Comparative Nutritional Assessment and Proximate Analysis of Basella Alba and Basella Rubra of Adilabad Agency

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ABSTRACT:
This study presents a nutritional assessment and proximate analysis of Basella alba and Basella rubra—two species of Malabar spinach—focusing on the leaves, stems, and fruits of both plants. Using standard methods outlined by the Association of Official Analytical Chemists (AOAC), the proximate analysis evaluated the moisture, crude protein, fat, fiber, ash, and carbohydrate content in these plant parts. The results revealed notable differences in the nutrient composition between the plant species and among their various parts. Basella alba leaves were rich in crude protein, dietary fiber, and vitamins, while the stems showed relatively higher moisture content with lower protein and fat levels. The fruits of both species had a moderate nutrient density, with slightly higher carbohydrate content compared to the stems. Comparative analysis between the two species showed that Basella alba generally exhibited higher nutritional values in the leaves, particularly in protein and fiber, making it more suitable for human consumption as a nutritious leafy vegetable. In contrast, Basella rubra exhibited slightly higher fat content in its leaves compared to Basella alba, but overall, both species presented significant nutritional potential. The study emphasizes the importance of using standardized methods for nutrient profiling and highlights the comparative nutritional benefits of Basella alba and Basella rubra in various parts, particularly in the leaves, which could be valuable in enhancing dietary diversity and nutrition.

Keywords: Proximate analysis, AOAC, Basella alba, Basella rubra, Nutritional assessment.

1. INTRODUCTION

1.1. Malnutrition in Indian tribal areas: Malnutrition remains a significant issue in many tribal areas of India, where poverty, inadequate access to healthcare, and lack of awareness about nutrition contribute to poor health outcomes [1]. Tribal communities often depend on traditional, limited food sources that lack essential nutrients, leading to deficiencies in vitamins, minerals, and proteins. Additionally, these regions may have limited access to clean water and sanitation, further exacerbating malnutrition-related diseases. Women and children are especially vulnerable, with high rates of undernutrition, stunting, and anemia. Efforts to address malnutrition in tribal areas must focus on improving healthcare, promoting sustainable agricultural practices, enhancing food security, and raising awareness about nutrition. Furthermore, governmental and non-governmental interventions, such as food distribution programs and nutrition education, are crucial to addressing the deep-rooted issue of malnutrition in these communities [2].

1.2. Green leafy vegetable, nutrition and its importance: Green leafy vegetables are rich in essential nutrients, making them a vital component of a healthy diet [3]. They are packed with vitamins such as A, C, and K, as well as minerals like iron, calcium, and magnesium, which are crucial for maintaining overall health. These vegetables are also high in fiber, promoting digestive health and helping to regulate blood sugar levels. The antioxidants present in green leafy vegetables help in reducing inflammation and protecting against chronic diseases like heart disease and cancer [4]. Additionally, their low-calorie content makes them an excellent choice for weight management. Regular consumption of green leafy vegetables can enhance immunity, improve bone health, and support healthy skin. Incorporating a variety of these vegetables into daily meals is essential for maintaining long- term health and well-being [5].

1.3. Nutritional evolution of Basella species: The nutritional evolution of Basella species, commonly known as Malabar spinach, highlights its growing recognition as a nutrient-dense leafy vegetable. Traditionally consumed in tropical and subtropical regions, Basella alba and Basella rubra have been valued for their rich content of Proteins, vitamins A, C, and B- complex, as well as minerals like iron, calcium, and magnesium [6]. Over time, scientific studies have revealed their high antioxidant potential due to bioactive compounds such as flavonoids, carotenoids, and phenolics, which contribute to health benefits like improved immunity and reduced oxidative stress. As interest in functional foods and plant-based diets has surged, Basella species have gained attention for their low calorie yet high nutrient profile, making them a popular choice in sustainable agriculture and health-focused diets. Additionally, their adaptability to diverse climates and resistance to pests further enhances their role in food security and nutritional advancements [7].

Basella species natural distribution and gradual cultivation in regions with favourable climates. Native to tropical Asia and Africa, Basella species thrive in warm, humid environments and are commonly found in home gardens, peri-urban areas, and small-scale farms. Their easy propagation through seeds and stem cuttings allows them to spread efficiently across neighbouring regions [8].

