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A review on diversity, conservation and nutrition of wild edible fruits

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Abstract: The United Nations adopted the Millennium Declaration of September 2009 to improve the global living conditions through reducing poverty and hunger. However, considerable numbers of people are still living in utter penury and are deprived of a dignified living. In such tough circumstances nature's free gift in the form of wild edible foods are benefiting the vulnerable and dependent communities. Wild edible plants (WEPs) are the species those are neither cultivated nor domesticated however are available in their wild natural habitat and used as sources of these plants have played a significant role in the development and civilization of human history throughout the ages and globe. These wild edible plants have played a significant role in supplying food and nutritional requirements of poor communities in many rural parts of the world. These wild edibles can be popularized only when they are compared for their nutritional and health benefits with major or widely used cultivated plants. The social, cultural, religious, and belief system of the rural communities are incomplete without these wild edible plants. Domestication of these wild edible plants can increase their use and their conservation as well. The present review paper has described the wild edible plants in context of their diversity, traditional knowledge, conservation practices and nutritional composition from the available secondary literature. Authors feel there is still scope to incorporate more contextual variables for explaining more variations embedded with local people's perception on values and usage of these wild edible fruits.

Keywords: Climate, Development, Domestication, Hunger, Nutrition, Poor

INTRODUCTION

Wild edible plants (WEPs) are the species those are neither cultivated nor domesticated but growing wild and are however edible (Beluhan and Ranogajec, 2010). Different wild edible plants have played a significant role in all geographical regions of world throughout human history (Sekeroglu *et al*., 2006). Poor communities through the world are dependent on these wild plants for their food, nutrition, subsistence needs and improving rural livelihoods as well (Sundriyal *et al*., 2003; Mishra *et al*., 2008; Tiwari *et al*., 2010; Badhani *et al*., 2011). Even nutritional superiority of some of the wild edibles was also reported over the cultivated ones (Burlingame, 2000). The traditional consumption of WEP is still supplemented today with staple crop plants staple crop plants by most agrarian societies throughout the world (Lulekal *et al*., 2011). The role of WEPs in ensuring food and nutritional security to the rural or indigenous communities is now widely recognized. Unfortunately data available on their identification, composition or nutritional properties, use and management or user's preferences is scanty or less documented (Frison *et al*., 2006; Vincetti *et al*., 2008).

Many such food resources and valuable plants are still to be explored (Mohan Ram, 2000). Interest on its research and development has now increased for developing superior varieties, genetic conservation and pre- and post-harvest management (Arora and Nayar, 1984; Rathore, 2001; Hebbar *et al*., 2003; Bagra *et al*., 2006; Deshmukh and Shinde, 2010; Deshmukh and Waghmode, 2011; Ekka and Ekka, 2016). Available literature indicates initiation of some systematic work though not detailed and complete. This article has compiled information from more than 100 research and review articles and has scanned the information on the present theme from them. A systematic attempt was made in the present review article in light of similar results collected from the available literature which are presented under the following heads:

Diversity and conservation
Associated traditional knowledge and cultural value of wild edible fruits
Utilization of wild edible fruits
Physico-chemical properties of wild edible fruits

Diversity and conservation

Plant species richness in a region is primarily influenced by the climatic (temperature, rainfall, altitude), edaphic and biotic factors (Brockway, 1998; Hegazy *et*

al., 1998; Le Brocque and Buckney, 2003; Wang *et al*., 2003; Demel and Abeje, 2004; Zhao *et al*., 2005; Mengistu and Hager, 2008; Pala *et al*., 2015). Till date 2, 50,000-3, 00,000 higher plant species are documented, of which only a few hundred species are cultivated and a few thousands are gathered from the wild. Approximately 75, 000 species of plants world-wide are believed to be edible. These species are widely available but are important only *in situ* (Sekeroglu *et al*., 2006; Sharma *et al*., 2008). The national per capita supplies are significantly contributed by only 103 species of food plants (90 %) and of these, staples are only 20 to 30 species (Anon., 1999). More than 7000 species of WEPs are documented worldwide (Grivetti and Ogle. 2000). About 1000 species were identified in Americas, 1200 species in Africa and 800 species in Asia (Verheij and Coronel, 1991; Anon., 2005; Rathore, 2009; Paull and Duarte, 2011; Sthapit *et al*., 2012; Lapeña *et al*., 2014).

About 3000 tropical fruits worldwide were reported as still unexploited (Mugnozza, 1996). About 400 wild edible fruit species were reported from Kenya (Anon., 2005), 700 from Tanzania (Maduka, 2004), 150 from Eastern Madagascar (Styger *et al*., 1999), 110 from Swaziland (Antonsson-Ogle, 1990), 300 from Cameroon and 105 from Uganda (Goode, 1998), 123 from southern Yunnan in China (Jin *et al*., 1999), 33 from Rupandehi district, Nepal (Acharya and Acharya, 2010) and 11 from Dera Ismail Khan district of north western Pakistan (Marwat *et al*., 2011). Very rich diversity of wild fruit species was reported from Nigerian lowland rainforest (Adekunle and Oyerinde, 2004) where in species richness of a few hectares is higher than the entire vegetation of Europe (Etukudo, 2000). In Ethiopia, the richness of WEP species is enormous (Abbink, 1993; Azene *et al*., 1993; Redzic, 2006) and 38-182 edible fruit bearing species was reported to be consumed in Ethiopia (Guinand and Dechassa, 2000; Zemede and Mesfin, 2001; Demel and Abeje, 2004; Addis *et al*., 2013; Getachew *et al*., 2013). The wild edible fruit species documented in India from Himalayas are more than 675 species (Samant and Dhar, 1997; Samant *et al*., 2001; Chettri *et al*., 2005; Sundriyal and Sundriyal, 2003, 2005), 118 species from Arunachal Pradesh (Angami *et al*., 2006), 12 species from Uttara Kannada district of Karnataka (Hebbar *et al*., 2010), 150 species from Orissa (Mahapatra *et al*., 2012), 132 species from Assam (Sarma *et al*., 2010) and 80 species from Chhattisgarh (Ekka and Ekka, 2016).

