

***Eleusine coracana* (L) Gaertn (Finger millet): A Crop With Medicinal Value**

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Abstract

Finger millet is one of the food crops with rich nutritional composition. It has been cultivated from 85 m to 3130 m altitudes of Nepal. A total of 121 household surveys were conducted in 11 villages of two ecological zones (Tarai /Siwalik and Mid-hills) of Central Nepal from September 2017 to March 2018 using questionnaire to document the ethno-medicinal value of finger millet. Locally finger millet is recognized as medicinal value besides food. More than 80% of local people were aware about its medicinal values and 83% of local people used it as medicine to cure the diarrhoea of cattle and 81% of people indicated it is very good for bone. The medicinal values of finger millet mentioned by the informants were compared with the published scientific facts. The comparison revealed that 15 different types of human ailments can be cured by using finger millet and its products. The human ailment categories are mostly related with lifestyle related diseases like diabetes, blood pressure, cardiovascular diseases and so on.

Keywords: Food, Human ailments, Lifestyle related diseases, Medicinal value

Introduction

Six species of millet are cultivated found in Nepal. Finger millet [*Eleusine coracana* (L.) Gaertn.], foxtail millet [*Setaria italica* (L.) P.Beauv.], proso millet [*Panicum miliaceum* L.], barnyard millet [*Echinochloa frumentacea* Link], sorghum [*Sorghum bicolor* (L.) Moench] and pearl millet [*Pennisetum typhoides* (Burm.f.) Stapf & C.E.Hubb.Hubb. (Ghimire et al., 2017)]. Two wild varieties of millets *Eleusine indica* (L.) Gaertn. and *Eleusine africana* Kenn.-O'Byrne have also been reported from Nepal. The commonly called Kodo (Finger millet) is cultivated throughout the country. It is a fourth cereal crop of Nepal and second important crop of mid-hill and Himalaya. Mid-hills and Himalayas cover about 10% of total cultivated land of country and nearly 75% of finger millet cultivation prevails in mid-hill and mountain (Upreti, 2002; Ministry of Agriculture, Land Management and cooperatives [MoAC], 2017).

Finger millet has been cultivated from low land Terai region in Kachorwa village (85 m asl) of Bara district (Amgain et al., 2004) to high hill area in Borounse village (3130 m asl) of Humla district (Baniya et al., 1992). Finger millet is called "kuanna" or an

unholy cereal not worth for worshipping. It as a neglected or orphan crop but provide staple food to millions of marginal community in the world and also to the population using on subsistence farming system in Nepal. It is also referred as "crop for poor" or a "famine food" (Vietnameyer et al., 1996). Finger millet grain has low infestation of pest in storage and can be stored for long periods due to its small grain size.

Finger millet is also used, for making Jadh (alcoholic liquor made from finger millet without distillation), Raksi and Tumba (alcohol made from finger millet) and animal feed. But in many parts of the country including Tarai and Siwalik regions, it is used in snacks eg. haluwa (sweet dish) and roti (bread). It is generally considered to be very nutritious rich food for pregnant women and also used for treatment of animal diarrhea (Rana et al., 2000) and for diabetic patients (Sri-Lankan Ministry of Agriculture [LMA], 2004). Finger millet has very high nutritional value particularly iron, calcium, and manganese (International Crops Research Institute for the Semi-Arid Tropics [ICRISAT], 2004). Being high nutritional value with lots of medicinal properties, there are enough opportunities of income generation through in agro-based industry (Sthapit et al., 1993).

Till date finger millet only occupies the traditional consumption pattern in Nepal. Systematic documentation of health benefit of finger millet and its products has not been done in Nepal. Beside nutrition, its plant parts have been used as folk medicine.

This study was focused on documenting opinions of small holder farmers on medicinal value of finger millet in different ecological regions in central Nepal. The finger millet is one of the main crops in mountains regions especially in remote areas. Besides, it has been used as folk medicine to treat different diseases directly or indirectly. These practices are based on knowledge transfer from generation to generation. However, finger millet grains are mostly used in preparation of traditional products like dhedo, roti, haluwa, alcoholic beverages like rakshi, chhyang, tumba, jandh which have religious and cultural importance in different ethnic communities of Nepal. Do the local people use finger millet as folk medicine? is the main research question of this study and an attempt has been made to compare the perception and experiences of local people on health benefit of finger millet with the published secondary facts. There were no previous studies on medicinal values of finger millet from Nepal. However, there are

several literatures quoted many health benefits of finger millet globally.

