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Nutritional profiling of two underutilized wild edible fruits *Elaeagnus pyriformis* and *Spondias pinnata*

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ABSTRACT

Many wild and underutilized edible fruits belonging to different families are found in the remote North- Eastern state of Manipur, India. These fruits may serve as natural source of food supplement to the human beings. Two wild edible underutilized fruits *Elaeagnus pyriformis* of Elaeagnaceae and *Spondias pinnata* of Anacardiaceae families were found to have very high nutrient compositions suitable for human health with medicinal properties. Standard protocols for biochemical analysis were employed for nutrient analyses. *Spondias pinnata* has showed potential contents of antioxidant activity (IC_{50} 518µg ml^{-1}), ascorbic acid (87mg$100g^{-1}$) and protein of 18.20mg$100g^{-1}$. While total soluble sugar, reducing sugar and non- reducing sugar was high in *Elaeagnus pyriformis* with values of 33.9mg$100g^{-1}$, 17.8mg$100g^{-1}$ and 16.1mg$100g^{-1}$ respectively. Significant correlation was observed between ascorbic acid and antioxidant activity of both the fruits. Slightly acidic of medium pH with 77.23% and 82.02% moisture content was recorded in *Spondias pinnata* and *Elaeagnus pyriformis* respectively. The work is a brief highlight on these two wild fruits to generate information about their favorable nutritive values as compared to well known fruits.

Key words: *Elaeagnus pyriformis, Spondias pinnata*, underutilized fruits, nutritive value.

Elaeagnus pyriformis of Elaeagnaceae family, commonly known as silverberry or Oleaster and locally known as *Heiyai* in Manipur, grows wild in the hills and valleys of Manipur state of India. *Elaeagnus pyriformis* found in other states such as Mizoram, Sikkim and Arunachal Pradesh is used as traditional healing medicine by the local tribes and as animal feed (Sundriyal and Sundriyal, 2003; Chandra Prakesh Kala, 2005; Lalfakzuala *et al*., 2007). The fruit of many members of this genus are considered to be very rich source of vitamins, minerals, flavanoids and other bio- active compounds. It is also a fairly good source of essential fatty acids (Chopra *et al*., 1986).

Elaeagnus pyriformis is a straggling woody deciduous shrub and sometimes spiny. Leaves are petiolate measuring 8 mm to 1 cm, length 4 - 13.5 × 1.3-4.6 cm, oblanceolate, acuminate, entire, coriaceous, glabrous above, lower surface leave is abaxial, surface covered with silvery white lepitode. Flowers are hermaphrodite and pollinated by bee, 10-12 mm long, pedicel short, 3-5 mm long and flower during September-December. Fruits are 7-10 mm long, yellowish to red at repining. This shrub is mostly grown in semi wild condition in the backyard gardens of the region. *Heiyai* requires well- drained soil and can be grown in nutritionally poor acidic soil. It can grow in dry as well as in moist soil and can tolerate drought. This species has a symbiotic relationship with nitrogen fixing bacteria.

Spondias pinnata commonly known as hog-plum are locally known as *Heining* in Manipur.

The fruit of this flowering plant of the family Anacardiaceae is product of glabrous tree with a characteristic of pleasant smell of wood. They are distributed in Andaman Island, Sri Lanka, Myanmar, Thailand, Malaysia, China and Indian Himalayas (Anoop and Chetna, 2009). In India they are distributed throughout the Western Ghats and cultivated in Punjab, Maharashtra, Bengal and Assam at elevation of 1500 m above sea level for edible purpose .They are deciduous or semi-evergreen trees with 9 to 25 m height .The leaves are spirally arranged, compound, pinnate, imparipinnate, alternate, petioles measuring 5 to 15 cm, leaflets 4-11 pairs with one terminal measuring length 6-15 × 2.5-5.3 cm, elliptic to oblong, apex acuminate, base obliquely rounded, margin entire (or serrate- crenate in young leaves). The inflorescence panicles are axillary with white flower, polygamous, sub sessile and flower in Jan- March. The fruit is a drupe, single seeded measuring 5 to 6 cm long and yellow orange at ripening. The unripe fruits are often used for making pickles and matured at October - December.