Undervaluation, underutilization, high population growth and modern development leading to deforestation have lead to loss of diversity of the wild edible fruit species (Ondachi, 1999; Ohiokpehai, 2003; Bagra *et al*., 2006). In addition to this they are being exploited from wild without any effort to propagate them or any *ex situ* conservation strategies (Ondachi, 1999). Promoting and domesticating these wild fruit species not only will improve nutritional status and improve livelihood of the local communities but also protect them from loosing from the wild and well being of environment (Brownrigg, 1985; Ohiokpehai and Ramosweu, 1999; Byron, 2003; Ohiokpehai, 2003; Rathore, 2009; Halewood *et al*., 2014).

Traditional knowledge and cultural value

Traditional or folk knowledge on plants is relationship between a society and its environment developed by the community variedly from region to region based on their real world experience and empirical testing (Aumeeruddy, 1996; Reyes-Garcia *et al*., 2005; Setalaphruk and Price, 2007; Fentahun and Hager, 2008). WEPs has been integrally associated with needs, tradition and culture of indigenous people (Addis *et al*., 2013; Bussmann *et al*., 2006; Medley and Kalibo, 2007). The indigenous people are the custodian of these plant resources and the traditional knowledge associated with it (Demel and Abeje, 2004). Documenting traditional knowledge based on ethnobotany of WEPs will help in identifying species for domestication and is necessary to create rich and complex production systems for its sustainable development and utilization through commercialization and conservation as well (Bell, 1995; Melnyk, 1998; Ohiokpehai, 2003; Shrestha and Dhillion, 2006; Jasmine *et al*., 2007; Qureshi *et al*., 2007; Pilgrim *et al*., 2008; Ubom, 2010; Shukla and Chakravarty, 2012; Biswakarma *et al*., 2015). The past studies like Reddy *et al*. (2000) in Yanadis community of Andhra Pradesh; Shukla and Chakravarty, (2012) in Rava and Oraon tribes in North Bengal; Mishra *et al*. (2008) in ethnic communities of Tamil Nadu; Srivastav *et al*. (1981) in Amiches community in Ladakh (J & K) showed that different tribes have intensively used a number of similar wild fruits with different uses. This proves the diversification of knowledge among the indigenous people in region to region and nation to nation.

The intensity of use and knowledge of the WEPs was reported to be function of characteristic of the used plants, habitat of the plants where it is found, frequency of food shortages and peoples way of life in terms of their social, cultural, religious and economical domains (Guinand and Dechassa, 2000; Puri and Vogl, 2005; Shrestha and Dhillion, 2006; Pardo-de-Santayana *et al*., 2007; Suresh *et al*., 2014). This knowledge differs among the communities and within a community in terms of age and gender where senior women folks were reported to be more knowledgeable in describing these plants as compared to their male counterparts (Koizumi, 2005; Shrestha and Dhillion, 2006). This is because communities and individuals may have different objectives, interests, perceptions, beliefs and access to information and resources. The use of WEPs in the life of rural and indigenous people is not only in terms of food, income or farm inputs but

also in terms of social, cultural and religious purposes as in sacred groves (Arnold, 1995; Clarke *et al*., 1996; Arora, 1998; Ohiokpehai and Ramosweu, 1999; Ohiokpehai, 2003; Pala *et al*., 2013). Unfortunately this traditional culture and knowledge is losing importance by the encroaching traditions of modern outside community along with spread of agriculture and homogenization of agricultural landscapes (Pretty, 2002). The use of these wild plants for food and other uses by the rural and indigenous communities can be continued by developing harmonious correlation among farming and wild biodiversity (Pretty, 2003). In order to deliver the economic benefits of the development programs meant for the rural and indigenous communities, it is imperative to renew, document and utilize the traditional knowledge systems of the target communities where the intangible, edible, economic and environmental roles of the WEPs can be the key.

Utilization

From time immemorial the WEPs have been a source of 'hidden harvest' which had supplemented the community with food and income (Heywood, 1999; Grivetti and Ogle, 2000). The traditional knowledge system and economic demand of a community influences the exploitation of WEPs in a particular area (Edeoga *et al*., 2003; Pauline and Linus, Tabuti 2004; Tabuti *et al*., 2004; Jasmine *et al*., 2007). In terms of wild edible fruits, its consumption indicates user's evaluation of the fruits in terms of its availability, tastes and preferences (Minae *et al*., 1994) along with duration of settlement near to a forest from where the community is procuring these fruits (Styger *et al*., 1999).

World's poorest of the poor those who are bereft of a dignified life and are most vulnerable dominates South Asia, Latin American, Northern Africa, Sub-Saharan Africa and the Caribbean (Pender and Hazell, 2000; SCN, 2002; Harris and Mohammed, 2003; FAO, 2004; Tiisekwa *et al*., 2004; Ahmed *et al*., 2007; Behrman *et al*., 2007; Misra *et al*., 2008; Afolayan and Jimoh, 2009; FAO, WFP and IFAD, 2012). There is prevalence of undernourishment in these regions due to production of insufficient food grains and at times food supplies are not easily available. Foods obtained from WEPs serve as 'buffer food' rescuing lives during food shortages and famines (Abbink, 1993; Bell, 1995; Anon., 1999; Debarata, 2002; Kebu and Fasil, 2006; Akinnifesi *et al*., 2008).

The vulnerability towards hunger and malfunctioned ecosystem services lead these people rely for food and other products more on intensive agriculture (Ericksen *et al*., 2009). Studies strongly indicate that the WEPs can significantly substantiate the global food basket in today's era of climate instability (Maghembe, 1995; Nazarudeen, 2010). These vulnerabilities has developed a greater understanding among the scientists, policy makers, national governments and international institutions of a strong linkage between nutritional security and biodiversity for formulating policy support to promote utilization, value addition and conservation of WEPs (Hegde *et al*., 1996; Ramadhani, 2002; Bharucha and Pretty, 2010).