Materials and methods

Study area

This study was conducted in eleven villages of four Palikas (municipalities) in three different districts of central Nepal. These Palikas were selected based on accessibility, cultivation of finger millet and population composition with diversity of communities. These Palikas of CHAL are important finger millet producers. These municipalities were located at different altitudes to represent different ecological regions. Two rural municipalities (Hupsekot and Bungdi Kaali) lie at less 500 m in Nawalparasi and two municipalities (Waling in Syangja and Besishahar in Lamjung) at 1000 - 2000 m. Majority households of the selected villages in Nawalparasi, Syangja and Lamjung districts cultivate finger millet for their food requirements. Farming system was traditional type integrated with animal husbandry.

Questionnaire preparation and household survey

The semi-structured questionnaire was prepared to gather the medicinal value of finger millet and survey

Table 1: Details of respondent in two ecological regions of Central Nepal, (Figures in parentheses indicates number of respondents above 70 years)

S.N.	Regions	Village Name	Districts	Total House holds	Total no. of elder (70 yrs) people in village		
					Total	Male	Female
1	Siwalik	Sankhadev	Hupsekot RM-6, Nawalparasi	151	25(6)	11(2)	14(4)
2		Machedi	Bungdikali RM-1, Nawalparasi	80	26(16)	10(5)	16(11)
3		Dhobaji	Hupsekot RM-1, Nawalparasi	42	13(13)	6(6)	7(7)
4	Mid-hills	Tamadi	Waling-14, Syangja	42	14(11)	5(4)	9(7)
5		Dhikidanda	Waling-12, Syangja	15	6(5)	3(3)	3(2)
6		Kapase	Waling-14, Syangja	55	21(16)	9(7)	12(9)
7		Gaire- Kattike	Waling-12, Syangja	18	6(6)	3(3)	3(3)
8		Dobate	Waling-12, Syangja	17	8(8)	5(5)	3(3)
9		Sirsekot	Waling-12, Syangja	37	15(12)	8(8)	7(4)
10		Kokhe	Waling-12, Syangja	45	20(12)	11(8)	9(4)
11		Chandidanda-baseni	Beshishahar-8, Lamjung	51	19(16)	10(10)	9(6)
Total					173(121)	81(61)	92(60)

was conducted from September 2017 to March 2018. A total of 121 individuals (61 male and 60 female) were selected for face-to-face interviews. The respondents were mostly aged people (>70 years), permanent resident and small holder farmers following traditional system of agriculture. Respondents were Brahmin (23), Magar (35), Gurung (39) and Dalit (5) from Mid-hill (Syangja and Lamjung districts) and 13 Brahmin and 5 Magar from Nawalparasi. The questionnaire had two major sections: (i) detailed information of the informant including socio-economic and agricultural practices and (ii) crop calendar of finger millet and its uses including medicinal value, local landraces, type of diseases, mode of uses, duration of uses etc.

Secondary literature

We compiled the medicinal values of finger millet from international and national journals, books, proceedings and internet base sources. The medicinal values were compiled in to 15 different categories based on human ailments.

Results and Discussion

Perceptions on medicinal values of finger millet

Eighty percent local people knew the medicinal value of finger millet from Nawalparasi (Siwalik region) and more than 81% people have mentioned

medicinal value of this crop in mid hills of CHAL. However, 100% respondents were aware about medicinal value of finger millet in Sakhadev, Tamadi and Dhikidanda villages. Only fifty percent respondent from Dobate and Gaire Kattike of Syangja mentioned medicinal values (Table 2).

The people of Nepal have rich ethno-botanical knowledge on plant resources. Wild medicinal herbs have been used in traditional medicinal practice; however, several crops species including finger millet have been used to treat human and animal ailments.

