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# Proximate and Mineral Composition of the Fruits of *Ziziphus mauritiana* Lam. (Rhamnaceae) and *Hypaena thebaica* L. (Arecaceae)

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**Abstract**
*The fruits of Ziziphus mauritiana and Hypaena thebaica are consumed by the people of Kano State, Nigeria for many centuries, however, the nutritional composition and medicinal values of the species growing in Kano State are not widely investigated. Thus, the present study was aimed at evaluating the proximate and mineral composition of their fruits using standard laboratory procedures. The results showed that the fruits of H. thebaica had the highest crude protein (9.03±0.21 %), moisture (7.28±0.01 %), crude lipid (0.62±0.01 %) and carbohydrate (72±0.06 %) contents, while the fruits of Z. mauritiana had the highest crude fibre (15.26±0.42 %) and ash (5.53±1.62 %) contents. Also, the mineral analysis showed that the fruits of H. thebaica had the highest potassium (350.52±0.50 mg/kg), magnesium (44.72±0.23 mg/kg), sodium (24.26±0.53 mg/kg), phosphorus (9.92±0.02 mg/kg), iron (12.65±0.51 mg/kg), selenium (9.81±0.29 mg/kg), copper (0.95±0.10 mg/kg), nickel (0.31±0.04 mg/kg), manganese (0.89±0.01 mg/kg) contents, while the fruits of Z. mauritiana had the highest calcium (190.95±0.15 mg/kg) content. The findings in this study showed that the fruits of H. thebaica and Z. mauritiana contain appreciable amounts of proximate, macro and microelements. Therefore, the fruits of these trees could be utilized as raw materials in food and pharmaceutical industries.*

**Keywords:** Fruits, *Hypaena thebaica*, Industries, Raw materials, *Ziziphus mauritiana*

## INTRODUCTION

*Ziziphus mauritiana* (Lam.) belongs to the family Rhamnaceae, it is commonly known as Indian Jujube or Chinese date, and locally called Magarya by the Hausa people of Northern Nigeria (Adzu *et al.*, 2001). It is a multipurpose tree; all parts of the plants are used by the Arab people

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in order to maintain a healthy lifestyle. The fruits have been reported to be a valuable source of vitamin C which can be eaten raw, pickled or used in beverages. The tree is also a valuable source of timber, which is used for making furniture and other household items (Nazif, 2002). Different parts of *Z. mauritiana* have been used in traditional medicine for many years to manage diabetes, cancer, inflammation, gastrointestinal disorders, respiratory infections, skin and liver diseases, asthma, fever and constipation (Farha *et al*., 2020). Some of the pharmacological activities of *Z. mauritiana* are antimicrobial (Najafi 2013; Sivasankari and Sankaravadivoo, 2015), antioxidant (Olajuyigbe and Afolayan, 2011) and antitumor (Lee *et al*., 2004).

On the other hand, *Hyphaene thebaica* (L.) belongs to the family Arecaceae. It is commonly referred to as Doum palm or ginger bread tree, and locally called Goruba in Hausa language. The doum palm is widely distributed in many African and Asian countries which include Benin, Cameroon, Chad, Congo, Egypt, Ethiopia, Gambia, Ghana, Libya, Mali, Niger, Nigeria, Saudi Arabia, Yemen, among others (Orwa *et al.,* 2009). The leaves of doum palm are probably the most important part which is used in basketry, making mats, brooms, coarse textiles, ropes, thatching, string among others (Moussa *et al*., 2000). Due to the high amount of fibers in its wood, it is often used for building, railway sleepers, planks and water ducts (Facciola *et al*., 2000). Also, the fruit is used as food, and the powder obtained from the outer covering of the fruits is added to water and milk and left to stand to make a mild alcoholic drink in some countries (Facciola *et al*., 2000), the powder is also applied in some food products as a source of fiber, stabilizer and minerals (Abd El-Rashid *et al.,* 2005). Pharmacologically, many studies showed that the fruits doum palm have hepatoprotective, antioxidant, anticancer, antidiabetic and anti-inflammatory properties (Shalaby, 2012; Aboshora, 2014; Fayad, 2015).

