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Nutritional potential of *Salacia fruticosa* Wall. ex M.A. Lawson: An unexplored wild edible fruit plant

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Abstract
In the current study, detailed nutritional composition of the wild edible fruit, Salacia fruticosa Wall. ex M.A. Lawson, consumed by Kanis, an indigenous tribal community residing in the Agasthyamala Biosphere Reserve, Southern Western Ghats was determined for the first time. All values were determined on fresh weight basis. Results indicated that the fruits have a high moisture content of 87.4 ± 0.44/100g while the carbohydrate content observed was 10.03 ± 0.20g in 100g of edible portion. The energy value was 39kcal/100 g. The ascorbic acid and Vitamin E composition noted were 60.94 ± 2.54mg and 0.18 ± 0.008 mg/100g respectively. Potassium was the most abundant mineral element (26mg/100g) analyzed. The current study emphasized the fact that this minor fruit is a potential source of the bioactive liposoluble pigment, β carotene, and the mean value observed was 70µg /100 g which is well comparable with many commercial fruits.

Keywords: *Salacia fruticosa* Wall. ex M.A. lawson, nutritional composition, Kanis, wild edible fruits, Agasthyamala biosphere reserve

1. Introduction
Wild edible fruits (WEF) are often known for their significant role in ensuring food and nutritional security to the rural or indigenous communities in all geographical regions across the globe. Being an essential component in the diet of ethnic populations as a food and nutrient supplement, WEFs contribute largely to enhance their health, household food security, livelihoods and sustainable development. These fruits species, particularly those currently identified as 'underutilized' have been recognized to have rich nutritional value as commercial fruit crops. Many reports state they show even nutritional superiority over the cultivated ones [1].

WEFs are a major component of the 'Non Wood Forest Products' (NWFP), a broad "group" of products that encompass all plant and animal forest resources excluding timber, proposed by forestry department of Food and agriculture organization (FAO) of the United Nations [2]. Even though, distinguishing certain wild edible plants, including fruits from the cultivated ones is not easy as they are occasionally grown as cultivated too, Dufour & Wilson [3] defined wild edible plants as 'plants those are neither managed nor cultivated, but available from their natural habitat and used as sources of food. Some authors often prefer the terms 'noncrop food' [4] and 'noncultivated' plants [5] instead of the more common term, 'wild' food plants.

Fruits, irrespective of their habit and habitat variations, are an excellent source of both macro and micro nutrients and playing an important role in a nutritionally balanced diet, particularly contain carbohydrates, protein, vitamins, minerals and some other phytonutrients with considerable health benefits [6]. Mostly they supply rapidly absorbed sugars which are very sweet and have relatively high calorific values. The nutritional value of fruits lies mostly in their micro nutrient content and dietary fibers. They are rich in several minerals including potassium, iron, calcium, manganese, phosphorous and magnesium. Fruits generally contain a large quantity of vitamins such as vitamin C, provitamin A in the form of β-carotenoids and to a lesser extend vitamin E and B group of vitamins. Scientific reports indicate consumption of fruits reduces the risk of several diseases like diabetes, cancer, coronary heart disease, neurodegenerative ailments and aging as they act as an optimal mix of compounds such as polyphenols, anthocyanins, carotenoids and other flavonoids along with antioxidant vitamins C and E, which can modify the metabolic activation of carcinogens [7]. They also maintain the pH of the body normal as they are rich in precursors to bicarbonate ions which serve to buffer acidity [8].

Living close to forests, the tribal communities all over the planet hold great understanding about the wild edible plants. Since late 1980's, a growing interest in the studies on the use of WEFs in tropical forests have been taken up especially to explore their nutritional features [9]. Increased consumption of fruits is promoted extensively as new reports frequently come out on the health benefits and nutrient potential provided by them [10]. However, the coverage of wild fruits in all existing nutrient databases is very limited, compared with the numbers of fruits consumed. The knowledge on these plants is also the part of an important strategy that is now being linked to the conservation of biodiversity.

Salacia fruticosa Wall. ex M.A. Lawson, locally known as *Korandi*, belongs to the family Celastraceae (Fig.1). The plant is endemic to Western Ghat ranges of India and mainly seen in the states Tamil Nadu, Kerala and Karnataka. The fruit of this liana, found in evergreen forests ascending to an altitude of 1600 m usually on the steep slopes, is widely consumed by *Kani*s, the primitive indigenous tribal community residing in the Agasthyamala Biosphere Reserve (ABR), Southern Western Ghats [11]. Their leaves are simple, opposite, entire estipulate, 2-3 cm broad and 4-8 cm long. From the axil of leaves, cyme inflorescence of tiny, bisexual and dark orange coloured flowers with mild fragrance are formed. Stamens three, inserted on the inner margin of the disc. Ovary conical and three celled with a short style. Fruit of *S. fruticosa* is a broadly ovoid, sub globular indehiscent berry with 1 - 4 seeds. They are usually formed as solitary or a bunch with 2 - 4 fruits. It has smooth and thick rind and each fruit weighed 5 - 10 gm. It is dark green when young which turns to yellow to orange and the fully ripen fruit is dark red in colour. Within the rind, a delicate yellowish orange coloured juicy aril completely covers the seeds. It is sweet in taste and bears an exceptionally pleasing aroma. There is not much information available in the literatures on nutritional constituents of this lesser known fruit until now. The present ethno botanical investigation concerned with these aspects of *S. fruticosa* fruit, therefore deserves a special attention.

