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Nutritional potential and ethnobotanical documentation of some wild edible fruits of family rutaceae

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Abstract
The aim of the present investigation is to survey and documentation of Ethnobotanical information and to determine the nutritional composition of wild edible fruits of family Rutaceae. The present study investigated the nutrional potential on different five selected plants from family rutaceae *viz*: *Atlantia recemosa*, *Clausena indica*, *Clausena anisata*, *Murraya paniculata* and *Toddalia asiatica.* Ethnobotanical observation from current study indicated that all the selected plants showed potent medicinal importance to cure various diseases like Rheumatism, paralysis, antimicrobial, anti-inflammation and many more. Results from proximate and mineral analysis were showed that highest amount of reducing sugar (1.86±0.0), total sugar (1.9±0.03) and energy content (117±0.74) were highly recorded in ripen fruit of *Toddalia asiatica*. Crude fat (8±0.20) and crude fiber (11.5±0.3) were highly found in ripen and unripen fruit of *Atlantia recemosa*. Moisture (11.5±0.3) and Ash (8.5±0.09). Crude protein (8.4±0.4) was highly found in ripen fruit of *Murraya paniculata*. Unripen fruit of *Murraya paniculta* showed higher amount of sulphur (1.22±1.7), copper (10.21±0.5) and manganese (21.2±1.5) while ripen fruit of this plant showed highest amount of nitrogen (1.32±0.7) and zinc (11.7±0.1). Potassium (1.8±0.7), magnesium (1.47±1.1) and ferrous (18.0±0.2) were highly found in ripen fruit of *Clausena anisata*. Unripen fruit of *Toddalia asiatica* and *Atlantia recemosa* showed highest content of phosphorus (1.09±0.5) and sodium (0.72±0.3). Proximate and mineral Analysis of wild edible fruits of selected plants emphases the sufficient amount of nutritional composition and their scope to be used as in alternative source of bio-nutrient.

Keywords: ethnobotany, proximate analysis, mineral analysis, wild edible fruit and rutaceae

Introduction
Wild edible fruits play a very significant role in food supplements of rural people. Most of the neighboring areas of Kolhapur district, the people were utilized these fruits in various types of food recipes and as a medicine for curing diseases. India is well known for its medicinal plant flora. Till today more than 2500 medicinal plants are reported and they have lot of medicinal properties [1]. Most of the rural people are closely bonded the forest ecosystem and plants growing around them play a very vital role in their daily needs [2]. Among various types of plants, food plants receive much more attention towards the nutritional qualities [3]. On the other hand many more plants are also shown medicinally important properties. The wild edible fruits play an essential role in the life and economy of rural people who belongs to the adjoining areas of Kolhapur district. All the essential human nutrients are commonly occurred in the plant body hence, plants also play a significant role in human diet. Diet is considered to complete, when it consist of sufficient amount of Carbohydrate, Fat, Fiber and protein hence they are also referred them as proximate principles. On the other hands minerals are also important in the regulation of metabolic activities. The family Rutaceae is well known to all over the world for its juicy citrus types of fruits. It comprises near about 150 genera and 1500 species which are widely distributed in tropical and temperate region. In our country 25 genera and over 80 species of this family have so far been reported [4]. The members belongs to the family Rutaceae have high percentage of vitamin-c and alkaloids. Tribal community utilizes these fruits juices for improving the immune system against infection. The fruits are also useful in stomach infection, circulatory problems, intestinal infection, skin irritation, eye complaints, relieves vomiting, external fever, cough, asthma, heart disease, tumor and ophthalmic. It also shows properties like Antibacterial, Anticancerous, Antiseptic, Antioxidants and many more [5]. Hence considering the above importance of this family we have selected five plants *viz*. *Atlantia recemosa*, *Clausena indica*, *Clausena anisata*, *Murraya paniculata* and *Toddalia asiatica Atlantia recemosa* is commonly called Makad limbu in Maharashtra. The people of Vishalgad and Amboli tahsil belong to Kolhapur district use this plant fruit in preparation of pickles. The ethnic people of Salem district Tamil Nadu utilize fruits pulp in the treatment of snake bite [6]. Warm oil of the berries is applicable in chronic rheumatism, paralytic limb and as stimulant [7]. People of paliyars region Tamil Nadu eaten unripe and ripen fruit of this plant [8]. The tribal group such as Kurumba gounder, Sadaya gounder, Ariyan, Muthuvan and Kattunaikkan use these fruits as pickles [9]. *Clausena indica* is commonly known as Ambatgara in kolhapur district. Leaf oil Showed significant antibacterial activity [10]. *Clausena anisata*