The species' adaptability to various soil types and resistance to drought have further facilitated their introduction to areas with limited agricultural resources. Over time, their high nutritional value and culinary versatility have made them a staple in local diets, fostering their cultivation in both rural and urban settings. This localized introduction pattern highlights the role of Basella as an accessible and sustainable green leafy vegetable in diverse communities, to obtain good amounts of several nutrients as it is widely accepted that Malabar spinach are significant nutritional sources of minerals. The Adilabad region of Telangana, India, is home to a rich diversity of indigenous plants, many of which hold significant nutritional value. These plants, often used by tribal communities, serve as vital sources of vitamins, minerals, and bioactive compounds [9]. Species such as Malabar spinach is rich in iron, calcium, and dietary fiber, supporting bone health and improving digestion. Basella species are notable for their protein content, vitamin C and antioxidants and for their roles in immunity and cognitive health. The use of these leafy green plants underscores the sustainable dietary practices of indigenous communities in the region while highlighting their importance in addressing malnutrition and promoting health [10].

The nutritional evaluations of such wild Basella species are very much important to find out any shortcoming in the daily food of the local public. In this study Basella species parts of and nutrient analysis, using standard AOAC methods.

2. MATERIALS AND METHODS

2.1 Sample collection:

The plant materials were collected from Adilabad agency area fields. Specific samples were obtained Genus and species was identified by plant taxonomist. Fresh Basella alba and Basella rubra samples (leaves, stems, fruits) were collected from a field in Adilabad, washed, rinsed, and drained. The samples were cut, blended, placed on clean stainless-steel plates, and labelled with sample details using a wax marking pencil, the stainless-steel plates containing the samples kept into hot air oven whose temperature is set at 60°C for overnight. Took them out and grounded the sample into powder and stored in containers for further analysis. Standard methodology was used for collection of plant samples (Humphry, 1993) and details of each plant's species in respect of scientific, family, and local names, parts used and status were noted [11].

Collection of samples (Fruits, Stem and Leaves) of Basella Species

Figure 1: Basella alba (Flower, Stem and Leaves)

Figure 2: Basella rubra (Stem and leaves)

Figure 3: Basella alba (Fruits)

Figure 4: Basella rubra (Fruits)

Malabar Spinach (Basella alba / Basella rubra) taxonomical classification [10].

- **Domain:** Eukaryota (organisms with cells containing a nucleus)
- **Kingdom:** Plantae (plants)
- **Division:** Magnoliophyta (flowering plants)
- **Class:** Magnoliopsida (dicotyledons)
- **Order:** Caryophyllales
- **Family:** Basellaceae
- **Genus:** *Basella*

2.2. Determination of moisture, ash and crude fiber contents:

Moisture in foods is measured using the gravimetric determination method, as specified by AOAC official method 934.01. In this method, the food sample is heated at 100–105°C until it reaches a constant weight. During this process, the moisture present in the sample evaporates, resulting in a reduced and stabilized weight. The difference between the initial and final weight of the sample represents the amount of moisture present in the given sample.

The organic substance is first charred to dryness [12]. It is then placed in a muffle furnace, where it undergoes complete decomposition, leaving behind only the ash.

The food sample is first gelatinized at 95°C and treated with α-amylase, protease, and amyloglucosidase to break down carbohydrates, proteins, and starches. The sample is then divided into two parts:

Insoluble Dietary Fiber (IDF): Determined by analyzing the filtered residue for protein and ash, with corrections applied.

Soluble Dietary Fiber (SDF): The filtrate is mixed with ethanol to precipitate SDF, which is filtered and analyzed separately.

The Total Dietary Fiber (TDF) is calculated by summing IDF and SDF values and adjusting for the reagent blank.

2.3. Determination of lipids, protein, carbohydrate contents:

Lipids are insoluble or sparingly soluble in water but soluble in organic solvents. Their solubility affects extraction efficiency and depends on the lipid type and the polar-to- nonpolar lipid ratio. A chloroform-methanol mixture is used to extract both lipid types, with lipids accumulating in the lower chloroform layer and non-lipid components in the upper methanol-water layer. The AOAC official method 954.01 uses the Kjeldahl method to determine protein content in food. Organic nitrogen is digested with sulfuric acid and a catalyst (potassium and copper sulfate), forming ammonium sulfate [13]. The solution is then made alkaline, releasing ammonia, which is distilled into sulfuric acid and back-titrated with sodium hydroxide to measure nitrogen content. The amount of total carbohydrates is determined by the method of "by difference calculation".

