Hydrocotyl nepalensis,* etc.

Field study: Field study was carried out by direct observation of herbaceous plant of CDB Garden. For phenological study 25 herb species was selected due to their relatively higher abundance in comparison to other herbaceous plant species an observation was made on either site of the path of the CDB Garden covering an area of about 1 hectare. Some species were identified in the field with the help of relevant literature (Malla *et al.*, 1986; Hooker, 1897) and unknown species were identified by cross checking the specimens deposited at Tribhuvan University Central Herbarium (TUCH), Kirtipur, Kathmandu, Nepal and with the help of expert of taxonomy as well. The nomenclature of identified plant species follows Press *et al*. (2000). Different phenophases of each herbaceous species such as vegetative growth, flowering, and fruiting, seed formation/ maturation and senescence or death stage were recorded in the every first week of each month from May to November 2005 by considering more or less phonological information collected within that period may support for carrying out further work in the relevant field by taking several plots in a varied location; otherwise observation would better to make oblique take at least for one complete year which is very essential for phonological study, however, it depends upon the objective of the study. Phenological events are customarily recorded diagrammatically month-wise or by season-wise manner. These diagrams are called phenograms which are represented by hexagonal benzene ring like structure. The phenogram and symbol legend used for different stages are shown in figure 1; where each part of the ring denotes a particular phenophase.

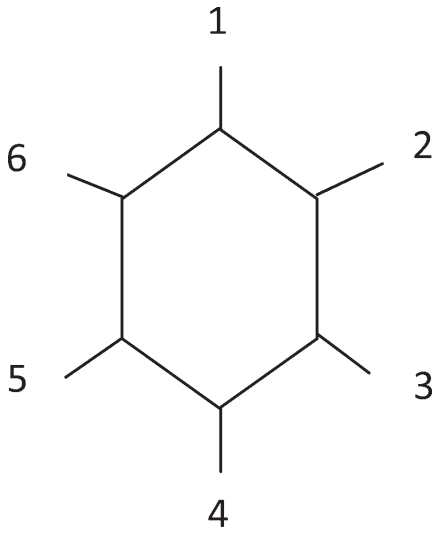

Figure 1 : A model of phenogram used to represent different phonological events (1-6)

1-germination, 2-vegetative stage, 3-flowering, 4-fruit formation/development (green), 5- seed formation /mature fruit(fully expanded) & 6 - senescence or death

Information on preference of the growing habitat/ habitat utilization i.e. distribution pattern of the plant species was carried out directly by visual estimation without sampling the studied plot and was made serpentine path for field observation.

Result and Discussion

In the CDB Garden, the most dominant herb species was *Trifolium repens*. Other associated species were *Centella asiatica*, *Imperata cylindrica*, *Cynodon dactylon*, *Hydrocotyl nepalensis* and *Ageratum conyzoides*, etc. Studied plot had somewhat similar type of plant species composition. But there are some plants which behave as the indicators of the particular habitat, showing their characteristic preference to that microclimate. Present study revealed that different species were found in different type of habitat. For example, *Persicaria hydropiper* was found to be actively growing only in shady and moist places i.e. especially near water sources. Similarly *Stellaria media* and *Drymaria diandra* prefer to grow in a place with sufficient humidity and comparatively higher soil moisture. Plant species like *Bidens pilosa, Eupatorium adenophorum, Ageratum conyzoides, Galinsoga parviflora, Cirsium verutum,* etc. were generally found away from the moist area. *Oenothera rosea* was found growing near by the water source which however, did not respond to other microclimatic conditions like shady and open places. According to preference of distribution of habitat of studied plant species, the perennial plant species like *Trifolium repens, Centella asiatica, Hydrocotyl nepalensis* and *Duchesnea indica* were densely grown in the studied plot while the annual plant species such as *Rorippa dubia, Plantago major, Oenothera rosea*,etc. were found to grow in scattered form, where the influence of perennials were found less. Generally *Cynodon dactylon* and *Imperata cylindrica* were found intermixed with all the other plant species which may be due to their ability to adopt adverse situation like long day season, poor soil quality, high light intensity, etc. These above mentioned annual plant species complete their life cycle within a certain period (Feb.-May) and found to grow in open as well as in moist and shady habitats. The preference of the growing habitat/habitat utilization i.e. distribution pattern of the plant species in a community reflects their vegetative growth pattern that may reduced the competition among them. Plants growing in dry habitat complete their life cycle during the relatively short period (Treshow, 1970). Herbaceous plants reveal the characteristic association with another particular plant or group of plants. *Trifolium repens*, for instance, which was found to grow as a dominant species showed close association with *Centella asiatica* and *Hydrocotyl nepalensis*. Similar finding was reported by Joshi (1997) where he had observed phenology of altogether 25 dicot herbaceous species in his three studied plot; one plot inside the CDB Garden and remaining two inside the Coronation Garden, Kirtipur, Kathmandu and Karki (1999) where she had enumerated phenological observation of altogether 40 herbaceous angiospermic plant species from the seven study sites (Sundarijal, Guheshwari, Pashupati, Shankhamul Dovan, Teku Dovan, Sundarighat & Chovar) of Kathmandu. *Trifolium repens, Centella asiatica, and Hydrocotyl nepalensis* may demand similar nutrients (no allelopathic effect) from the soil and favors other environmental factors

for their growth. Therefore, the association between them might be either due to lack of competition among themselves or there is a mutual relations among themselves. Another possible factor may be due to difference in the duration of flowering and fruiting among the species. The marked difference between the period of flowering and fruiting among the species may reduce the competition (for habitat, nutrient, light, water, etc.) between them for extra nutrient since they require more nutrients for their active growth phase. The difference in time and duration of blooming & photoperiodic condition facilitate them to co - exist in such associatioin. Likewise other plant species such as *Rorripa dubia, Ageratum conyzoides, Galinsoga parviflora,* etc. are less sensitive to microclimatic conditions and did not show any remarkable association with particular plant species. Most of the herbaceous species flourish well in the rainy season which may be due to arrival of favourable condition of environmental factors like light, soil moisturte, temperature, etc. since the environmental factors play vital role in the life cycle of plant. Joshi (1985) further reported that soil moisture often have significant effect on flowering and fruiting of herbaceous species; so rainy season may be favourable to them for flourishing/blooming. Joshi (1997) further reported that the amount of nutrient decreased from vegetative to generative phase because during the active vegetative growth period the physiological and enzymatic reactions were highly active and therefore they require more nutrients during that period. The different phenophase of the herbaceous angiosperm species (3 monocot & 22 dicot) in different month is given in Table 1 and Figure 2.

In terrestrial ecosystems, higher plants predominantly reproduce by sexual means of formation of flowers and then seeds. The structure and number of fruits, number of seed per fruit, the seasons of fruit formation, etc. are important aspects in the ecological life cycle that greatly influence the success of a species among the members of the community in regeneration and establishment, generation after generation (Ambasht, 1982). It was found that different herbaceous species showed the different phenophases within the seven months of observation viz. vegetative (seedling emergence or vegetative flushing stage), flowering, fruiting, seed formation and senescence (Table 1). Climatic factors such as rainfall, temperature along with edaphic factor have pronounced effect on different phenophases of the plant which are responsible for the change in particular phase of life cycle of herbs, as they are very sensitive to environmental factors, seasonality and photoperiodic condition (Joshi, 1997; Karki, 1999). Apart from these factors, physiological and genetical factors are also responsible for changing phenological behavior of the plants (Bertiller *et al*., 1982); however both physiological and genetical bases for many phenological events have yet to be uncovered. In the life cycle of plant species, phenophases are closely correlated with seasonality of the area which varies in different parts of the world due to annual change in temperature, water regime and day length in the environment (Muchow, 1985). Nepal falls in the monsoonal system of the Indian subcontinent and shows mainly three distinct seasons i.e. rainy, winter and summer.

From the phenological study of herbs of CDB Garden it was found that June was the peak season for the vegetative stage of the herbaceous plants where 85% species were in vegetative stage. Flowering pattern showed that 80% of the species flowered in July (Figure 2). Likewise fruiting pattern showed that 40% of the species were in fruiting stage

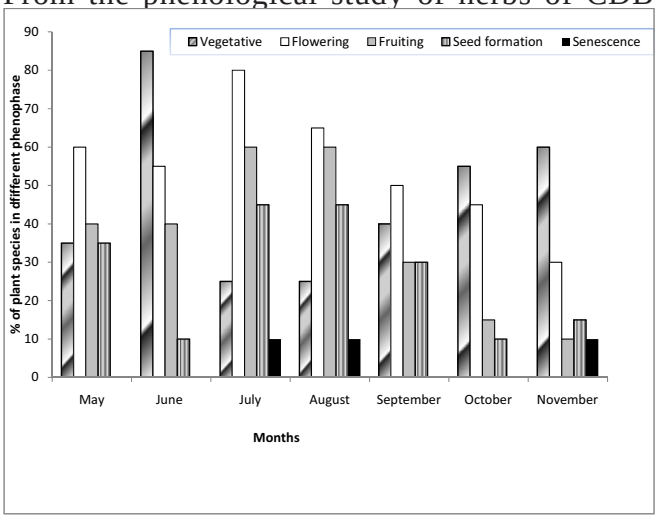

Figure 2 : Percentage of plant species in different phenophases

Table 1 : Phenological observations in the form of phenograms of different plant species

S.N.	Name of plant species	Phenophases of species in different month						
		May	June	July	Aug.	Sept.	Oct.	Nov.
1	*Ageratum conyzoides* L.							
2	*Artemisia vulgaris* L.							
3	*Bidens biternata* (Lour.) Merr & Sheriff							
4	*Bidens pilosa* L.							
5	*Centella asiatica* L. Urb.							
6	*Circium verutum* (D. Don) Spreng.							
7	*Cuscuta reflexa* Roxb.							
8	*Cynodon dactylon* (L.) Pers.							
9	*Cyperus difformis* L.							
10	*Drymaria diandra* Blume							
11	*Duchesnea indica* (Andr.) Focke							
12	*Eupatorium adenophorum* Spreng.							
13	*Galinsoga parviflora* Cav.							
14	*Hydocotyl nepalensis* Hook.							
15	*Imperata cylindrica* (L.) P. Beauv							
16	*Lobelia chinensis* Lour.							
17	*Oenothera rosea* Her. ex Ait.							
18	*Oxalis corniculata* L.							
19	*Persicaria hydropiper* L.							
20	*Plantago major* L							
21	*Polygonum hydropiper* L.							
22	*Ranunculus scleratus* L.							
23	*Rorripa dubia* (Per.) Hara							
24	*Stellaria media* L. Vill							
25	*Trifolium repens* L.							