Fig 1: Habit of *Salacia fruticosa* Wall. ex M.A. Lawson

2. Materials and Methods

2.1. Specimen and Data collection

The participatory rural appraisal (PRA) method [12] was adopted as the tool for gathering ethno botanical information from the *Kani* people regarding the plant. The participatory approach, though difficult to quantify, provided a valuable insight into the multiple meanings, dimensions and experiences of local people with the WEF. During field survey, collection of the plant and data related to it, informants from the tribal settlements were accompanied. The plant samples were identified with the help of published, authentic literature. Length and diameter were measured as an average of randomly selected 10 fruits with the help of a vernier calliper and expressed in centimetres. Ten randomly selected fruits were also weighed using an electronic weighing balance; range and the average of weights are expressed in grams. Unblemished fully ripened fruits which are free of bruises collected were cleanly washed, placed in a plastic box, kept on ice and transported to the laboratory immediately. In the lab, fruits were washed under tapwater, then rinsed in distilled water three times and stored at 4ºC for further analysis. Approximately 200 gram of fruit was collected and the edible portions were separated for the evaluation of total carbohydrate, total protein, and vitamins. One portion was dried in a hot air oven for 24 hours at 45ºC. Then the dried fruits were ground well and kept in an air tight bottle for the evaluation of mineral composition.

2.2. Nutritional evaluation

Nutritional composition of fruits samples was determined on fresh weight basis. The sample was scrutinized for a total of 15 parameters which include proximates, vitamins, minerals and other phytonutrients. The proximate composition including the moisture level was estimated as per the gravimetric method [13]. Total carbohydrates were estimated by the method given by Hedge & Hofreiter [14]. Total protein content was quantified using the method by Hartree – Lowry assay [15]. Crude fat (Total lipids) was determined by Bligh and Dyer's method [16]. Total energy was estimated by Atwater specific factor (ASF) system [17], a more refined energy conversion system based on the Atwater general factor. The vitamins C, and E were evaluated by as per methods given by Association of Analytical Chemists [18, 19]. Solid-liquid extraction method [20] with petroleum ether was used to estimate the amount of β carotene in the fruit. The minerals; Potassium (K), Magnesium (Mg), Calcium (Ca), Iron (Fe), Copper (Cu) and Manganese (Mn) in the sample prepared by either dry ashing or wet digestion, are quantitatively measured by atomic absorption spectrophotometer (AAS) at specific wavelengths [13].

3. Results and Discussion

The rich diversity of wild fruits in Indian tropics provides nutritious food to ethnic people living close to the forests. These indigenous groups are well aware of the seasonal availability of wild edible fruits they use. Known for the rich tradition of herbal medicinal practices, *Kani*s in ABR are well aware of the plant resources like wild edible fruits around them. Besides consuming the fruits, *Kani* tribal healers also use the roots of *S. fruticosa* Wall. ex M.A.Lawson as a substitute of the true raw drug, *Ekanayakam* extracted from *Salacia reticulata* Wight. in the treatment of Diabetes mellitus [21]. Apart from *Kani*s, tribal communities such as *Urali*, *Ulladan*, *Malappandaram* and *Malavedans* in Pathanamthitta district of Kerala are also reported to consume this fruit [22]. Prasad and Raveendran [23] has also reported its edible property. A health beneficiary glucosyl xanthone, Mangiferin [24] and the triterpenoids, friedelin, amyrin and sitosterol have been isolated from its root bark [25]. Extracts prepared from its various parts possess antioxidant and anti-hyperglycemic activities [26, 27].

3.1. Nutritional profiling

The nutritional composition of the *S. fruticosa* Wall. ex M.A. Lawson sample under investigation is summarised in Table 1.

3.1.1. Macronutrients

The moisture content in fresh fruits was relatively very high with value of 87.4g/100g. Foods stuffs of greater than 40g/100g of moisture are considered to be high moisture foods and they require better preservation as they are highly perishable in nature [28]. The total carbohydrate was noted in the fruit was 10.03g/100g of edible portion. The result suggested that carbohydrate content of this fruit is compared favourably with some popular *low-Carb* counter parts such as strawberry (7.68 g), water melon (7.55 g) and peaches (9.54) [29]. *Koranti* fruit is a relatively poor source of dietary protein. The fruit showed the protein content of 0.46 g/100 g. Compared to some protein rich tropical fruits such as guava (2.55 g) and dates (2.45 g), this value is much lesser, but well matched to many popular temperate cultivars like orange (0.70 g) and apple (0.26 g). Despite a very low fat content of 0.21 g/100g registered, as generally observed in most of the popular cultivated counterparts [30], the fruit exhibits better fat composition than that of the very popular fruits such as apple (0.17g) and pine apple (0.12g). The result showed this WEF provides the total energy of 39kcal per 100 gram of edible portion on fresh weigh basis. According to ASF system, an increase in any of the three proximate principles, carbohydrate, protein and fat or these factors together proportionately increases the energy value. Total ash, which is an index of mineral contents [31] recorded for the fruit was 0.24g/100g.