is a tropical shrubby or tree plant attains a height up to 10 meters and highly growing in evergreen forests [11]. In traditional system of medicine this plant is meant for effective remedies against malaria, worm's infections, headaches, rheumatism, arthritis and other inflammatory conditions [12]. Akwaibom state people prepared a decoction from boiled stem bark to treat measles [13]. The detail work on the fruit of this two species was not yet to be done. So, in the present investigation we have focused on proximate and mineral analysis for assessing its nutritional potentiality. *Murraya paniculata* is locally known as kunti. Fruits are commonly used as spice in various types of curries for the flavor and fragrance. Its leaves are used in preparing soup, fish, and meat and chicken dishes. The ethnic people of sugali tribes of yeramalais Andhra Pradesh used this plant in the treatment of snake bite [14]. Flavanoid is isolated from fruits and its play a vital role against various biotic and abiotic stresses [15]. *Toddalia asiatica* is commonly known as Jungali mirchi, occurred in tropical and sub tropical areas of India. Traditionally, the fruits are useful in treatment of malaria and cough [16]. In the treatment of stomachache and toothache the powder paste is useful [17]. In the treatment of cough and throat pain the fruit decoction is useful and also used for culinary purposes in the form of pickles [18].

Material and Methods

Collection of Plant material

All species were collected in their respective flowering and fruiting seasons during frequently visits. The specimens were identified by utilizing taxonomic keys and regional floras [19]. The herbarium were prepared as per the standardized method and deposited at the Shivaji university herbarium center (SUK). The collection numbers of selected specimens are as follows. *Atlantia recemosa*- KDG-2, *Clausena indica* KDG-7, *Clausena anisata* KDG-1, *Murraya paniculata* KDG-5 *and Toddalia asiatica* KDG-6. Plants in table no.1 are arranged in their alphabetically manner in order of their local name, Flowering and fruiting seasons, part used and medicinal importance.

Preparation of plant extracts

The collected plants fruits were washed immediately in laboratory with the help of distilled water and kept for in shady places until weight has been constant [20]. Then all the fruit sample are dried with the help oven at 40ºC for one week, and finally sample was ground with grinder and stored in air tight bottles for further investigation [21].

Ethnobotanical documentation of selected plants

Frequently field visits were undertaken in various localities of Kolhapur district. Information regarding selected medicinal plants was obtained from farmers, rural people who utilized these plants fruit in their livelihood and as medicine in curing of different types of diseases.

Proximate analysis

Moisture and Ash content were determined by Association of Official Analytical Chemists method (AOAC) [22]. Ash was determined by silica crucibles with the help of ignition in a muffle furnace at 625ºC for 2hrs. Crude fat and fiber were determined by Sadasivam and Manikam [23]. Kjeldahl's nitrogen assay (NX6.25) was involved in the determination of crude protein. Reducing, non-reducing sugar and starch was determined by according to the described method by Nelson [24]. Carbohydrate was determined by sum of total sugar and starch. Nutritive value (Kcal/100g sample) was calculated with Atwater factor of 4, 9 and 4 for protein, fat and carbohydrate respectively. This conversion factor was multiplied by 4.186 in order to obtain energy values in KJ [25].

Mineral analysis

The sample was digested using HNO_3 and Perchloric acid and passed through AAS for the analysis of different minerals such as Calcium, Magnesium, Iron, Manganese, Zinc and Copper [26]. Individual element like Nitrogen was determined using the recommended method [27]. Potassium and Sodium was determined by flame photometer after acid digestion. Phosphorus was determined spectrophotometrically by using Molybdate-Vanadate reagent and KH_2PO_4 as a standard [28].

Results and discussions:

Ethnobotanical information, local names of selected plants, their part used, flowering and fruiting season and edible and medicinal importance were depicted in table no.1.

