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Original Article

Nutritional Evaluation of Fruits of *Gynochthodes umbellata* (L.) Razafim. & B. Bremer–An Underutilized Edible Fruit Plant

Anjusha Sudhakaran and Gangaprasad Appukuttan Nair*

Department of Botany, University of Kerala, Kariyavattom Campus, Thiruvananthapuram, Kerala, 695581, India.

ABSTRACT

Objective: The present investigation aimed to assess the nutritional, mineral profiling and anti-nutritional analysis of *Gynochthodes umbellata* (Syn. *Morinda umbellata*), an underutilized edible plant belongs to the family Rubiaceae. Literature perusal reveals that, there are no previous reports on nutritional studies for this valuable fruit. **Methods:** Nutritional, mineral profiling and anti-nutritional analysis of fruits were carried out. **Results:** In nutritional analysis, carbohydrates (6.98 g/100g fw), protein (2.68 g/100 g fw), crude fat (0.13 mg/g dw) and crude fibre (32.58%) content were detected. The fruits of *G. umbellata*, Vitamin C (25 mg/100g fw) was higher when compared to other three vitamin evaluated, Four macro elements and 6 micro elements were also quantified. **Conclusion:** Nutritional and Anti- nutritional analysis reveals that, the *G. umbellata* fruits could be used as a source of protein, vitamin and minerals and highly recommended for consumption as they contain low amount of the anti–nutrients analysed. This is the first report on nutritional analysis of *G. umbellata* fruit.

Key words: *Morinda umbellata*, Nutritional analysis, Underutilized edible fruit, Anti-nutritional analysis.

Address for Correspondence:

Prof. Gangaprasad Appukuttan Nair, Assistant professor, Department of Botany, University of Kerala, Kariyavattom Campus, Thiruvananthapuram, Kerala, 695581, India.

Phone no: 09447552783

E-mail: gp@keralauniversity.ac.in
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INTRODUCTION

Fruits are widely accepted as a good and important source of nutrients and supplement for food in a world faced with problem of food scarcity. Fruits are very vital portion of an adequate diet and they serve as food supplement, and an appetizer. Wild fruits are potential source of antioxidants, vitamins and minerals and they act as an important source of nutrient to the rural population, and can be act as a source of micronutrients, so knowledge about composition of fruits and their nutrient potentials is imperative.[1] In most developing nations, numerous types of edible wild plants are exploited as sources of food to provide supplementary nutrition to the inhabitants.[2] The plants, which are neither grown commercially on large scale nor traded widely, may be termed as underutilized plants. These plants are cultivated or grown wild, traded and consumed locally. In recent years, a growing interest has emerged to evaluate various wild edible plants for their nutritional features.[3-4]

The plant selected for the present study was *Gynochthodes umbellata* (syn: *Morinda umbellata*) belongs to the family Rubiaceae is an underutilized plant (Figure 1). Plant distributed in India, Srilanka, China, Japan and North Australia. In India, it is seen in East Bengal, Tamil Nadu and Kerala, especially in sacred grooves.[5-6] This plant produces large number of fruits which are edible and used in curries in younger stage.[7] *Morinda citrifolia* fruit (noni) is the major edible close relative of *G. umbellata*. *M. citrifolia* has long history of use as a food in tropical regions throughout the world and has been reported to have a broad range of health benefits.[8] In recent years, the noni fruit juice has received much attention because of its nutritional and antioxidant properties and has been now accepted widely as a nutraceutical and marketed worldwide. Noni juice is also claimed to relieve inflammation. It is reported to have antibacterial, anti fungal, analgesic, hypotensive, anti-inflammatory and immune enhancing effects.[9-11] Extensive research has been carried out on *M. citrifolia* (noni), there is a lack of information on the other related species like *G. umbellata* (Syn. *M. umbellata*). *G. umbellata* produces large number of edible fruits but the conception of fruit is very rare. Literature perusal reveals that there is no literature regarding the nutritional analysis of its fruit. Hence the present study on the nutritional value of fruits of *G. umbellata* is very important as it will definitely help in popularising this underutilized crop from a nutraceutical point of view. Thus the major objectives of this study were nutritional, anti-nutritional and mineral composition analysis as indication of nutritional values of the fruit of *G. umbellata.*

MATERIALS AND METHODS

Fruit collection and storage

The ripened fruits were collected during April-May from wild grown plant from Kariyavattom Campus of University of Kerala, Thiruvananthapuram, Kerala. The fruits were washed and cleaned with distilled water to remove the surface residues and blotted with tissue paper and one part of fresh ripened fruits were stored at 4°C for the evaluation of total carbohydrate, total protein, vitamins, pH of the juice. The other portion of the ripened fruits was dried in a hot air oven for 24 hours at 45°C. Then the dried fruits were ground well in a mixer grinder and kept in an air tight bottle and stored at 4˚C in a refrigerator for the evaluation of crude fibre, fatty acid, crude fat, mineral profiling and anti-nutritional analysis. All chemicals used in the study were of reagent grade, unless otherwise stated.