In an average more than 80% people in CHAL knew about the medicinal values of finger millet (Table 2). People realize that finger millet as food is much nutritious and good for hard working people. Though several respondent mentioned medicinal values of finger millet. However, few statements are mentioned here to quote the value of this crop as medicine and other in the villages. Kaumaya Gurung (87 F) from Kokhe village of Syangja feels appetite just after having rice meal but she do not want any more food throughout the day after having dhido (a product of finger millet). She could not swell the rice well but can easily eat dhido and roti of finger millet. She told that food habitat of her family has been changed from finger millet and maize to rice culture and also mentioned that her health and

Table 2: Perception of respondents on medicinal values of finger millet (figures in parentheses is percentage)

S.N.	Regions	Village Name	Total no. of respondents	Medicinal value of finger millet		
				Yes	No	Don't know
			Total			
1	Siwalik	Sankhadev	6	6(100)	0	0
2		Machedi	16	10(62.5)	2(12.5)	4(25)
3		Dhobaji	13	12(92.3)	0	1(7.7)
	Total in Siwalik		35	28(80)	2(5.7)	5(14.28)
4	Mid-hills	Tamadi	11	11(100)	0	0
5		Dhikidanda	5	5(100)	0	0
6		Kapase	16	13(81.25)	1(6.2)	2(12.5)
7		Gaire- Kattike	6	3(50)	0	3(50)
8		Dobate	8	4(50)	2(25)	2(25)
9		Sirsekot	12	10(83.34)	0	2(16.67)
10		Kokhe	12	9(75)	1(8.3)	2(16.67)
11		Chandidanda-baseni	16	15(93.75)	0	1(6.25)
	Total in Mid-hills		86	70(81.4)	4(4.6)	12(13.95)
	Grand Total		121	98(81)	6(4.95)	17(14.04)

physical is still strong only due to finger millet food during her life. Similarly, Dorna Kandel (78 M) from Machedi village of Nawalparasi would be happier when main food in his kitchen is dhido or roti of finger millet. He added the product of finger millet is real food for us who has been still active physically. He also mentioned that he has not taken a single tablet of medicine for headache throughout his life which may be due to benefit of finger millet diet. Chandri Thapa (98 F) from Kapase village of Syangja mentioned that finger millet is a real food for villagers who has been working daily in the farm. She added that it is not only food but also life supporting medicine. She remembered that they spend about ½ tons of finger millet to produce liquor (kodo ko raksi) yearly which is a strong medicine for people and has to take about 60 ml daily at the time of sleep in night. Therefore, the views and experience of local people from different villages of central Nepal reveals the medicinal value of finger millet.

Ailments wise perceptions

A total of seven different types of ailments have been used by local people to cure by finger millet and its production in their villages. More than 83% respondent mentioned that this crop is very good to control diarrhea of castles and 81% mentioned good food for bone of human beings. Respondents could not identify the scientific detail of diseases and its therapeutic value and mechanism. They commonly mentioned that finger millet is good for health and makes the man strong without diseases. The common perception regarding the therapeutic value includes, it makes bone strong, increases stamina of people, good for health, help to heal wound, joins the fractured bones, control diarrhea in human as well

as in cattle, good for common cold and cough, etc. Overall perception regarding the health benefit of finger millet with percent is presented in Table 3.

The local perceptions on medicinal value (categorical) of finger millet (Table-3) can be summarized with possible logic in the following ways.

1. Consumption of finger millet regularly, protect from malnutrition, degenerative diseases and premature aging because of the nutraceutical importance of finger millet as it contains high calcium (0.38%), protein (6%–13%), dietary fiber (18%), carbohydrates (65%–75%), minerals (2.5%–3.5%), phytates (0.48%), tannins (0.61%), phenolic compounds (0.3–3%) and trypsin inhibitory factors (Chandra et al., 2016).
2. Strengthen the bones of human due to good source of natural calcium (0.38%) (Chandra et al., 2016) and reduces the risk of fracture and prevent from osteoporosis. Join the fracture of bones due to high natural calcium.
3. Due to antioxidant property of finger millet, good for late aging and metabolic diseases.
4. Finger millet diet has lower glycemic responses (lower ability to increase blood sugar level) which lower digestibility and absorption of starch as a result person having finger millet diet can avoid appetite.
5. Nature of phytochemicals of finger millet controls the blood sugar level which is beneficial for diabetic patients.
6. Due to high natural iron and calcium content in finger millet, it is good food for pregnant and delivered women as well as protect from anemia.