during May and June, 60% in July and August and 30% in September. It was found that the peak season for fruiting as well as seed formation was during July and August (rainy season) (Figure 2) on the basis of monitoring seven months (May to November) phenological observation in the studied plot. Callow *et al.* (1992) found that early and late flowering is due to temperature factor than precipitation. Several environmental factors were found to have pronounced effect on different phenophases of the

plants (Joshi, 1997). Lynch (1971) studied two plant communities and found that soil moisture percentage and phenological activity of plants are very much related. Because of higher rainfall in rainy season and wide ranges in temperature throughout the year, the vegetation shows well marked seasonal aspects. Among the plant community, the herbaceous plants are more sensitive to seasonality (Joshi, 1997; Karki, 1999). For example, rainfall is the prime factor for their germination to be effected and the plants which germinate following the rainfall in rainy season flourish and complete their life cycle by the middle of winter season. Similarly, those which germinate after rainfall in winter season complete their life cycle by the end of summer season (Joshi, 1997; Karki, 1999). As a result especially herbaceous annual angiospermic plant species appear in the summer season may disappear in the winter season due to attain senescence stage and the species appear in the rainy season may disappear in the winter season and vice versa. Irregularities in rainfall pattern effect changes in vegetation, especially among grasses and annual herbs since rainfall is the prime factor for the germination of herbaceous plants. The seedlings can be found at all times with the exception of mid and late summer. The species that will be abundant in the following growing season and which scarce or absent will be depend to a large extent on the time and amount of rainfall (Lynch, 1971). The region with uniform distribution of rainfall, the phonological events are less conspicuous than in the region with marked seasonal rhythmicity in climate (Larcher, 1995). Regarding the germination there are mainly two favorable periods i.e. after winter rainfall and during rainy season. Out of 25 species selected for phenological study, some plants like *Centella asiatica, Oxalis corniculata, Artemisia vulgaris, Cuscuta reflexa, Cynodon dactylon, Plantago major,* etc. have medicinal property; collection practice is not there since the study area has not been used for the collection of medicinal plants (MPs) and is frequently cut during Garden management. Due to lack of proper training in scientific collection techniques, lack of knowledge about proper time of harvesting and unhealthy competition among collectors are some of the reasons leading to unsustainable harvesting of parts of the MPs. In many cases the immature extraction of fruits, roots, tubers, etc. has drastically reduced the quality as well as the quantity of the raw product to below critical level (Mishra *et al*., 2003). So by knowing the different phenophases of the medicinal plant, used part of such plant for medicinal purposes can be harvest which minimize the risk of quality and quantity of the collected raw product (from immature collection of the plant parts) due to unscientific collection and support for sustainable harvesting. In contrast, plants like *Cynodon dactylon, Imperata cylindrica, Cyperus difformis, Trifolium repens, Drymaria diandra, Cirsium verutum, Ageratum conyzoides, Galinsoga parviflora, Bidens pilosa,* etc. found in the studied plot are commonly found in the agricultural land as herbaceous weed species which can be used as a grass fodder for cattle and to make green manure as well. In agriculture, weed management during the cropping season has been a serious problem in spite of using huge amount of herbicides and integrated weed management (Manandhar *et al*., 2007). Weed should be controlled at proper time to check reduction in crop yield and they must be removed before flowering and fruiting to reduce the source of seed in soil seed bank for the next year (Thapa & Jha, 2002). So phenological information of weed of the crop field may be fruitful in removing weed before to attain reproductive stage (flowering and fruiting). By knowing the photoperiod and phenology of the crop plant, rotation/selection of the suitable crop plant can be done for crop cultivation. Although study area never been subjected/used as a grass/pasture land for livestock grazing (managed for conservation purpose), application of phonological information of herbaceous species can be interlinked with management of grass/pasture land for grazing livestock, however, such practices has not been applied yet in our country. For example any grass/ pastureland which has been designated specifically for grazing purpose, there may be found both palatable and non palatable plant species. If all the palatable plant species have same phonological behavior like germination, vegetative flushing stage or flowering stage during the same period; there may

be the scarcity of fodder for livestock grazing in any season. In this case, other palatable herbaceous plant species having different phonological period of germination, vegetative flushing stage or flowering stage than that of the already existing palatable plant species; can be introduced in the grassland by replacing the non palatable species that may support intensive management of grass/pastureland for grazing the livestock throughout the year.

Conclusion

From the present study it can be concluded that different phenological behavior of plant species in the same area within same climatic conditions makes their co-existence possible. The difference in period of vegetative growth, flowering and fruiting behavior of different plant species growing under same habitat and distribution pattern of the plant species in a community reflects their vegetative growth pattern that may reduced the competition among them and make possible for them to co-exist. Besides, phenological information of herbaceous species can be helpful for sustainable harvesting of medicinal plants and grassland management.

Acknowledgements

I gratefully acknowledge my teacher Dr. Bharat Babu Shrestha, Lecturer, Central Department of Botany, Tribhuvan University (Kirtipur, Kathmandu) for his valuable comments and suggestions to prepare early draft of this manuscript. Thanks are also due to Central Department of Botany, Tribhuvan University, for providing the necessary facilities. I am thankful to Dr. Bhaskar Adhikari & Prof. Dr. Krishna Kumar Shrestha for their help in plant identification. I am really grateful to Mr. Gaurav Parmar, Mr. Mitra Lal Pathak and Mr. Pramesh Bahadur Lakhe for their co-operation and kind help in computer work. I want to remember Dr. K. R. Rajbhandari, Dr. Khem Raj Bhattarai, Mr. Dhan Raj Kandel, Mr. Tirtha Raj Pandeya and Ms. Seerjana Maharjan for sharing their valuable knowledge.

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Major aspects of Medicinal and Aromatic Plants (MAPs) management in Nepal – Baseline information as reflected in experts' opinions.

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Abstract

The present work was carried out with the aim to generate baseline information on major aspects of Medicinal and Aromatic Plants (MAPs) management in Nepal. The study is mainly based on primary data collected as expert opinions from three groups of respondent viz. Government officials, I/NGO officials and Freelancers involving directly or indirectly in the management of MAPs. The work was carried out in the year 2012.The present study reveals that Nepal is rich in medicinal plants resources, with great potential of contributing in the national economy, but at present, the country is unable to exploit this resource in proper way because of weak efforts from the state in the management of MAPs. The findings are validated by one way ANOVA as scores assigned by three groups of respondents do not vary significantly at 5% level of significance. The study also concludes that problems exist in the management of MAPs in Nepal, and almost 85% to 91% of respondents identified both the policy and institutional issues in the management of MAPs, some included other issues along with this while others did not.

Key Words: MAPs, NTFPs, management, policy, institution.

Introduction

Medicinal plants have special meanings to people, related to the major contributions that they make in their lives in terms of health support, financial income, cultural identity and livelihood security (Hamilton 2005). Medicinal plant is a plant which has been used for medicinal purpose at one time or another, and which, although not necessarily a product or available for marketing, is the original material of herbal medicines (WHO 1988). Aromatic plants are group of plant species which possess volatile oils on their parts. Medicinal and aromatic plants (MAPs) are the biggest and by far the most important component of the Non-Timber Forest Products (NTFPs) and its contribution to the rural economy and healthcare is far more than services offered by other NTFP sub-sectors.

According to World Health Organization, the majority of the world's human population, especially in developing countries, depends on traditional medicine based on MAPs (WHO 2002). About 50,000 and 70,000 plant species are known to be used in traditional and modern medicinal systems throughout the world (Schippmann *et al.* 2006). According to Butler (2005) and Newman et al. (2003) approximately half of the drugs currently in clinical use are of natural product origin.

MAPs Contribution to the National Economy

In the mountains of Nepal, 10-100% households in the rural areas are involved in commercial collection of NTFPs including medicinal plant, and in certain rural areas, this provides up to 50% of the family income (Shrestha et al. 1995, Edwards 1996a, Olsen and Helles 1997a, Chhetry 1999, Olsen and Larson 2003). The livelihood of the majority of population of Himalayan and High Mountain, especially in Western Nepal, is sustained by NTFP trade (Subedi 2006). Non-Timber Forest Products (NTFPs) of which a significant portion constitutes of medicinal plants is estimated to contribute about 5% to Nepal's GDP (Malla *et al.* 1995, ANSAB 1999). The revenue from NTFPs, including medicinal plants, for the government of Nepal is more than 16% of the total

revenue generated from the forest based products (GoN 2010).

Objectives of the Study

Present status and management of MAPs in Nepal is one of the less explored areas in research. The specific objective of the research is to collect, compare and consolidate baseline information as experts' opinions in terms of point rating scale on major aspects of MAPs management in Nepal such as MAPs availability, contribution to the national economy, its potential to contribute in the national economy and Nepal's efforts on MAPs management. Further, to identify the issues in management of MAPs is another objective of the research.

Materials and Methods

The study was focused on collecting the primary data. All the individuals who were involved in the management of MAPs directly or indirectly irrespective of governmental or nongovernmental organizations and freelancers were taken as population for the study. As population itself was heterogeneous, non-random sampling method was used for data collection. Sampling units were selected from population through purposive method as the aim of the research was to analyze the expert opinions related to the management of MAPs. For that information were collected from concerned officials of governmental and nongovernmental organizations and from freelancers who were involved in the management of MAPs directly or indirectly. Altogether sample size for the study was 64 with representing 40 from government and government owned organizations, 11 from nongovernmental organizations and 13 freelancers. Among the government and officials from government owned organizations, almost all respondents were of officer rank including Director General of Government Departments and Managing Director of Company owned by government.

Structured type of questionnaire was designed in order to fulfill the objectives of the research. The questionnaire contained 5 questions, first four were objective questions having options in point rating scale with score ranging from 1 to 5 representing minimum to maximum, fifth question was objective with one open ended option.

As the respondents were categorized into three groups, namely government or government-owned organization officials, I/NGO officials and freelancer of MAPs sector; their opinions were analyzed separately as well as collectively. Difference in population means on the scores assigned by governmental officials, I/NGO officials and freelancers were statistically analyzed with one way ANOVA as statistical tool through using Statistical Package for Social Sciences (SPSS) software and the results are presented in bar diagram.

Results and Discussions

Availability of MAPs in Nepal

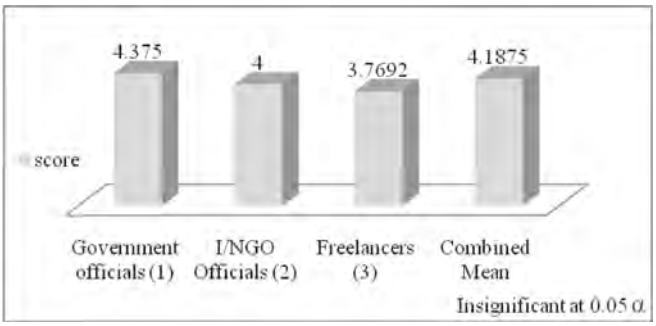

Diagram 1: Score on availability of MAPs in Nepal

Nepal is rich in Medicinal and Aromatic Plants (MAPs). Regarding the availability of MAPs in Nepal, an encouraging result was observed. Average score 4.1875 was observed out of maximum score 5, and according to respondent groups Government officials assigned maximum scores and Freelancers assigned minimum scores while I/NGO officials assigned in between them. The population means of different respondent group scores did not vary significantly at 5% level of significance.

The present finding indicates Nepal is rich in MAPs which supports the general perception that Nepal is rich in MAPs in terms of its diversity as well as in terms of its quantity.