Spondias pinnata tree is being used for treating many diseases by tribal people of the country. Ethno medicinally, the fruit plant is used in Asian countries for treatment of various cancerous diseases. It is also used as refrigerant, tonic, treatment of reticular and muscular rheumatism, dysentery, diarrhea, ear ache, stomach pain, for regulation of menstruation, biliousness etc. (Anoop and Chetna, 2009) .

In Manipur, *Elaeagnus pyriformis* and *Spondias pinnata* fruits are consumed oblivious to their nutritive values. People of the region are not aware of the important pharmacological aspects of these fruit plants explored in various countries. The present investigation was undertaken to study the nutritive values of these fruits which grow in wild condition in Manipur to bring them into mainstream utilization as common fruits and popularize them as a potent source of phytochemical.

Materials and Methods

Fruit samples were collected from the valley forest of Manipur and identified at Botanical Survey of India (BSI), Eastern Regional Central, Woodlands, Laitumkhrah, Shillong, Meghalaya, India. The study was carried out during 2008-2011. For bio-chemical analysis the fruits were washed thoroughly and dried at 50 to 60°C in hot air oven. Fresh fruit samples were taken for ascorbic acid (vitamin C) estimation. Vitamin C was determined titrimetrically by the modified Tillmann's method (Pauel and Pearson, 1967) using 2, 6-dichlorophenol, indophenol reagent. In all cases samples for analysis were prepared in 4% oxalic acid solution for giving end point as pink colour. For pH determination, fruits were finely minced, pH meter was calibrated with standard buffer solution and then pH was determined.

Carbohydrate protein estimations

The total soluble sugar content was determined by anthorne method (1951), reducing sugar content by Nelson- Somogy's (1944) and non-reducing sugar content was determined by Malhotra and Sarkar, (1979). The phosphate buffer soluble protein was estimated following Lowery *et al*. (1951) method .Moisture content of the fruits was estimated by AOAC, (1970) method.

Antioxidant activity of fruit

The antioxidant activity was examined by the chemical assays of DPPH (Krings and Berger, 2001) using ascorbic acid as standard.

The reaction mixture consisted of .004% of DPPH methanol with 50- 250 µg ml-1 of the fruits extracts in methanol was incubated for 30 min at dark at 37°C and absorbance was read against a blank at 517 nm. Percentage inhibition was determined by comparison with a methanol treated control group. The percentage of DPPH decoloration was calculated as follows:

% DPPH decoloration = (1 - O.D. Sample/ O.D. Control) × 100

The degree of decoloration indicates the free radical scavenging efficiency of the fruits and the IC_{50} value shows the potential of antioxidant activity which was correlated by plotting graph of concentration sample vs the % of DPPH inhibition.

Pearson's coefficient correlationship was implemented between Vitamin C and

antioxidant activities of both the fruits. All the above experiments were repeated three times and presented as a mean of three determination ± SD of three biological samples.

Results and Discussion

The findings of bio-chemical analyses of both the fruits are presented in Table 1. The vitamin C content of *Spondias pinnata* (Fig. 1) was 87.45 ± 12.7 mg 100 g^{-1} exhibiting high vitamin C content and simultaneously the antioxidant activity was also high having lower IC_{50} value of 518.8 ± 1.7 µg ml^{-1}. The low IC_{50} value reflects the antioxidant activity of a fruit. The protein content was found reasonable with 18.92±1.992 mg 100g^{-1} whereas less amount of carbohydrate was recorded in the fruits. Acidic value of pH (3.92 ± 0.10) and 82.02% of moisture content was recorded.

The vitamin C and antioxidant activity of *Elaeagnus pyriformis* (Fig. 2) were found to be 20.11± 4.8 mg100 g^{-1} and IC_{50}867.8 ± 25.3 µg ml^{-1} respectively. The protein, total soluble sugar, reducing sugar and non-reducing sugar contents were found to be 5.28 ± 0.10 mg 100g^{-1}, 33.93 ± 1.8 mg 100g^{-1}, 17.83 ± 0.99 mg 100g^{-1} and 16.1 ± 2.16 mg 100g^{-1} respectively ,which indicates that this fruit is a good source of sugar. Acidic value of pH (3.96 ± 0.43) and 77.23% of moisture content was observed.