Table 3: Total number of perceptions of respondent on medicinal values (categorical) of finger millet out of 121 in CHAL

S.N.	Health benefit of finger millet (Ailments)	Total no of respondent
1	Makes bone strong	98 (81%)
2	Finger millet consumption people are resistant to common diseases	67(55.3%)
3	Flour controls the diarrhea in goat, lamb, sheep, calf of caw, buffaloes	101(83.4%)
4	Wound healing property	81(66.7%)
5	Flour soup is good for children during cough and cold	34(28%)
6	Prevent premature aging	29(24%)
7	Good for pregnant and delivered women	73(60.3%)

Table 4: Medicinal value of finger millet quoted in different published literatures

S. N.	Uses	Reference
1	Antioxidant (Due to high total phenolic and flavonoids, level of enzymatic and non enzymatic antioxidant)	Sripriya, et al., 1996; Hedge, et al., 2005a, Viswanath, et al., 2009; Chandrasekara & Shahidi, 2010; Veenashri & Muralikrishna, 2011; Devi et al., 2011; Amadou et al., 2011; Mohamed et al., 2011
2	Antimicrobial activities (Polyphenol extract from finger millet flour active against <i>Bacillus cereus</i> , <i>Aspergillus niger</i> and Fermented finger millet extract-suppress growth of <i>Salmonella</i> sp., <i>Escherichia coli</i> Inhibition of <i>Salmonella typhimurium</i> and <i>Escherichia coli</i> by fermented flour of finger millet Protocatechuic, caffeic, gallic, parahydroxy benzoic acid, polyphenols, and quercetin from finger millet inhibited the growth of several pathogenic bacteria	Antony, et al., 1998; Viswanath, et al., 2009; Usha et al., 1998; Chethan and Malleshi, 2007
3	Anti-ulcerative property (Diet with finger millet prevent mucosal ulceration)	Tovey, et al., 1975; Chandra et al., 2016
4	Wound healing property	Rajeseakaran et al., 2004; Hedge et al., 2005b
5	Diarrhea control (fermented drink by lactic acid bacteria used as therapeutic agent against diarrhea)	Manzoni et al., 1999; Venkateswaran & Vijayalakshi, 2010
6	Improve haemoglobin (rich in natural source of iron- improve haemoglobin in blood)	Tatala et al., 2007
7	Protection from diseases Cancer, Diabetes, heart disease, hypertension, metabolic syndrome, and Parkinson's disease (due to phyto-chemical properties of finger millet) Prevent cardiovascular diseases by reducing plasma triglycerides, Reducing tumor incidence, lowering blood pressure, risk of heart disease	Srivastava & Sharma, 2012; Lee et al., 2010; Chandrasekara & Shahidi, 2011; Taylor & Emmambux, 2008; Taylor, et al., 2006; Gull et al., 2015; Manach et al., 2005; Scalbert et al., 2005; Saleh et al., 2013; Gupta et al. 2012
8	Good for abdominal patients (millet do not contain gluten therefore good for abdomen)	Chandrasekar & Shahidi, 2010
9	Delay ageing (By reducing glycosylation of body proteins)	Doraiswamy et al., 1969.
10	Checks constipation, high blood cholesterol formation and intestinal cancer due to high fiber content in grain,	Usha, 2004; Enas et al., 2003
11	Folk medicine for leprosy, liver diseases	Watt & Breyer-Brandwijk, 1962
12	Folk medicine for Measles, Pleurisy, Pneumonia, Small pox	Duke & Wain, 1981
13	Anti-inflammatory, antiviral	Chethan & Malleshi, 2007
14	Prevention and management of diabetes	American Diabetes Association 2005; Shobana et al., 2009; Kim et al., 2011
15	Miscellaneous uses from Ayurvedic perspective (Promotes weight loss, healthy choice for vegans, mental relaxation, lowers triglycerides, improve lactation, child growth and weaning, promote hair growth, women friendly, geriatric tonic, gluten free food, lower the risk of gall stones and fights diseases.	Chandra et al., 2016

Medicinal value of finger millet in literatures

Based upon ethnobotanical practices, finger millet was effective against 15 types of human ailments, viz. antioxidant; antimicrobial activities; anti-ulcerative ; wound healing property; diarrhea control; improve haemoglobin; Inhibition of pathogenic bacterial strains; protection from non communicable

diseases; delay ageing; checks constipation; leprosy, pneumonia, measles; anti-inflammatory and antiviral; prevent cardio-vascular diseases; prevent diabetics; miscellaneous (Table 4).

Health benefit of finger millet such as prevention of diabetes (Kim et al., 2011), cardiovascular diseases (Saleh et al., 2013), lowering blood pressure (Gupta

et al. 2012), antioxidant, anti-ulcerative, anti-microbial, anti-inflammatory, anti-viral, anti-cancer has also been documented as therapeutic property of finger millet. Its medicinal properties are also valued in Ayurvedic medicine though it is known as Kuanna.