For many centuries, the fruits of *Z. mauritiana* and *H. thebaica* are consumed and grown by the people of Kano State, Nigeria, however, the nutritional composition and health benefits of the species growing in the State are not widely investigated, therefore, the present study was aimed at evaluating their proximate and mineral compositions.

## MATERIALS AND METHODS

### Collection of the Samples

Fresh fruits of *Z. mauritiana* and *H. thebaica* were purchased from Rimi Market, Kano State, Nigeria, they were then taken to the Herbarium of Ethnobotany Division of Bioresources Development Centre, Kano for identification and authentication, a reference number was assigned to each plant: *Z. mauritiana* (BDCKN/EB/2202) and *H. thebaica* (BDCKN/EB/2203).

### Proximate Analysis

#### i- Determination of Moisture Content

The moisture contents of the samples were measured using moisture analyzer, and the moisture content of each sample was recorded as percentage moisture (Ooi *et al*., 2012).

#### ii- Determination of Crude Lipid Content

Determination of crude lipid content of the samples was performed following Soxtec method previously described by Noureddini and Byun 2010, using a SoxtecTM 8000 automated analyzer (FOSS Analytical, Hillerød, Denmark). Petroleum ether was used for the extraction, and the percentage of crude lipid of each sample was obtained using the equation below:

$$Percentage\ Lipid = \frac{Weight_{extraction\ cup+residue} - Weight_{extraction\ cup}}{Weight\ sample} \times 100$$

**iii- Determination of Crude Protein Content**

The percentage of crude nitrogen content in each sample was determined according to method described by Ng et al. (2008) using Kjeltec 8400 Auto Distillation Unit (FOSS Tecator Line). A nitrogen-to-protein conversion factor of 6.25 was used for the determination the percentage of crude protein each sample;

$$\text{Percentage Nitrogen} = \frac{0.014 \times \text{Molarity} \times \text{Volume}}{\text{Weight of the sample}} \times 1000$$

Therefore,

% crude protein = 6.25x % Nitrogen

**iv- Determination of Ash Content**

The ash content of each sample was determined using dry ashing method as described by AOAC (2000), each sample was incinerated in a furnace at 550 °C, and the remaining inorganic material was cooled, weighed and the ash content was determined as follows;

$$\text{Percentage Ash} = \frac{\text{Weight after ashing } (W_3) - \text{Weight of empty crucible } (W_1)}{\text{Weight of crucible + sample before ashing } (W_2) - \text{Weight of empty crucible } (W_1)} \times 100$$

**v- Determination of Crude Fibre Content**

Determination of the crude fibre content of each sample was performed following instrumental method previously described by Noureddini and Byun (2010), using a Fibretec 8000 auto fibre analysis system (FOSS Analytical, Hillerød, Denmark). Approximately 2 g of the sample was put into a round bottom flask, then 100 ml of 0.25 M $H_2SO_4$ solution was added and the mixture was boiled under reflux for 30 minutes. The hot solution was quickly filtered under suction, and the insoluble matter was washed several times with hot water until it was acid free. It was transferred into the flask and 100 ml of 0.31 M NaOH solution was added and the mixture was boiled again under reflux for 30 minutes and quickly filtered under suction. The insoluble residue was washed with boiled water until it was base free, it was then dried at constant weight in the oven at 100 $^{o}$C, cooled in a desiccator and weighed ($W_1$). The weighed sample ($W_1$) was then incinerated in a muffle furnace at 550 $^{o}$C for two hours, cooled in a desiccator and reweighed ($W_2$) and the percentage crude fibre was calculated as follows;

$$\text{Percentage Fibre} = \frac{W_2 - W_1}{\text{Weight of the sample}} \times 100$$

**vi- Carbohydrate Content**

The total carbohydrate content (%) in the samples was calculated by difference method as follows;

% Carbohydrate = 100 - (% moisture + % ash + % protein + fibre + % lipid)