Contribution of MAPs in Nepal's economy

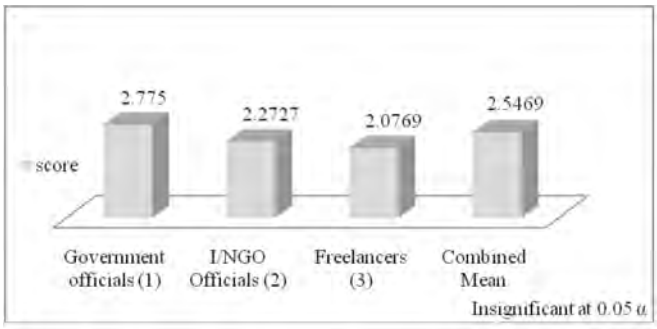

Diagram 2: Score on contribution of MAPs in Nepal's economy

MAPs not contributing significantly in Nepal's economy! Regarding the contribution of MAPs on Nepal's economy, an encouraging result was not observed, as only 2.5469 score was observed. Among the respondent groups, Government officials assigned somewhat higher scores and I/NGO officials and Freelancer assigned comparatively lower scores. The population means of different respondent group scores were not significantly different at 5% level of significance.

The present finding differs from the previous findings of Malla *et al.* (1995) and ANSAB (1999) that NTFPs sector contribute 5% to the GDP, which is significant figure that demands somewhat higher score in the present study. Hence, there is a need to reassess the actual contribution of MAPs using various yardsticks.

Possibility of MAPs playing a key role in Nepal's economy after its proper management

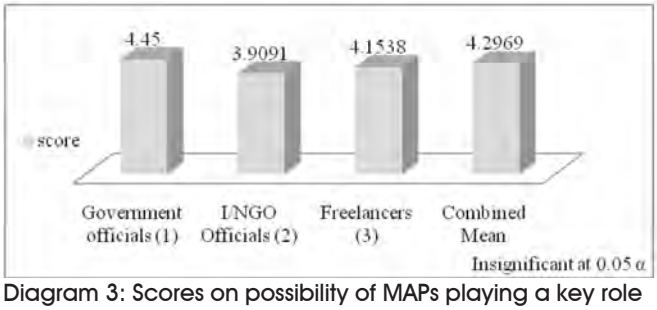

Diagram 3: Scores on possibility of MAPs playing a key role in Nepal's economy after its proper management

MAPs sector has great potential of playing key role in Nepal's economy! Regarding the possibility of MAPs playing key role in contributing Nepal's economy through its proper management, an encouraging result was observed. Average score 4.2969 was observed out of maximum score 5. Three groups of respondents assigned almost equal scores, though Government officials assigned comparatively higher score. The population means of different respondent groups scores did not vary significantly at 5% level of significance.

The present finding indicates that there is high hope of positive consequences of proper management of MAPs, and investment in this sector will be better for the state to enhance the economy.

Present scenario about Nepal's efforts on MAPs management

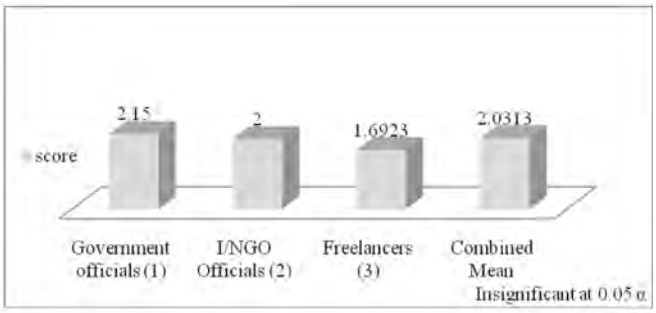

Diagram 4: Scores on present scenario about Nepal's efforts on MAPs management

Nepal's current efforts on MAPs management are very weak! Regarding the present scenario on Nepal's efforts on MAPs management, a discouraging result was observed, average score of only 2.0313 was observed, the minimum score so far in the study. Among three groups of respondents Government officials and I/NGO officials assigned almost equal scores and freelancer assigned minimum scores of 1.6923. The population means of different respondent group scores did not vary significantly at 5% level of significance.

The present finding indicates current efforts of Nepal on MAPs management are weak. There is depletion of resource bases due to over exploitation and lack of management systems (Edwards 1994; Malla et al., 1995; Subedi 1999). The result is that the poor become poorer and end up destroying their only livelihood the biodiversity rich forests (Subedi 2006). About 80 per cent of the value and volume in

trade is occupied by 20 high demand and high valued products. Further, half the traded amount is covered by the transaction of five highly-traded NTFPs, thereby creating tremendous pressure on a few selected NTFPs (Olsen 2005a).

Despite the huge potential of contribution from MAPs sector in the development of the country, only a limited benefit has been realized from this sector at present. Nepal is not able to appear as key exporter in the global market of medicinal plants and its products, despite of being 25th largest exporter of MAPs it shared just 0.61 percentage of the global market (UN Comtrade 2009 cited in Sharma and Shrestha 2011). Similarly, the world's production of essential oils is estimated to about 100,000 - 110,000 tones (Farooqi and Sreeramu 2001 cited in Sharma and Shrestha 2011), and Nepal has negligible percentage in terms of global production despite its rich diversity in aromatic plant species.

Problem in management of MAPs

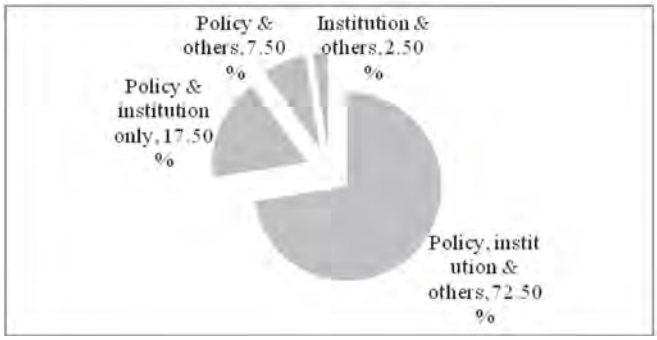

Diagram 5: Government official's views on problem in management of MAPs

Policy, institutional and other problems prevail in the management of MAPs! 72.5% of Governmental officials saw the problems in the policy, institution and others as well, 17.5% viewed that problems exist in policy and institution, 7.5% blamed it for policy and others and 2.5% viewed the problems in institution and others.

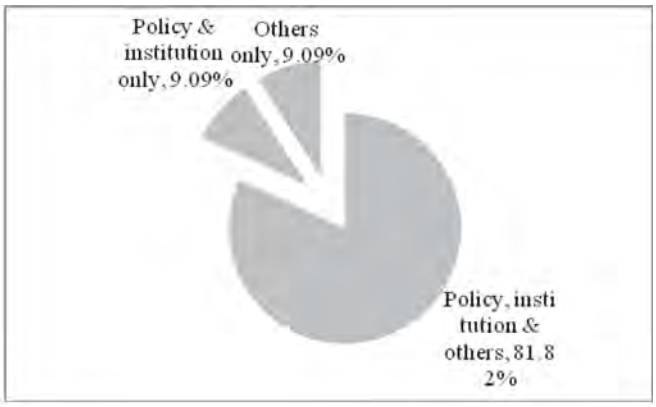

Fig. 6: I/NGO officials views on problem in management of MAPs

81.82% of I/NGO officials saw the problems in the policy, institution and others as well, 9.09% viewed that problems exist in policy and institution, 9.09% blamed it for other problems than policy and institution.

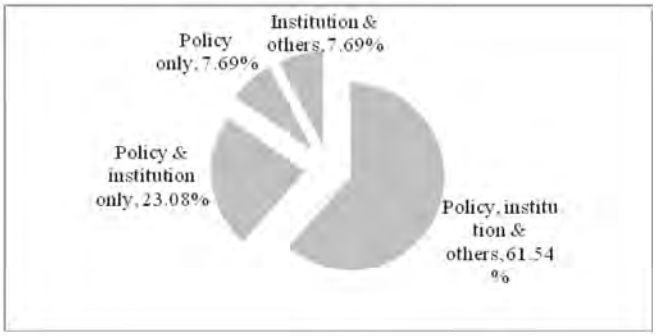

Diagram 7: Freelancers views on problem in management of MAPs

In case of Freelancers, 61.54% saw the problems in the policy, institution and others as well, 23.08% viewed that problems exist in policy and institution, 7.69% blamed it for policy only and 7.69% viewed the problems in institution and others.

Above findings on problems in policy, institutions and others are also supported by several scholars. Although government policies and legislative measures in the forestry sector such as Herbs and NTFP Development Policy (HNDP) 2004, Forest Act 1993 and Forest Regulations 1995, Environment Protection Act 1996 and Environmental Protection Regulation 1997 etc. provide a framework for the improved utilization of forest products, these are often criticized as ineffective due to lack of proper

implementation (Olsen & Helles 1997a, b; Larsen *et al.* 2000). Kanel (2000) had identified this policy environment of MAPs management in Nepal as 'confusing policy environment'. There is no separate policy or legislation for plant resources management and sustainable utilizations. Separate policy and legislation on plant resources is thus urgently needed (Aryal 2005).

Government institutions involved in the MAPs sector in Nepal include the Department of Forests (DoF), Department of Plants Resources (DPR), Department of National Parks and Wildlife Conservation (DNPWC), Department of Forest Research and Survey (DFRS), Herbs Production and Processing Company Limited (HPPCL) and the Department of Ayurveda. International Non-Governmental Organizations (INGOs) such as WWF-Nepal, ICIMOD, IUCN, ANSAB, MAPPA-IRC etc. and Non-Governmental Organizations (NGOs) such as FECOFUN, Forest Action etc. are also involved in the promotion and development of NTFPs and other medicinal plants in the country. Throughout the country, there are different projects and programs related to the conservation, cultivation, management and development of MAPs implemented by both government and non-government sectors. Furthermore, there are only a limited number of small and micro industries that produce herbal products which are mostly in the private sector.

Various actions have been attempted by these institutions; however, these attempts have often been isolated and sometimes not based on a systematic analysis of the condition needed for success. Situations in which the resources are being managed are often very complex since they are related to a web of interrelated ecological, socio-economic, cultural and political factors (Aumeeruddy-Thomas and Karki 2005). Similarly human resources related problems especially weak knowledge among the technicians was identified by Kanel (2000), that people involved in the regulation of NTFPs collection and export e.g. DFO staff, Custom staff, Police, etc. have difficulties in identifying NTFP species especially MAPs.

Issues pertaining to equity in benefit sharing from the commercialization of medicinal plants are quite complex as the medicinal plant sub-sector involves diverse group of stakeholders (Subedi 2006, Olsen and Bhattarai 2005). Moreover, lack of knowledge about legal provisions, market information, institutional support, production management and post-harvest operation forbid the user groups from equitable benefit sharing of medicinal resources (Subedi 2006).

Conclusion

The present study reveals that Nepal is rich in medicinal plants resources, with great potential for contribution in the national economy, but at present, the country is unable to exploit this resource in proper way because of weak efforts from the country in management of MAPs. The inference is drawn on the basis of scores assigned by respondents of the present study as well as various secondary sources. The scores assigned by different respondents such as Government officials, I/NGO officials and Freelancers did not vary significantly at 5% level of significance, means that experts of different group have similar opinions regarding the research questions .

The study validates the general perception that the country is attaining very small fraction of benefit from MAPs resources as compared to its potentialities as a whole. Therefore immediate rethinking is necessary for the present management strategy as well as practice for the fine tuning between legal and institutional frameworks. For this, identification of the issues and solutions for each and every issue is utmost important for the management of MAPs. The country will get benefits from the MAPs sector provided identified solutions implemented in a systematic way. The MAPs sector is one of the resources which has potential to make significant contribution to the national economy of Nepal.

