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BIOCHEMICAL COMPOSITION OF AERIAL PARTS OF *MADHUCA LONGIFOLIA*

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ABSTRACT

Madhuca longifolia, commonly known as Mahua, is a medicinal plant recognized for its high content of carbohydrates, proteins, vitamins, and bioactive compounds. The study aimed to assess the proximate and mineral composition in Mahua aerial parts. Results indicated that Mahua flowers were rich in protein and phosphorus, while Mahua seeds contained high levels of fat and fibre. The fruit exhibited the highest sugar and vitamin C content. The findings suggest that Mahua flowers can be effectively utilised in nutrient-rich products, which hold promising commercialisation prospects in the health and organic food sector. Further research is recommended to optimise formulations and explore fortification strategies for improved sensory and functional attributes.

Index Terms – *Madhuca longifolia,* Proximate and Mineral Composition, Sugar content

I. INTRODUCTION

The Mahua tree, belonging to the Sapotaceae family, is one of the most valuable forest plants, with every part serving a purpose. The tree has two main species: *Madhuca longifolia* and *Madhuca indica,* both of which originate in India, Sri Lanka, Myanmar, and Nepal (Yadav *et al.*, 2012; Sunita and Sarojini, 2013). It is a multipurpose tree which fulfils three fundamental needs of tribal individuals, i.e. Food, Fodder and Fuel (Solanki, 2020). The flower is available from March to May, and its ripe fruits are available from June to August. Flowers of plant are edible and have high nutritive value, majorly high amounts of sugars and subsequently having a good amount of vitamins, proteins, minerals and fats (Patel *et al*., 2007). Because of the higher amount of sugar, the flowers are utilized as a liquor, Traditionally, it have been used as toxic, analgesic, diuretic, and cooling agent as well as of treating helminthes, acute and chronic tonsillitis, bronchitis (Singh *et al.*, 2022). Mahua seeds are contain around 40% of a pale yellow, semi-solid fat, commonly referred to as "Mahua Butter". Fresh Mahua seeds oil has numerous medicinal applications due to its emollient properties. It's used in treating skin diseases, rheumatism, and headaches, and is a natural laxatibe for habitual constipation piles (Sinha *et al*., 2017). The fruits of *Madhuca longifolia* also contain a variety of bioactive and phytochemical properties (Ramchandra *et al*., 2007). This study aim to analysis the proximate and mineral composition of aerial parts of *Madhuca longifolia.*

II. MATERIALS AND METHODS

2.1 Collection and identification of plant materials

The aerial parts (fruits, flowers and seeds) of *Madhuca longifolia (*Mahua) in dried form were purchased from the local market of Chhattisgarh.

2.2 Biochemical analysis

Proximate analysis was carried out by the Association of Official Analytical Chemists (2019). This constitutes the different classes of nutrients present in the samples, including moisture content, which was determined by drying the samples in an oven at 105 °C until a constant weight was achieved. Ash content was determined by incinerating a dried powdered sample 5g in a muffle furnace at 600°C for 6 hours until the ash turned white. The Micro-Kjeldhal method was used to estimate the total nitrogen content, and protein content was calculated using the 6.25 conversion factor for protein nitrogen. The fat was estimated using the ether extraction method with a Soxhlet apparatus. Crude Fibre was determined by acid-alkali digestion by using fibre tech. Carbohydrate was calculated using the difference method by subtracting the protein, fibre, moisture, fat, ash content from 100. And the sugar content were determined by the Fehling's solution. Mineral analysis was carried out as per NIN (2003). The diet necessary metal calcium was determined by the help of inductively coupled Plasma-Optical emission spectrometry (ICP-OES), and potassium was determined by using the flame photometry method (Model Systronics).

2.3 Statistical Analysis

The data was expressed as Mean ± Standard Deviation and One-Way ANOVA of three determinations, and also statistically analyzed to ascertain its significance at P≤0.05 level.

III. RESULTS AND DISCUSSION

Table 1. Proximate Composition of Aerial Parts of *Madhuca longifolia* on a Dry Weight Basis

Parameters (g/100g)	Fruit	Flower	Seed
Moisture	18.13±0.5[a]	19.06±0.5[b]	10.36±0.05[c]
Ash	2.73±0.03[a]	3.33±0.03[b]	4.37±0.11[c]
Fat	0.16±0.11[a]	0.56±0.09[b]	4.16±0.12[c]
Protein	5.89±0.00[a]	8.43±0.01[b]	5.39±0.01[a]
Fibre	2.76±0.00[a]	1.13±0.04[b]	7.34±0.17[c]
Carbohydrate	70.33±0.12[a]	66.4±0.32[b]	68.42±0.35[c]

The values are expressed as Mean ± SEM (n=3) on a dry weight basis,
Values sharing different superscript letters between different rows are significantly different at p≤0.05

Table 1 shows the proximate composition of aerial parts of *Madhuca longifolia* in terms of dry weight. The table displays the moisture, ash, fat, protein, fibre, and carbohydrate mean ± standard deviation, along with the corresponding p-value.

