Nutritional profiling of two underutilized wild edible fruits

_Elaeagnus pyriformis_ and _Spondias pinnata_

Sushma Khomdram¹, Shyamananda Arambam² and Guruaribam Shantibala Devi¹

¹Life Sciences Department, Manipur University, Canchipur-795 003 (Manipur)
²ICAR Research Complex for N.E.H. Region, Mizoram Centre, Kolasib-796 081 (Mizoram)
e-mail: sam.tamo@yahoo.com; samarambam@yahoo.in; guruaribam_shantibala@rediffmail.com

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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 (IC₅₀ 518 μg ml⁻¹), ascorbic acid (87mg100g⁻¹) and protein of 18.20mg100g⁻¹. While total soluble sugar, reducing sugar and non-reducing sugar was high in _Elaeagnus pyriformis_ with values of 33.9mg100g⁻¹, 17.8mg100g⁻¹ and 16.1mg100g⁻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 x 1.3-4.6 cm, oblanceolate, acuminate, entire, coriaceous, glabrous above, lower surface leaf is abaxial, surface covered with silvery white lepitude. 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 anthrone 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 = \( (1 - \text{O.D. Sample/ O.D. Control}) \times 100 \)

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 correlation 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 IC₅₀ value of 518.8 ± 1.7 μg ml⁻¹. The low IC₅₀ 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 IC₅₀ 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'

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

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

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

<table>
<thead>
<tr>
<th>Biochemical parameters</th>
<th><em>Spondias pinnata</em> (Local name- Heining)</th>
<th><em>Elaeagnus pyriformis</em> (Local name-Heiyai)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascorbic acid mg 100g⁻¹ (F.W)</td>
<td>87.45 ± 12.7</td>
<td>20.11±4.8</td>
</tr>
<tr>
<td>Antioxidant IC₅₀ μg ml⁻¹</td>
<td>518.8± 1.7</td>
<td>867.8±25.3</td>
</tr>
<tr>
<td>Protein mg 100g⁻¹</td>
<td>18.92± 1.9</td>
<td>5.28± 0.10</td>
</tr>
<tr>
<td>Total sugar mg 100g⁻¹</td>
<td>4.35 ± 0.11</td>
<td>33.93± 1.8</td>
</tr>
<tr>
<td>Reducing sugar mg 100g⁻¹</td>
<td>1.51 ± 0.25</td>
<td>17.83±0.99</td>
</tr>
<tr>
<td>Non-reducing sugar mg 100g⁻¹</td>
<td>2.83±0.26</td>
<td>16.10±2.16</td>
</tr>
<tr>
<td>pH</td>
<td>3.93±0.10</td>
<td>3.96±0.43</td>
</tr>
<tr>
<td>Moisture % content</td>
<td>77.23 ± 021</td>
<td>82.02±0.78</td>
</tr>
<tr>
<td>Correlation between Vit. C &amp; antioxidant activity (p&lt;0.05)</td>
<td>-0.924</td>
<td>-0.896</td>
</tr>
</tbody>
</table>

FW- fresh weight

Traditionally wild edible fruits have been serving as good source of protein, carbohydrate and vitamin requirements for the local residents.
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 \(\mu\)g ml\(^{-1}\) and IC\(_{50}\) 867.8 \(\mu\)g ml\(^{-1}\) respectively were exhibited. The degree of discoloration indicates the scavenging potential of the sample antioxidant resulting in a decrease in absorbance at 517 nm. 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 \(\mu\)g ml\(^{-1}\) of Spondias pinnata and IC\(_{50}\) 105.43 \(\mu\)g 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 correlation 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.

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 latifolia* 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

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

<table>
<thead>
<tr>
<th>Common fruits</th>
<th>Vitamin C (mg/100 g)</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape</td>
<td>10</td>
<td>0.6</td>
</tr>
<tr>
<td>Apricot</td>
<td>10</td>
<td>1.4</td>
</tr>
<tr>
<td>Plum</td>
<td>10</td>
<td>0.7</td>
</tr>
<tr>
<td>Watermelon</td>
<td>10</td>
<td>0.6</td>
</tr>
<tr>
<td>Papaya</td>
<td>60</td>
<td>0.5</td>
</tr>
<tr>
<td>Banana</td>
<td>9</td>
<td>1.3</td>
</tr>
<tr>
<td>Strawberry</td>
<td>60</td>
<td>0.8</td>
</tr>
<tr>
<td>Orange</td>
<td>53</td>
<td>0.9</td>
</tr>
<tr>
<td>Apple</td>
<td>48</td>
<td>0.3</td>
</tr>
<tr>
<td>Lemon</td>
<td>53</td>
<td>1.1</td>
</tr>
<tr>
<td>Pineapple</td>
<td>53</td>
<td>0.5</td>
</tr>
<tr>
<td><em>Spondias pinnata</em></td>
<td>87.45</td>
<td>18.92</td>
</tr>
<tr>
<td><em>Elaeagnus pyriformis</em></td>
<td>20.11</td>
<td>5.28</td>
</tr>
</tbody>
</table>
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 a suitable plant of economic importance and as a 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