Acknowledgement

I would like to thank all the respondents whose opinions are core of this research. I am grateful to Mr. Shamik Mishra, Director of Madan Puraskar Pustakalaya (MPP) for his kind support to improve the quality of the research.

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A brief introduction to flower arrangement for ceremonial displays

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Abstract

The art of flower arrangement is practiced by human kind since long. The art of composition and skill of flower arrangement is an artistic imagination which is appealing to others.

Key words: Beautify, artistic pattern determination, composition, utensils, leaves, trimming

Introduction

Widely celebrated as a kind of elegant and graceful art, the flower arrangement is able to beautify people's daily lives, refine sentiment, and bring delight and refined tastes as well. Since the remote antiquity, people have been fond of the flower arrangement. Flower arrangement display is mostly used for the social ceremonial activities. Its main goals include creating and promoting the pleasant ambience, amiable environment, or even a sense of serenity at the mourning ceremony for the deceased. This is used to express humankind's emotions and creativity. In most cases, a variety of flowering plants are used. The use of these flowering plants should target the social customs and taboos followed by different ethnic groups in different countries during different festivals. We should be prudent in making choices. In Nepal, with rapid urbanization, the flower arrangement for ceremonial displays is growing faster in cities and its skill demand is ever growing since.

Most flower arrangements are made for a certain purpose or place. The structure of flower arrangement varies, including flower baskets, flower bunches, wreaths, wedding bouquets, corsage, and dinner table flowers. They can be used on different occasions and for different atmospheres expressing different theme and ideas accordingly.

I. Concept of Flower Arrangement Art

The flowers with the visual value, artificial plants and all kinds of ornamental materials are processed (techniques – trimming, pruning, bending; art – artistic pattern determination, color combination, modeling) on the basis of the integration of aesthetical principles in a bid to create an exquisite shape with poetic and artistic imagination which blends both natural beauty and artistic taste. The art is characterized by the use of ingenious arrangement within limited space in showcasing the natural beauty. Namely, such a concept is supposed to concentrate the natural landscape into the small bottles or pots. It sets great store by the perfection of composition, harmony of colors, variation of rhythm, transformation of lines and embodiment of vitality. With the passage of seasons, it showcases different landscapes. As a result, it is a living artwork.

II. Significance of Flower Arrangement Art

1. Environmental Beautification

The fresh flowering branches with bright colors, such a piece of art can provide the colorful setting to the inner decoration, filling the rooms with vitality, romantic flavor and pleasant atmosphere. It helps to express yourself creatively, and to make your home or room more livable and attractive.

2. Refining Sentiment

Just like listening to sweet melodies, enjoying the arranged flowers is an artistic treat for people. In addition to arousing people's craving for the Great Nature, it can also help them improve health and refine sentiment.

3. Enhancing Friendship and Disseminating Information

Serving as a friendly partner, the flowers are not only a precious gift with a refined taste but also the one which can enhance mutual friendship and disseminate information.

III. Characteristics of Flower Arrangement Art

1. Timeliness

Flowering displays differs with different ceremonial occasions like wedding, birthdays, valentines, mourning etc.

2. Unrestrained Decoration Choices

The selection of flowering plant materials is extensive, ranging from wild flowers to wild grass to flower branches. All of them are good materials. Beauty and good composition of an arrangement is not determined by the cost or rarity of plant materials used, but by the way they are selected, cared for and arranged.

3. Decoration

The artistic decoration is a must using colorful flowers different kinds of utensils with various colors and shapes.

4. Visual features

Visual characteristics of selected plant materials like colors, shapes, size and aromas is very important for effective and artistic displays.

IV. Classification of Flower Arrangement Art

1. Flower Arrangement for Ceremonial Displays

It is prepared mainly for the purpose of social occasions. The goals include setting off a certain theme and creating the specific atmosphere depending upon the occasion. The usual forms involve the flower basket, flower bunches, wreath, corsage and dinner table flowers, etc.

2. Artistic Flower Arrangement

Without limitation caused by outdated conventions, the artistic flower arrangement of this kind usually takes different forms. Any piece of art is of its own motif and is integrated into the creator's own conception and originality.

V. Ways of Learning Flower Arrangement Art

The flower arrangement art can be defined as a comprehensive subject which is related to botany, science of composition, chromatics, literature and other learning areas. The process of flower arrangement can improve the makers' own artistic appreciation and cultural accomplishments itself.

The flower arrangement does not simply refer to the craftsmanship of piecing together the blooming plants. Instead, it stands for the combination and modeling based on meditation, art of composition and skills. Besides, the creator's thoughts and emotions should also be added to the enticement of the artworks.

1. From the elementary to the profound, follow an order and advance step by step, from the easy to the complex and from the concrete to the abstract.
2. A good command of botany, drawing, literature, etc is needed. Only with the way of ceaseless enrichment and improvement of literary and artistic accomplishments, flower arrangement artists can produce the masterpieces full of poetic and artistic imagination which will be appealing to others and convey its creativity, sentiment, beautiful ambience as well as the sense of spiritual beauty.
3. Emphasize on Practice
4. Maintain close contacts with life and society with a intention to seek the sources and inspiration of artistic creation and innovations.

VI. Preparatory Work for Flower Arrangement at Early Stage

1. Artistic Pattern Determination

The so-called "artistic pattern determination" means that a flower arrangement artist should have a definite creative intention before getting down to the artistic creation. In short, it means the motive or purpose of the artistic creation.

Producers should have a definite purpose before engaging in the artistic creation. Although art is the showcase of every-day life, it cannot be considered as the duplication of every-day life. Art stems from

daily life but meanwhile it should take precedence over daily life. The fabulous art pieces can bring spiritual pleasure and noble temperament to the viewers.

2. Composition

The composition is the arrangement or handling of sights. Namely, the artistic pattern determination, conception and images hidden in the producer's mind should be reflected through flowering plants. A novel artistic pattern determination is by no means enough during the work of flower arrangement. On the contrary, the birth of an excellent flower arrangement artwork hinges on the properly-designed composition. The key to the composition lies in a good mastery of an artwork's dots, lines, surfaces, numbers and sense of reality.

1. Dots: The plants with the dot-shaped blooms should be applied in a proper way. First of all, the familiarity with the physiological characteristics and growth period of these plants is needed. The use of the flowers with the same growth period, size and colors for the flower arrangement would rid the whole artwork of the vitality and appeal. But several branches with blooming buds would enable the whole art piece to gain vitality and interest. The large-sized plants with dot-shaped flowers play a crucial role in artistic creation in most cases. The small-sized plants with dot-shaped flowers, like a forget-me-not and daisy, play a minor role.

2. Lines: The original appearances of the line-shaped plants should be reserved. Their original forms include the straight line, curve and irregular line. The combination of the above-mentioned shapes with dots and surfaces will bring about the art pieces which are blessed with varied natural shapes.

3. Surfaces: The so-called "surface-shaped flowering plants" are characterized by their green leaves, such as Japan atsia, palms, tuber ferns, and *Monstera deliciosa. Philodendron sellomn* can also be counted as a plant of this kind. Just like a huge stage, they serve as a foil to set off the plants with dot-shaped flowers and the line-shaped plants.

4. Numbers. This concept refers to the definite number of flowering plants. And this relates to the whole artwork's color effects. A great number brings a sense of abundance while a small number causes a sense of simplicity. How many flowering plants should be used depends on an art piece's characteristics and functional occasions. It does not make any sense if the flower arrangement practitioners take the numbers of consumed flowers into consideration only. The long-time exercises are the prerequisite of a good command of the suitable number of flowering plants and a masterpiece.

5. Sense of Reality: Various flowering plants with different sizes, lengths and flexible stems impress viewers in different ways. For example, a dahlia enjoys a much more imposing sense of reality than a cyclamen does. Similarly, the grandeur of sense of reality embedded in a carnation with a dark color overtakes that of a carnation with a light color.

Composition can be classified into two categories: symmetry and asymmetry. Generally speaking, the rules that all composition styles should follow read as follows:

1. Scattering in disorder and unevenly: The flowers should not be put in a horizontal line or a vertical line. Instead, they should be scattered about but properly spaced.

2. Alternate density: Both flowers and leaves should not be arranged in excessively cramped space or be arranged over sparsely. Excessively cramped space seems to be suffocating while over-sparsely arranged space presents a visual sense of emptiness.

3. Integration of appearance and fiction: Generally speaking, flowers stand for appearance while leaves fiction. Fiction serves as a foil to set off appearance so that appearance would be endowed with life, intelligence and vitality. As a result, appearance is of more artistic flavor.

4. Correspondence and Agreement in space: The flowers and leaves should be positioned in a three-dimensional space from top to bottom, or from left to right. This aims to achieve the effect of correspondence and agreement in space. In this way, both unity and balance of the artwork would be well kept.

5. The Minor Flowers in Upper Space & the Principal Ones in Lower Space: The small flowers are positioned on top of the big ones. The flowers with the light colors are put on top of those with dark colors. Thus, the structure's stability and balance can be kept.

6. Sparseness in Upper Space & density in Lower Space: The bottom of flower plants should be arranged densely so that it gives viewers a feeling that they come from the same root. On the contrary, the top of flower plants should be positioned sparsely to get a charming shape.

3. Selection of Flowering plants

1. Classification of commonly-used flowering plants: It may be line-shaped flowering plants, chunk-shaped flowering plants, irregular shaped flowering plants, sparsely-grown flowering plants, and leaves are used as a foil to set off flowers used.

2. Color matching of flowering Plants: The color matching plays a vital part in flowering arrangement simply because it really holds strong appeal for viewers. Different colors provide people with different psychological feelings. For example, the color of red reminds people of the sun and flames which symbolize enthusiasm, flourishing and happiness. The color of white reminds people of purity, holiness and lightheartedness. The flower arrangement practitioners can make use of varieties of flowering plants to produce the feeling of softness, comfort and delight following the comprehensive understanding of all these different features of different colors for different occasions.

Dominant Color: Any flowering arrangement artwork should have a dominant color. Other colors serve as a foil to set off the dominant color.

Contrasting colors: Two or more kinds of flowers with different colors are put together so that the artwork's tint difference comes into being, such as cool hues, warm hues, bright hues and dark hues. The goal is to create a visual effect of liveliness and vivacity.

Harmonizing colors: It refers to the combination of flowers with the same hue or similar hues. For example, the combination of red, orange, yellow and light red can make the whole work of art look soft, coordinated and refined. The secret lies in the similarity of the flowers' hues, purity and lightness.

4. Selection of Leaves

Traditional culture reveals that red flowers need to be set off through contrast by green leaves. But the function of leaves cannot be underestimated while doing a flower arrangement artwork. In addition to the suitable proportional relations, flower arrangement designers should also use qualified leaves as the visual backdrop. Moreover, the leaves predominate the artistic conception of a work of art. Different leaves have different colors, shapes and senses of reality. Leaf veins have different characteristics as well. There also exist water drops resting on stems, the subsequent glows under sunshine and motley of blurred tints. It is usually hard for leaves to win viewers' affection outdoors. However, they can easily take the fancy of viewers indoors simply because they can make people relaxed, give them high spirits and create a peace ambience in rooms.