Finger millet is still second main food stuff in large parts of mid-hills and mountains region, but consumption rate is decreasing due to changing food habit of people. Health benefit of finger millet should be communicated to people in urban area, so that finger millet would become popular. Finger millet can serve as an ideal crop in term of nutrition and medicinal benefits to people of Nepal.

Conclusion

Finger millet could be an idol crop of Nepal due to rich in nutrition as well as medicinal value for several lifestyle related diseases like diabetes, cardio vascular disease. Locally finger millet is recognized as medicinal value besides food. More than 80% of local people were aware about its medicinal values and more than 83% of local people used it as medicine to cure the diarrhoea of cattle and 81% of people indicated it is very good for bone.

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References

- Amadou, I., Amza, T., Shi, Y.H. & Le, G.W. (2011). Chemical analysis and antioxidant properties of foxtail millet bran extracts. *Songklanakarinn J Sci Technol*, 33(5), 509–15.
- American Diabetes Association. (2005). Diagnosis and classification of diabetes mellitus. *Diabet Care*, 28, 37–42.
- Amgai R.B., Joshi, B.K., Shrestha, P. Chaudahry, B. Adhikari, N.P & Baniya, B.K. (2004). Intra- and interpopulation variation in finger millet (*Eleusine coracana* (L.) Gaertn) landraces grown in Kachorwa, Bara, Nepal. In: *On-farm Conservation of Agricultural Biodiversity in Nepal* (BR Sthapit, MP Upadhyay, PK Shrestha, DI Jarvis, eds). Volume 1. 2nd National Workshop on CUAPGR, 2017 223 Amount and Distribution of Genetic Diversity On-farm. Nagarkot, Nepal, pp.84-95. Proceedings.
- Antony, U., Moses, L.G. & Chandra, T. S. (1998). Inhibition of *Salmonella typhimurium* and *Escherichia coli* by fermented flour of finger millet (*Eleusine coracana*), *World J. Biotechnol*, 14(6), 883–886.
- Baniya, B.K., Riley, K.W., Dongol, D.M.S. & Sherchand, K.K. (1992). *Characterization of Nepalese hill crops landraces (Barley, Buckwheat, Finger millet, Grain Amaranth, Foxtail, Proso and Barnyard millets)* (pp. 162). Kabre, Dolakha, Nepal: NARC-IBPGR,
- Chadra, D., Chandr, S. & Sharma Pallavi, A.K. (2016). Review of finger millet (*Eleusine coracana* L. Gaertn), a power house of health benefiting nutrients. *Food Science and Human Wellness* 5, 149–155.
- Chandrasekara, A. & Shahidi, F. (2011). Determination of antioxidant activity in free and hydrolyzed fractions of millet grains and characterization of their phenolic profiles by HPLC-DAD-ESI-MS, *J. Funct. Foods*, 3(3), 144–158.
- Chandrasekara, A. & Shahidi, F. (2010). Content of insoluble bound phenolics in millets and their contribution to antioxidant capacity, *J. Agric. Food Chem.*, 58 (11), 6706–671.
- Chethan, S. & Malleshi, N.G. (2007). Finger millet polyphenols: characterization and their nutraceutical potential, *Am. J. Food Technol.*, 2 (7), 582–592.

