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STUDY ON THE CHEMICAL COMPOSITION OF JACKAL BERRY (*Diospyros mespiliformis*) FRUIT EDIBLE PART

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ABSTRACT

Some of the major challenges facing developing countries such as Nigeria are hunger and starvation due to the consumption of inadequate nutritive food. This ugly situation can be partially resolved, if good food rich in ascorbic acid and mineral contents are consumed. *Diospyros mespiliformis* is an indigenous wild-tree whose importance has not been fully explored. This study was aimed at investigating the proximate, ascorbic acid and mineral composition of the edible portion of the fruit. Matured samples of the fruit were collected from Bakiya village in Katsina state. The fruits edible portion was assessed for proximate, ascorbic acid and mineral content using standard procedure. The results obtained from the proximate analysis were (g/100g): Moisture content (13.11 ± 0.35), Crude fibre (3.37 ± 0.26), Ash content (2.20 ± 0.17), Crude fat (19.08 ± 0.46), Crude protein (6.01 ± 0.37), and Carbohydrate (56.55 ± 0.72). The mineral analyzed were (mg/100g): Copper (30.30 ± 5.833), Lead (5.063 ± 1.253), Iron (9.88 ± 2.136), Zinc (4.63 ± 2.12), Magnesium (24 ± 22.52), Calcium (69.44 ± 12.73), Sodium (14.45 ± 3.85) and Potassium (8.44 ± 4.43). The Vitamin analyzed was Vitamin C (24.56 ± 0.16 mg/100g). From the mineral analysis, Calcium is the most abundant indicating that fruit edible portion can be used for management of Oesteomalacia. The results also, indicated that Jackal berry fruit pulp could be promoted as carbohydrate and fat enhancement for rural communities. It can also serve as a raw material for juice and jam production.

Keywords: *Diospyros mespiliformis*, Fruit, Mineral composition, Proximate, Vitamins.

INTRODUCTION

Despite the availability of vast fertile land for agricultural activities in Nigeria. Food insecurity, scarcity, huger, poor health and malnutrition are some of the greatest challenges facing the country. This can be attributed to none diversification of crops, concentration on farming of fewer crops and rapid increase in the population. (Baldermann *et al.,* 2016; Ilouno *et al.,* 2018). Blössner *et al.*,(2005), defined malnutrition as the deficiency of nutrition because of the consumption of poor-nutrient food in respect of the daily nutritional requirement. In the underprivileged population it was estimated that around 800 million people suffer from food and nutrition deficiency. Also poor nutrition causes nearly half (45%) of deaths in children under five, which accounts for about 3.1 million children each year. Food security exists when all people at all, times, have physical, social and economic access to adequate, safe and healthy food to meet their dietary needs and food preferences for an active and healthy life (Otaha, 2013). Some cultivated food crops become scarce and expensive at the beginning of the planting season or during famine, particularly for low income earners. This causes food insecurity which exists when people are undernourished as a result of the physical absence of food, their lack of social or economic access to sufficient food. This triggers researchers' interest toward wild edible fruit as potential to complement stable food. The plantation of wild edible fruit can serve as a means of diversification of diet in rural and urban areas. Many of the wild edible fruit are seasonal and most of their fruit and fruits seeds become available at the beginning of the dry season or at the end of the year. Some may even last throughout the year. Wild edible fruit can be dried and used throughout the year. This is important as the fruits and their seeds can serve as food until the cultivated crops become available there by promoting dietary diversification (Ilouno *et al.,* 2018). However, majority of wild edible fruit are under-utilized despite their potential as a source of diet for people living in rural and urban areas. Massive plantation of wild edible fruit can serve as a means of dietary diversification, source of income and help in tackling the problem of climate change.

Diospyros mespiliformis, commonly known as jackal berry, African ebony, or jackal Bessie and in northern part of Nigeria, it's called kanya (Hausa), Nelbi (Fulani). It belongs to the family Ebenaceae and is extremely widespread in African countries such as Senegal east, Ethiopia, Kenya, South to Namibia, Northern South Africa, Swaziland and Nigeria (Ebbo *et al.*,2014; Maitera *et al.,* 2018). It is evergreen tree of 12-15m height but sometimes reaches up to 20m or more in the rain forest (Ebbo *et al.,* 2014). The leaves are simple alternate dark green with small heirs on the underside of old leaves. Flowing of the tree occur during the rainy season but fruit ripening takes place in the dry season (Ilouno *et al.,* 2018). The fruit of this

plant is a traditional food of high nutritive value in Africa. The leaf extract is used against fever and syphilis. It is also used as an anthelmintic and as wound dressing agent (Ebbo *et al.*, 2014). The fruit is yellowish to orange in colour and has a sweet lemon-like taste when it's ripe. It is eaten raw by children and adults or may be dried and kept for later use. There are about 4-6 seeds per fruit which are usually brown in colour and bean shaped (Ilouno *et al.,* 2018). However, research on *Diospyros mespiliformis* has focused on the medicinal use of the leaves, stem, bark and roots.