2.4. Statistical analysis This study, SPSS version 23 was used to analyze the nutrient values and bio-accessibility of different types of plants, specifically Basella alba and Basella rubra. The data were presented as mean ± standard deviation (SD), and a Mann-Whitney U test was employed to compare the significance of differences between the two plant species for different parts (leaves, stems, and fruits).

3. RESULTS

3.1. Moisture, ash and crude fiber contents

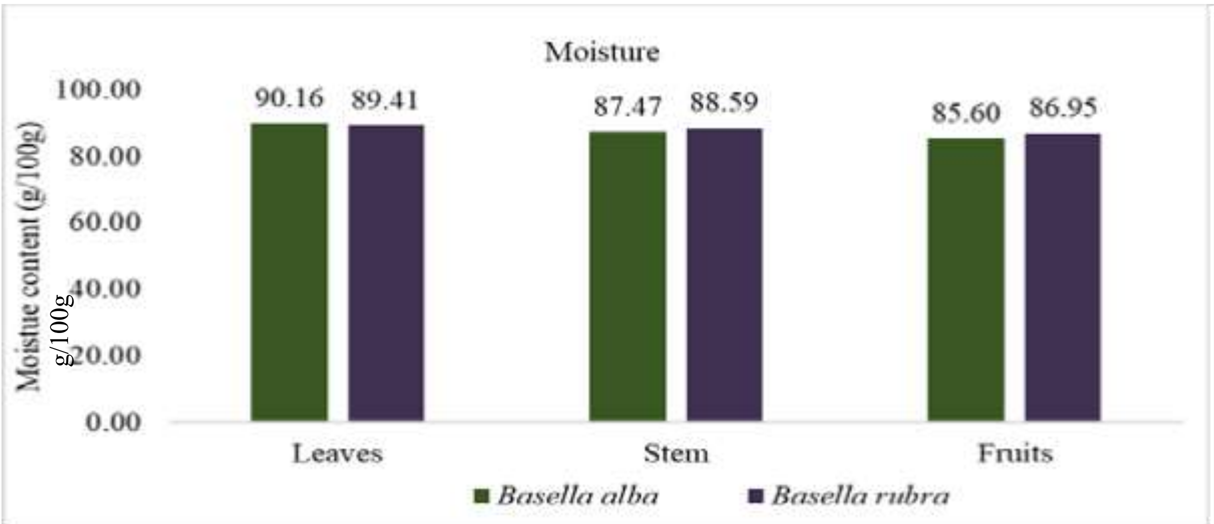


Figure 5: Graphical representation of Moisture content of Basella alba and Basella rubra

Moisture content is vital for the quality and shelf life of leafy greens. In this study, Basella alba leaves contain 90.16% moisture, slightly higher than Basella rubra leaves (89.41%). The moisture content in the stems is 87.47% (B. alba) and 88.59% (B. rubra), while in the fruits, it is 85.60% (B. alba) and 86.95% (B. rubra). Both species are highly hydrating, making them beneficial in warm climates. [17-18] The slight variations in moisture levels may affect their texture, flavour, and culinary uses—leaves may be ideal raw, while fruits and stems may be better suited for cooking due to their lower moisture content.

