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Nutritional potential of some wild edible fruits of Shinyanga region, Tanzania

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Abstract: Wild edible fruits play a crucial role in human nutrition and cannot be disregarded due to their importance for human health. In Tanzania, particularly in the Miombo woodland of the Shinyanga region, wild edible fruits are primarily consumed by local communities. However, information on the nutritional composition of these fruits is limited. This study analyzed four selected wild edible fruits using standard procedures. Crude fat, fibre, protein, ash, moisture, and carbohydrates were determined following AOAC methods. Mineral content was determined using the method described by Allen (1989). Vitamins were determined using the method outlined by Klein and Perry (1982). ANOVA and post hoc were used for statistical test. The results show that the proximate composition, carbohydrates, and vitamin content of *Tamarindus indica*, *Adansonia digitata*, *Akocanthera schimperi*, and *Vitex doniana* exhibited the following ranges: moisture (12.68–77.90%), crude protein (3.20–12.37%), crude fat (1.14–21.40%), crude fibre (1.20–15.4%), total ash (3.60–9.30%), carbohydrates (20.78–45.64%), Vitamin B9 (2.24–12.64 mg/100g), Vitamin A (0.43–9.63 mg/100g), and Vitamin C (43.65–210.38 mg/100g). *Adansonia digitata*, compared to the studied fruits, was found to be an excellent source of protein with lower crude fat, while it was also high in carbohydrates and vitamins A and C. Additionally, *Akocanthera schimperi*, compared to the studied fruits, was rich in iron, zinc, sodium, magnesium, phosphorus, and manganese, while *Vitex doniana* had high levels of potassium and calcium. This study indicates that the four studied fruits can be valuable for improving nutrition, particularly for malnourished populations, and their increased consumption is recommended. Further studies on their potentially harmful compounds to human health are recommended.

Keywords: Nutritional composition, wild edible fruits, consumption, intake value
Abbreviations: AOAC_ Association of Official Analytical Chemists; AAS_ Atomic Absorption Spectroscopy; HPLC_ High-Performance Liquid Chromatography; DIV_ Daily Intake Values; SPSS_ Statistical Package for the Social Sciences; ANOVA_ Analysis of Variance; FAO_ Food and Agriculture Organization; WHO_ World Health Organization; B9_ Vitamin B9 (Folic Acid); mg/100g_ Milligrams per 100 grams; SPSS_ Statistical Package for the Social Sciences.

Introduction

Wild fruits are often considered neglected food items due to the lack of nutritional value data compared to cultivated fruits (Mpasiwakomu, 2017). Wild edible fruits contain vitamins, minerals, and antioxidants (Mpasiwakomu, 2017). Vitamins such as Vitamin C, E, and A carotenoids, including beta-carotene (Vitamin A), act as defence antioxidants. These vitamins neutralise radicals such as O-OH, while glutathione scavenges many radicals including O2 OH and detoxifies oxidising air pollutants like ozone and NO2, and free radicals from cigarette smoke. Vitamin E scavenges peroxyl radicals produced during lipid peroxidation, thus protecting cell membranes. Flavonoids, a group of phenolic compounds present in plants, act as lipid peroxidation and lipoxygenase inhibitors (Yeung et al., 2018).

An important feature of vitamins is that they cannot be synthesised by the human body and must be obtained from the diet. Insufficient intake of vitamins can result from poverty and food preferences. Food preferences are often more critical than poverty, as neglected foods, which are good sources of vitamins such as wild fruits, are not consumed regularly. For example, Vitamin B9 (Folic acid) is found in small amounts in commonly consumed plants like spinach and seasonal fruits such as oranges and melons (Yeung, 2017). However, wild fruits and vegetables may provide sufficient Vitamin B9 to meet daily intake values (DIV). Vitamin B9 is a water-soluble compound that helps prevent heart diseases and congenital malformations in fetuses (Yeung, 2017).

Mineral nutrients serve various purposes in body development and maintenance. Some minerals, including calcium, phosphorus, potassium, iron, and sodium, are needed in large amounts, while others like zinc, manganese, and sometimes chromium are needed in smaller amounts. Unfortunately, many diets lack sufficient amounts of these essential minerals, leading to inadequate daily intake (Yeung, 2018).