Table 1: Ethnobotanical Survey Documentation of Wild Edible Fruits

Sr.No.	Botanical names	Local Name	Part used	Season of Flowering and fruiting	Medicinal uses
1	*Atlantia recemosa*	Makad limbu	Fruits and leaf	Oct-Jun	Digestive and cough [29]. Pickles by tribes [30]. Rheumatism and paralysis [31]. As a Fodder [32]
2	*Clausena indica*	Ambatgara	Fruits and leaf	Feb-June	Fruits are edible in local areas Of Tillarinagar. Decoction was used in the treatment of Malaria [33]

3	*Clausena anisata*	Ambatgara	Fruits and leaf	Sept-May	Ripen fruits are edible in local areas of Vishalgad.
4	*Murraya paniculata*	Kunti	Ripe fruit and leaf	Nov-June	Fruits are edible and leaf is used in food Curry
5	*Toddalia asiatica*	Jungali mirchi	Fruits, stem and leaf	Oct-June	Malarial treatment [34]. The unripe fruit is rubbed down with oil make a stimulant for Arthritis.

The results obtained on proximate composition of wild edible fruits of selected plants are depicted in table no.2. The moisture content of the analyzed sample ranged between 51.5±1.5 to 64.7±0.16 g/100g with the highest being in a Ripen fruit of *Clausena anisata* (64.7±0.16). The moisture contents obtained from *Glycosmis pentaphylla* had (61.7±0.34) and it was showed in the study of nutrient analysis of Some Selected Wild Edible Fruits of Deciduous Forests of India [35]. The earlier author recorded slightly lesser value of nutrients than present study. The ash content (8.5±0.09) was highly recorded in unripen fruit of *Clausena anisata* and it was least (2.0±0.08) in ripen fruit of *Clausena indica*. The rest of the wild edible fruits contain appropriate amount of ash. Unripen fruit of *Murraya paniculata* showed highest amount of protein 8.4±0.4, the recorded value is more than the work done by [36]. The commercial fruits like apple (0.2%), curd apple (7.1%) and lichi (1.1%) [37], here all these values are smaller than the present investigation, hence this fruits may be utilized as alternative sources for commercial fruits. The crude fat ranged between 8±0.26 g/100g in the ripen fruit of *Atlantia recemosa* to 2.5±0.08 g/100g in unripen fruit of *Murraya paniculata.* Similar work, entitled with "Nutritional potential of wild edible fruits used by local people of Meghalaya" [38]. They have mentioned crude fat value (12.54±0.04) in the fruit of *Zanthoxylum armatum* and it was slightly greater than the present study. Crude fiber (11.5±0.3) were maximum reported in Unripen fruit of *Atlantia recemosa* while lowest amount were occurred in ripen fruit of *Clausena indica* in present study the crude fiber values are more than commercial fruits like apple, curd apple and lichi [39]. Reducing sugar (1.86±0.05), Total sugar (1.9±0.03) in ripen and starch (10.6±) were higher in the unripen fruit of *Toddalia asiatica* while less amount of reducing sugar(0.3±0.05) and total sugar (0.46±0.02) were reported in unripen fruit of *Clausena indica.* Higher value of total sugar was recorded in commercial fruit like orange (9.1) [40]. The ripen fruit of *Toddalia asiatica* showed highest nutritive values (117.02±0.74).

Table 2: Proximate Composition of Wild Edible Plant Species (G/100g Fresh Weight)

Sr. No.	Plant Name		Moisture	Ash	Crude Protein (NX6.25)	Crude Fat	Crude Fiber	Reducing Sugar	Total Sugar	Starch	Nutritive Value
1	A.r.	UR	51.5±0.2	5.0 ±0.2	3.62±0.1	4±0.40	11.5±0.3	0.6±0.02	0.84±0.04	2.59±0.07	66.86±4.5
		R	56.0±0.4	3.6±0.4	4.1±0.15	8±0.20	7.0±0.2	0.7±0.05	0.98±0.04	2.13±0.3	104.2±2.9
2	C. a.	UR	61.2±0.2	8.5±0.09	7.56±0.4	6.±0.005	9.0±0.06	0.3±0.05	0.46±0.02	2.91±0.08	98.97 ±8.44
		R	64.7±0.4	6.0±0.08	8.1±0.3	6.5±0.01	5.0±0.02	0.59±0.01	0.68±0.01	1.82±0.12	106.6±1.88
3	C.i.	UR	56.5±0.6	7.1±0.1	5.62±0.1	4.12±0.1	7.22±0.1	0.33±0.4	0.56±0.02	2.19±0.08	71.9±2.17
		R	60.7 ±0.4	2.0±0.08	6.3±0.02	7.5±0.5	3.2±0.01	0.61±0.01	0.7±0.01	1.82±0.12	105.2±2.2
4	M. p.	UR	54.2±0.4	4.1±0.06	7.4± 0.2	2.5±0.05	5.1±0.03	0.73±0.4	1.14±0.05	3.18±0.02	72.37±1.7
		R	55.0±0.7	3.2±0.04	8.4±0.4	4.2±0.04	4.0±0.2	1.19±0.03	1.71±0.04	2.75±0.04	92.93±2.4
5	T. a.	UR	53.4±0.5	6.0±0.1	6.5±0.1	6.5±0.07	7.39±0.1	1.16±0.04	1.19±0.06	3.54±0.4	94.97 ±1.37
		R	58.4±0.3	7.01±0.7	6.87±0.1	7.22±0.4	9.21±0.0	1.86±0.05	1.9±0.03	2.45±0.1	117.02±0.74