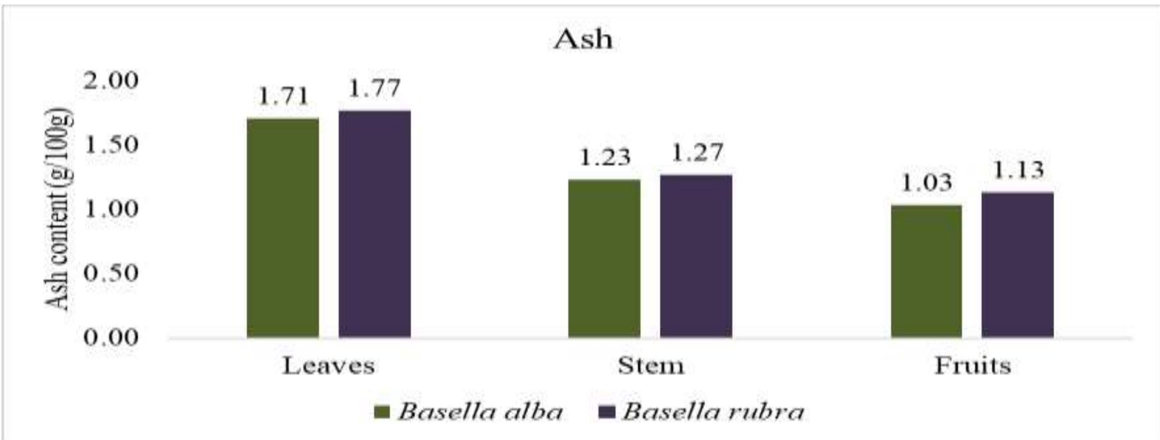
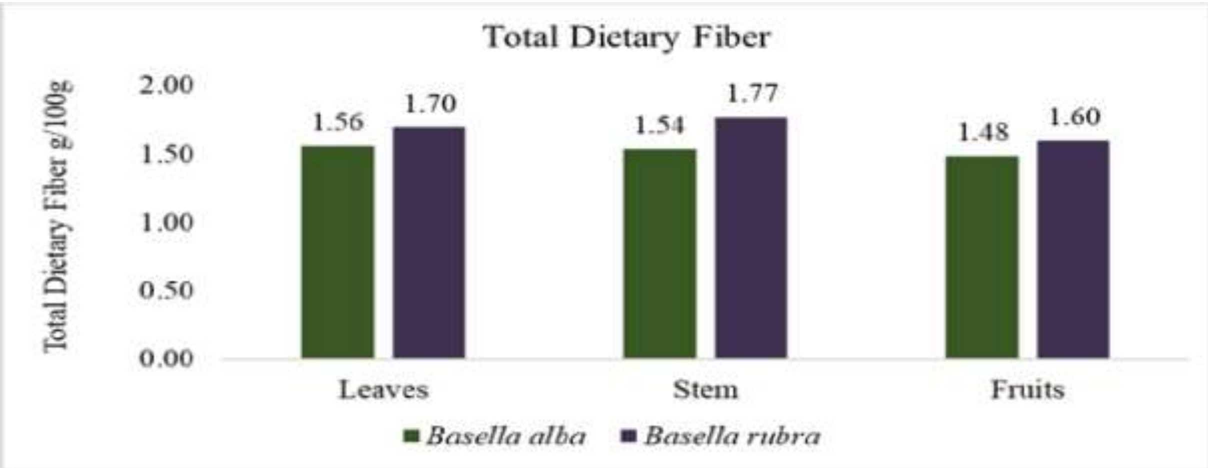


Figure 6: Graphical representation of Ash content of Basella alba and Basella rubra

Ash content indicates the overall mineral content of plant material. In this study, Basella rubra leaves have a slightly higher ash content (1.77%) than Basella alba leaves (1.71%). Similarly, Basella rubra has higher ash content in its fruits (1.23%) and stems (1.27%) compared to Basella alba fruits (1.03%) and stems (1.23%). Ash content reflects the presence of essential minerals like calcium, magnesium, and potassium, which support nerve function, bone health, and fluid balance [19-21]. While both species are rich in minerals, the slightly higher ash content in Basella rubra suggests a superior mineral profile.

Figure 7: Graphical representation of Total dietary fiber of Basella alba and Basella rubra



Dietary fiber is essential for digestive health, blood sugar control, and weight management [22]. It includes soluble dietary fiber (SDF), insoluble dietary fiber (IDF), and total dietary fiber (TDF), each with specific digestive functions. In this study, Basella rubra has a slightly higher TDF content in its leaves (1.70%), stems (1.77%), and fruits (1.60%) compared to Basella alba (1.56%, 1.54%, and 1.48%, respectively). IDF, which supports bowel regularity, follows a similar pattern, with Basella rubra showing slightly higher levels. Both species have comparable SDF content, which helps lower blood sugar and cholesterol, contributing to heart health. While both species are rich in fiber, Basella rubra has a slight advantage, making it particularly beneficial for gut health, preventing constipation, and managing conditions like diabetes and high cholesterol.