The Miombo woodland provides various products and ecosystem services to indigenous people. It offers a variety of wild edible fruits to local communities, and their consumption has been emphasised (WHO-FAO, 2004; Daudet, 2012; Mpasiwakomu et al., 2017). Chakravarty et al. (2016) report high mineral nutrient richness, sugar, fibre, and antioxidant potential in wild edible fruits.

Wild edible fruits have significant potential to meet nutritional needs for poor families in rural areas near woodlands and can contribute to food security and household income. However, there are limited studies informing local communities about the value of wild edible fruits. Several studies indicate that Africa is rich in wild fruits (Motlhanka and Makhabu, 2011; Awodoyin et al., 2015; Oryema and Oryem-Origa, 2016; Kouassi et al., 2019). Yet, the composition of wild edible fruits in different parts of the Miombo woodland is not well understood. The Miombo woodland has been shrinking due to land clearance for crop farming and settlement as human populations increase (Walker and Desanker, 2004).

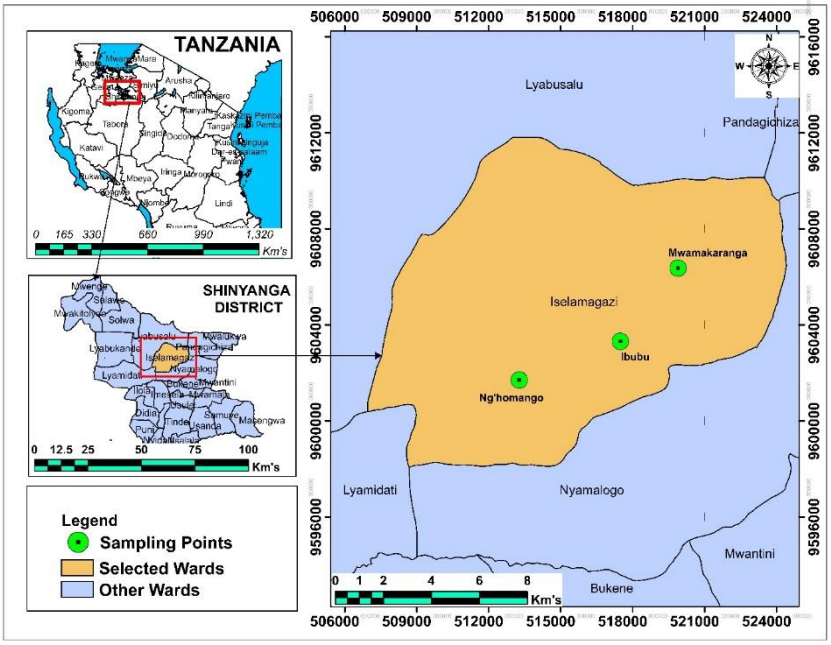

Figure 1. Map showing study areas (source: IRA 2024).

Table 1. Mineral nutrients obtained from wild fruit extracts.

	Composition (mg/100 g)							
Wild fruit	**Iron (Fe)**	**Sodium (Na)**	**Magnesium (mg)**	**Calcium (Ca)**	**Phosphorus (P)**	**Potassium (K)**	**Zinc (Zn)**	**Manganese (Mn)**
Tamarindus indica	27.56±0.02^{b}	32.76±0.06^{a}	23.78±0.2^{a}	668.47±0.4^{b}	18.59±0.39^{a}	362.73±0.12^{a}	15.84±0.36^{b}	1.36±0.08^{a}
Adansonia digitata	12.50±0.02^{a}	35.66±0.06^{a}	23.84±0.2^{a}	613.77±0.4^{b}	18.96±0.2^{a}	922.93±0.12^{c}	1.60±0.36^{a}	0.70±0.08^{a}
Akocanthera schimperi	162.78±0.02^{d}	487.26±0.06^{b}	632.98±0.2^{c}	281.77±0.4^{a}	448.70±0.2^{d}	407.73±0.12^{b}	52.83±0.36^{c}	32.48±0.08^{c}
Vitex doniana	85.62±0.02^{c}	270.62±0.06^{c}	287.68±0.2^{b}	1127.67±0.4^{c}	316.40±0.2^{c}	3658.24±0.12^{e}	2.88±0.36^{a}	0.55±0.08^{a}
P - Value	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

Means not followed by the same superscript letters in each column of the underutilised wild edible fruits are significantly (P < .05) different from each other. Data is expressed as mean ± standard error of replicate determinations (P = 3).