3.1.2. Micronutrients

Among the six minerals that have been analysed, potassium was the most abundant (26 mg/100g) among the macro elements, followed by calcium registered a value of 14 mg/100g which is relatively a common concentration in most of the domesticated fruits. Mg concentration observed was 12 mg/100 g. This result is at par with the Mg level of most of the commercial fruits [29]. Regarding the microelements, the quantitative data for the *Koranti* fruit indicated a good amount of manganese (0.354mg/100g), followed by iron (0.199 mg/100g) and copper (0.19 mg/100g). Manganese is a cofactor of hydrolase, decarboxylase, and transferase enzymes and is an essential element for the nervous systems [32]. As iron and copper are constituents of various important proteins and enzymes involved in macronutrient metabolism [33], this minor fruit can be included as a potential nutrient supplement in the regular diet.

The vitamins present in fruits make an important contribution to human nutrition, as they have specific functions in normal body performance. Tropical fruits are considered to be the main dietary sources of vitamin C, a water soluble antioxidant vitamin which protects the body against oxidative stress [34]. Ascorbic acid content observed in *S. fruticosa* was 60.94 mg per 100 gm of edible portion, a value very much par with many tropical fruits species (20-60 mg/100 g) [30]. *Koranti* fruit showed vitamin C content higher than that of fruits such as sapota (23.0 mg/100 g), pineapple (27.9 mg/100g) and mango (36.4mg/100g) whereas, closely akin to papaya (60.90 mg/100 g) and orange (53.20 mg/100 g). The vitamin E level (0.18 mg/100g), by contrast, was lower than that of guava, mango, and avocado (0.73, 0.90 and 2.07 mg/100 g, respectively) [29], which are generally known as fruits rich in vitamin E. In general, vitamin E in tropical fruits ranged between 0.1 mg and 1.8 mg/100 gram [30]. Having strong hydrophilic and lipophilic antioxidant properties, ascorbic acid and vitamin E [35] contribute significantly in enhancing the total antioxidant capacity of fruits.

Table 1: Nutritional Composition of Salacia fruticosa Wall. ex M.A. Lawson

Nutrient	Unit	Value/100 g
Proximates		
energy	kcal/kJ	39/165
Protein	g	0.46 ± 0.076
Total lipid (fat)	g	0.21 ± 0.008
Carbohydrate	g	10.03 ± 0.20
moisture	g	87.4 ± 0.44
ash	g	0.24
Minerals		
Potassium	mg	26
Calcium	mg	14
Magnesium	mg	12
Iron	mg	0.19
Copper	mg	0.199
Manganese	mg	0.354
Vitamins		
Vitamin C (Ascorbic acid)	mg	60.94 ± 2.54
Vitamin E (α-tocopherol)	mg	0.18 ± 0.008
Other		
Carotene-β (Pro-vitamin A)	µg	70 ± 1.90

The current study also emphasized the fact that the fruit of *S. fruticosa* Wall. ex M.A. Lawson is a good source of β carotene, a bioactive liposoluble pigment responsible for the yellow, orange and red colour of most of the fruits. In the body, beta-carotene is changed into an active form of retinol (vitamin A), the chief compound in the metabolism of the vision protein, opsin [36]. In comparison with USDA National Nutrient Database of commercial fruits [29], these values were at par with the fruits such as orange (71 µg/100 g), sapota (82 µg/100 g) and avocado (62 µg/100 g).

4. Conclusion

In the present study, a detailed chemical composition of the wild minor fruit, *S. fruticosa* was determined for the first time. Agricultural research in India has not given due emphasis to these group of fruits resulting limited literature on diversity, distribution, phenology and uses. The nutritional profile of the *S. fruticosa* indicates that this fruit is well compared with many popular commercial fruits and also underlines the fact that this lesser known fruit can be included in the diet as a new source of natural dietary supplement. Several studies states, consumption of minor WEFs, which are often referred to as "natural functional products" [37], has been associated with diverse health benefits such as prevention of heart disease, hypertension, certain forms of cancer and other degenerative or age-related diseases [38]. Owing to high degree of endemism, fragmented distribution, over exploitation for roots, poor fruit set and seed infestation, *S. fruticosa* is facing a serious threat in their habitats [39]. Threats are not only limited to WEF plants themselves; the traditional knowledge associated with these nutrient rich plants is also endangered. It is the need of the hour therefore to identify, evaluate, improve, propagate and cultivate these minor fruits for its sustainable use which can broaden human food diversity and also enrich the socio-economic status of the ethnic communities.

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