3.2. Protein, fat, carbohydrate and energy contents:

Protein is essential for enzyme production, tissue repair, and growth. In this study:

- Leaves: Basella rubra (2.90%), Basella alba (2.73%)
- Stems: Basella rubra (1.67%), Basella alba (1.53%)
- Fruits: Basella rubra (1.43%), Basella alba (1.17%)

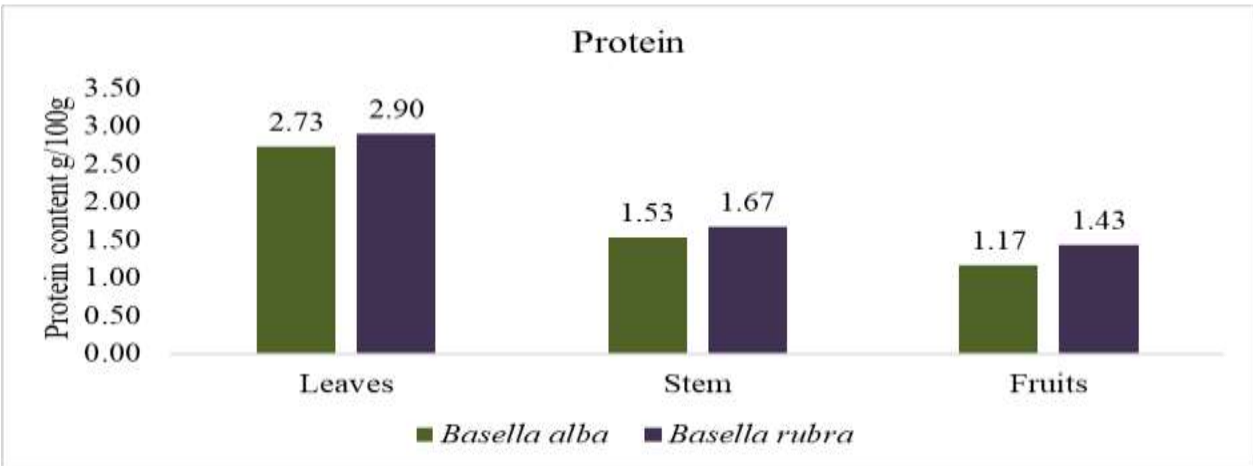


Figure 8: Graphical representation of Protein content of Basella alba and Basella rubra

Basella rubra has slightly higher protein content in all parts, making it a better plant-based protein source [23]. However, both species are nutrient-rich and valuable for vegetarian or vegan diets. Since boiling reduces protein availability, consuming leaves raw or lightly cooked helps retain protein levels.

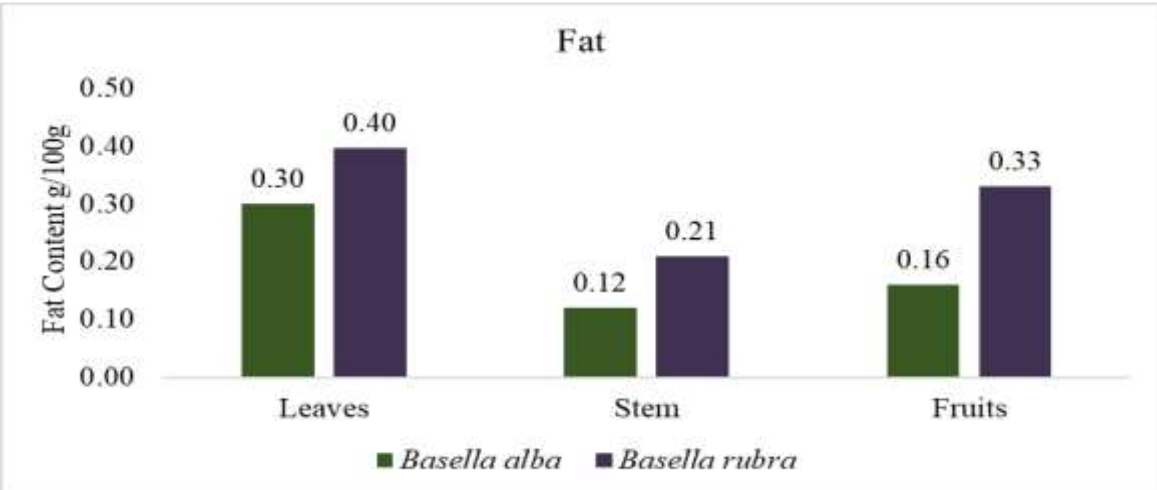


Figure 9: Graphical representation of Fat content of Basella alba and Basella rubra