Tamarindus indica (Tamarind): Native to Africa, tamarind is a tropical tree that produces brown, pod-like fruit with a tangy, sweet-sour flavour. The fruit is used in a variety of culinary dishes, from sauces and chutneys to beverages and candies. The tamarind tree thrives in hot climates and is valued not only for its culinary uses but also for its medicinal properties and as a source of timber (Awodoyin et al., 2015).

Adansonia digitata (Baobab): Commonly known as the baobab or "the tree of life," this tree is native to Africa and parts of Madagascar. It produces large, oval fruits with a hard, woody shell. Inside, the fruit has a dry, powdery pulp that is rich in Vitamin C, antioxidants, and fibre. The baobab tree is renowned for its ability to store large amounts of water in its trunk, making it crucial in arid environments. Its leaves, seeds, and fruit are all used in traditional medicine and cuisine (Awodoyin et al., 2015).

Akocanthera schimperi (Schimper's Oleander): Native to East Africa, this plant produces small, greenish-yellow fruits that are toxic if ingested. The plant is related to the oleander and is known for its use in traditional medicine and as a natural insecticide. Despite its toxicity, it has cultural significance in some African communities where it is used in rituals and medicine (Awodoyin et al., 2015).

Vitex doniana (Black Plum): Also known as the black plum or 'dodo,' this fruit is native to tropical Africa. The tree produces small, dark purple to black fruits that are sweet and juicy when ripe. The fruit is eaten fresh or used in various culinary preparations. The *Vitex doniana* tree also has medicinal uses and is valued for its wood and shade (Awodoyin et al., 2015).

Given the limited knowledge of the nutritional quality of wild edible fruits in Miombo woodland regions of Shinyanga and other areas of Tanzania, this study aimed to establish data on the potential benefits of these fruits for health improvement at minimal cost. The study investigated the vitamin, mineral, and nutrient composition of wild edible fruits from the Shinyanga region in Tanzania.

Results and Discussion

Results of the analyses for both mineral nutrients and proximate composition are presented in Tables 1 and 2 at the end of the document.

Tamarind is high in Vitamin C, which is beneficial for immune function and skin health. It also provides a moderate amount of carbohydrates and fibre. Its moisture content is quite high, which may contribute to its perishable nature. Overall, tamarind is suitable for consumption and provides valuable nutrients, especially Vitamin C. *Tamarindus indica* is a good source of iron and zinc but lacks magnesium, calcium, phosphorus, and potassium, which are safe and beneficial to humans according to standard and recommended daily intake of mineral nutrients for adults (Awodoyin et al., 2015).

Baobab has a high Vitamin C content and is rich in fibre and protein. Its carbohydrate content is also significant, making it a good energy source. The high moisture content suggests it might be more perishable, but its nutritional profile indicates it is highly beneficial and suitable for consumption. *Adansonia digitata* provides moderate iron and calcium but is low in most other minerals. With this level of mineral nutrients, the fruit is recommended for human consumption according to recommended daily intake of mineral nutrients for adults (Awodoyin et al., 2015). The fruit is an option for those seeking protein-rich, low-fat foods. Additionally, its high carbohydrate

Table 2. Proximate composition, reducing sugar and vitamins of the indigenous fruit species.