5. Utensils

Utensils are an indispensable tool for flower arrangement. Any piece that can integrate flowers and their utensils in a proper way is the result of a fabulous job. This is also a factor that should be taken in consideration before the design conception of flower arrangement. The different features of the utensils can be used to enhance the attraction of flowers' beauty and vitality. The different choices of utensils are made to satisfy the different needs of flowers shapes and structures displayed in different occasions and locations. The choices of different utensils also depend on different ways of flower arrangements. For example, the classical-style flower arrangement needs some kinds of exquisite utensils with a traditional flavor. An incorrect choice will destroy the harmonious atmosphere in between.

The commonly-used utensils include pottery, ceramics, and glass, metal and flower baskets.

6. Ornaments

The suitable ornamental objects have the function of emphasizing the artistic theme. Sometimes, the ornaments under the utensils can add to the attraction of the whole masterpiece.

7. Tools commonly used for flower arrangement

Flower-nurtured mud, packing paper, scissors, bamboo skewers, ribbons, transparent adhesive tapes, double-surfaced adhesive tapes, nail base, knives, stapler, pinchers, green iron wires, green adhesive tapes, paper-cutters are commonly used.

VII. Handling Flowering Plants

A. Time for Picking Flowering Plants

It is better to pick the fresh flowers before the daybreak when the dews have not evaporated or immediately after the sunrise. Evening period is another good choice. Under the influence of the sunlight, the thin capillary tubes inside the flower branches would close so that the flower branches cannot absorb the nutrients completely at that time. But at the same time this would impair the flower branches' health and shorten their life time. As a result, it is not suitable to pick flowering plants under sunshine during the daytime. Otherwise, the flowering branches should be dipped into water immediately at noon after they are plucked off the trees.

B. Keeping flowering plants fresh

The only way to prolong the life time of flowering plants is to improve their capacity of absorbing water. The usual way is to cut the flower stems into inclined planes or to break the stems so that the area of absorption has been enlarged. This applies to the woody plants. It is better to cut flower stems in water so as to prevent the air from entering the stems. And this can also extend the flowers' lifetime.

C. Art Processing for Flowering Plants

If the unprocessed flowering plants are used for flowering arrangement, the result might be unsatisfactory. So, the unprocessed stuff should undergo a series of suitable art processing (trimming, bending, and reinforcement) according to the demand of composition in order to make the artwork more beautiful.

The detailed analyses into the chose branches and leaves should be made above all according to the requirements of composition and modeling. Only after that can the trimming kick off.

Notes for learning trimming skills

1. In accordance with natural tendency:

   For those flowering branches with perfect natural shapes, it is best to keep their original curved but smooth lines. It is the prerequisite of the success of flower arrangement.
2. Using main visual side as the center, accepting or rejecting other leaves and branches:

   When using certain branch, we should explore the shape and ascertain the posture. Before doing the job of trimming in accordance with composition, we should ascertain the main visual side.
3. If a decision cannot be made, just keep the branches temporarily, try for different arrangements. During the subsequent trial process of flower arrangement, we should decide to do trimming or not according to demands.
4. The branches that need to be discarded include:
   (a) Branches and leaves that is turning yellow or broken because of being infected by virus, germs and insects
   (b) Branches and leaves growing in over cramped space which exerts negative influence upon the shapes
   (c) Branches that impair the flowering plants' pose (parallel branches, symmetrical branches, crisscross branches and sagging branches). In most cases, all other branches should be cut off after one branch in the same direction has been kept. The redundant branches and crisscross branches should get rid of to make the whole piece look vivid and have a sense of variety.

Modeling of leaves

In modern flower arrangement art, we often process leaves to satisfy our demand for composition. The usual ways of leave processing are as follows:

i. Trimming

The leaves are cut into ones with different shapes by dint of scissors. The deliberately-processed leaves can enrich the composition.

ii Bending

Usually fingers are used to bend the soft leaves. For those relative hard leaves, we use pins, staple pins, adhesive tapes and iron wires are used to bend and fasten.

iii. Reinforcement

Iron wire are used to reinforce or extend the leave stalks. For example: the leaves of ivy-arums (*Epipremnum aureum*) and corn plant (*Dracaena fragrans*).

Acknowledgement

Thanks are due to Director General Yam Bahadur Thapa and Deputy Director Generals Ms. Sushma Upadhaya and Mr. Bed Nidhi Sharma for their encouragement. I would also like to thank Dr. Annapurna Nand Das, then Director General and Mr. Suraj Ketan Dhungana, ex Scientific Officer of Department of Plant Resources for their support and encouragement to pursue my training in China, without which I would not be able to produce this writing.

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Belcher, Betty. 1993. *Creative Flower Arranging: Floral Design for Home and Flower Show*, Timber Press, Inc.

Fig.: Different types of flower arrangement

Index of articles published in Bulletin of Department of Plant Resources from 2003 to 2013 AD

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Abstract

The present paper includes the index of 217 articles published in the Bulletin of Department of Plant Resources - "Plant Resources" from 2003 to 2013 AD.

Key words: Plant Resources, Articles.

Introduction

The Department of Plant Resources has been continuously publishing **'Plant Resources'**% A Scientific publication; Bulletin of Department of Plant Resources since 2003 AD. The findings of the research works carried out by the department staff in various aspects of plant science is disseminated in the form of these publications. The present paper is the index of articles published in the Bulletin from 2003 to 2013 AD. The articles are given here in authors' alphabetic order, tittles of article, name of the bulletin, bulletin number and pages. It is expected that this index will be helpful to researchers, students, planners and others concerned.

A

Acharya, N. 2005. Type Specimens. *Bull. Dept. Pl. Res.* No. **26:** 73-74.

Acharya, S. K. 2007. Study of Plants Used for Washing Garments in Dang District, Mid - West Nepal. *Ibid.***29:** 97-98.

Includes a list of 5 species (*Brassica comprestries, Holarrhena pubescens, Musa paradisiaca, Sapindus mukorossi, Solanum surattense and Vitex negundo*) used for washing purpose by the Tharu communities in Dang District.

_____. 2009. Ethnobotanical use of some plants in community forests of Kailali District. Far Western Nepal. *Ibid.* **31:** 114-116. 22 species of ethenomedicinal plants were recorded.

Adhikari, M. K. 2004. Mushroom poisoning and its state in Nepal. *Ibid.* **25:** 38- 44.

_____. 2005. National herbarium and plant laboratories: An introduction. *Ibid.* **26:** 78-84.

_____. 2007. Witches' Broom of Bamboos: A New Record From Nepal. *Ibid.* **29:** 1-5.

_____. 2008. The Diversity of Cordycepioid Fungi (Ascomycotina: Clavicipitales) Reported from Nepal. *Ibid.* **30:** 1-9.

Includes a list of 21 species of Cordycepioid fungi and their distribution.

_____. 2009. New record of fleshy fungi from Nepal. *Ibid.* **31:** 1-10.

Includes 14 species *(Amanita castanopsis, Amanita fritillaria, Amanita pilosella, Amanita silvicola, Amanita sculpta, Albatrellus dispansus, Baeospora myosura, Boletellus emodensis, Cantharellus ferruginascens, Cyathus olla, Lactarius subpurpureus, Leccinum veriicolar, Sarcosphaera crassa and Scleroderma polyrhizum)* are new to Nepal and one species *Scleroderma bovista* is new to central Nepal.

_____. 2011. *Hexagonia apiaria*: a new record of polyporoid fungus from Nepal. *Ibid.* **33:** 31-32.

_____. 2011. Some new records and noteworthy higher fungi from Nepal. *Ibid.* **33:** 20-26.

Among the six species four species *(Daedaleopsis conchiformis, Ganoderma carnosum, Merulius tremellosus and Pycnoporus coccineus)* are recorded as new to the mycoflora of Nepal.

_____. 2012. *Erysiphe cichoracearum* DC.: The Powdery Mildew (Erysiphales) from Nepal. *Ibid.* **34:** 18-21.

_____. 2012. The *Oidium* species: Powdery Mildews (Erysiphales) from Nepal. *Ibid.* **34:** 26-29.

_____. 2012. Myxomycetes in Nepal. *Ibid.* **34:** 22 -25.

_____. and Durrieu, G. 2003. Coconut fruiting decline in Nepal. *Ibid.* **22:** 32-34.

Durrieu, and Shrestha, K. 2011. New records of some higher fungi (Mushrooms) from Nepal. *Ibid.* **33:** 12-16.

Includes six species *(Clathrus archeri, Climacodon septentrionale, Mycorrhaphium adustum, Phaeolus schweinitzii, Pterula multifida and Tapinella atromentosus)* of higher fungi.

_____. and K. Watanabe (2009). Some interesting fungi from Nepal. *Ibid.* **31:** 16-22.

Includes a 8 species of fungi (*Hypomyces chrysospermus, Hypomyces tulasneanus, Hypomyces hyalinus, Kobayasia nipponica, Morchella costata, Pholiota terrestris, Russula brunneoviolacea , Russula flavida)* are new to Nepal.

_____. and Watanabe, K. 2010. New record and the revised list of mushroom genus *Amanita* in Nepal. *Ibid.* **32:** 7-19.

Includes 42 species of *Amanita* and among them *Amanita alauda, Amanita avellaneosquamosa and Amanita subglobosa* are new to Nepal.

_____. and Devkota, S. 2007. The Clavarioid Fungi of Nepal. *Ibid.* **29:** 7- 22.

Includes six new records of Clavarioid fungi for Nepal *i.e. Tremellodendropsis tuberosa, Clavaria fumosa, Clavaria zollingeri, Multiclavula mucida, Ramariopsis kunzei* and *Ramariopsis botrytis* var. *parvula*.

_____. and Manandhar, V. 2004. Some fungi collected from Nepal. *Ibid.* **25:** 5- 10.

Includes the list of 31 species of fungi collected from Kathmandu valley and adjoining areas. Amoung these, *Amanita japonica* Hongo and *Amanita sychnopyramis* Corner are new records for Nepal.

_____. and Manandhar, V. K. 2005. Some rust fungi from Kathmandu valley, Nepal. *Ibid.* **26:** 8-9. Includes a list of 7 species of rust fungi.

_____. and Manandhar, V. K. 2008. A new record of rust (Basidiomycotina: Uredinales) on *Ribes* from Nepal. *Ibid.* **30:** 9-16. The rust *Puccinia ribis* DC. is newly reported from Nepal.

_____. and Manandhar, V. 2004. *Populus* trees and their diseases in Nepal. *Ibid.* **25:** 56- 62. The study carried out the *Populus* trees are infected by different kinds of fungi. Amoung these *Pleurotus sapidus, Fomes pomaceus, Panellus mitis* and *Fomitopsis rhodophaea* recorded as a new to Nepal.

_____. and Manandhar, V. 2006. New Record of Smut of *Cynodon* from Nepal. *Ibid.* **27:** 1- 2. *Ustilago cynodontis* (Passerini) P. Hennings – A new record for Nepal.

_____. and Manandhar, V. 2013. New record of the rust *Gymnosporangium padmarense* (Uredinales) from East Nepal. *Jour. Dept. Pl. Res.* N. **35:** 70 -73.

_____., Manandhar, V. Joshi, L. and Kurmi, P. P. 2006. Die back of *Dalbergia sissoo* Roxb. ex Dc in western terai belt of Nepal. *Ibid.* **27** (30- 38).