Basella species have low fat content, making them ideal for low-calorie diets, heart health, and weight management. In this study

- Leaves: Basella rubra (0.40%), Basella alba (0.30%)
- Stems: Basella rubra (0.21%), Basella alba (0.12%)
- Fruits: Basella rubra (0.33%), Basella alba (0.16%)

While Basella rubra has slightly higher fat content, both species contain minimal fat, primarily unsaturated, which supports cell function and overall health [24-25]. The minor variations may be due to genetic or environmental factors.

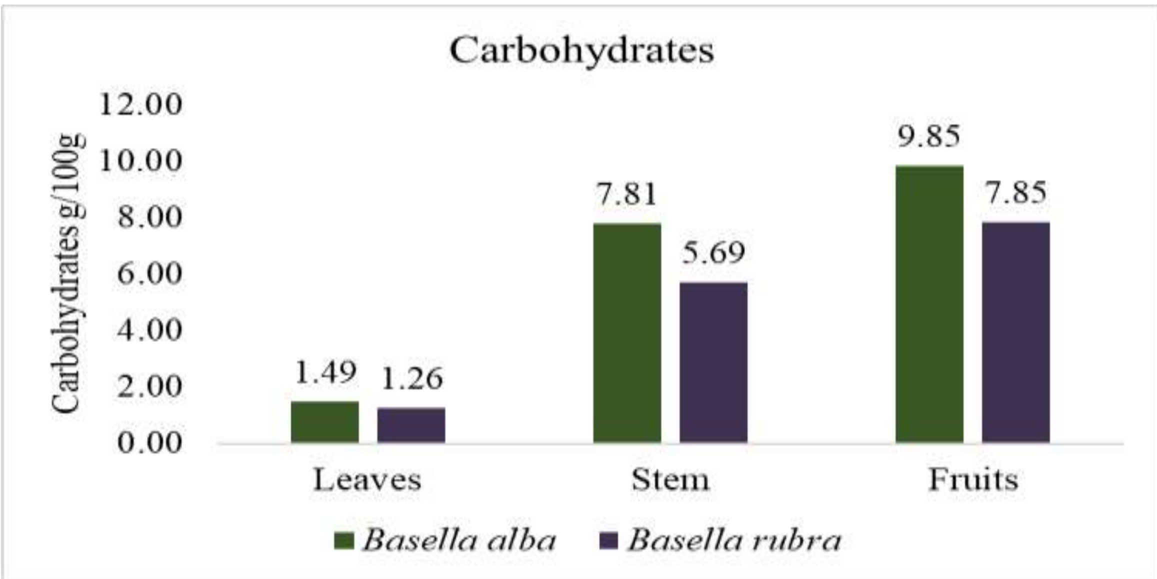


Figure 10: Graphical representation of Carbohydrate content of Basella alba and Basella rubra

Carbohydrates are the primary energy source in the human diet, especially in plant-based foods. In **Basella species**, carbohydrate content varies across different plant parts.

Leaves: Basella alba (1.49%) has slightly more carbohydrates than Basella rubra (1.26%).
Stems: Basella alba (7.81%) also contains more carbohydrates than Basella rubra (5.69%).
Fruits: The highest carbohydrate content is in the fruits, with Basella alba at 9.85% and Basella rubra at 7.85%.
This indicates that Basella alba generally contributes more energy than Basella rubra [26].