Wild fruit	Composition								
	Moisture	Ash	Crude protein	Crude fat	Crude fibre	VIT B9	VIT A	VIT C	Carbohydrate
Tamarindus indica	68.60±0.33^{c}	3.60±0.14^{a}	3.20±0.03^{b}	1.74±0.02^{a}	3.33±0.02^{a}	2.24±0.02^{c}	4.60±0.07^{b}	170.58±1.95^{d}	20.78±0.05^{a}
Adansonia digitata	77.90±0.30^{a}	8.85±0.14^{b}	12.37±0.06^{d}	1.50±0.01^{a}	8.17±0.15^{c}	11.05±0.03^{a}	9.63±0.03^{d}	210.38±0.16^{a}	45.64±0.05^{b}
Akocanthera schimperi	42.33±0.37^{b}	4.81±0.08^{d}	3.53±0.23^{a}	2.51±0.02^{ab}	15.4±0.36^{d}	2.44±0.02^{c}	8.17±0.06^{e}	120.70±0.32^{c}	34.90±0.05^{d}
Vitex doniana	12.68±0.09^{a}	9.30±0.36^{e}	10.9±0.26^{e}	21.40±0.26^{c}	1.20±0.20^{a}	12.64±0.34^{d}	0.43±0.02^{a}	43.65±0.04^{b}	32.44±0.05^{c}
P - Value	> 0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

Means not followed by the same superscript letters in each column of the underutilised wild edible fruits are significantly (P < .05) different from each other. Data is expressed as mean ± standard error of replicate determinations (P = 3).

content, along with substantial amounts of vitamins A and C, further enhances its nutritional profile. Mapunda et al. (2019) and Mapunda and Mligo (2019) reported a similar nutritional profile for *Adansonia digitata* compared to other wild edible fruits from the southern regions of Tanzania.

Akocanthera schimperi is notable for its high mineral content, especially in terms of iron and zinc, which are critical for various physiological functions, including oxygen transport and immune response. It also has a significant amount of potassium and magnesium. However, caution should be exercised as some parts of the plant are toxic. This makes it important to ensure proper handling and preparation before consumption. Despite its toxic nature, *Akocanthera schimperi* is potentially beneficial for providing essential minerals if used correctly (Mpasiwakomu et al., 2017).

Vitex doniana has a high potassium and calcium content, which is important for bone health and cellular function. The fruit also contains notable amounts of iron and magnesium, contributing to overall nutritional value. Its high potassium content is particularly beneficial for cardiovascular health. The mineral content suggests that this fruit is a valuable dietary addition for maintaining electrolyte balance and bone health. This finding aligns with other research indicating that wild edible fruits can offer significant nutritional benefits (Mpasiwakomu et al., 2017).

Materials and Methods

Geographical description of the study area

The area primarily consists of well-drained sandy loams and sandy soils. These soils are typically found in the semi-arid regions of Tanzania and are often characterised by low fertility, which may necessitate the use of fertilisers for optimal agricultural productivity. The soil in Iselamagazi is generally low in organic matter, and the sandy texture leads to relatively quick drainage but may also mean lower water retention (FAO, 1982).

The region experiences a semi-arid climate with average annual rainfall ranging from 600 mm to 800 mm. Rainfall is usually concentrated in the rainy season, which typically spans from November to April. Rainfall is often erratic, and there can be significant variability from year to year. The majority of precipitation occurs during the long rains (usually from March to May) and short rains (from November to December) (FAO, 1984).

The area experiences warm to hot temperatures throughout the year. Average temperatures typically range from 20°C to 30°C. Daytime temperatures can exceed 30°C, while nighttime temperatures can drop to around 20°C. There is limited seasonal variation in temperature, with relatively consistent warmth throughout the year (1984).

The natural vegetation is primarily composed of dry, deciduous woodland and savanna. Trees such as acacia and baobab are common, along with various grasses adapted to semi-arid conditions. The vegetation is adapted to withstand dry conditions, with many plants having drought-resistant features (1984).

In terms of cultivation, the area supports a range of fruit plants that are well-suited to the semi-arid environment. The fruit plants in this area include mango, tamarind, baobab, guava, papaya, black plum, Schimper's Oleander, and citrus trees (1984).

Fruit collection

Four wild edible fruits were collected from three villages in Iselamagazi ward (Ibubu, Ng'omango and Mwamakaranga) of Shinyanga region, Tanzania (33° 8'14.52"E to 33° 8'26.97"E and 3°32'28.44"S to 3°32'40.38"S) during the peak harvest season (Figure 1). The fruits selected were *Tamarindus indica* (tamarind), *Adansonia digitata* (baobab), *Akocanthera schimperi* (Schimper's Oleander), and *Vitex doniana* (black plum). Fruits were collected in clean, labelled containers and transported to the laboratory for analysis.