Values are means of three determinations ±SD (n=3), Calculated by using Atwater factors (Nutritive value).
A.r- *Atlantia recemosa,* C.a.- *Clausena anisata,* C.i- *Clausena indica,* M.p.- *Murraya paniculata* and T.a. - *Toddalia asiatica.*

The results obtained from mineral analysis of wild edible fruits are expressed as g/100g (macroelements) and mg/100g (microelement) of dry weight and they were depicted in table no. 2 and 3 respectively. Most of the local resident in different parts of the world utilized these wild edible fruits as good sources of minerals [41, 42 and 43]. In present study, Potassium (1.8±0.7) was maximum being recorded in unripe fruit of *Clausena anisata* and least amount were occurred in unripen fruit of *Atlantia recemosa.* High content of potassium in diet plays vital role in controlling hypertension [44]. Potassium also associated with a decrease in blood pressure, important for heart and bone health, also reduces the coronary heart deseases [45]. Similar work was done in "Nutreint analysis of some selected wild edible fruits of decideous forest of India [46]. They have selected two speceis of family rutaceae i.e. *Glycosmis pentaphylla* and *Toddalia asiatica*. The values mentioned in this work for sodium, potassium and calcium is lower than the present study. The variaion may be due to genetic origin, soil fertility, age of plants and geographical regions [47]. Maximum number of nitrogen (1.6±1.5) was recorded in ripen fruits *Toddalia asiatica.* In addition mineral such as calcium and magnesium play vital role in maintinig body tempreture, building of red blood cell and making good of worm out cell [48]. In present study higher number of calcium (1.4±1.05) was recorded in unripen fruit of *Clausens indica.* In growth, skeletal development and various vital processess within living organisms both of these elements shows significant role [49]. Sulphur and

sodium were sufficiently occurred in all selected plants fruits. All the above trace element act as a structural and functional compound of metalloprotein and enzyme.

Table 3: macro- elements of wild edible fruits (g/100 g dry weight)

Sr.No.	Plant Species		Name of Macro elements						
			Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Sodium
1	A.r	UR	0.58±0.02	0.15±0.02	0.22±0.2	1.0±0.3	1.02±0.02	0.9±0.2	0.72±0.3
		R	0.67±0.03	0.19±0.03	0.24±0.01	0.49±0.3	1.18±0.02	0.2±0.6	0.44±0.08
2	C. a.	UR	1.21±0.1	0.81±0.2	1.4±0.2	1.06±1.1	0.90±0.8	0.4±0.9	0.21±0.05
		R	1.3±0.1	0.83±0.7	1.8±0.7	1.03±1.0	1.47±1.1	0.1±1.0	0.17±1.0
3	C.i	UR	0.91±0.04	0.59±0.5	0.90±0.08	1.49±1.0	1.30±1.01	0.4±1.01	0.33±0.05
		R	1.01±0.1	0.76±0.4	1.32±0.04	0.91±1.5	1.33±1.12	0.3±1.02	0.37±0.03
4	M. p.	UR	1.2±0.1	0.27±1.0	0.94±0.5	1.34±1.3	0.90±1.15	1.22±1.7	0.20±1.2
		R	1.32±0.7	0.85±1.2	0.94±2.1	0.98±2.0	0.93±1.5	1.01±0.7	0.47±1.4
5	T. a.	UR	1.1±0.01	0.96±1.1	0.86±1.73	0.7±2.08	0.80±1.1	0.98±1.02	0.21±2.1
		R	1.6±0.1	1.09±0.5	1.20±2.03	0.2±2.0	0.91±1.15	0.73±1.5	0.10±2.8

Table 4: Micro- Elements of Wild Edible Fruits **(**Mg/100 G Dry Weight).