Correlation analysis of vitamin C and antioxidant activity of both the fruits exhibited very high and significant relationship having 'r' values as -0.924 in *Spondias pinnata* and -0.896 in *Elaeagnus pyriformis*.

(a) (b)

Fig. 1. (a) Matured fruits of *Spondias pinnata* (L.f) Kurz; (b) Flower of the fruit plant

(a) (b)

Fig. 2. (a) Matured fruits of *Elaeagnus pyriformis* .HK.f; (b) Flower of the fruit plant

Ascorbic acid profile

Traditionally wild edible fruits have been serving as good source of protein, carbohydrate and vitamin requirements for the local residents

Table 1. Biochemical profile of underutilized wild fruit *Spondias pinnata* (L.f) Kurz and *Elaeagnus pyriformis* HK.f

Biochenical parameters	*Spondias pinnata* (Local name- Heining)	*Elaeagnus pyriformis* (Local name-Heiyai)
Asorbic acid mg 100g-1 (F.W)	87.45 ± 12.7	20.11±4.8
Antioxidant IC_{50} µg ml^{-1}	518.8± 1.7	867.8±25.3
Protein mg 100g^{-1}	18.92± 1.9	5.28± 0.10
Total sugar mg 100g^{-1}	4.35 ± 0.11	33.93±1.8
Reducing sugar mg 100g^{-1}	1.51 ± 0.25	17.83± 0.99
Non-reducing sugar mg 100g^{-1}	2.83± 0.26	16.10±2.16
pH	3.93±0.10	3.96±0.43
Moisture % content	77.23 ± 021	82.02±0.78
Correlation between Vit. C & antioxidant activity (p<0.0 5)	-0,924	-0.896

FW- fresh weight

to a great extent. Earlier reports indicated 12.04 mg 100 g^{-1}, 13.8 - 16.9 mg 100 g^{-1} , 4.8-7.2 mg 100 g^{-1} and 0.072 mg 100 g^{-1} of vitamin C in the *Elaeagnus* species found in Sikkim, Pakistan and Meghalaya (Sundriyal and Sundriyal, 2001; Sabir and Riaz, 2005) which were quite low as compared to our investigation. This variation may be a result of adaptation of plants in different environmental soil conditions or the harvesting of fruits at different time or the climatic factors and the species variation (Sabir and Raiz, 2005).Vitamin C content in *Spondias pinnata* has been reported by Sundriyal and Sundriyal (2001) as 216.50 mg 100 g^{-1} from Sikkim Himalaya region and 38 mg 100 g^{-1} in Nigeria (Owolarafe *et al*., 2006) which suggests that our estimates are quite low as compared to the Sikkim species but very high as compared to the Nigerian species which may be due to the breakdown of starch to glucose as vitamin C increases at maturity or ripening (Ighodalo *et al*., 1991). The vitamin C content of *Spondias pinnata* fruit found in Manipur indicated a promising value and assumed that the species is quite nutritious and good for consumption by human being for health worth as it has higher vitamin C content than well known fruits like orange, grape, lemon etc, as shown in Table 2. (Ighodalo *et al*., 1991). Besides, the differences in ascorbic acid contents of wild fruit *Spondias pinnata* and *Elaeagnus pyriformis* from Manipur origin could possibly be also attributable to genetic traits or lack of certain elements in soil interfering with proper absorption of organic acids by the plant roots. Since the release of nutrients in soils is dependent mostly on soil pH and parental sources of soil nutrients, these may have an effect on the available amounts of nutrients in soils leading variations in the nutritional profile of the fruits.