Nutritional analysis

The proximate composition including the moisture content and crude fibre were estimated as per the method given by Association of Analytical Chemists.[12] Total carbohydrates were estimated by the method given by Sadasivam and Manickam[13], Total protein content were quantified using the method by Lowry *et al.*[14] Vitamin A, vitamin C, vitamin B_1 and vitamin B_{12} determined using standard procedures by Deepak.[15] Crude fibre content and crude fat was estimated by the method given by AOAC[12] and for fatty acids quantification the procedure given by Akinyeye *et al.*,[16] were also evaluated in fruits of *G. umbellata.* pH of fruit juice were determined using a pH meter (Cyberlabs, USA). Total carbohydrate, total protein, vitamins, pH of the juice were evaluated in fresh fruits and crude fibre, fatty acid, crude fat were conducted in dried fruit powder of *G. umbellata*.

Mineral profiling (macro and micro elements)

The powdered dried fruit sample was digested using nitric acid-perchloric acid mixture (4:1) for 24 hours. This was then filtered using Whatman

Figure 1: Habit of Gynochthodes umbellata

Figure 2: Young fruit of Gynochthodes umbellata

No. 42 filter paper and the filtrate was used to determine the mineral content using Atomic Absorption Spectroscopy (AAS).[17] Four macro elements, Magnesium (Mg), Sodium (Na), Calcium (Ca), Potassium (K) and six micro elements like, Iron (Fe), Copper (Cu), Manganese (Mn), Zinc (Zn), Lead (Pb), Cadmium (Cd) were quantified in ripened fruit of *G. umbellata*.

Anti-nutritional analysis

The method described by Day and Underwood[18] was used for the determination of oxalate content. The method described by Cataldo *et al.*,[19] was adopted in the determination of nitrate. The method reported by Reddy and Love[20] was used for the determination of phytate. Measurement of saponin concentration of the extract was based on the method described by El-Olemy *et al.*[21] All the anti–nutritional parameters were conducted in fresh fruits of *G. umbellata*.

Anti-nutrient to nutrient molar ratios

Anti-nutrient to nutrient molar ratios of *G. umbellata* fruit were also determined by using compare the critical values reported by Hassan *et al.*[22-23] Anti-nutrient to nutrient molar ratio helps to predict the effect of anti-nutrient on the bioavailability of mineral elements.

Figure 3: Ripened fruit of Gynochthodes umbellata

RESULTS AND DISCUSSION

Fruit collection and storage

Young fruits of *G. umbellata* are green in colour (Figure 2), when mature it becomes orange red in colour (Figure 3). The change of fruit skin colour and firmness of fruit which ripen naturally on the plant is represented in Table 1. Fruit contain numerous seeds and were small. The average number of seeds/ fruits were 13.43 ± 4.43. The size of the fruits range with an average length of 3.93 ± 0.84 cm, a width of 2.35 ± 0.50 cm. The fully ripened fruits were collected for the analysis (Figure 4).

Figure 4: Ripened fruit harvested for analysis

Nutritional analysis

The nutritional analysis results of *G. umbellata* were listed in Table 2. The moisture content in fresh fruits (58.32%) was low when compared to other fruits like Banana (74.91%), Mango (81%) and *Morinda tinctoria* (78.34).[24] Desai *et al.*,[25] studied the proximate composition and some physicochemical properties of the two species of *Morinda* fruits, and observed that the moisture content in *M. citrifolia* was 63% and *M. pubescens* was 22%. The low moisture content in the fruit suggests that the levels of other nutrients might be high.[26]

Carbohydrates are one of the most important components in many fruits. The total carbohydrate content in fresh fruits of *G. umbellata* was

Table.1: Change of fruit skin colour and firmness in the course of ripening of *G. umbellata* fruit

Maturity stage	Colour	Firmness
1	Dark green	Very hard
2	Dark green	Very hard
3	Green – pale orange	Very hard
4	Orange	Very hard
5	Orange red	Soft

Table.2: Nutritional analysis of fruits of *G. umbellata*

Nutritional Compound	Concentration*
Moisture content (%)	58.32
Carbohydrate (g/100g fw)	6.98
Protein (g/100g fw)	2.68
Crude fat (mg/g dw)	0.1316
Fatty acid (mg/g dw)	0.1053
Fibre (%)	32.58
Vitamin C (mg/100g fw)	25
Vitamin A (mg/100g fw)	1.29
Vitamin B_1 (mg/100g fw)	0.023
Vitamin B_{12} (mg/100g fw)	0.014
pH	4.80

*Each value is an average of 3 determinations.