Physico-chemical properties

Physico-chemical analysis of wild edible fruits will help in selection of valuable wild species which can then be improved through hybridization for development of a cultivated variety (Mahapatra *et al.*, 2012). There are several analytical studies related to these wild fruits from different parts of the world which are important for commercial and dietary values (Parmar and Kaushal, 1982; Sundriyal *et al*., 1998; Koyuncu *et al*., 2004; Zatylny *et al*., 2005; Paull and Duarte, 2011). Total soluble solid (TSS) is an important characteristics giving information about sugar content of fruits. Sugar, a main source of energy is found to be high in many wild fruits. Titratable acidity indicates the total or potential acidity such that it includes the total number of acid molecules, both protonated and unprotonated. TSS, sugar and acidity of many wild edible fruits have been reported from many parts of the world (Parmar and Kaushal, 1982; Sundriyal *et al*., 1998; Sundriyal and Sundriyal, 2001; Elmac and Altuq, 2002; Koyuncu *et al*., 2004; Zatylny *et al*., 2005; Ercisli and Orhan, 2007; Nath *et al*., 2008; Deshmukh and Waghmode, 2011). Certain essential amino acids are also derived from plants (Fox and Cameron, 1976). Protein and fat content of wild edible fruits reported varied from 0.4-18 % and 2.0-5.0 %, respectively (Sundriyal and Sundriyal, 2001; Deshmukh and Waghmode, 2011). The fruits were *Prunus cerasoides*, *Diploknema butyraceae*, *Spondias axillaris*, *Machilus edulis*, *Passiflora indica*, *Eleagnus latifolia*, *Eriolobus indica*, *Terminalia chebula*, *Capparis zeylanica*, *Carissa congesta*, *Elaeagnus conferta* and *Limonia acidissma*.

Antioxidants are substance present in low concentrations that restricts oxidation in a chain reaction (Leong and Shui, 2002; Halliwell and Whitemann, 2004) while ascorbic acid are also antioxidant that reduces free radical damage by scavenging oxyradicals (Fischer-Nielsen *et al*., 1992). Many wild edible fruits like berries are reported as rich sources of antioxidants like vitamins β-carotene (pro-vitamin A), α-tochopherol (vitamin E), and ascorbic acid or vitamin C (Beekwilder *et al*., 2005; Netzel *et al*., 2007; Abu Bakar *et al*., 2009; Ikram *et al*., 2009). Wild edible fruits like mulberry, *Ficus roxburghii* and *Capparis zeylanica* are rich source of vitamin C (Parmar and Kaushal, 1982; Holford Fox and Cameroon, 1976;, 1998; Imran *et al*., 2010; Deshmukh and Waghmode, 2011).

Carotenoids reported from many wild edible fruits like sea buckthorn and mulberry are the chemo-protective agents or are antioxidants and are responsible for ap-

pearance and attractiveness of fruits (Young and Lowe, 2001; Eccleston *et al*., 2002; McGhie and Ainge, 2002; Nishiyama *et al*., 2005; Gropper *et al*., 2005; Rodriguez-Bernaldo de Quiros and Costa, 2006; Venkatesh and Chauhan, 2011). Anthocyanin is a polyphenolic pigment of flavonoid group that imparts orange, red, blue and violet colour to many wild edible fruits like chokeberry and bilberry (Chandra *et al*., 1992). Cyanidin 3-glucoside is the most common anthocyanin found in these fruits (Fukumoto and Mazza, 2000) that potential protective effects against disease.

Conclusion

The present article was an attempt to review the available information regarding the diversity, conservation, indigenous knowledge and physico-chemical characteristics of wild edible fruits. The research work on these aspects seems to be confined to certain limited regions with severe poverty. In order to achieve the Millennium Development Goals to improve the living condition, more regions needs to be brought under this type of study and more research work be initiated to determine the nutritional composition of wild edible fruits so that they can be compared with widely cultivated major fruit crops. Use of these fruits also has the potential through selective conservation and domestication which can contribute to the maintenance of plant biodiversity. There is a need to distinguish/ recognize these fruits and their value added products in the local or national or international market. It is also important to analyze the market environment for these fruits compared with alternative possibilities such as exotic fruits or agricultural crops. In general, future contemplations on wild edible fruits around the globe need to be studied at forefront by involving local indigenous communities.

REFERENCES

Abbink, J. (1993). Meén ritual, medicinal and other plants: A contribution to south-west *Ethiopian Ethnobotany. J. Eth. St*., 26: 1-21

Abu Bakar, M.F., Mohamed, M., Rahmat, A. and Fry, J. (2009). Phytochemicals and antioxidant activity of different parts of bambangan (*Mangifera pajang*) and tarap (*Artocarpusodoratissimus). Food Chemistry*, 113: 479-483

Acharya, K.P. and Acharya, R. (2010). Eating from the wild: Indigenous knowledge on wild edible plants in Paroha VDC of Rupandehi district, Central Nepal. *International Journal of Social Forestry*, 3: 28-48

Addis, G., Asfaw, Z. and Woldu, Z. (2013). Ethnobotany of wild and semi-wild edible plants of Konso ethnic community, South Ethiopia, Ethnobotany Research & Applications, vol. 11, pp. 121–142

Adekunle, V.A.J. and Oyerinde, O.V. (2004). Food potential of some indigenous wild fruits in lowland rainforest ecosystem of South West Nigeria. *Journal of food Technology*, 2: 125-130

Afolayan, A. and Jimoh, F. (2009). Nutritional quality of some wild leafy vegetables in South Africa. *International Journal of Food Science and Nutrition*, 60: 424-431

Ahmed, A.U., Hill, R.V., Smith, L.C., Wiesmann, D.M. and T. Frankenberger. (2007). The world's most deprived: characteristics and causes of extreme poverty and hunger. Washington: International Food Policy Research Institute

Akinnifesi, F.K., Mhango, J., Sileshi, G. and Chilanga, T. (2008). Early growth and survival of three Miombo indigenous fruit tree species under fertilizer, manure and dry-season irrigation in southern Malawi. *Forest Ecology and Management*, 255: 556-557

Angami, A., Gajurel, P.R., Rethy, P., Singh, B. and Kalita, S. K. (2006). Status and potential of wild edible plants of Arunachal Pradesh. *Indian Journal of Traditional Knowledge*, 5: 541-550

Anonymous (1999). *Use and potential of wild plants in farm households*. FAO Rome, Italy

Anonymous (2005). *Current state and trends*. Millennium Ecosystem Assessment, Washington DC

Antonsson-Ogle, B. (1990). *Dietary Use of Wild Plant Resources in Rural Switzerland*, Proceedings of the twelfth Plenary Meeting of AETFAT, Symposium VII, Hamburg, pp. 895-910

Arnold, J.E.M. (1995). Socio- economic benefits and issues in non - wood forest products use. In: *Report of the expert consultation on non - wood forest products*, Yogyakarta, Indonesia, 17-27 January 1995Non - Wood Forest Products 3. FAO, Rome.