Antioxidant activity

Antioxidants provide chemical protection for biological systems against harmful effects of reaction or processes that cause excessive oxidation, protein and DNA damage and cell death (Arnao *et al*., 2001). Primary antioxidant properties are generally measured by DPPH assays (expressed as IC_{50}). The DPPH assay measures the ability of the fruit extract to donate hydrogen to the DPPH radical resulting in bleaching of the DPPH solution. The greater the bleaching action higher the antioxidant activity AEAC value (Ascorbic Acid equivalent antioxidant capacity), and this is reflected in lower IC_{50} value. Same trends in our samples of *Spondias pinnata* and *Elaeagnus pyriformis* of lower IC_{50} 518.8 µg ml^{-1} and IC_{50} 867.8 µg ml^{-1} respectively were exhibited. The degree of discoloration indicates the scavenging potential of the sample antioxidant resulting in a decrease in absorbance at 517nm. Hence, the more rapidly the absorbance decreases, the more potent the antioxidant activity of the extract (Sujata *et al*., 2011). Close conformity with the same species has been reported from the present finding in *Spondias pinnata* (Bibhabasu *et al*., 2008). It is known that fruit ripening continues after harvest and this process leads to significant changes in the contents of the antioxidant (Lim *et al*., 2006) which supported our finding in both the fruits. In an independent study on wild fruits of Manipur, (collection site not given) IC_{50} 102.79 µg ml^{-1} of *Spondias pinnata* and IC_{50} 105.43 µg ml^{-1} of *Elaeagnus umbellate* (Haripyaree *et al*., 2010) was reported earlier which is quite higher than the values obtained in this investigation. This could be due to difference in collection site of the fruits as various pH of soil subsists in the state or analysis done using different varieties. Further study by collecting various fruit samples from different regions of Manipur will give a clear picture.

Correlation analysis between vitamin C and antioxidant activity of Spondias pinnata and Elaeagnus pyriformis

Many fresh fruits have been found to contain natural antioxidants, mainly ascorbic acid and phenolic compounds. Ascorbic acid is easily oxidized, and the majority of its functions *in vivo* depend on this property. Ascorbic acid (vitamin C) also plays a role in detoxifying by-products of respiration and donates a hydrogen atom to a free radical, and thus prevents these reactions from occurring (Scartezzini *et al*., 2006) . It can be observed from the analysis that a very strong and significant correlationship of ascorbic acid

with antioxidant activity exists in the fruit extract of *Spondias pinnata* and *Elaeagnus pyriformis* having 'r' values as -0.924 and -0.896 respectively, indicating that antioxidant activities in the fruits are highly correlated with vitamin C contents. Similar results were obtained in guava fruits and various wild fruits which are rich sources of ascorbic acid content. (Lim *et al*., 2006; Sushma and Shantibala, 2010).

Protein, carbohydrates, pH and moisture contents

The quality of protein in plant tissue may be as important as its quantity in meeting protein requirements and according to our investigation *Elaeagnus pyriformis* contain valuable protein as that of *Elaeagnus umbellata* berry, showing rich protein content of 5.1% (Sabir and Riaz, 2005) and *Elaeagnus latifolia* showing 7.80% (Sundriyal and Sundriyal, 2001), which proves this particular fruit to be rich in protein and thus consumption should be encouraged. The protein content of *Spondias pinnata* is very high as compared to the species found in Nigeria containing 0.93% (Owolarafe *et al*., 2006) and 0.70% in Sikkim region of India. Because of its high protein content, these fruits can be used in preparation of cakes and biscuits for diabetic patients too (Agunbiade and Olanlokun, 2006).Thus, *Spondias pinnata* can be treated as very efficient source of protein and must be consumed as food stuff. In Table 2, a relative comparison of protein and vitamin C content of these two fruits with well known common fruits are shown.

Table 2. Relative Vitamin C and protein content of *Spondias pinnata* and *Elaeagnus pyriformis* with selected well known fruits.

Common fruits	Vitamin C (mg/100 g)	Protein
Grape	10	0.6
Apricot	10	1.4
Plum	10	0.7
Watermelon	10	0.6
papaya	60	0.5
Banana	9	1.3
Strawberry	60	0.8
Orange	53	0.9
apple	48	0.3
Lemon	53	1.1
Pineapple	53	0.5
Spondias pinnata	87.45	18.92
Elaeagnus pyriformis	20.11	5.28

Soluble carbohydrates are the major nutritional attribute in the pulp of most vertebrate - dispersed fruits. The high amount of total soluble sugar, reducing sugar and non-reducing sugar present in *Elaeagnus pyriformis* makes it good quality fruit as well as its use in other food products like jams, jellies, chocolates etc as indicated by (Sabir and Riaz, 2005). Thus the fruit can be supplemented as source of energy since, it has good source of carbohydrates.