6.98g/100g. This value is comparable with total carbohydrate content reported by Brett[27] in *M. citrifolia* fruit (7.21g/100g). The protein is another important nutritional factor. *G. umbellata* fresh fruit have 2.68g/100g protein. Protein is a major source of energy, as well as containing essential amino acids which are important for human being.[28] Lewis *et al*.,[29] reported *M. citrifolia* fresh fruit have 5.98g/100g protein. The *M. citrifolia* juice reported to have a lesser amount of protein (0.4g/100g).[30] This reduction in protein may be due to the processing of fruit for the preparation of juice. Crude fat (0.1316 mg/g) and fatty acid (0.1053 mg/g) were detected in dried fruits of *G. umbellata.* In *M. citrifolia* the crude fat content were reported by various authors, as 0.10g/100g[27] and 0.14g/100g[31] were comparable with this result. Low fat foods are considered as preferable.[32]

High fibre content (32.58%) was detected in *G. umbellata* dried fruit. High amounts of fibre were also reported in *M. citrifolia* (33%) and *M. pubescens* (48%).[33] Fibers in diet help the digestion process and aid absorption of trace elements in the intestine. It also reduces the absorption of cholesterol and helps in efficient elimination of wastes.[34]

The Vitamin content of the fresh fruit of *G. umbellata* reveals high content of Vitamin C (25 mg/100g). Vitamin A (1.29 mg/100g), Vitamin B_1 (0.023 mg/100g) and Vitamin B_{12} (0.014 mg/100g) were detected in fresh fruit of *G. umbellata* (Table 2). European Commission[35] reported *M. citrifolia* fruit juice contains 3-25 mg/100g vitamin C. The pH of fruit juice of *G. umbellata* was 4.80. Similar pH (4.76) was reported in *M. citrifolia* fruit juice[36] and this pH fall outside the range that incidentally favours bacterial growth.

Mineral profiling

The mineral composition is an important for reliable nutrient information and its pivotal role in human life provides healthy growth.[37] Minerals are essential for normal cellular function and provide additional protection to the human body and act as second messenger in some biochemical cascade mechanisms.[38] The results of mineral analysis of *G. umbellata* are depicted in Table 3. Out of four macro elements quantified, potassium (956 mg/100g dw) was higher followed by calcium (450 mg/100g dw). The value of potassium is much greater than the popular potassium enriched fruit, banana, with only of 348-370 mg/100g.[39] In addition the fruit also contain substantial amount of Magnesium (245 mg/100g dw), Iron (3.4 mg/100 g), Manganese (14.1 mg/100g) and Zinc (1 mg/100g). The Fe and Zn content of the tropical and sub-tropical fruits ranged from 0.09-3.4 mg/100 g and 0.06-0.64 respectively.[39] Brett[27] reported 214.34 mg/100 g potassium in fresh fruit juice of *M. citrifolia.* All the elements quantified were higher in *G. umbellata* than the *Morinda citrifolia.*[27] This difference in mineral elements is due to the difference in experiment materials used and the difference in plant species. Anuradha *et al*.,[37] reported the difference in nutrient content in fresh and dry fruits of *M. tictoria* were different.

Anti-nutritional analysis

Fruits are important sources of minerals, fibre and vitamins, which provide essential nutrients to the human body. But it is known that some fruits have so-called anti-nutritional factors that diminish nutrient bioavailability, especially if they are present at high levels.[40] The high content of these anti-nutrients exert negative effects on the bioavailability of some mineral nutrient.[41]

Table. 3: Major mineral composition of *G. umbellata* dry fruit powder

Minerals	Concentration (mg/100g dw)*
Macro elements	
Magnesium (Mg)	245
Sodium (Na)	34.1
Calcium (Ca)	450
Potassium (K)	956
Microelements	
Iron (Fe)	3.4
Copper (Cu)	0.9
Manganese (Mn)	14.1
Zinc (Zn)	1
Lead (Pb)	0.2
Cadmium (Cd)	Not Detected

*Each value is an average of 3 determinations.