Arora, R.K. (1998). Genetic resources of native tropical fruits in Asia: Diversity, distribution and IPGRI's emphasis on their conservation and use. In: *Tropical Fruits in Asia: Diversity, Maintenance, Conservation and Use*. Proc. IPGRI-ICAR-UTFANET Regional Training Course on the Conservation and Use of Germplasm of Tropical Fruits in Asia, eds. Arora, R.K. and Rao, V. Ramanatha. Bangalore, India, 18-31 May 1997

Arora, R.K. and Nayar, E.R. (1984). *Fruits. Wild relatives of crop plants in India*. National Bureau of Plant Genetic Resources, New Delhi 19-20

Aumeeruddy, Y. (1996). Ethnobotany, linkages with conservation and development. In: *Proceeding of first training workshop on Ethnobotany and its applications to conservation NARC, Islamabad*, Pp 152-157

Azene Bekele-Tessema; Birnie, A. and Tengnas, B. (1993). *Useful trees and shrubs for Ethiopia: Identification, propagation and management for agricultural and pastoral communities*. Regional Land Management Unit (RELMA) Sida, Nairobi

Badhani, A., Sakalani, S. and Mishra, A.P. (2011). Variation in biochemical's and antioxidant activity of some wild edible fruits of Uttarakhand. *Report and Opinion*, 3: 1-10

Bagra, G., De, L.C. and Singh, V.B. (2006). Collection and evaluation of some indigenous lesser known fruits of Arunachal Pradesh. In: *Horticulture for Sustainable Income and Environmental Protection*, Vol. 1. Pp 224-231

Beekwilder, J., Hall, R.D., de Vos, C.H.R. (2005). Identification and dietary relevance of antioxidants from raspberry. *Biofactors*, 23: 197-205

Behrman, J.R., Hoddinott, J., Maluccio, J.A., Soler-

Hampejsek, E., Behrman, E.L., Martorell, R., Ramirez-Zea, M. and Stein, A.D. (2007). What detemines adult cognitive skills? Impacts of pre-schooling, schooling and post-schooling experiences in Guatemala, working paper.

Bell, J. (1995). The hidden harvest. In: *Seedling*. The Quarterly Newsletter of Genetic Resources Action International (GRAIN). www.grain.org.

Beluhan, S. and Ranogajec, A. (2010). Chemical composition and non-volatile components of Croatian wild edible mushrooms. *Food Chemistry,* 124: 1435-1452

Bharucha, Z. and Pretty, Z. (2010). The roles and values of wild foods in Agricultural systems. *Phil. Trans. R. Soc. B.*, 365: 2913-2926

Biswakarma, S. Sarkar, B.C., Shukla, G., Pala, N.A. and Chakravarty, S. (2015). Traditional Application of ethno medicinal plants in Naxalbari area of West Bengal, India. *International Journal of Usuf. Management,* 16: 36-42

Brockway, D.G. (1998). Forest plant diversity at local and landscape scales in the Cascade Mountains of Southwestern Washington. *Forest Ecology and Management* ,109: 323-341

Brownrigg, L. (1985). *Homegarden in international development: what literature shows*? League for International Food Production, Washington, D.C.

Burlingame, B. (2000). Wild nutrition. *Journal of Food Composition and Analysis,* 13: 99-100

Bussmann, R.W., Gilbreath, G.G., Solio, J., Lutura, M., Lutuluo, R., Kunguru, K., Wood, N. and Mathenge, S.G. (2006). Plant use of the Maasai of Sekenani Valley, Maasai Mara, Kenya. *Journal of Ethnobiology and Ethnomedicine,* 2: 22

Byron, E. (2003). *Market integration and health: morbidity, diet and nutritional status in the Tsimane' Ameridians of Lowland Bolivia*. Ph. D. thesis, University of Florida, Gainesville

Chandra, A., Nair, M.G. and Lezzoni, A. (1992). Evaluation and characterization of the anthocyanin pigments in tart cherries (*Prunus cerasus* L.). *Journal of Agricultural and Food Chemistry,* 40: 967-969

Chettri, N., Sharma, E. and Lama, S.D. (2005). Non timber forest produces utilization, distribution and status in a trekking corridor of Sikkim, India. *Lyonia,* 8: 89-101

Clarke, J., Cavendish, W. and Coote, H.C. (1996). Rural households and Miombo woodlands: use, value and management. In: The Miombo woodlands and welfare in America, ed. Campbell, A. CIFOR, Bongor, Indonesia. Pp101-135

Debarata, D. (2002). Wild food plants of Medinipur, West Bengal Used During Drought and Flood. In: *Ethnobotany and Medicinal Plants of Indian Subcontinent*, ed. Maheshwari, J. K. Scientific Publishers, Jodhpur, India.

Demel, T. and Abeje, E. (2004). Status of indigenous fruits in Ethiopia. In: *Review and Appraisal on the status of Indigenous fruits in Eastern Africa*. A synthesis report for IPGRI – SAFORGEN, eds. Chikamai, B., Eyog-Matig, O., Mbogga, M http://www.bioversityinternational.org/Networks/saforgen/publications.htm.