The amount of acids in fruits may be used as an index in identifying fruit maturity stages and it could possibly be one of the major analytical measurements on flavor quality. It may be used as indicators in determining its full ripening age for harvesting. The organic acids could provide an authenticity of fruit materials for making juices and beverages. Fruit flavor and taste also depends greatly on a balance between sugars and acids present in the ripened fruit (Moing *et al*., 2003). Analysis of a medium (pH 3.96 and 3.92) were recorded in *Elaeagnus pyriformis* and *Spondias pinnata* which suggested that the fruit samples are slightly acidic. The medium pH value was due to corresponding decrease in total acids of the pulp whereas, the pH of *Spondias pinnata* was less as compared with *Spondias mombin*, another species found in Nigeria with 5.6 values (Owolarate *et al*., 2006). This indicates that the *Spondias* species found in Manipur is acidic compared with Nigerian species. The acidic nature of *Spondias pinnata* from the region could be due to the persistent acidity of soil.

The moisture content of *Elaeagnus pyriformis* was higher than *Emblica officinalis* (81%) and fig (80.80%) and on par with *Zizyphus mauritiana* (82%), *Elaeagnus latifolius* species (87.3%), *Chinese gooseberry* cultivar *Allison* (84.40%), litchi (84.30%), guava (85.30%) and apple (85.90%) (Sundriyal, 1999). The moisture content of *Spondias pinnata* as (77.23%) was compatible for the same in different pomegranate cultivars *viz*. Khog × Jalore seedless (79.6%), Ganesh × Khog

(79.9%) and Khog × Ganesh (79.8%) (Dheeraj and Meena, 2003). The decrease in moisture content of the fruits might be due to continuous moisture loss by evaporation and respiration in fruits.

Information is lacking on the chemical composition, physical characteristic, pharmaceutical and socio-economic development of these two wild edible fruits in Manipur. The present investigation revealed their potential as important alternatives of the regular cultivated fruit crops of Manipur. This information will also contribute in recognizing their nutritive potentials and encourage in establishing *Elaeagnus pyriformis* and *Spondias pinnata* as suitable plant of economic importance and as good dietary supplement. In conclusion out of both the fruits *Spondias pinnata* was found to be richer in micro nutrient Vitamin C and antioxidant content thereby showing an edge over *Elaeagnus pyriformis* in nutritional quality.

REFERENCES

A.O.A.C. 1970. Official method of analysis (10th Ed.), Association of Official Analytical Chemists, Washington D.C.

Agunbiade, S.O. and Olanlokun, J.O. 2006. Evaluation of some nutritional characteristics of Indian Almond (*Prunus amygdalus*) nut. *Pak. J. Nutr.* **5**(4) : 316-318.

Anoop, B. and Chetna, B. 2009. Importance and problems in Natural Regeneration of *Spondias pinnata. Rpt. and Opinion* **1**(5) : 12-13.

Arnao, M.B., Cano, A. and Acosta, M. 2001. The hydrophilic and lipophilic contribution to total antioxidant activity. *Food Chem.* **73** : 239-244.

Bibhabasu, H., Santanu, B. and Nripendranath, M. 2008. Antioxidant and free radical scavenging activity of *Spondias pinnata. BMC Compl. Alter. Medicine* **8** : p. 63.

Chandra Prakesh Kala, 2005. Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. *J. Ethnobiol. Ethnomed.* **1** : 1-8.

Chopra, R.N., Nayar, S.L. and Chopra, L.C. 1986. Glossary of Indian medicinal plants, Council of Scientific and Industrial Research, New Delhi.

Dheeraj, S. and Meena, K.K. 2003. Quality assessment of different arid zone pomegranate cultivars. *Ann. Agril. Res.* **24** : 276-282.

Dubois, M., Giller, K., Hamilton, J.K., Robers, P.A. and Smith, F. 1951. Colorimetric method for determination of sugar. *Nature* **186** : p. 167.