In *G. umbellata* oxalate content detected (1.12 mg/g) is higher than phytate (0.01 mg/g) and nitrates (0.018 mg/g). The saponin is absent in *G. umbellata* fruit (Table 4). Levels of all the anti-nutritional factors in the fruits of *G. umbellata* were lower than the value what can cause mal-absorption of other nutrients, so the consumption of other nutrients should be encouraged when available.[1]

Anti-nutrient to nutrient molar ratios

Anti-nutrients to nutrients molar ratio are used to predict the effect of oxalate and phytate on the bioavailability of important macro and micro elements.[23] The Anti-nutrient to nutrient molar ratios were listed in Table 5. All the Anti-nutrient to nutrient molar ratios are below the critical level except [Ca] [Phytate]/[Zn]. This indicate that bioavailability of Ca and Zn may be effected by the phytate content which can overcome by little processing of fruit before their consumption.

CONCLUSION

The present study showed that the underutilized *G. umbellata* fruits could also be used as a potential source of protein, vitamin and minerals with

Table. 4: Anti-nutritional analysis of *G. umbellata* fruit

Anti- nutritional compound	Concentration (mg/g dw)*
Phytate	0.01
Oxalate	1.12
Saponin	Not detected
Nitrates	0.018

*Each value is an average of 3 determinations.

Table 5: Anti- Nutrient to Nutrient molar ratios

Molar ratio	Value	Critical level*
[Oxalate]/[Ca]	0.2489	2.5
[Oxalate /[Ca + Mg]	0.1612	2.5
[Ca] [Phytate]/[Zn]	4.5	0.5
[Phytate]/[Ca]	0.0022	0.2
[Phytate]/[Fe]	0.2941	0.4
[Phytate]/[Zn]	1	10

*(Source: Hassan *et al*., 2008; Hassan *et al*., 2011).[22-23]

some of them being even better than *M. citrifolia* and other popular fruits. Anti- nutrient to nutrient molar ratio suggest that little processing is needed before the consumption of *G. umbellata* fruit. This study suggests more scientific studies should be conducted to identify the nutritional and functional compounds present in *G. umbellata* fruits and explain their mechanisms of action in order to determine the real potential of this fruit and the technological processes that preserve these. This information is also pertinent to help underutilized and neglected species for better health and nutritional status of the rural communities of the country. The present study also reveals that this fruit can be a substitute for noni.

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CONFLICT OF INTEREST

The authors declare that there are no conflict of interests.

ABBREVIATION USED

fw: fresh weight, **dw:** dry weight, **mg/g:** milligram/gram, **cm:** centimetre.

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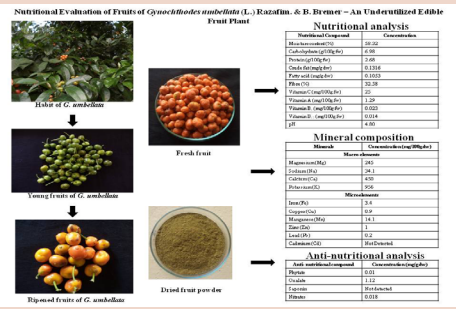
PICTORIAL ABSTRACT



SUMMARY

- This is the first report on nutritional evaluation of *G. umbellata*, an under-utilized edible fruit plant belongs to the family Rubiaceae.
- Nutritional, mineral profiling were studied using standard procedures and find that this plant have high nutritional value.
- The present study showed that the underutilized *G. umbellata* fruits could also be used as a potential source of protein, vitamin and minerals.
- *Morinda citrifolia* (noni) is the major edible close relative of *G. umbellata*. The present study reveals that this underutilized fruit plant has potent nutritional value and can be a substitute for noni.
- This information is also pertinent to help underutilized and neglected species for better health and nutritional status of the rural communities of the country.

ABOUT AUTHOR

Dr. A. Gangaprasad: Got his Ph. D. in Botany from Tropical Botanic Garden and Research Institute, Palode at University of Kerala in 1997. Dr. A. Gangaprasad has 22 years of research experience in the field of Conservation Biodiversity and has long experience in the area of Plant Biotechnology. Dr. A. Gangaprasad has made substantial contribution in the areas of conservation Biology, Plant Tissue culture, plant Taxonomy and phytochemistry.