Estimation of the Mineral Composition of Wild Jackfruit and its Comparison with Other Artocarpus Fruits

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Research Article

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Abstract

Impoverished nations are suffering from malnutrition due to a lack of access to nutrient-rich food. Lack of information about the nutrient rich endemic fruits is one of the major reason for malnutrition, rather than a real shortage. The present study focused on the estimation of the mineral composition of the fruit constituents of *Artocarpus hirsutus*Lam. by ICP-MS, followed by a comparative study of the mineral composition of *A. hirsutus* fruits with values obtained from fruits of other Artocarpus species. Of the estimated 16 minerals analysed, the flesh, seed and seed coat of *Artocarpus hirsutus* have a high amount of magnesium compared to other minerals (153.8, 148.8 and 128.6 mg/100g, respectively). Calcium (9.564 mg, 9.195 mg, and 4.69 mg respectively) and iron (6.03 mg, 2.815 mg and 7.77 mg respectively) are the two minerals found comparatively higher than other minerals. The content of heavy minerals such as vanadium, arsenic, cobalt, cadmium and mercury was very low, less than 0.005 mg/100g. A comparative study also shows that wild jackfruit contains a high amount of magnesium than other selected Artocarpus fruit species and hence can be recommended as a source of magnesium for the diet.

1. Introduction

Humans generally require more than 22 different minerals for healthy growth and function, and any of these deficiencies contribute to malnutrition issues (Khan et al., 2015). Among them, some are required in large amounts and are called macro elements, such as Calcium (Ca), Potassium (K), Magnesium (Mg), and Sodium (Na), while others are needed in trace or ultra-trace quantities and are called micro elements, such as Copper (Cu), Iron (Fe), Nickel (Ni), Zinc (Zn), manganese (Mn), etc. Micronutrient deficiencies, such as iron deficiency, impaired immunity to infections causing varied degrees of impairment in cognitive ability, reduced work capacity, pregnancy difficulties, and so on, are serious public health issues in many developing countries (Batra and Seth 2002). Infants should get special attention since they require enough micronutrients for normal growth and development (Rush 2000). But the excessively elevated dose of these elements (even essential elements) compared to the usual dosage can cause toxic effects on cells. Whereas some elements like Lead (Pb) and Cadmium (Cd) are non-essential elements and can cause toxic effects even in trace amounts (Magdas et al. 2012). Therefore, it is essential to have a fundamental understanding of "what we require, what we eat, and the amount we consume."

Nowadays, impoverished nations are suffering from a higher risk of illness, stunting, underweight, and infant mortality due to a lack of access to nutrient-rich food (Webb et al. 2018). But the fact that these developing countries have tropical and sub-tropical regions blessed with a great diversity of indigenous, underutilised fruit species with high nutritional content (Rahman and Rahman 2014). So, the problem is not really associated with a real shortage but rather due to the lack of sufficient information regarding the composition of bioactive compounds in several endemic crops (hence, they fall under the category of underutilised or neglected crops), which results in a low availability of these products in domestic markets and local consumption. Hence, diverse use of these local neglected fruit species in our daily diet would be a solution for this problem and would also make a significant contribution to improving nutrition (Hunter et al. 2019). To benefit from the nutritional and economic values of these underutilised fruit species, the nutritional constitution of these fruits should be well assessed and documented. For instance, most of the

Artocarpus species are rich in nutrients and are used as a source of food and in traditional medicinal practises in the treatment of diabetes, diarrhoea, dermatitis, malarial fever, asthma, tapeworm infection, anaemia, and many other diseases. The important species belonging to this genus are *Artocarpus heterophyllus, Artocarpus altilis, Artocarpus hirsutus, Artocarpus lakoocha*, and *Artocarpus camansi*. These species are known to contain many potential bioactive compounds and minerals that possess many nutraceutical qualities (Hari et al. 2014). But most of the species are less utilised by the scientific world, and only limited literature is available regarding the nutritional composition of the fruits.