Haripyaree, A., Guneshwor, K. and Damayanti, M. 2010. Evaluation of Antioxidant properties of some wild edible fruit extracts by cell free assays. *EJEAFChe Electronic J. Environ. Agril. Food Chem.* **9**(2) : 345-350.

Ighodalo, C., Eromosele, Catherine, O., Eromosele, Daniel, M. and Kuzhkuzha, 1991. Evaluation of mineral elements and ascorbic acid content in fruits of some wild plants. *Plant. Fd. Human Nutr.* **41** : 151-154.

Krings, U. and Berger, R.G. 2001. Antioxidant activity of some roasted foods. *Fd. Chem.* **72** : 223-229.

Lalfakzuala, R., Lalramnghinglova, H. and Kayang, H. 2007. Ethnobotanical usages of plants in Western Mizoram. *Ind. J. Trad. Knowl.* **6**(3) : 486-493.

Lim Yau Yan, Lim Theng Teng and Tee Jing Jhi. 2006. Antioxidant properties of guava fruit: Comparision with some local fruits. *Sunway Academic J.* **3** : 9-20.

Lowery, O.H., Rosebrough, N.J., Far, A.L. and Randall, R.J. 1951. Protein measurement with the Folin-phenol reagent. *J. Biol. Chem.* **193** : 265-275.

Malhotra, S.S. and Sarkar, S.K. 1979. Effects of Sulphur dioxide on sugar and free amino acid content of pine seedling. *Physiol. Plant* **47** : 223-228.

Manju, Sundriyal and Sundriyal, R.C. 2001. Wild Edible plants of the Sikkim Himalaya : Nutritive values of Selected species. *Econ. Bot.* **55**(3) : 377-390.

Mapson, L.W. 1970. Vitamins in fruits, In: The Biochemistry of Fruit and their products, Vol.1.Hulme AC(ed). Academic Press London, p. 369.

Moing, A., Poessel, J.L., Svanella Dumas, L., Loonis, M. and Kervella, J. 2003. Biochemical basis of low fruit quality of *Prunus davidiana*, a pest and disease resistance donor for peach breeding. *J. Am. Soc. Hort. Sci.* **128**(1) : 55-62.

Nelson, N. 1944. A photometric adaptation of the Somogy's method for the determination of glucose. *J. Biol. Chem.* **153** : 375-380.

Owolarafe, O.K., Adebooye, O.C. and Adegbenjo, O.A. 2006. Physical properties and food value of *Spondias mombin* L. an underexploited fruits of Nigeria. *J. Fd. Sci. Technol.* **43**(6) : 626-628.

Pauel, G.and Paerson M.N.1967. The Vitamins, 2nd(edn.), **vii** : 31-32.

Sabir, S.M. and Riaz, K. 2005. Morphological, biochemical and elemental analysis of a *Elaeagnus umbellata*, a multipurpose wild shrubs from Pakistan. *J. Appl. Hort.* **7**(2) : 113 -116.

Samant, S.S. and Dhar, U. 1997. Diversity, organism and economic potential of wild edible plants of Indian Himalaya. *Int. J. Sustain. Deve. World Ecol.* **4** : 179-191.

Scartezzini, P., Antognoni, F., Raggi, M.A., Poli, F. and Sabbioni C. 2006. Vitamin C content and antioxidant activity of the fruit and of the ayurvedic preparation of *Emblica officinalis Gaetrn. J. Ethnopharmacol* **104** : 113-118.

Sujata, R., Valvi, V., Rathod, S.,and Yesane, D.P. 2011. Screening of three wild edible fruits for their antioxidant potential. *Curr. Bot.* **2**(1) : 48-52.

Sundriyal, M.1999. Distribution, propagation and nutritive value of some wild edible plants in the Sikkim Himalaya. Thesis, H.N.B. Garhwal University, Srinagar, India.

Sundriyal, M. and Sundriyal, R.C. 2003. Underutilized edible plants of the Sikkim Himalaya: Need for domestication. *Curr. Sci.* **85**(6) : 731-793.

Sushma, K.H. and Shantibala, Devi, G.A. 2010. Determination of antioxidant activity and Vitamin C of some wild fruits of Manipur. *The Bioscan.* **5**(3) : 501-504.