_____., Ono, Y. and Swar, S. 2009. A new record of false smut fungus (*Graphiola phoenicis*) on *Phoenix* (Palmae) from Nepal. *Ibid.* **31:** 11-13.

_____., Shrestha, M. and Kharel, U. 2005. *Mahonia napaulensis* (Jamanemandro): The Nepalese plant of floricultural importance. *Ibid.* **26:** 46-48.

Adhikari, S. and Adhakari, M. K. 2006. A Brief Account on Medicinal Plants, Prevalence of Diseases and Treatment by Amchis in Shey Phoksundo Area Nepal. *Ibid.* **27:** 21- 29.

Includes a list of 20 major plant species used by Amchis to cure the different diseases.

Amatya, K. R. 2003. MAP Trade and Promotion. *Ibid.* **22:** 104- 117.

Amatya, M. P. 2005. Research on medicinal plants. *Ibid.* **26:** 74.

_____. and Pradhan, N. B. 2003. Preliminary Pharmacological Investigation of *Stephania glandulifera* Miers. *Ibid.* **22:** 14- 15. A Study carried out the anti – inflammatory activity.

_____. and Pradhan, R. 2012. Antimicrobial Activity of Some Medicinal Plants. *Ibid.* **34:** 31 -33. The alcoholic extracts of 10 species of medicinal plants *(Rhododendron sp., Artemesia vestata, Arctium lappa, Berberis mucrifolia, Buddleja sp., Inula racemosa, Oxytropis williamsii, Senecio lateus, Rheum australe and Cyanchum cancscens)* were studied for their anti" microbial properties.

_____., Srivastav, D. L. Shakya, K. S. Pradhan, N. B. Karmacharya, K. Shrestha, U. K. and Ranjitkar,R. 2009. Phytochemical and Pharmacological studies of *Osbeckia stellata* Buch.- Ham. ex D. Don. *Ibid.* **31** (56-63).

_____., Pradhan, N. Shakya, K. and Karanjit, N. 2006. Biological studies of *Didymocarpus albicalyx* C. B. Clarke. *Ibid.* ***27:*** 12- 15.

Aryal, H. P., Budhathoki, U. and Adhikari, M. K. 2012. Mycodiversity in Peepaldanda Community Forest, Western Terai Region of Nepal. *Ibid.* **34:** 13 -17.

Enumeration of 21 species of mycoflora are listed.

B

Baral, D., Joshi, S. D. and Manandhar, M. D. 2012. Studies on Phytochemical Screening of some Swertia species. *Ibid*. **34:** 87 - 89. The photochemical screening of *Swertia angustifolia, Swertia chirayita, Swertia ciliata* and *Swertia nervosa* were carried out.

Basnet, B. 2003. Floral Diversity of Maipokhari: Ilam. *Ibid.* **22:** 60- 69.

Includes a list of 233 plant species.

Basnet, B. K. and Adhikari, M. K. 2005. Vegetative propagation of *Swertia chirayita. Ibid.* **26:** 58-60.

Basnet, R. and Pant, B. 2012. *In Vitro* study of *Citrus aurantifolia* Swingle. *Ibid.* **34:** 101 - 106.

_____., Paudel, H. R. and Chhetri, R. B. 2013. Documentation of flora in and around Dhorbaraha wetlands, Western Nepal. *Jour. Dept. Pl. Res.* N. **35:** 22 -27.

_____., Poudel, H. R. and Khatri, S. 2012. Documentation of Wetland Flora of Rara Lake, Mugu. *Ibid.* **34:** 56 - 64.

Includes 106 species of flowering plant.

Bhatt, G. D. and Bhattarai, A. P. 2011. Botanical Expedition in Khaptad and Bajhang Area, West Nepal in 2009. *Ibid.* **33:** 82 -87.

_____. and Rajbhandari, K. R. 2010. New additions of two species of *Potamogeton* L. (Potamogetonaceae) to the flora of Nepal. *Ibid.* **32:** 3-4.

Two species *Potamogeton distinctus* and *Potamogeton perfoliatus* are reported as new addition to the flora of Nepal.

_____., Kurmi, P. P. and Rajbhandari, K. R. 2011. *Evolvulus alsinoides* (L.) L. var. *hirsutus* (Lamk.) Ooststr. (Convolvulaceae), a new addition to the flora of Nepal. *Ibid.* **33:** 3-4.

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_____., Phuyal, Maharjan, N. S. and Srivastav, D. L. 2012. Index of newly reported species from Nepal published in Bulletin of Department of Plant Resources from 2003 - 2011 AD. *Ibid.* **34:** 90 - 97.

Includes the index of 31 species and 1 variety of Phanerogams and 55 species of mycoflora.

_____., Uprety, R. K. and Rajbhandari, K. R. 2012. *Maesa indica* (Roxb.) A. DC. (Myrsinaceae), a new addition to the flora of Nepal. *Ibid.* **34:** 4 -5.

Bhattarai, A. P., Bhatt, G. D. Joshi, L. and Baral, S. R. 2009. Ethnobotanical note on medicinal plants used by Amchis of Upper Mustang of Nepal adjoining Tibet. *Ibid.* **31:** 101-107.

Records 103 plants belonging to 89 genera of 48 families used in traditional medicine for curing 32 body ailments.

_____. and Rajbhandari, K. R. 2010. Genus *Polygonatum* Mill. (Convallariaceae) in Nepal. *Ibid.* **32:** 30-38.

Includes 12 species of *Polygonatum*, among them *Polygonatum griffithii, Polygonatum kansuense* and *Polygonatum sibiricum* are new additions to the flora of Nepal.

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_____., Acharya, N. and Adhikari, M. K. 2005. Domestication of medicinal plants in Nepal: An Overview. *Ibid.* **26:** 61-66.

Bhattarai, N., Shrestha, U. K. and Joshi, S. D. 2011. *In-vivo* Propagation of *Ginkgo biliba* L. *Ibid.* **33:** 60-66.

C

Chapagain, N. 2004. Propagation of *Elaeocarpus sphaerius* (Rudraksha). *Ibid.* **25:** 53- 55.

_____. and Gupta, V. N. P. 2003. Impact of water pollution on the chlorophyll pigments a case study on *Persicaria perfoliata* L. rooted in the muddy habitat of Dhobikhola, (Kathmandu). *Ibid.* **22:** 120-125.

_____., Rajbahak, S. and Sah, S. K. 2010. Plant tissue culture and its perspectives. *Ibid.* **32** (104-106).

_____., Rajbahak, S. and Shah, S. K. 2010. Micropropagation of *Withania somnifera* (L.) Dunal from germinating seeds. *Ibid.* **32:** 86-89.

D

Dahal, S. 2005. Preparation of herbarium specimens. *Ibid.* **26** (70-71).

_____. 2007. New Records of *Premna* L. (Verbenaceae) to the Flora of Nepal. *Ibid.* **29:** 24- 25.

Two species *Premna lucidula* Miq. and *Premna mucronata* Roxb. are reported as new records for Nepal.

_____. 2008. The flowering plant families: Martyniaceae and Sonneratiaceae in Nepal. *Ibid.* **30:** 68-70.

Dani, R. S. 2011. An introduction to the Economic Botany Museum of National Herbarium and Plant Laboratories, Godawari, Nepal. *Ibid.* **33:** 96 -114.

Includes a list of 373species and 276 genera of 112 families.

Devkota, S., Tiwari, R. D., Manandhar, V. and Adhikari, M. K. 2005. Some wild mushrooms collected from Lumle, Kaski, Nepal. *Ibid.* **26:** 10-15.

Includes a list of 31 species of wild mushrooms.

G

Gautam, C. M. and Poudel, S. 2010. Anthropogenic disturbance and its impact on density- diameter distribution in the hill forests, Gulmi district of Nepal. *Ibid.* **32** (60-68).

Gautam, L. and Adhikari, M. K. 2007. *Ophiocordyceps sinensis* (=*Cordyceps sinensis*) and its Phytochemistry: A Brief Review. *Ibid.* **29:** 73- 78.

Ghimire, M. 2010. Caryophyllaceae of Nepal: A Checklist. *Ibid.* **32:** 39-46.

Ghimire, M. D. and Kurmi, P. P. 2007. *Vaccaria hispanica* (Miller) Rauschert (Caryophyllaceae) New Record for Nepal. *Ibid.* **29:** 26 - 27.

J

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_____. 2005. A new microtomy method for anatomical study of soft materials. *Ibid.* **26:** 53.

_____. 2004. Wood structure of the Nepalese genus *Albizzia. Ibid.* **25:** 1- 4.

The study carried out the anatomical characters of 4 species of *Albizzia* (*A. lebbeck, A. odoratissima, A. julibrissin and A. chinensis*).

_____. 2006. Leaf and Branch Wood Structure of *Taxus wallichiana* Zucc. *Ibid.* **27:** 5- 8.

_____. 2007. Effects of Altitude in Wood Structure of *Pinus wallichiana* A. B. Jackson. *Ibid.* **29:** 28- 31.

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_____. 2009. Wood structure of some Nepalese Plants of the family Malvaceae. *Ibid.* **31:** 74-85.

Comparative and quantitative anatomical characteristics of 14 species (*Abelmoschus manihot, Abutilon indicum, Gossypium hirsutum, Hibiscus rosa" sinensis, Hibiscus mutabilis, Hibiscus syriacus, Kydia glabrescens, Malva sylvestris, M. verticillata, Malvaviscus penduliflorus, Sida acuta, S. cordata, Sida rhombifolia and Urena lobata)* belonging to the family Malvaceae are mentioned.

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Includes a list of 76 plant species**.**

Joshi, M. D. and Khadka, M. K. 2013. Floristic composition and species diversity: A case study of Churia region in Dhanusha and Mahottari District. *Jour. Dept. Pl. Res.* N. **35:** 28 -37.

Joshi, N. 2004. Study on propagation and economic importance of *Mahonia napaulensis* DC. *Ibid.* **25:** 49-52.

_____. 2005. Some wild flowers of Sagarmatha National Park and its surrounding area, Solukhumbu district of Nepal. *Ibid.* **26:** 33-40.

Includes a list of 123 plant species (dicotyledons 106, monocotyledons 12 and gymnosperms 5).

_____. 2007. The genus *Spiraea* L. of Nepal. *Ibid.* **29:** 41- 45.

Includes the keys and botanical description of 9 species of genus *Spireae* L.

_____. 2009. Botanical gardens of Nepal and their role in conservation of plant resources. *Ibid.* **31:** 121-126.

_____. 2011. Native Shrubs Suitable for Hedge Landscaping in Nepal. *Ibid.* **33:** 75 -81.

Includes a list of 105 species of native shrubs.

_____. and Sharma, I. 2003. Inventory of Dye Plants of Royal Botanical Garden and its surroundind area, Godawari, Lalitpur, Nepal. *Ibid.* **22:** 51- 56.

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_____. and Sharma (Dhakal), K. 2013. Taxonomy and Ecological Features of *Dioscorea* L. (Dioscoreaceae) in Nepal. *Jour. Dept. Pl. Res.* N. **35:** 1 -8.

Joshi, R. 2003. Bitter principle in differentparts of *Swertia chirayita* (Roxb. Ex Flem.) Karsten. *Ibid.* **22:** 25- 26.