- Devi, P.B., Vijayabharathi, R., Sathyabama, S., Malleshi, N.G. & Priyadarisini, V.B. (2011). Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review. *J Food Sci Technol*, DOI: 10.1007/s13197-011-0584-9.
- Doraiswamy T.R., Singh, N. & Daniel, V.A. (1969). Effects of supplementing ragi (*Eleusine coracana*) diets with lysine or leaf protein on the growth and nitrogen metabolism of children. *British Journal of Nutrition*, 23, 737-743.
- Duke, J.A. & Wain, K.K. (1981) *Medicinal Plants of the World*, Computer index with more than 85,000 entries (Vol. III), London, UK: Longman Group Ltd.
- Enas, A., Kumar, S., Chennikkara, H. & Bjurlin, M.A. (2003) Prudent diet and preventive nutrition from pediatrics to geriatrics: Current knowledge and practical recommendations: *Indian Heart Journal*, 55, 310-318.
- Ghimire, K.H., Bhandari, B., Gurung, S.K., Dhani, N. B. & Baniya, B.K. (2017). Diversity and utilization status of millets genetic resources in Nepal. Conservation and Utilization of Agricultural Plant Genetic Resources in Nepal (BK Joshi, HB KC and AK Acharya, eds). 2nd National Workshop, 22-23 May 2017 Dhulikhel; NAGRC, FDD, DoA and MoAD; Kathmandu, Nepal. Proceedings.
- Gull, A., Prasad, K., & Kumar, P. (2015). Effect of millet flours and carrot pomace on cooking qualities, color and texture of developed pasta. *LWT Food Science and Technology*, 63, 470–474. <http://dx.doi.org/10.1016/j.lwt.2015.03.008>
- Gupta, N., Srivastava, A.K. & Pandey, V.N. (2012). Biodiversity and nutraceutical quality of some indian millets. *Proceedings of the National Academy of Sciences*, India Section B: *Biological Science*. DOI: 10.1007/s40011-012-0035-z.
- Hegde, P.S., Rajasekaran, N.S. & Chandra, T.S. (2005a). Effects of the antioxidant properties of millet species on oxidative stress and glycemic status in alloxan-induced rats, *Nutr.Res.*, 25(12), 1109–1120.
- Hegde, P.S., Anitha, B. & Chandra, T.S. (2005b). In vivo effect of whole grain flour of finger millet (*Eleusine coracana*) and kodo millet (*Paspalum crobicum- ulatum*) on rat dermal wound healing, *Indian J.Exp.Biol.*, 43(3), 254–258.
- International Crops Research Institute for the Semi-Arid Tropics. (2004). Finger millet. <http://www.icrisat.org/web/ASP/mainsection.asp/> (assessed: 15 July, 2004).
- Jennings, H.M., Merrell, J., Thompson, J.L. & Heinrich, M. (2014). Food or medicine? The food-medicine interface in households in Sylhet. *J Ethnopharmacol.*, 167, 97–104.
- Kim, J.S., Hyun, T.K. and Kim, M.J. (2011). The inhibitory effects of ethanol extracts from sorghum, foxtail millet and proso millet on α -glucosidase and α -amylase activities. *Food Chem.*, 124, 1647–51.
- Lee, S. H., Chung, I. M., Cha, Y. S., & Park, Y. (2010). Millet consumption decreased serum concentration of triglyceride and C-reactive protein but not oxidative status in hyperlipidemic rats. *Nutrition Research*, 30, 290–296.
- Sri-Lankan Ministry of Agriculture. (2004). Finger millet: *Eleusine coracana* : Department of Agriculture. <http://www.gov.lk/Agriculture/Agridept/Techinformations/Cgrains/Fmillet.htm>.
- Manach, C., Mazur, A. & Scalbert A. (2005). Polyphenols and prevention of cardiovascular diseases. *Current Opin Lipidol*, 16, 77–84.
- Manzoni, M. Bergomi, S. Rollini, M. & Cavazzoni, V. (1999). Production of stains by filamentous fungi, *Bio technol. Lett.*, 21(3), 253–257.
- Ministry of Agriculture, Land Management and cooperatives. (2017). *Statistical Information on Nepalese Agriculture (2073/74)*. Kathmandu, Nepal: Author.
- Mohamed, E.A., Ahmed, I.A.M. & Babiker, E.E. (2011). Preservation of millet flour by refrigeration: changes in total protein and amino acids composition during storage. *World Acad Sci Eng Technol*, 52, 11-15.