Moisture Content

A low moisture level is recommended to protect the items against enzyme activity and microbial spoilage (Akonor *et al*., 2016). The maximum moisture content (g/100g) of *Madhuca longifolia* aerial parts was found in fruit (18.13±0.5 g/100g), followed by the flower (19.06±0.5 g/100g), while the lowest moisture content was found in the seed (10.36±0.05 g/100g). The data showed a significant difference ($p \leq 0.05$). Similar data was observed by Kureel *et al*. (2009), moisture content in dried Mahua flower was 19.8%, whereas the seed contained 53%, as shown by (Sahu *et al*., 2022).

Ash Content

Higher concentrations of different mineral elements are expected due to the high percentage of ash content. These elements are beneficial for stimulating metabolic processes, which could boost growth and development (Fekadu *et al*., 2013). The maximum moisture content of *Madhuca longifolia* aerial parts was found seed (g/100g), followed by flower (g/100g) and fruit (g/100g). The data showed a significant difference ($p \leq 0.05$). Similar data was observed by Kureel *et al*. (2009), ash content in dried Mahua flowers was 4.36%, whereas the seed contained 3.4%, as shown by (Sahu *et al*., 2022).

Fat Content

Fat is the major source of energy but should be consumed with caution to avoid obesity and other related diseases. Diet must provide 1-2% of its caloric energy as fat is said to be sufficient to human beings, because low fat content would favour prevention of metabolic disorders (Kris-Etherton *et al*., 2002). Seeds exhibited the highest fat content (3.16±0.12 g/100g), followed by flowers (0.56±0.09 g/100g) and then fruits (0.16±0.11 g/100g). The data showed a significant difference ($p \leq 0.05$). The high fat content in seeds aligns with their known use as an oil source, indicating their potential for oil extraction and commercial utilization in the food and cosmetic industries. Similar data were observed by Kureel *et al*. (2009) fat content in dried Mahua flowers was 0.5%, whereas the seeds contained 33%, as shown by (Sahu *et al*., 2022).

Protein Content

It is worth noting that plant-based foods that contain more than 12% protein are a healthy source of protein (Ali, 2009). The maximum protein content (g/100g) of *Madhuca longifolia* in aerial parts was found in flowers (8.43±0.01 g/100g) and seeds (5.39±0.01g/100g), while fruits contained the least (5.89±0.00 g/100g). The data showed a significant difference ($p \leq 0.05$). This suggest that flowers and seeds are better in protein as compared to fruits, highlighting their potential use in protein rich dietary formulations. Similar data were observed by Kureel *et al*. (2009), protein content in dried Mahua flowers was 6.37%, whereas the seeds contained 16.9%, as shown by (Sahu *et al*., 2022).

Fibre Content

Intake of fibre may lower serum cholesterol levels and chances of having the risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Prasad and Singh, 2015). The highest fibre content was found in seeds (7.34±0.17 g/100g), followed by fruits (2.76±0.00 g/100g) and flowers (1.13±0.04 g/100g). They showed a significant difference ($p \leq 0.05$). Similar data was observed by Hiwale. (2015) and according to Patel *et al*. (2011), fibre content in dried Mahua flowers was 10.8%, whereas the seeds contained 3.2%, as shown by (Shau *et al*.; 2022).

Carbohydrate Content

Carbohydrate content of aerial parts of *Madhuca longifolia* was highest in fruit (70.33±0.12 g/100g), followed by seed (68.42±0.35 g/100g), and flower (66.4±0.32 g/100g). The data showed a significant difference (p≤0.05). Similar data were observed by vora *et al*. (2016), carbohydrate content in moist Mahua flowers was 65.81%, whereas the seeds contained 22%, as shown by (Shau *et al*., 2022).

Table 2. Minerals and Vitamin-C Composition of Aerial Parts of *Madhuca longifolia* on a Dry Weight Basis

Parameters (mg/100g)	Fruit	Flower	Seed
Calcium	197.48±0.44[a]	44.91±0.15[b]	46.68±0.09[c]
Phosphorus	10.25±0.22[a]	8.29±0.27[b]	22.01±0.50[c]
Vitamin C	0.186±0.00[a]	0.508±0.00[b]	0.258±0.00[c]

The values are expressed as Mean ± SEM (n=3) on a dry weight basis,
Values sharing different superscript letters between different rows are significantly different at p≤0.05

Table 2 show the proximate composition of aerial parts of *Madhuca longifolia* in terms of dry weight. The table displays the means and standard deviations of calcium, phosphorus, and Vitamin C, along with the corresponding p-values.