The highest percentage of bitter principle was found in the inflorescence of *Swertia chirayita*. So the plant should be collected in the flowering season to get the maximum bitter principle, which is the main principal constituent of the plant.

Joshi, S. K. G. and Shakya, K. S. 2004. Screening of some anthelmintic plants of Nepal. *Ibid.* **25:** 11- 15.

Includes a list of 72 plant species screened for anthelmintic (antitapeworm) effect.

K

Kandel, D. R. and Pathak, M. 2013. Documentation of ferns from subtropical forests of Pyuthan District, Western Nepal. *Jour. Dept. Pl. Res.* N. **35:** 46 -49.

Includes a list of 25 plant species.

Karanjit, N., and Singh, S. 2003. Phytochemical screening of flavonoid containing medicinal plants of Nepal. *Ibid.* **22:** 22-24.

Phytochemical screening of fourteen medicinal plants *(Hypericum uralum, Myrica esculenta, Schima wallichii, Podophylum hexandrum, Betula alnoides, Cymbopogon stracheyi, Rhododendron setosum, Rhododendron arboreum, Daphne bholva, Luculia gratissima, Machilus odoratissima, Cordyceps sinensis, Berginia legulata and Polygonum perfoliatum*) in different solvent (ether,and alcohol) were carried out for the presence of chemical constituents mainly flavonoid with high therapeutic value.

_____., Shakya, K., Pradhan, N. B., Gautam, L. and Shakya, D. M. 2007. A Compilation Report of Preliminary Phytochemical and Biological Screening of Some Medicinal Plants of Nepal. *Ibid.* **29:** 79- 98.

Includes a list of 171 plant species screened of phytochemically and 142 plant species scanned pharmacologically.

_____., Shrestha, U. K. and Ranjitkar, R. 2008. A study on hypoglycemic properties of *Pterocarpus marsupium* Roxb. From Nepal. *Ibid.* **30:** 97-101.

Karki, A. and Rajbahak, S. 2007. Micropropagation of *Bergenia ciliata* (Haw.) Sternb. through Leaf culture. *Ibid.* **29:** 35- 37.

_____., Rajbahak, S. and Sainju, H. K. 2003. Pilot scale production of Nepal Cardamom (*Amomum subulatum* Roxb. Cultivar Dambersay) through tissue culture. *Ibid.* **22:** 5- 7.

_____., Rajbahak, S. and Sah, S. K. 2009. Clonal propagation of *Stevia rebaudiana* Bertoni through shoot tips culture and antibacterial assay of its leaf extracts. *Ibid*. **31:** 86-92.

Karkee, D. B. 2005. Conservation of some medicinal and aromatic plants in Physic Garden (Royal Botanical Garden), Godawari. *Bull. Dept. Pl. Res.* No. **26:** 49- 52.

Includes a list of 136 plant species.

_____. 2009. Distribution of *Epipactis* (Orchidaceae) in Nepal. *Ibid.* **31:** 134-137.

_____. and G. D. Bhatt 2003. Terrestrial Orchids of Langtang National Park. *Ibid.* **22:** 57- 59.

Includes a list of 31 species of terrestrial orchids.

Karmacharya (Shrestha), K. and Yadav, P. 2011. A Report of Some Essential Oil Bearing Commercial Herbs in Nepal. *Ibid.* **33:** 17 -19.

Kattel, L. P. 2003. A quantification study on JADIBUTI trade from Daman and its adjacent area (Makwanpur). *Ibid.* **22:** 97- 99.

_____. 2007. Invasive Plants of Jhapa District, East Nepal. *Ibid.* **29** (50- 53).

Includes a list of 28 invasive plant species.

_____. 2009. National efforts to conserve plant diversity in Nepal. *Ibid.* **31:** 117-120.

_____. and Kurmi, P. P. 2004. A study on plants used by traditional herbal healers (Road) in mid western and eastern region of Nepal. *Ibid.* **25:** 16- 21.

Khadka, M. K. and Jha, S. 2013. Wetland flora for the restoration of Chimadi lake, Sunsari district, Eastern Nepal. *Jour. Dept. Pl. Res.* N. **35:** 59 -61.

Kunwar, D., Thapa, D. and Shrestha, U. K. 2010. Preliminary study of marshland vegetation of Gunde and Maidi lake System of Pokhara valley, Kaski, Nepal. *Ibid.* **32:** 69-72.

Kurmi, P. P. and Bhatt, G. D. 2003. A Survey Report on *Pterocarpus marsupium* Roxb. from Western Nepal. *Ibid.* **22:** 89- 91.

_____. and Baral, S. R. 2009. Two new records of *Asparagus* for Nepal. *Bull. Dept. Pl. Res.* No. **31:** 25-27.

Asparagus adscendens and *Asparagus lycopodineus* are new additions to the flora of Nepal.

L

Luitel, D. R. and Pathak, M. 2013. Documentation of Medicinal and Aromatic Plants of Dhorpatan Hunting Reserve, Western Nepal. *Jour. Dept. Pl. Res.* No. **35:** 36 -43.

M

Maharjan, S. and Baral, S. R. 2010. Distribution of genus *Lloydia* Salisb. in Nepal. *Bull. Dept. Pl. Res.* No. **32:** 27-29.

Malla, K. J. and Kurmi, P. P. 2004. Wild ornamental plants of Phulchoki and Godawari. *Ibid.* **25:** 22- 37.

Includes a list of 202 plant species.

_____., Uprety, R. K. and Watanabe, T. 2003. Survey of Medicinal Plants in Upper Mustang, Nepal. *Ibid.* **22:** 38- 46.

Includes a list of 129 medicinal plants and their use pattern.

Manandhar, P. 2006. Digestive Enzyme Inhibitors from Some Species of Nepalese Plants. *Ibid.* **27:** 69- 70.

Manandhar, V. K. 2008. The genus *Acer* in Nepal. *Ibid.* **30:** 58-67.

Includes botanical description, distribution and key to the 12 species of *Acer.*

Manandhar, V. 2007. A New Record of Rust Fungi from Nepal. *Ibid.* **29**: 23.

Uredo nigropuncata P. Henn – a new record for Nepal.

_____. 2009. A new record of rust (*Uromyces euphorbiae*) on *Euphorbia* from Nepal. *Ibid.* **31:** 14-15.

_____. and Adhakari, M. K. 2006. Fungi of Nepal (Part IV). *Basidiomycotina*: *Ustilaginales*. *Ibid.* **27:** 73- 79.

Includes a list of Smuts and host species.

_____. and Adhikari, M. K. 2009. The family Sclerodermataceae: ectomycorhizal fungi from Nepal. *Ibid.* **31:** 29-34.

_____. and Dahal, S. 2006. *Cuscuta chinensis* Lamarck (Convolulaceae). A New Record for Flowering Plants of Nepal. *Ibid.* **27:** 3- 4.

_____., Dahal, S. and Subedi, M. N. 2007. A Checklist of DPR's Publications on the Flora of Nepal. *Ibid.* **29:** 99 -100.

_____., Dahal, S. and Subedi, M. N. 2008. A checklist of DPR's publications on flora of Nepal-2 (Non-flowering plants). *Ibid.* **30:** 109.

O

Olley, L. and Sharma, L. R. 2013. A Provisional Checklist of the Lichens of Nepal. *Jour. Dept. Pl. Res.* N. **35:** 18-21. .

Includes the 39 species of Lichens as a new to Nepal. Among them one species *Leparis squamatica* Elix is new to Asia.

P

Pandey, B. and Adhikari, M. K. 2005. *Oidium citri*: the Citrus disease in Nepal. *Ibid.* **26** (6-7).

Pandey, J. 2013. Documentation of Ethnomedicinal Knowledge on Plant Resources Used by Magar Community in Dhanbang VCD, Salyan District. *Jour. Dept. Pl. Res.* No. **35:** 62 - 66.

Includes the list of 65 plant species.

Pandey, R. 2006. Simple Qualitative Methods for the Identification of **'Silajeet'**. *Ibid.* **27:** 65- 68.

Parajuli, R. R. 2011. Study on Ethnomedicinal Plants of Maipokhari Wetland Area in Ilam, Eastern Nepal. *Ibid.* **33:** 33 -42.

Includes the list of 92 plant species.

. 2012. Ethnomedicinal use of plants in Rai community of Maimajuwa and Puwamajuwa VDCs of Ilam District, Eastern Nepal. *Ibid.* **34:** 65 - 73.

Includes the list of 79 species of medicinal plants belonging to 44 families and 73 genera.

. 2013. Indigenous Knowledge on Medicinal Plants: Maipokhari, Maimajhuwa and Mabu VDCs of Ilam District, Eastern Nepal. *Jour. Dept. Pl. Res.* N. **35:** 50 -58.

Includes a list and their using patterns of 92 plant species.

Pathak, L. and Pandey, S. R. 2005. Ethno-medicinal plants of Daman area, central Nepal. *Ibid.* **26:** 30-32.

Includes a list of 59 etheno medicinal plant species.

Pathak, L. N. and Pandey, S. R. 2005. An experimental cultivation of Saffron (*Crcocus sativus* L.) in Tistung Botanical Garden, Central Nepal. *Ibid.* **26:** 43-45.

Pathak, M. L., Phuyal, N. and Tharu, L. R. 2012. Inventory of the Pteridophytic Flora of Sankhuwasabha District, Eastern Nepal with notes on Medicinal Values. *Ibid.* **34:** 34 -46.

Includes a list of 133 plant species belonging to 26 families and 59 genera.

., Chhetri, R. and Tharu, L. R. 2012. Enumeration of the Pre - monsoonic vascular Plants of Makalu Barun National Park, Sankhuwasabha, Eastern Nepal. *Ibid.* **34:** 47- 55.

Includes a list of 216 species belonging to 80 families and 148 genera.

Pathak, M., Shrestha, B. B., Joshi, L. and Jha, P. K. 2011. Variation in length of Vessel Element and Fiber of two species of Rhododendron along the altitudinal gradient in Eastern Nepal .*Ibid.* **33:** 67-71.

Includes the *Rhododendron anthopogon* and *Rhododendron lepidotum.*

Paudel, H. R. 2011. *Smilax myrtillus* A. DC. (Smilacaceae): A Rare species in Nepal. *Ibid.* **33:** 43-44.

Paudel, S., Bhattarai, N., Yogi, P. N. and Karmacharya, R. B. 2010. Ethnomedicinal Plants used by the People of Argha VDC, Arghakhanchi District, West Nepal. *Ibid.* **32:** 73-85.

Includes a list of 141 plant species.

Phuyal, N. and Baral, S. R. 2010. Distributional notes on Nepalese *Arisaema. Ibid.* **32:** 20-26.

., G. D. Bhatt, Maharjan, S. and Pokhrel, K. K. 2011. A Contribution to the Pteridophytic Flora of Makwanpur District, Central Nepal. *Ibid.* **33:** 45 -59.

Includes a list of 100 species belonging to 26 families and 48 genera of Pteridophytes.

Poudel, S. 2012. Epiphytic Lichen Diversity on *Alnus nepalensis* D. Don and *Castonopsis tribuloides* (Sm.) A. DC. at Maipokhari and Sulubung VCDs, Ilam District, Eastern Nepal. *Ibid.* **34:** 6 -12.