Sampling setup and techniques

To determine the number of blocks and replicates for realistic sampling of the wild fruits based on their compositional data, a balanced statistical rigor with practical constraints approach was established (Zar, 2010): **Number of Replicates:** Replicates are individual samples taken from each block or treatment. The aim is to ensure that sample means are reliable and can accurately reflect the population's mean (Middleton, 2023). **Minimum Number of Replicates:** For a basic analysis, 3-5 replicates per treatment are often sufficient. This allows estimating the variability within each treatment group and testing for statistical significance (Middleton, 2023). **Recommended Number of Replicates:** For more robust and reliable results, aim for 5-10 replicates per treatment. This will help account for natural variability and improve the accuracy of the results (Zar, 2010). **Number of Blocks:** Blocks are used to control for variability in the experimental conditions, often representing different times, locations, or other sources of variability (Middleton, 2023). **Minimum Number of Blocks:** At least 2-3 blocks are usually necessary to effectively account for variability and to validate that the differences observed are not due to block effects. **Recommended Number of Blocks:** Ideally, 4-6 blocks are recommended. This number helps to control for variability and increase the reliability of the results (Zar, 2010).

Practical considerations

Availability of samples: Ensure to have enough of the wild fruits to perform the required number of replicates and blocks. **Homogeneity of Sample:** Ensure that samples are as homogeneous as possible to reduce variability within each treatment or block (Middleton, 2023). **Consistency in measurement:** Use consistent methods for measuring the composition to reduce potential sources of error. **Suggested setup for the 4 wild fruits:** For a study with 4 wild fruit types, it is suggested to have: **Replicates:** 5 per fruit type × 4 fruit types = 20 samples in total per block. **Blocks:** 4 blocks × 20 samples per block = 80 samples in total. This setup would provide a good balance between statistical power and practical feasibility, allowing for reliable estimation of the composition of each wild fruit and any significant differences among them (Zar, 2010).

Sample preparation

Collected fruits were cleaned, sorted, and washed to remove any dirt or contaminants. The edible parts of the fruits were separated from non-edible parts and then dried in a well-ventilated area to reduce moisture content. Dried samples were ground into a fine powder using a laboratory grinder.

Proximate analysis

The proximate composition of the fruit powders was determined using standard methods of AOAC (AOAC, 2000). Moisture content was measured by drying samples to a constant weight. Crude protein was determined by the Kjeldahl method, crude fat by Soxhlet extraction, crude fibre by the acid-detergent fibre method, and total ash by incineration in a muffle furnace. Carbohydrate content was calculated by difference.

Mineral content analysis

Mineral content was determined using atomic absorption spectroscopy (AAS) for elements such as calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc. Samples were digested with nitric acid before analysis.

Vitamin content analysis

Vitamins were extracted from the fruit powders and analysed using high-performance liquid chromatography (HPLC). The content of Vitamin A (as β-carotene), Vitamin C (ascorbic acid), and Vitamin B9 (folic acid) was determined based on standard calibration curves.

Statistical analysis

Data were analysed using SPSS statistical software to determine the mean, standard deviation, and significance of differences between fruit types. Analysis of variance (ANOVA) was used to compare the nutritional content of different wild fruits, and post-hoc tests were performed to identify significant differences. Results in Table 1 and 2 were compared to standard level for human consumption to recommend their suitability for human dietary and the recommendation summarized in Appendix 1 and 2. Appendix 3 was used to show species name, English name and fruits morphology.

Conclusion

Wild edible fruits from the Shinyanga region exhibit varying nutritional profiles that are rich in essential vitamins and minerals. The consumption of these fruits can significantly contribute to high improved nutrition and health for local communities. *Tamarindus indica* and *Adansonia digitata* offer vitamin and mineral content, while *Akocanthera schimperi* and *Vitex doniana* provide valuable minerals. Further research is recommended to explore potential harmful compounds and enhance the understanding of these fruits' health impacts. The study recommends providing awareness education to the community on the importance of consuming wild edible fruits in their daily diet to improve health and well-being. A study on the harmful compounds present in these fruits and their impact on human health is recommended.

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