Vitamin C

Vitamin C is a crucial antioxidant that supports immune function, collagen synthesis, and protection against oxidative stress (Carr & Maggini, 2017). The Vitamin C content in the aerial parts of *Madhuca longifolia* varies significantly, with the highest found in the fruit (0.186±0.00 mg/100g), followed by the seed (0.258±0.00 mg/100g), and the lowest in the flower (0.508±0.00 mg/100g). These differences are statistically significant, $p \leq 0.05$ value. Similar data was observed by Singh *et al*. (2005) vitamin c content in fresh Mahua flower was 44.30%, whereas the fruit contained 66%.

Calcium

Calcium is an important mineral for human beings, which provides the strength of bones and teeth (Turan *et al*., 2003). The calcium content in the aerial parts of *Madhuca longifolia* varies significantly, with the highly found in the fruit (197.48±0.44 mg/100g), seed (46.68±0.09 mg/100g), and flower (44.91±0.15 mg/100g). These differences are significant, $p \leq 0.05$ values. Similar data was observed by Hiwale *et al*. (2015) total s content in fresh Mahua flower was 0.14-8%, whereas the fruit contained 45%.

Phosphorus

Potassium is are important intracellular and extracellular action, respectively, which is involved in the regulation of plasma volume, acid-base balance, and nerve and muscle contraction (Akpanyung, 2005). The phosphorus content in the aerial parts of *Madhuca longifolia* varies significantly, with the highly found in the seed (22.01±0.50 mg/100g), fruit (10.25±0.22 mg/100g), and flower (8.29±0.27 mg/100g). These differences are significant, $p \leq 0.05$ values. Similar data was observed by Hiwale *et al*. (2015) total sugar content in fresh Mahua flower was 0.14-2%, whereas the fruit contained 22%.

Table 3. Sugar Composition of Aerial Parts of *Madhuca longifolia* on a Dry Weight Basis

Parameters (g/100g)	Fruit	Flower	Seed
Reduced sugar	24.83±0.05[a]	0.56±0.02[b]	0.26±0.01[c]
Non-Reduced sugar (Sucrose)	17.89±0.01[a]	10.66±0.08[b]	5.21±0.07[c]
Total Sugar (RS + Sucrose)	42.73±0.12[a]	11.3±0.01[b]	5.42±0.13[c]

The values are expressed as Mean ± SEM (n=3) on a dry weight basis,
Values sharing different superscript letters between different rows are significantly different at p≤0.05

Table 3 show the proximate composition of aerial parts of *Madhuca longifolia* in terms of dry weight. The table displays the sugar content mean ± standard deviation along with the corresponding p-value.

Reduced sugar

Reducing sugar intake lowers the risk of obesity, type 2 diabetes, and cardiovascular diseases (Mann *et al*., 2013). The reduced sugar content in the aerial parts of *Madhuca longifolia* varies significantly, with the highly found in the fruit (24.83±0.05 g/100g), flower (0.56±0.02 g/100g), and seed (0.26±0.01 g/100g). These differences are significant, $p \leq 0.05$ values. Similar data was observed by Singh *et al*. (2005) total sugar content in fresh Mahua flower was 17.94%, whereas the fruit contained 7.8%.

Non-Reduced sugar

The non-reduced sugar content in the aerial parts of *Madhuca longifolia* varies significantly, with the highly found in the fruit (17.89±0.01 g/100g), flower (10.66±0.08 g/100g), and seed (5.21±0.07 g/100 g). These differences are significant, $p \leq 0.05$ values. Similar data was observed by Singh *et al*. (2005) total sugar content in fresh Mahua flower was 11.78%, whereas the fruit contained 24.24%.

Total Sugar

The total sugar content in the aerial parts of *Madhuca longifolia* varies significantly, with the highly found in the fruit (42.73±0.12 g/100g), flower (11.3±0.01 g/100g), and seed (5.42±0.13 g/100g). These differences are significant, $p \leq 0.05$ values. Similar data was observed by Singh *et al*. (2005) total sugar content in fresh Mahua flower was 24.24%, whereas the fruit contained 11.78%.

IV. CONCLUSION

Madhuca longifolia aerials parts were utilized in tribal and rural communities conventionally for medicinal properties, high sugar content, and a rich nutritional profile, including vitamins, minerals, and antioxidants. The study analysis the nutritional composition of *Madhuca longifolia* aerial parts (fruit, flower, seeds) collected from the local market in Chhattisgarh on a dry basis. Proximate analysis revealed that *Madhuca* flower had the highest protein and phosphorus, while seeds were rich in fat, fiber, and calcium. Fruits exhibited the highest carbohydrate and vitamin C content. Sugar content analysis *Madhuca* fruits had the highest total sugar, followed by the flowers and seeds.

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