Deshmukh, B.S. and Shinde, V. (2010). Fruits in wilderness: A potential of local food resource. *International Journal of Pharmacology and Bio Science*, 2: 1-5

Deshmukh, B.S. and Waghmode, A. (2011). Role of wild edible fruits as a food resource: Traditional knowledge. *International Journal of Pharmacy and Sciences*, 2: 919 -924

Eccleston, C., Baoru, Y., Tahvonen, R., *Kallio*, H., Rimbach, G.H. and Minihane, A.M. (2002). Effects of an antioxidant- rich juice (Sea buckthorn) on risk factors for coronary heart disease in humans. *Journal of Nutritional Biochemistry*, 13: 346-354

Edeoga, H.O., Okwu, D.E and Mbaebie, B.O. (2003). Minerals and nutritive value of some Nigerian medicinal plants. *Journal of Medicinal and Aromatic Plant Science*, 25: 1010-1015

Ekka, N.S. and Ekka A. (2016). Wild edible plants used by tribles of North-east Chhattisgarh (Part-I) India. *Research Journal of Recent Science*, 5: 127-131

Elmac, Y. and Altuq, I. (2002). Flavour evaluation of three black mulberry (*Morus nigra)* cultivars using GC/MS, chemical and sensory data. *Journal of the Science of Food and Agriculture*, 82: 632-635

Ercisli, S. and E. Orhan. (2007). Chemical composition of white (*Morus alba),* red *(Morus rubra)* and black (*Morus nigra)* mulberry fruits. *Food Chemistry,* 103: 1380-1384

Ericksen, P.J., Ingram, J.S.I and Liver man, D.M. (2009). Food security and global environmental change. *Environmental Science Policy,* 12: 373–377

Etukudo, I. (2000). *Forest, Our Divine Treasure*. Dorand Publishers. Uyo , Nigeria. 194p.

FAO, WFP and IFAD. (2012). The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO.

Fentahun, M.T. and Hager, H. (2008). Exploiting locally available resources for food and nutritional security enhancement: wild fruits diversity, potential and state of exploitation in Amhara region of Ethiopia. *Food security,* 1: 207-219

Fischer-Nielsen, A., Poulsen, H.E. and Loft, S. (1992). 8-Hydroxydeoxyguanosine in vitro: effects of glutathione, ascorbate, and 5-aminosalicylic acid. *Free Radical Biology and Medicine,* 13: 121-126

Food and Agriculture Organization of the United Nations (2004). The State of Food and Agriculture: Agricultural Biotechnology; Meeting the Needs of the Poor? Rome: FAO.

Holford Fox, B.A. and Cameron, A.G. (1976). *Food Science-a Chemical Approach*. London, Sydney, Auckland & Toronto: Hodder and Stoughton

Frison, E.A., Smith, I.F., Johns, T., Cherfas, J. and Eyzaguirre, P.B. (2006). Agricultural biodiversity, nutrition and health. *Food Nutrition Bulletin,* 27: 167-179

Fukumoto, L.R. and Mazza, G.(2000.) Assessing antioxidant and pro-oxidant activity of phenolic compounds. *Journal of Agricultural and Food Chemistry,* 48: 3597-3604

Getachew, G.A. , Asfaw, Z., Singh, V., Woldu, Z., Baidu-Forson, J.J. and Bhattacharya, S. (2013). Dietary values of wild and semi-wild edible plants in Southern Ethiopia. African *Journal of Food, Agriculture, Nutrition and Development*, 13(2):121–141

Goode, P.M. (1998). *Edible plants of Uganda. The value of*

wild and cultivated plants as food. FAO Food and Nutrition Paperno, 42/1, FAO, Rome

Grivetti, L.E. and Ogle, B.M. (2000). Value of traditional foods in meeting macro and micro nutrient needs: The wild plant connection. *Nutritional Research Review*, 13: 31-46

Gropper, S.S., Smith, J.L. and Groff, J.L. (2005). *Advanced nutrition and human metabolism*, 4th ed. Belmont, USA: Thomson Wadsworth, Pp 259-367

Guinand, Y. and Dechassa, L. (2000). *Indigenous food plants in southern Ethiopia Reflections on the role of 'famine foods' at the time of drought*. UNEUE Survey, Addis Ababa.

Halewood, M., Baidu-Forson, J.J., Clancy, E. and Vodouhe, R.S. (2014). Cooperating to make the best use of plant genetic resources in west and Central Africa: A Regional Imperative. Bioversity International, Rome, and CORAF/ WECARD, Dakar

Halliwell, B. and Whiteman, M. (2004). Measuring reactive species and oxidative damage in vivo and in cell culture: how should you do it and what do the results mean*? British Journal of Pharmacology*, 142: 231–255

Harris, F.M.A. and Mohammed, S. (2003). Relying on nature: wild foods in Northern Nigeria. *Ambio.*, 32: 24−29

Hebbar, S.S., Harsha, V.H., Shripathi, V. and Hegde, G.R. (2003). Wild fruits of Dharwad, Karnataka. *Journal of Economic and Taxonomic Botany*, 27: 982

Hebbar, S.S., Hegde, G. and Hegde, G.R. (2010). Less known wild edible fruits and seeds of Uttar Kannada district of Karnataka. *Indian Forester*, 136: 1218-1222

Hegazy, A.K., El-Demerdash, M.A., and Hosni, H.A. (1998). Vegetation in the intermediate altitudinal belt attains the highest species richness and diversity with relatively high evenness. *Journal of Arid environment*, 38: 3-13

Hegde, R., Suryaprakash, S., Achpth, L. and Bawa, K.S. (1996). Extraction of non-timber forest products in the forest of Biligiri Rangan Hills, India. I: Contribution to rural income. *Economic Botany*, 50: 243–251

Heywood, V. (1999). *Use and potential of wild plants in farm households*. Rome, Italy: FAO Farm Systems Management Series

Ikram, E.H.K., Eng, K.H., Jalil, A.M.M., Ismail, A., Idris, S., Azlan, A., Nazri, H.S.M., Diton, N.A.M. and Mokhtar, R.A.M. (2009). Antioxidant capacity and total phenolic content of Malaysian underutilized fruits. *Journal of Food Composition and Analysis*, 22: 388-393