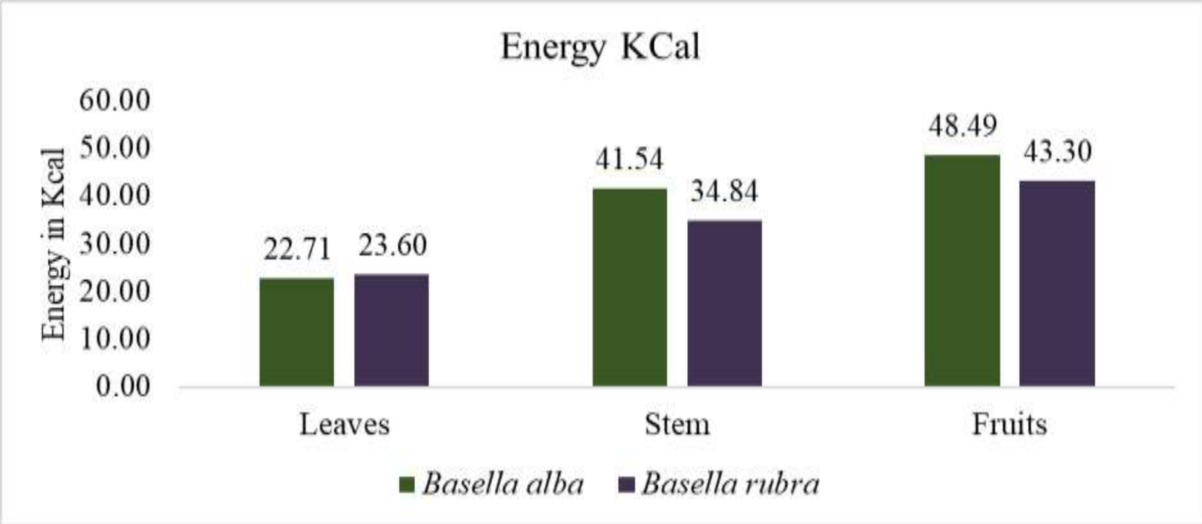


Figure 11: Graphical representation of Energy in Basella alba and Basella rubra

The energy value of Basella species varies across different plant parts:
Leaves: Basella alba (22.71 kcal/100g) has slightly less energy than Basella rubra (23.60 kcal/100g), though both are low-calorie.
Stems: Basella alba (41.54 kcal/100g) contains more energy than Basella rubra (34.84 kcal/100g).
Fruits: Basella alba (48.49 kcal/100g) has a higher energy value than Basella rubra (43.30 kcal/100g).
Since Basella alba has more carbohydrates, it provides higher energy, making it a better option in diets where calorie intake is important, especially in food-scarce regions [27].

3.3. Statistical analysis:

The Statistical analysis shows a significant difference between two plant species, supporting the hypothesis that improving dietary patterns can effectively reduce iron deficiency anemia prevalence**.** The findings align with national health programs such as the Anemia Mukt Bharat (AMB) program, emphasizing the need for sustainable, food-based interventions tailored to tribal populations [30].

Table 1: Statistical analysis on Proximate Analysis of Basella alba and Basella rubra leaves

Test	Moisture	Ash	Fat	Protein	TDF	IDF	SDF	Carbohydrates	Energy (kcal)
Mann- Whitney U	4.000	3.000	1.000	2.000	2.000	2.000	2.000	4.000	0.000

Interpretation

Based on the fact that the exact and asymptotic p-values are both more than 0.05, there is no statistically significant difference in the moisture content between the groups. Based on the p-values, there is no significant difference in the ash content across the groups. The fat content does not exhibit a statistically significant difference, since the p-values surpass the 0.05 cutoff. There is no discernible variation in the protein composition across the groups. Regarding TDF content, there is no discernible variation. There are no appreciable differences in content between the groups in

IDF and SDF. There are no appreciable differences in the amount of carbohydrates in the study leaf samples. demonstrated a notable variation in energy.

Table 2: Statistical Analysis on Proximate Analysis of Basella alba and Basella rubra stems

Test	Moisture	Ash	Fat	Protein	TDF	IDF	SDF	Carbohydrates	Energy (kcal)
Mann- Whitney U	2.000	3.000	0.000	2.500	0.000	2.500	0.000	2.000	0.000

Since the p-values for moisture, ash, protein, IDF, and carbohydrate content are higher than the 0.05 value threshold, there is no discernible difference. The asymptotic p-value of 0.046 and the exact p-value of 0.100 both show a significant difference in the fat content of the two plant species. The marginal significance of the p-value (0.050 for asymptotic and 0.100 for exact) suggests that there might be a variation in the TDF and SDF content amongst the plant species. demonstrated a notable variation in energy.