Sr.No.	Plant Species		Name of Micro elements			
			Zinc	Ferrous	Copper	Manganese
1	A.r	UR	2.28±0.05	2.44±0.49	2.5±0.1	3.4±0.04
		R	7.88±0.08	8.4±0.3	1.90±0.71	1.8±0.3
2	C. a.	UR	2.9±0.01	8.2±0.1	8.4±0.25	21.1±0.35
		R	3.5±1.14	14.04±0.1	7.1±0.1	19.9±0.1
3	C.i	UR	8.6±0.13	16.9±0.3	9.2±0.11	20.4±0.18
		R	11.0±0.14	18.0±0.2	8.6±0.12	18.4±0.17
4	M. p.	UR	9.1±0.2	4.7±0.21	10.21±0.5	21.2±1.5
		R	11.7±0.1	9.8±0.04	10.09±0.4	12.6±0.14
5	T. a.	UR	3.8±0.1	11.8±0.05	8.3±0.01	19.1±0.15
		R	6.9±0.06	14.3±0.3	7.7±0.1	9.1±0.1

Micro element such as copper (10.21±0.54) and manganese (21.2±1.5) in unripen and zinc (11.7±0.1) in ripen were highly reported in fruit of *Murraya paniculata*. Highest amount of Ferrous (18.0±0.2) was showed in ripen fruit of *Clausena indica.* Similar investigation was done entitled with "Proximate and mineral analysis of fruit of *Zanthoxylum rhetsa* and *Glycosmis pentaphylla.* [50] Most useful ethnomedicinal plants in Kolhapur district". Here they have mentioned the values of microelements which are ranged (0.86±0.33 to 2.9 ±0.23, 1.2±0.2 to 3.1±0.3, 2.9±0.14 to 9.7±0.13 and 1.69±0.12 to 6.1±0.17) for Zinc, Ferrous, Copper and Manganese respectively. According to the above significant results, the present study suggest that the all selected fruits are rich in proximate and mineral composition. Appropriate amount of consumption of these fruit will contribute great impotant towards nutritional potential, protection against deseases and malnurtition.

Images of selected plants show Flowering Twig, Unripen fruit and Ripen fruit.

Fig 1: *Atlantia recemosa*

Fig 2: *Clausena anisata.*

Fig 3: *Clausena indica*

Fig 4: *Murraya paniculata*

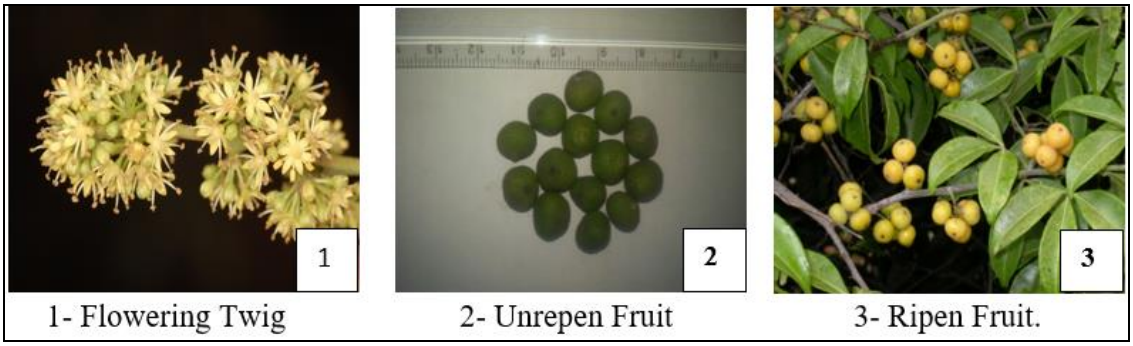

Fig 5: *Toddalia asiatica*

Conclusion

This study indicates that the proximate and minerals may serves as a sources of nutrition and supplement. The present investigation also gives supporting evidence regarding medicinal values of selected plants. Thus, the present study concluded that the selected plants are alternative sources of nutrition and medicine to cure different types of diseases.

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