One among them is *Artocarpus hirsutus*, an endemic fruit species in the southern Western Ghats of Peninsular India, commonly known as wild jack (Matthew et al. 2006). Wild jack should be recognised as a minor fruit species with excellent nutritional value and should be investigated as a prospective fruit crop species. Hence, the current study focused on the estimation of the mineral composition of fruit components (flesh, seed, and seed coat) of *Artocarpus hirsutus*, followed by a comparative study on the proximate mineral composition of *A. hirsutus* fruit with values obtained from fruits of other related *Artocarpus* species.

Several methods are currently available to estimate the mineral element content, and a suitable one is selected based on the sample's digestion. For instance, techniques including Graphite furnace atomic absorption spectrometry (Liang et al. 2016), Inductively coupled Plasma-optical emission spectrometry (Nyaba and Nomngongo 2020), and Inductively coupled Plasma mass spectrometry (ICP-MS; Chen et al., 2020) utilise open and microwave-assisted sample digestion, while the energy dispersive X-ray Fluorescence (Hondrogiannis et al. 2012) technique considers dried powdered samples. In addition, the ICP-MS method is the most popular choice for element estimation since it has high sensitivity, can detect several elements, and requires less sample preparation (Wang et al. 2017). Hence, the present study utilised the ICP-MS technique for the estimation of mineral content and composition of fruit components (flesh, seed, and seed coat) of *Artocarpus hirsutus.*

2. Materials and Methods

The wild jackfruit samples were collected from a healthy tree of *Artocarpus hirsutus* located in Kariavattom, Thiruvananthapuram, Kerala, in March 2019 (Fig. 1). In the laboratory, these samples were washed with deionized water, followed by the separation of their flesh, seeds, and seed coat. All these separated fruit components were freeze-dried (or lyophilized), then finely powdered and stored in airtight bottles at room temperature. The mineral components of the wild jackfruit were analysed using inductively coupled plasma quadrupole mass spectrometry.

For digestion of the pulverised samples, 2.5 ml of high-purity HNO_3 was added to 2.5 ml of samples in a tightly sealed Teflon vessel. The whole system was placed in an oven at 200° C for 12 hours. A colourless solution was formed, and volume was made up to 50 ml with double-distilled water. Thus, the samples were diluted at a ratio of 1:20 v/v (Dehelean and Magdas 2013). The mineral composition of each sample was determined by a semi-quantitative method using a Perkin-Elmer ICPMS instrument (Perkin-Elmer Total Quant III). Three replicates were measured for each sample analysis to ensure the quality of the measurements and reported as mean values.

3. Result and Discussion

The aim of the study was to determine and evaluate the mineral composition of the fruits of *Artocapus hirsutus* by employing ICP-MS. The main mineral contents of the samples studied are shown in the following diagrams (Graph 1–3).

Among the estimated 16 minerals analysed, all the three samples *viz* flesh, seed and seed coat of fruit contain high amount of magnesium than other minerals (153.8, 148.9 and 128.6 mg/100g, respectively). Calcium (9.564 mg, 9.195 mg, and 4.69 mg per 100 g respectively) and iron (6.03 mg, 2.815 mg and 7.77 mg per 100 g respectively) are the two minerals found comparatively higher than other minerals. The heavy metals composition of foods is of interest because of their toxic nature. For example, Fe, Zn, Cu, Cr, Co, and Mn are essential, while As, Pb, Cd, Ni, and Hg are toxic at certain levels. The concentrations of heavy metals, Ni, Cu, Zn, Cr, Mn, Co, As, Cd, and Pb, in analysed in fruit pulp, seed and seed coat of fruit of wild jack are presented in graph 2 and 3. The composition of minerals such as vanadium, arsenic, cobalt, cadmium and mercury were very low at less than 0.005 mg/100g.