Imran, M., Khan, H., Shah, M., Khan, R. and Khan, F. (2010). Chemical composition and antioxidant activity of certain *Morus* species. *Journal of Zhejiang University of Science B.*, 11: 973-980

Jasmine, T.S., Jeeva, S., Febreena, G.L., Mishra, B.P. and Laloo, R.C. (2007). Wild edible plants of Meghalaya, North-east India. *Natural Product Radiance*, 6: 410-426

Jin, C., Yin-Chun, S., Gui-Quin, C. and Wen-Dun, W. (1999). Ethnobotanical studies on wild edible fruits in southern Yunnan: folk names; nutritional value and uses. *Economic Botany*, 53: 2-14

Kebu, B. and Fasil, K. (2006). Ethnobotanical study of wild edible plants in Derashe and Kucha Districts. South Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 2: 53

Koizumi, M. (2005). Ethnobotany of the Penan Benalui of east Kalimantan, Indonesia: difference of ethnobotanical knowledge among villagers of long Belaka. *African Study Monographs. Supplement*, 29: 53-60

Koyuncu, F., Koyuncu, M.A., Yidrm, F. and Vural, E. (2004). Evaluation of black mulberry (*Morus nigra* L.) genotypes from lakes region, Turkey. *European Journal of Horticultural Science*, 69: 125-131

Lapeña, I., Turdieva, M., Noriega, I.L. and Ayad, W.G. (2014). Conservation of fruit tree diversity in Central Asia: Policy Options and Challenges. Bioversity International, Rome, 251 p.

Le Brocque, A.F. and Buckney, R.T. (2003). Species richness-environment relationships within coastal sclerophyll and mesophyll vegetation in Ku-ring-gai Chase National Park, New South Wales, Australia. *Australian Ecology*, 28: 404-412

Leong, L.P. and Shui, G. (2002). An investigation of antioxidant capacity of fruits in Singapore markets. *Food Chemistry*, 76: 69-75

Lulekal, E., Asfaw, Z., Kelbessa, E. and Van Damme, P. (2011). Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. *Afrika Focus*, 24: 71-121

Maduka, S.M. (2004). Country report for tanzania. In: *Review and Appraisal on the status of Indigenous fruits in Eastern Africa*. A synthesis report for IPGRI – SAFORGEN, eds. Chikamai, B., Eyog-Matig, O. and Mbogga, M. http://www. Biodiversity international.org/ Networks/ saforgen/ publications htm.

Maghembe, J.A. (1995). Achievement in the establishment of indigenous fruit trees of the Miombo woodlands of southern Africa. In: *Improvement of indigenous fruit trees of the Miombo woodlands of Southern Africa*, eds. Maghembe, J.A., Ntupanyama, Y. and Chirwa, P.W. ICRAF, Nairobi, Kenya, Pp 39-49

Mahapatra, A.K., Satarupa, M., Basak, U.C. and Panda, P.C. (2012). Nutrient analysis of some selected wild edible fruits of deciduous forests of India: an Explorative Study towards Non Conventional Bio-Nutrition in *Advance Journal of Food Science and Technology*, 4: 15-21

Marwat, S.K., Fazal-ur Rehman; Usmaan, K., Khakwani, A. A., Ghulam, S., Anwar, N., Sadiq, M. and Khan, S.J. (2011). Medico-ethnobotanical studies of wild edible fruits plants species for the flora of north western Pakistan (D.I. Khan District) *Journal of Medical Plant Research*, 5: 3679-3686

McGhie, T.K. and Ainge, G.D. (2002). Color in fruit of genus *Actinidia*: carotenoids and chlorophyll compositions. *Journal of Agricultural and Food Chemistry*, 50: 117-121

Medley, K.E. and Kalibo, H.W. (2007). Ethnobotanical survey of 'wild' woody plant resources at mount Kasigau, Kenya. *Journal of East African Natural History*, 96: 149-186

Melnyk, M. (1998). *Indigenous enterprise for the domestication of trees and the commercialization of their fruits*. International Conference on Domestication and Commercialization of Non-Timber Forest Products in Agroforestry Systems. Non-Forest Products 9. FAO, Rome.

Mengistu, F. and Hager, H. (2008). Wild edible fruit species cultural domain, species competence and preference in three districts of Amhara Region, Ethiopia. *Ethnobotany Research and Applications*, 6: 487-502

Minae, S., Sambo, E.Y., Munthali, S.S. and Ng'ong'ola. (1994). Selecting priority indigenous fruit-tree species for central Malawi using farmers' evaluation criteria. In: Improvement of indigenous fruit trees of the Miombo woodlands of Southern Africa, eds. Maghembe, J.A., Ntupanyama, Y., Chirwa, P.W. Proceedings of a conference held 23-27 January 1994 in Mangochi, Malawi. ICRAF, Nairobi. Pp 84-99

Mishra, S., Maikhuri, R.K., Kala, C.P., Rao, K.S. and Saxena, K.G. (2008). Wild leafy vegetables: a study of their subsistence dietetic support to the inhabitants of Nanda Devi Biosphere Reserve, India. *Journal of Ethnobiology and Ethnomedicine*, 4: 15-23

Mishra, S.B., Dwivedi, S., Shashi, A., Prajapati, K. (2008). Ethnomedicinal uses of some plant species by ethnic and rural peoples of the Salem district of Tamilnadu with special reference to the conservation of vanishing species. *Ethnobotanical Leaflets*, 12, 873–887

Mohan, Ram, H.Y. (2000). *Plant Resources of Indian Himalaya*. 9th G.P. Pant Memorial Lecture, G B Pant Intititute of Himalayan Development, Gangtok, Sikkim.