- Rajasekaran, N.S., Nithya, M. Rose, C. & Chandra, T.S.(2004). The effect of finger millet feeding on the early responses during the process of wound healing in diabetic rats, *BBA-Mol. Basis Dis.*, 1689 (3) , 190-201.
- Rana, R.B., P. Chaudhary, D. Gauchan, S.P. Khatiwada, B.R. Sthapit, A. Subedi, M.P. Upadhyay & D. I. Jarvis. (2000) . *In situ* crop conservation: findings of agro-ecological, crop diversity and socio-economic baseline survey of Kachorwa eco-site, Bara, Nepal. NP Working Paper No. 1/2000. NARC/LIBIRD/IPGRI, Kathmandu, Nepal/Pokhara, Nepal/Rome, Italy.
- Saleh, A.S.M., Zhang, Q., Chen, J. & Shen, Q. (2013). Millet grains: nutritional quality, processing and potential health benefit. *Comprehensive Reviews in Food Science and Food Safety*, 12, 281-295. doi: 10.1111/1541-4337.12012
- Scalbert, A., Manach, C., Morand, C., Remesy, C. & Jimenez, L.(2005). Dietary polyphenols and the prevention of diseases. *Crit Rev Food Sci Nutr.*, 45, 287-306.
- Shobana, S., Sreerama, Y.N., & Malleshi, N.G. (2009). Composition and enzyme inhibitory properties of finger millet (*Eleusine coracana* L.) seed coat phenolics: mode of inhibition of glucosidase and amylase, *Food Chem.*, 115 (4) , 1268–1273.
- Sripriya, G., Chandrasekharan, K., Murty, V.S. & Chandra, T.S. (1996). ESRspectro- scopic studies on free radical quenching action of finger millet (*Eleusine coracana*), *FoodChem.*, 57(4), 537–540.
- Srivastava, K. & Sharma, A. K. (2012) . Nutraceutical importance of finger millet (*Eleusine coracana*) for improved human health.*The European Journal of Plant Science and Biotechnology*, 6(2), 91-95.
- Sthapit, B.R., P.M. Pradhanang, R.J. Khadka & Subedi, K.D. (1993). Finger millet relay intercropping system in the hills of Nepal: its constraints, research findings and prospects. *In* Advances in small millets (K.W. Riley, S.C. Gupta, A. Seetharam and J.N. Mushonga, eds.), New Delhi, India: Oxford and IBH Publishing Company.
- Tatala, S., Ndossi, G., Ash, D. & Mamiro, P. (2007). Effect of germination of finger millet on nutritional value of foods and effect of food supplement on nutrition and anemia status in Tanzania children, *Tanzan. J. Health Res.*, 9 (2), 77-86.
- Taylor, J. R. N., & Emmambux, M. N. (2008). Gluten free foods and beverages from millets. In *E. Gluten free cereal products and beverages* (pp. 1-27). Gallagher (Eds.), Burlington, USA: Elsevier.
- Taylor, J. R. N., Schober, T. J., & Bean, S. R. (2006). Novel food and non-food uses for sorghum and millets. *Journal of Cereal Science*, 44, 252-271. (<http://dx.doi.org/10.1016/j.jcs.2006.06.009>)
- Tovey, F. I. Jayaraj, A.P. & Clark, C.G. (1975). The possibility of dietary protective factors in duodenal ulcer, *Postgrad. Med. J.*, 51 (596), 366-372.
- Upreti, R.P. (2002). Production system with millets as component. *In*. Enhancing the Contribution of Nutritious but Neglected Crops to Food Security and to Incomes of Rural poor's: Nepal Component-Nutritious Millets. Inception Workshop. 2-3 May 2007, NARC Kathmandu, Nepal. Proceedings.
- Usha, A. (2004). Nutrition in HIV/AIDS. *iJM Diet and Nutrition.*, 7(2), 12-18.
- Usha, A, George, M.L. & Chandra, T.S.(1998). Inhibition of *Salmonella typhi- murium* and *Escherichia coli* by fermented flour of finger millet (*Eleusine coracana*). *World Journal of Microbiology and Biotechnology.*, 14, 883-88.
- Veenashri, B.R. & Muralikrishna, G. (2011). Invitro anti-oxidant activity of xylo- oligosaccharides derived from cereal and millet brans –a comparative study, *Food Chem.*, 126(3), 1475-1481.

- Venkateswaran, V. & Vijayalakshmi, G. (2010). Finger millet (*Eleusine coracana*)— an economically viable source for anti-hypercholesterolemic metabolites production by *Monascus purpureus*, *J.Food Sci.Technol.*, 47(4), 426–431.
- Vietnameyer, N.D., Borlaugh, N.E., Axtell, J., Burton, G.W., Harlan, J.R., & Rachie. K.O. (1996). Fonio. In: *Lost Crops of Africa* (pp. 39-58) (Vol 1), National Academy Press, New York: Grains BOSTID Publications.
- Viswanath, V., Urooj, A., & Malleshi, N.G. (2009). Evaluation of antioxidant and antimicrobial properties of finger millet polyphenols (*Eleusine coracana*), *Food Chem.*, 114(1), 40–346.
- Watt, J.M. & Breyer-Brandwijk, M.G. (1962). *The Medicinal and Poisonous Plants of Southern and Eastern Africa*, 2nd Ed (pp. 1457), Edinburgh: E. and S. Livingstone.