The fruit flesh contains comparatively higher amounts of Mg (153.8 mg/100g), Ca (9.564 mg/100g), V (0.0023 mg/100g), Cr (0.1128 mg/100g), Cd (0.0019 mg/100g), Pb (0.0234 mg/100g) and Hg (0.0039 mg/100g) than the seeds and seed coat. Seed coat contain comparatively high quantity of V (0.0023 mg/100g), Fe (7.7749 mg/100g), Co (0.004 mg/100g), Ni (0.1742 mg/100g), Cu (0.016242 mg/100g), Zn (0.9714 mg/g) and As (0.0007 mg/100g) whereas seed contain proportionately high amount of Ti (0.0437 mg/100g), Mn (0.697 mg/100g) and Se (0.0087 mg/100g) than other two.

A comparative study was also conducted by analysing the proximate composition (mg/100g) in *A. hirsutus* (wild jackfruit) flesh and seed together with values obtained from other closely related *Artocarpus* species such as *Artocarpus odoratissimus* (Tarap), *Artocarpus heterophyllus* (Jackfruit) and *Artocarpus camansi* (Breadnut) and provided in the table below.

Table 1
Proximate mineral composition (mg/100g) of flesh and seed *A. hirsutus* with other closely related *Artocarpus* species.

***Artocarpus* Species**	***Artocarpus hirsutus***		***Artocarpus odoratissimus***		***Artocarpus heterophyllus***		***Artocarpus camansi***	
Fruit component	Flesh	Seed	Flesh	Seed	Flesh	Seed	Flesh	Seed
Ca	9.564	9.195	0.95	2.25	31.28	40.86	151	126
Mg	**153.8**	**148.9**	16.39	117.5	36.96	102.94	-	1.48
Fe	6.0398	2.815	0.41	1.00	3.26	1.00	20.6	15.8
Mn	0.6585	0.697	0.475	4.455	-	0.56	1.83	1.60
Cu	1.0404	0.591	0.98	0.705	0.38	4.25	2.23	1.57
Zn	0.7302	0.971	0.31	1.27	-	2.280	44.0	28.5
Cd	**0.0019**	**0.0007**	0.0125	0.0148	-	0.010	-	-
References	Current study		Tang et al., 2013		Borgis & Bharati, 2020 Gupta et al., 2011	Khan et al., 2021; Sulaiman, 2019; Ranasinghe et al., 2019	Rabeta & Nor Syafiqah, 2016	Adeleke & Abiodun, 2010

The estimation of the mineral composition of the fruit components (pulp, seeds and seed coat) of wild jack by ICP-MS shows that the amount of magnesium (153.8, 148.9 and 128.6 mg/100g, respectively) is greater than that of other minerals analysed and is more than 100 mg per 100 grams. A comparative study analysing the proximate mineral composition of wild jackfruit with fruits of other closely related Artocarpus species also shows that wild jackfruit contains a high amount of magnesium and can be used as a dietary source of magnesium. Therefore, the inclusion of this wild jackfruit in our daily diet can be recommended as a supplement to help us acquire a sufficient amount of magnesium to meet the recommended daily requirement. Furthermore, cadmium is a heavy metal whose content is very low compared to other species.

4. Conclusion

From the study we found that, fruit pulp, seed and seed coat of *Artocarpus hirsutus* possess a high amount of magnesium. Minerals like calcium and iron were found relatively in high concentration compared to others. Whereas the fruit of this wild jack possesses a very ultra-trace amount of minerals like As, Pb, Cd and Hg. These data can be utilized to disseminate the knowledge on mineral composition of this wild jackfruit. This will also help to promote its inclusion in daily diet and to foster its usage for commercial production.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

Both authors, Mr. Abin P Mathew and Dr. Gangaprasad A contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript**.**

Not applicable

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Graphs

Graphs 1 to 3 are available in the Supplementary Files section.

Figures

Figure 1

Fruit of *Artocarpus hirsutus*

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Graph1.jpg
- Graph2.jpg
- Graph3.jpg