Mugnozza, G.T.S. (1996). Ethics of biodiversity conservation. In: *Biodiversity, science and development: towards a new partnership*, eds. Di Castri, F. and Younes, T. CAB International, United Kingdom. Pp 622-629

Nath, V., Pandey, D., Kumar, D. and Pandey, V. (2008). *Fruits for the future. Vol.1. Well known arid and semi arid fruits*. Gyan books private ltd. Delhi. 512p

Nazarudeen, A. (2010). Nutritional composition of some lesser-known fruits used by ethnic communities and local folks of Kerala. *Indian Journal of Traditional Knowledge,* 9: 398-402

Netzel, M., Netzel, G., Tian, Q., Schwartz, **S.** and Konczak, I. (2007). Native Australian fruits- A novel source of antioxidants for food. *Innovative Food Science and Emerging Technologies*, 8: 339-346

Nishiyama, I., Fukuda, T. and Oota, T. (2005). Genotypic difference in chlorophyll, lutein, and β-carotene contents in the fruits of *Actinidia* species. *Journal of Agricultural and Food Chemistry*, 53: 6403-6407

Ohiokpehai, O. (2003). Promoting the nutritional goodness of traditional food products. *Pakistan Journal of Nutri*tion, 2: 267–270

Ohiokpehai, O. and Ramosweu. (1999). The role of agricultural processing and nutrition in improving food security at household level. In *Proceedings of the national post harvest conference* held October 6-8 1998, Sebele, Botswana.

Ondachi, P.W. (1999). *Nutritional studies of indigenous fruit trees in support of conservation*. Annual Research Report,part 1. African Academy of Sciences.

Pala, N.A., Negi, A.K. and Todaria, N.P. (2015). Ecological status and socio-cultural significance of sem mukhem temple landscape in Garhwal Himalaya, India. *Indian Forester,* 141 (5): 496-504

Pala, N.A., Negi, A.K., Shah, S. and Todaria, N.P. (2013) Floristic composition, Ecosystem services and Biodiversity value of sacred forests in Garhwal Himalaya. *Indian Journal of Forestry*, 36(3): 353-362

Pardo-de-Santayana, M., Tardio, J., Blanco, E., Carvalho, A. M., Lastra, J.J., San-Miguel, E. and Morales, R. (2007). Traditional knowledge of wild edible plants used in the northwest of the Iberian Peninsula (Spain and Portugal): A comparative study. *Journal of Ethnobiology and Ethnomedicine,* 3: 27

Parmar, C. and Kaushal, M.K. (1982). *Ficus roxburghii*. In: *Wild Fruits*. Kalyani Publishers, New Delhi, India. Pp 35-37.

Pauline, M. and Linus, W. (2004). Status of indigenous fruits in Kenya. In: *Review and appraisal on the status of Indigenous fruits in Eastern Africa*. A synthesis report for IPGRI-SAFORGEN, eds. Chikamai, B.; Eyog-Matig, O. and Mbogga, M. http://www.bioversity international.org.

Paull, R.E. and Duarte, O. (2011). Tropical Fruits. 2nd Edition, CAB International, London, 1-10

Pender, J., and P. Hazell. (2000). Promoting sustainable development in Less-Favored Areas: Overview. Brief 1 in J. Pender and P. Hazell (eds.), Promoting Sustainable Development in Less-Favored Areas. 2020 Vision Initiative, Policy Brief Series, Focus 4. Washington, DC: International Food Policy Research Institute.

Pilgrim, S., Cullen, L., Smith, D.J. and Pretty, J. (2008). Ecological knowledge is lost in wealthier communities and countries. *Environmental Science and Technology*, 42: 1004–1009

Pretty, J. (2002). *Agri-Culture*. Earthscan, London, UK.

Pretty, J. (2003). Social capital and the collective management of resources. *Science*, 302: 1912–1915

Puri, R.J. and Vogl, C.R. (2005). *A methods manual for ethnobotanical research and cultural domain analysis with analysis using ANTHROPAC.* University of Bodenkultur, Vienna.

Qureshi, R.A., Ghufran, M.D., Gilani, S.A., Sultana, K. and Ashraf, M. (2007). Ethnobotanical studies of selected medicinal plants of Sudhan Gali and Ganga Chotti hills, district Bagh, Azad Kashmir. *Pakistan Journal of Botany*, 39: 2275-2283

Ramadhani, T. (2002). *Marketing of indigenous fruits in Zimbabwe*. Socio-economic Studies on Rural Development, Vol. 129. Wissenschaftsverlag Vauk. Kiel, Germany.

Rathore, D.S. (2001). Overcoming malnutrition through non-traditional fruits. *Indian Horticulture*, Jan-Mar: 8-12

Rathore, M. (2009). Nutrient content of important fruit trees from arid zone of Rajasthan. *Journal of Horticulture and Forestry*, 1: 103-108

Reddy, R.V., Lakshmi, N.V.N., Raju, R.R.V. (2000). Traditional phytotherapy for epilepsy, fits and hysteria by Yanadis of Cuddapah district A.P. Ancient Science of Life XIX, 92–95

Redzic, S.J. (2006). Wild edible plants and their traditional use in the human nutrition in Bosnia- Herzegovina. *Ecology of Food and Nutrition*, 45: 189-232

Reyes-Garcı´a, V., Vadez, V. and Byron, E. (2005). Market economy and the loss of folk knowledge of plant uses. Estimates from the Tsimane' of Bolivian Amazon Victoria. Current Anthropology, 46: 653-656

Rodriguez-Bernldo de Quiros, A. and Costa, H.S. (2006). Analysis of Carotenoid in vegetable and plasma samples: A review. *Journal of Food Composition and Analysis*, 19: 97-111