**Mineral Analysis**

The method described by Li *et al* (2013) was employed for the determination of the mineral elements in each sample; 200 mg of each was weighed and transferred into 90 ml microwave digestion vessel, 10 mL mixture of 15.9 N trace metal grade Nitric acid, hydrogen peroxide and perchloric acid (7:2:1) were added to the vessel. After standing for one hour, the sample was processed by microwave digestion system as follows: ramp temperature from ambient to 200 $^{o}$C over 20 minutes, then hold at 200 $^{o}$C for 20 minutes, after digestion, the sample was allowed cool to approximately 50 $^{o}$C or lower before handling. The digest was then transferred to 50 ml volumetric flask, the volume was adjusted to 50 ml with deionised water and filtered, and the mineral contents which include calcium, potassium, magnesium, sodium, phosphorus, iron, selenium, copper, nickel, sulphur, manganese and cobalt were analyzed using Agilent Micro Plasma Atomic Emission Spectrometer (MP-AES, 4210) available at the Centre for Dryland Agriculture, Bayero University, Kano, Nigeria.

**Statistical Analysis**

All determinations were carried out in triplicates, and data was expressed as mean ± standard deviation (SD).

## RESULTS

**Proximate Composition of the Fruits of *Ziziphus mauritiana* and *Hypaena thebaica***

The proximate analysis showed that the fruit of *H. thebaica* had the highest moisture, crude protein, crude lipid and carbohydrate contents, while the fruit of *Z. mauritiana* had the highest ash and crude fibre contents as shown in Table 1;

**Table 1: Proximate Composition of the Fruits of *Ziziphus mauritiana* and *Hypaena thebaica***

| S/N | Parameters Tested | *Ziziphus mauritiana* (%) | *Hypaena thebaica* (%) |
|---|---|---|---|
| 1 | Ash | 5.53±1.62 | 5.01±0.34 |
| 2 | Crude fibre | 15.26±0.42 | 6.06±0.38 |
| 3 | Crude lipid | 0.37±0.01 | 0.62±0.01 |
| 4 | Moisture | 3.36±0.12 | 7.28±0.01 |
| 5 | Crude protein | 8.23±0.15 | 9.03±0.21 |
| 6 | Carbohydrate | 67.25±0.34 | 72±0.06 |

All values were mean ± standard deviation of triplicate determinations

**Mineral Composition of the Fruits of *Ziziphus mauritiana* and *Hypaena thebaica***

The mineral analysis showed that the fruits of *H. thebaica* had the highest K, Mg, P, Fe, Se, Na, Cu, Ni, Mn content, while the fruits of *Z. mauritiana* had the highest Ca content. On the other hand, Co and S were not detected in the fruits of *Z. mauritiana* as presented in Table 2;

**Table 2: Mineral Composition of the Fruits of *Ziziphus mauritiana* and *Hypaena thebaica***

| S/N | Minerals | *Ziziphus mauritiana* (mg/kg) | *Hypaena thebaica* (mg/kg) |
|---|---|---|---|
| 1 | Ca | 190.95±0.15 | 130.97±0.09 |
| 2 | P | 6.34±0.25 | 9.92±0.02 |
| 3 | S | ND | 1.01±0.36 |
| 4 | Se | 1.18±0.30 | 9.81±0.29 |
| 5 | Fe | 8.84±0.46 | 12.65±0.51 |
| 6 | Cu | 0.64±018 | 0.95±0.10 |
| 7 | Ni | 0.26±0.06 | 0.31±0.04 |
| 8 | K | 238.42±0.35 | 350.52±0.50 |
| 9 | Co | ND | ND |
| 10 | Mg | 30.77±0.23 | 44.72±0.23 |
| 11 | Mn | 0.75±0.005 | 0.89±0.01 |
| 12 | Na | 20.21±0.03 | 24.26±0.53 |

All values were mean ± standard deviation of triplicate determinations
Key:
ND = Not Detected

## DISCUSSION

The proximate analysis showed that the fruit of *H. thebaica* contain the highest amount of crude protein content (9.03±0.21 %), and interestingly, the value reported in this study agreed with the value (9.26 %) reported by Bonde et al (1990). However, it was significantly higher than those reported by Datti et al (2020) and Hussein et al (2010) who reported a protein content of 2.86 % and 6.41 % respectively.