Poudel, S. and Gautam, C. M. 2008. Studies on Ethnomedicine of Magar Community in Dhading District, Central Nepal. *Ibid.* **30:** 80-86.

Includes a list of 62 plant species used for preparing 72 medicinal remedies.

Pradhan, N. B. 2003. Effects of some Nepalese medicinal Plants on isolated tissue of Rat. *Ibid.* **22:** 18- 19.

Extracts of ten medicinal plants (*Myrica esculenta, Leucoceptum canum, Gerbera maxima, Cassia mimosoides, Clematis cannata, Epilobium roseum, Cotoneaster microphyllus, Bistorta vacinifolia, Betula utilus and Bidens bipinnata)* were used for the biological screening and the result showed different effects on isolated rat ileum, uterus and also the acute toxicity test was carried out.

Prajapati, P. 2003. Cryosophanol and Physcion: Anthraquinones from the rhizomes of *Rheum australe* D. Don (Polygonaceae). *Ibid.* **22** (20- 21).

R

Rai, S. K. 2007. Aromatic Plants of Karnali Zone, Midwestern Nepal. *Ibid.* **29:** 54- 72.

Includes a list of 72 aromatic plant species.

. 2008. Hurdels to cross for the 'Jadibuti' cultivation in Nepal: A case study of Karnali, Midwestern, Nepal. *Ibid.* **30:** 105-108.

. and Pokhrel, M. 2006. Ethnobotanical Survey of Medicinal and Aromatic Plants of Chandannath, Depalgaun and Garjyangkot Village Development Committees (VDCs) of Jumla, Mid Western Nepal. *Ibid.* **27:** 16- 20.

Includes a list of 44 species.

Rajbahak, S., Karki, A. and Sainju, H. K. 2005. *In- vitro* multiplication of *Vanilla planifolia* Andrews using axillary bud explant. *Ibid.* **26:** 3-5.

., N. Chapagain, Shrestha, J. and Basnet, P. 2012. *In* -

Vitro Shoot Tips Culture of *Aloe vera* Mill. *Ibid.* **34:** 78 - 84.

Rajbhandari, K. R. 2005. Fascicles of flora of Nepal: Myricaceae and Saururaceae. *Ibid.* **26:** 22-23.

_____. 2005. Functions of Herbarium. *Ibid.* **26:** 70.

_____., Joshi, L., Manandhar, V., Bhatt, G. D. and Phuyal, N. 2011. Two new records of flowering plants for Nepal. *Ibid.* **33:** 1-2.

New additions of *Cremanthodium palmatum* and *Mollugo nudicaulis* to the flora of Nepal.

_____., Joshi, L., Manandhar, V., Bhatt, G. D., Phuyal, N. and Shrestha, J. 2012. Two New Records of Flowering Plants (Dicots) for Nepal. *Ibid.* **34:** 2 -3.

New additions of *Hypoestes phyllostachya* (Acanthaceae) and *Fraxinus excelsior* (Oleaceae) to the flora of Nepal.

_____. and Kurmi, P. P. 2009. The *Oryza* (wild rice) species of Nepal. *Ibid.* **31:** 35-38.

Includes detail information about 4 species of Oryza (*Oryza meyeriana* var. *granulata*, *Oryza officinalis, Oryza nivara* and *Oryza rufipogon).*

_____., Joshi, R. and Dahal, S. 2008. The genus *Bistorta* (L.) Adans. (Polygonaceae) in Nepal. *Ibid.* **30:** 47-57.

Includes a botanical description and key to the 14 species of *Bistorta* (L.) Adans.

_____. and Uprety, R. K. 2005. Herbarium management in the Royal Botanic Garden Edinburgh (U. K.). *Ibid.* **26:** 54-57.

_____. and Upreti, R. K. 2009. New additions of two species of *Setaria* P. Beauv. (Poaceae) to the flora of Nepal. *Ibid.* **31:** 23-24.

Setaria homonyma and *Setaria sphacelata* are new additions to the flora of Nepal.

_____., Uprety, R. K. and Bhatt, G. D. 2012. *Digera muricata* (L.) Mart. (Amaranthaceae), a New Record of Flowering Plant for Nepal. *Ibid.* **34:** 1.

_____., Upreti, R. K. and Kurmi, P. P. 2009. *Hodgsonia heteroclita* (Roxb.) Hook.f. & Thomson (Cucurbitaceae), a new addition to the flora of Nepal. *Ibid.* **31:** 28.

_____., Uprety, R. K., Manandhar, V. K., Maden, K. and Adhikari, B. 2004. Botanical Expedition in the Sagarmatha National Park, East Nepal in 2004. *Ibid.* **25:** 63- 67.

_____. and Dahal, S. 2008. New additions of two grass species to the flora of Nepal. *Ibid.* **30:** 17-18.

New additions of *Lolium multiflorum* Lam. and *Paspalum dilatatum* Poir. to the flora of Nepal.

_____. and Dhungana, S. K. 2011. Diversity of the endemic flowering plants of Nepal. *Ibid.* **33:** 7 -11.

Includes the number of 283 species endemic flowering plants of Nepal with families and genera.

_____. and Baral, S. R. 2010. New records of grasses for Nepal. *Ibid.* **32:** 1-2.

Includes 4 species of grasses *(Lophatherum gracile, Mnesithea laevis, Ophiuros exaltatus, Spodiopogon dubius)* are new to Nepal.

_____., Dahal, S. and Joshi, R. 2003. *Rhododendron* L. (Ericaceae) of Nepal: A Checklist. *Ibid.* **22:** 35-37.

Includes a list of 31 species of *Rododendron* of Nepal.

_____., Baral, S., Joshi, R., Dahal, L. S. and Manandhar, V. 2010. New records of the flowering plants (Monocots) for Nepal. *Ibid.* **32:** 5-6.

New additions of 4 species of monocots *Asphodelus tenuifolius, Coelogyne fimbriata, Commelina undulate* and *Pycreus sulcinux* to the flora of Nepal.

_____., Manandhar, V. K., Dahal, S., Uprety, R. K. and Pandey, N. 2008. Additions of the flowering plants in the Herbarium (KATH) of Department of Plant Resources, Nepal collected through Darwin Initiative Project (U. K.) in 2004 and 2005. *Ibid.* **30:** 22-46.

Includes a list of 158 plant species which are new additions to KATH herbarium.

Rajkarnikar, K. M. 2003. Micropropagation of *Dendrobium fimbriatum* Hook. *Ibid.* **22:** 8- 10.

_____. 2007. Micropropagation of *Rhyncostylis retusa* (L.) Blume From Seeds. *Ibid.* **29 :**38- 40.

_____. 2010. *In- vitro* propagation of *Dendrobium amoenum* Wall. ex Lindl. from seed culture. *Ibid.* **32:** 90-93.

_____. 2011. Propagation of *Cymbidium aloifolium* (L.) Sw. *In- vitro* by seeds. *Ibid.* **33:** 27-30.

_____. and Bhatt, G. D. 2005. Micropropagation of Cactus: *Mammillaria carnea. Ibid.* **26:** 1-2.

_____. and Bhatt, G. D. 2006. Micropropagation of *Neopicrorhiza scrophulariifolia* (Pennell) Hong. *Ibid.* **27:** 9- 11.

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_____. and Bhatt, G. D. 2009. Micropropagation of *Spathiphyllum wallisii* Hort *Ibid.* **31:** 93-95.

Ranjitkar, R. 2009. A study on hypoglycemic activity of *Urtica dioica* L. (Sisnu) leaves. *Ibid.* **31:** 99-100.

_____. 2013. Study on hypoglycemic activity of *Ceropegia pubescens* Wallich. *Jour. Dept. Pl. Res.* N. **35:** 44 -45.

_____., Ghimire, A. and Shahi, R. 2012. A Study of Hypoglycemic activity of *Cinnamomum tamala* (Buch. Ham) Ness and Ebern (Tejpat) leaves. *Ibid.* **34:** 98 - 100.

_____., Shrestha, U. K. and Pant, S. M. 2011. A Study on hypoglycemic activity of *Allium wallichii* Kunth. (Ban lasun) fibrous roots. *Ibid.* **33:** 72 -74.

Raskoti, B. B., Bhatt, G. D. and Rajbhandari, K. R. 2013. *Acrochaene punctata* L. and *Bhutanthera alpina* (Hand. Mazz.) Renz (Orchidaceae), new records for flora of Nepal. *Jour. Dept. Pl. Res.* N. **35:** 67 - 69.

_____., Ale, R. and Bhatt, G. D. 2011. *Zeuxine grandis* Seidenf. Orchidaceae – a new addition to the orchid flora of Nepal. *Ibid.* **33:** 5-6.

S

Shakya, D. M., Pradhan, R. and Ranjitkar, R. 2008. A preliminary screening of some Nepalese medicinal plants for anti-microbial activity. *Ibid.* **30:** 87-94.

Includes a list of 215 species of medicinal plants.

Shakya, K. S. 2003. Antifertility activity of some high altitude plants. *Ibid.* **22:** 16- 17.

Twelve high altitude plants were studied for their anti–fertility effect in female rats. Pharmacological screening was carried out using 50% alcoholic extract of these plants. *Rhododendron lepidotum, Phytolacca acinosa* and *Dipsacus mitis* showed 100% abortifacient effect, while *Rabdosia coestsa, Dicranostigma lactucoides* and *Wickstroemia canescens* showed more than 65% effect and *Leucas lanata, Rhododendron setosum, Elsholtzia eriostachya* showed 50% effect.

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Screening of 12 different plant species for anti fertility effect was carried out. Among these plant species *Bistorta amplexicaulis* showed 100% effect, while *Stephania glandulifera, Zanthoxylum acanthopodium, Hippophae salicifolia, Mimosa pudica, Melia azardirachta, Paulawnia fortune* showed 75% effect. *Murrya koenigii* and *Osmanthus fragrans* showed 50% effect. *Zanthoxylum nepalensis, Mahonia nepaulensis,* and *Betula utilis* showed very less effect.

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Sharma, I. 2008. *Polygonum hastatosagittatum* Makino (Polygonaceae): a new record for Nepal. *Ibid.* **30:** 19.

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The survey carried out in 2 districts (Banke and Jhapa) and found 5 major invasive species (*Eichhornia crassipes, Lantana camara, Parthenium hysterophorus, Mikania micrantha* and *Euptorium* sp.) in the study area.

Sharma, M., Chapagain, N. H., Rajbahak, S. and Sah, S. K. 2010. Phytochemicals as Emerging Antimicrobials.

Ibid. **32:** 96-103.

Shrestha, P. R., S. Sharma, R. K. Giri and H. Karki 2009. Antibacterial activity of medicinal plant extracts. *Ibid* **31:** 51- 55.

Includes an antibacterial activity of 10 medicinal plants *(Ageratum conyzoides, Cissampelos pareira, Citrus maxima, Lawsonia inermis, Myrica esculenta, Psidium guajava, Rhododendron setosum, Selinum tenuifolium, Solanum verbascifolium).*

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Acknowledgement

We are thankful to Mr. Yam Bahadur Thapa, Director General Department of Plant Resources and Dr. Khem Raj Bhattarai, Chief, National Herbarium and Plant Laboratories for their encouragement. We express our sincere gratitude to Dr. Keshab Raj Rajbhandari, Senior Taxonomist for his inspiring suggestions to carry out this work.

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