Table 3: Statistical Analysis on Proximate Analysis of Basella alba and Basella rubra Fruits

Test	Moisture	Ash	Fat	Protein	TDF	IDF	SDF	Carbohydrates	Energy (kcal)
Mann- Whitne U	0.000	1.000	0.000	1.500	2.000	4.000	0.000	0.000	0.000

A marginally significant variation in moisture content between Basella alba and Basella rubra is indicated by the asymptotic significance p-value of 0.050. The precise p-value of 0.100 indicates that the finding is not very significant. A marginally significant difference in fat content between the two plant species is indicated by a p-value of 0.050 for asymptotic significance. Although the difference is not statistically significant, the exact p-value of 0.100 supports this conclusion. A marginally significant difference in SDF content between Basella alba and Basella rubra is indicated by the asymptotic significance p-value of 0.050. Although a difference exists, it is not very significant, according to the precise p-value of 0.100.

Table 4: Marginal Significant variations of Proximate Analysis

Leaves of Basella Alba and Basella Rubra	Demonstrated aa notable variation in energy
Stems of Basella Alba and Basella Rubra	Demonstrated a notable variation in Fat, SDF, Energy
Fruits of Basella Alba and Basella Rubra	Demonstrated a notable variation in Moisture, Fat, SDF, Carbs, Energy

4. DISCUSSION:

The proximate analysis of Basella alba and Basella rubra revealed significant differences in their nutritional composition per 100g of fresh weight. In terms of moisture content, Basella alba leaves contained a higher amount than Basella rubra leaves. However, the moisture content in the stems and fruits of Basella rubra was greater than that of Basella alba. Regarding protein content, Basella rubra exhibited higher values in all parts, including leaves, stems, and fruits, compared to Basella alba [28]. Similarly, the ash content, which indicates the total mineral composition, was also higher in the leaves, stems, and fruits of Basella rubra than in Basella alba. The fat content followed the same trend, with Basella rubra containing more fat in its leaves, stems, and fruits compared to Basella alba. In terms of total dietary fiber, Basella rubra consistently had a higher content across all parts than Basella alba, indicating its potential for better digestion and gut health benefits.

Conversely, the carbohydrate content showed an opposite pattern, with Basella alba having higher carbohydrate levels in its leaves, stems, and fruits compared to Basella rubra. This suggests that Basella alba may serve as a better energy source due to its carbohydrate richness. Finally, the energy content varied between the two species [29]. While Basella rubra leaves contained more energy than Basella alba leaves, the stems and fruits of Basella alba had a higher energy content than those of Basella rubra. These findings highlight the nutritional advantages of both species, depending on the specific dietary needs.

The leaves of Basella alba and Basella rubra show a notable variation in energy content, which may be due to differences in their metabolic composition and pigment concentration. The stems of both varieties exhibit significant variation in fat, soluble dietary fiber (SDF), and energy, likely influenced by differences in their structural composition and nutrient storage. The presence of higher fat in the stems suggests possible variations in lipid accumulation between the two species. Additionally, differences in SDF indicate potential variations in their fiber composition, affecting digestion and gut health. The fruits of Basella alba and Basella rubra display notable variation in moisture, fat, SDF, carbohydrates, and energy, likely due to differences in water retention, sugar composition, and nutrient density. The moisture variation affects the texture and shelf life of the fruits. Carbohydrate differences impact their energy contribution, influencing their role in the diet. The fat variation in fruits suggests different lipid compositions, which may affect flavour and nutrient absorption. Overall, these variations highlight the distinct nutritional profiles of Basella alba and Basella rubra, making them unique in their dietary contributions.

5. CONCLUSION:

The comparative analysis of Basella alba and Basella rubra highlights significant differences in their nutritional composition. Basella rubra generally exhibits higher levels of protein, ash, fat, dietary fiber, and energy in its leaves, making it a more nutrient-dense option for consumption. On the other hand, Basella alba contains higher carbohydrate content in all its parts, suggesting that it may be a better source of energy from carbohydrates. The moisture content varies, with Basella alba leaves having higher moisture than Basella rubra leaves, while Basella rubra stems and fruits contain more moisture than Basella alba. These findings suggest that both species offer unique health benefits and can be incorporated into diets based on specific nutritional needs.

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