Similarly, the crude protein content (8.23±0.15 %) of the fruit of *Z. mauritiana* reported in this work was also significantly higher than the value (2.71 %) reported by Keta (2017). This is a good indication that the fruits of both plants could serve as potential sources of protein to humans and animals (Gordon and Kessel, 2002).

The study also showed that the fruit of *Z. mauritiana* had the highest crude fibre content (15.26±0.42 %); and the value reported in this work was significantly higher than the value reported in the previous study (Keta, 2017). On the other hand, the crude fibre content (6.06±0.38 %) detected in the fruit of *H. thebaica* was in agreement with the value (6.64 %) reported by Aboshora et al (2014), however, it was lower than the value (12.87 %) reported by Datti et al (2020). Foods rich in dietary fiber have many health benefits which include gastrointestinal health, decrease cholesterol and fat contents, reduction in the risk of obesity, diabetes, coronary heart disease, reduction of hyperlipidemia and hypertension (Anderson *et al*., 2009; Viuda-Martos *et al*., 2010; Brownlee, 2011).

The ash content represents the total mineral content in foods and other edible substances; higher ash content indicates higher mineral contents, and vice versa. The present study showed that there was no significant difference in the ash content of the two samples under investigation, and the values were found to be very close to those reported in the previous studies (Keta, 2017; Datti *et al*., 2020).

The moisture contents of the fruits of *Z. mauritiana* and *H. thebaica* were found to be 3.36±0.12 and 7.28±0.01 % respectively. The lower moisture content of the fruit of *Z. mauritiana* is an indication of good storage quality with minimal microbial contamination (Hassan and Umar, 2004). The moisture content of the fruit of *H. thebaica* was close to the value (8.64 %) reported in the previous study (Datti *et al*., 2020).

Also, it was observed that the fruits of both trees have very low crude lipid content; this suggests that the fruits could not be considered as good sources of lipid. On the other hand, the carbohydrate contents of both samples were found to be very high, thus, they could be considered as good sources of energy. Also, it was observed that the fruit of *H. thebaica* had the highest carbohydrate content (72±0.06 %), and this was in agreement with the values reported by many workers (Venn and Mann, 2004; Hussein *et al*., 2010; Babiker and Makki, 2013; Aboshora *et al*; 2014; Reda, 2015; Datti *et al*., 2020).

For the mineral composition, the study showed that calcium, magnesium, phosphorus, sodium, copper, iron, selenium, nickel and manganese were present in all the samples, while sulphur was only detected in the fruit of *H. thebaica*. It is worthy to note that both samples contain higher amounts of potassium and calcium which are essential elements that are required by the body in large amounts in order to function properly; potassium is needed for proper fluid balance, nerve transmission and muscle contraction in the body, while calcium is very important for healthy bones and teeth, muscles relaxation and contraction, nerve functioning, blood clotting and blood pressure. Many workers also reported the presence of potassium and calcium in large quantities in the fruits of these trees, this suggests that their fruits could be utilized as excellent sources of potassium and calcium (Admassu *et al*., 2013; Auwal *et al*., 2013; Aboshora *et al*., 2014; Keta, 2017; Datti *et al*., 2020).

Apart from potassium and calcium, the study also showed that the fruits of both trees contain appreciable quantities of sodium and magnesium which are also essential elements required by the body. The concentration of sodium (24.26±0.53 mg/kg) in the fruit of *H. thebaica* was much lower than the value (76.52 mg/kg) reported by other workers. On the other hand, the concentration of magnesium (44.72±0.23 mg/kg) in the fruit of *H. thebaica* was higher than the value (11.66 mg/kg) reported in the previous study (Auwat *et al*., 2013).

**CONCLUSION**

The findings in this study showed that the fruits of *H. thebaica* and *Z. mauritiana* contain appreciable amounts of proximate, macro and microelements, therefore, the fruits of these trees could be utilized as raw materials in food and pharmaceutical industries. It is recommended that the bioactive compounds responsible for the pharmacological activities of these important plants should be isolated, characterized and identified.

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