Samant, S.S. and Dhar, U. (1997). Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *International Journal of Sustainable Develop-*

ment and World Ecology, 4: 179-191
Samant, S.S., Dhar, U. and Rawal, R.S. (2001). Diversity and distribution of wild edible plants of Indian Himalaya. In: *Plant Diversity of the Himalaya*, eds. Pande, P. C. Samant, S. S. Gyanodaya Prakasha, Nainital, India. pp 421-482.
Sarma, H., Sarma, C.M. and Bhattacharjya, D.K. (2008). Host specificity of *Cuscuta reflexa* Roxb. in the Manas Biosphere Reserve, Indo-Burma Hotspot. *International Journal of Plant Product*, 2: 175-180
Sarma, H., Tripathi, A.K., Borah, S. and Kumar, D. (2010). Updated estimates of wild edible and threatened plants of Assam: A meta- analysis. *International Journal of Botany*, 6: 414-423
SCN (2002). Nutrition: A Foundation for Development − Why Practitioners in Development Should Integrate Nutrition. UN Standing Committee on Nutrition, Geneva.
Sekeroglu, N., Ozkutlu, F., Deveci, M., Dede O. and Yilmaz, N. (2006). Evaluation of some wild plants aspect of their nutritional values used as vegetable in eastern black sea region of Turkey. *Asian Journal of Plant Science*, 5: 185-189
Setalaphruk, C. and Price, L.L. (2007). Children's traditional ecological knowledge of wild food resources: A case study in a rural village in Northeast Thailand. *Journal of Ethnobiology and Ethnomedicine*, 3: 33
Shrestha, P.M. and Dhillion, S.S. (2006). Diversity and traditional knowledge concerning indigenous food species in a locally managed forest in Nepal. *Agroforestry Systems*, 66: 55-63
Shukla, G, and Chakravarty, S. (2012). Ethnobotanical plant use of Chilapatta Reserved Forest in West Bengal. Indian *Forester*, 138: 1116-1124
Srivastava, T.N., Badola, D.P., Gupta, O.P. (1981). Medicinal herbs used by amchies of ladakh. Paper Presented in the Seminar on Recent Researches in Ethnobotany, Calicut on 29-12-1981. Central Council for Research in Ayurveda and Siddha, India.
Sthapit, B., Rao, V.R. and Sthapit, S., Eds. (2012) Tropical Fruit Trees Species and Climate Change. Bioversity International, New Delhi, 15-26, 97-125
Styger, E., Rakotoarimanana, J.E.M., Rabevohitra, R. and Fernandes, E.C.M. (1999). Indigenous fruit trees of Madagascar: potential components of agroforestry systems to improve human nutrition and restore biological diversity. *Agroforesty System*, 46: 289-310
Sundriyal, M. and Sundriyal, R.C. (2001). Wild edible plants of the Sikkim Himalaya: Nutritive values of selected species. *Economic Botany*, 55: 377-390
Sundriyal, M. and Sundriyal, R.C. (2003). Underutilized edible plants of the Sikkim Himalaya: Need for domestication. *Current Science*, 85: 731- 736
Sundriyal, M. and Sundriyal, R.C. (2005). Seedling growth and survival of selected wild edible fruit species of Sikkim Himalayas, India. *Acta Oecologica*, 28: 11-21
Sundriyal, M., Sundriyal, R.C. and Sharma, E. (2003). Dietary use of wild plant resources in the Sikkim Himalaya, India. *Economic Botany*, 58: 626-638
Sundriyal, M., Sundriyal, R.C., Sharma, E. and Purohit, A. N. (1998). Wild edibles and other useful plants of Sikkim Himalayas, India. *Oecologia Montana*,7: 43-54
Suresh, C.P., Bhutia, K.D., Shukla. G., Pradhan, K. and Chakravarty, S. (2014). Wild edible tree fruits of Sikkim Himalayas. *Journal of Tree Sciences*, 33: 43-48
Tabuti, J.R.S, Lye, K.A. and Dhillion, S.S. (2004). The status of wild food plants in Bulamogi County, Uganda. *International Journal of Food Sciences and Nutrition*, 55: 485-498
Tiisekwa, B.P.M., Ndabikunze, B.K., Samson, G. and Juma, M. (2004). Suitability of some indigenous tree fruits for manufacturing juices and jams in Tanzania. In: *Agroforestry impacts on livelihoods in southern Africa: Putting research into practice*, eds. Rao, M.R., Kwesiga, F.R. Proceedings of the Regional Agroforestry Conference held in Warmbaths, South Africa 20−24 May, 2002. World Agroforestry Centre (ICRAF), Nairobi, Kenya, Pp 331-335
Tiwari, J.K., Ballabha, R. and Tiwari, P. (2010). Some promising wild edible plants of Srinagar and its adjacent area in Alaknanda valley of Garhwal Himalaya, India. *Journal of American Science*, 6: 167-174
Ubom, R.M. (2010). Ethnobotany and biodiversity conservation in the Niger Delta, Nigeria. *International Journal of Botany*, 6: 310-322
Venkatesh, K.R. and Chauhan, S. (2011). Biochemical constituents of different parts of mulberry genotypes in *International Journal of Agriculture Sciences*, 3: 90-96
Verheij, E.W.M. and Coronel, R.E. (1991). *Plant resources of South-East Asia: edible fruits and nuts*. Pudoc-DLO, Wageningen the Netherlands.
Vincetti, B.; Eyzaguirre, P. and Johns, T. (2008). The nutritional role of forest plant foods for rural communities. In: *Health and Forests: a global overview of issues practice and policy*, ed. Coler, C.J.P. London, UK. Pp 63-96
Wang, G., Zhou, G. and Yang, L. (2003). Distribution, species diversity and life-form spectra of plant communities along an altitudinal gradient in the northern slopes of Qilianshan Mountains, Gansu, China .*Vegetation*, 165: 169-181
Young, A.J. and Lowe, G.M. (2001). Antioxidant and prooxidant properties of carotenoids. *Archives of Biochemical and Biophysics*, 385: 20-27
Zatylny, A.M.; Ziehl, W.D., St-Pierre, R.G. (2005). Physicochemical properties of fruit of chokecherry (*Prunus virginiana* L.), high bush cranberry (*Viburnum trilobum* Marsh.), and black currant (*Ribes nigrum* L.) cultivars grown in Saskatchewan. *Canadian Journal Plant Science*, 85: 425-429
Zemede, A. and Mesfin, A. (2001). Prospects for sustainable use and development of indigenous food plants in Ethiopia. *Economic Botany*, 55: 47-62
Zhao, C.M., Chen, W.L., and Tian, Z.Q. (2005). Altitudinal pattern of plant species diversity in Shennongia Mountains, Central China. *Journal of Integrative Plant Biology*, 1431-1449