Ilouno *et al.,* (2018) reported proximate, mineral and anti-nutritional composition of jackal berry *Diospyros mespiliformis* seeds. They reported that *Diospyros mespiliformis* seeds have nutritional value comparable to conventional food crops. Ebbo *et al.,* (2014) reported preliminary phytochemical screening of *Diospyros mespiliformis*. The results showed the presence of tannins, saponins, alkaloids, flavonoids and glycosides in the extract of the root, leaf and bark of the plant. They concluded that *Diospyros mespiliformis* root, leaf and bark extract can be used to discovered new drugs. Dangoggo *et al.,* (2012) reported phytochemical Analysis and Antibacterial screening of leaves of *Diospyros mespiliformis* and *Ziziphus spine-chriti*. The phytochemical screening showed that both plants contain alkaloid, tannins, saponins, glycosides, steroids, flavonoids and terpenoids, while the antibacterial analysis showed that the leaves extract showed significant activity on both *S.aureus* and *shegella Spp.* They concluded that parts of *Diospyros mespiliformis* plant can serve as antibiotics. Shagal *et al.,*(2012) study the phytochemical and antimicrobial activity of roots, stem-bark and leaves extract of *Diospyros mespiliformis*, from the test carried out the result revealed the presence of saponins, tannins, volatile oils, alkaloids and phenols in both the leaves extract of the plants, while the antimicrobial activity show that both the plant extracts were active against *shigella sp, selmonella typhii, Escherichia coli* and *streptococcus sp*. They concluded that the plant extract can be used for treatment of disease caused by some pathogens. Mohamed *et al.,* (2009) reported high antioxidant activity of the bioactive phytochemicals such as alkaloids, tannins and saponins of the *Diospyros mespiliformis* and *Croton zambesicus* plant. Mann *et al.,*(2004) reported the presence of phytochemicals and unsaturated fatty acid in the pulp and seed extract of *Diospyros mespiliformis*. They concluded that *Diospyros mespiliformis* plant part could be used for antimicrobial activity. However, little information on the nutritional composition of the *Diospyros mespiliformis* fruit pulp was reported from literature. Therefore, this work is aimed at evaluating the proximate, ascorbic acid and mineral content of *Diospyros mespiliformis* fruit edible part with the hope that it will boost food security of Nigeria.

MATERIALS AND METHODS

Sample Collection and Preparation

Ripe fruit of *Diospyros mespiliformis* were collected from Bakiya village in Batagarawa Local Government Area of Katsina State, Nigeria. The samples were conveyed to the laboratory in sealed polyethylene bags. The seed were separated from the pulp using mortar and pestle, and the pulp was dried and crushed into powder form, sieved and stored in a sealed container before analysis.

Proximate analysis.

Determination of Moisture Content.

The moisture content was measured according to official methods of Association of official analytical chemists (AOAC). Crucible was washed with distilled water and oven dry at 105 ℃ for 3hrs, then cooled in a desicator and weighed. 3g of the sample in triplicate was placed inside the crucibles and then reweighed. The samples were dried in oven at 105 ℃ until a constant weight is obtained. The dried samples were then cooled and weighed. Moisture content in percentage of sample was then calculated.

$$Moisture\ content\ \% = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where w_1= Initial weight of empty crucible
w_2= Weight of crucible + sample prior to drying
w_3= Final weight of crucible + sample after drying

Determination of Ash

5g of sample in triplicate was measured inside crucible. It was then placed in muffle furnace at 550 ℃ for 3 hrs. until a light greyish residue is obtained. The crucible was then cooled in desiccator and the new (weight of crucible + Ash), was recorded. The ash content in percentage was calculated (AOAC);

$$Ash\ content\ \% = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where w_1= Weight of empty crucible; w_2= Weight of crucible + sample prior to ashing; w_3= Weight of crucible + Ash.

Determination of Crude fat

300 ml conical flask was washed with hot water and dried in oven at 105 ℃ for 3 minute and cooled in a desiccator and weigh. 300 ml of petroleum ether was poured into the flask. 2g of the sample was weighed and put inside the thimble. The extraction set-up was assembled and allowed to reflux for 8hrs. The heating rate was adjusted to temperature of $50 - 55$ ℃ so as to give a condensation rate of 2-3 drops/sec. The thimble was removed and the ether recovered and the remaining sample was dried at 105 ℃ for 1hr to remove the remaining solvent. It was then cooled in a desiccator and weigh. The crude fat was calculated as (AOAC):

$$Crude\ fat\ \% = \frac{W_1 - W_2}{W_1} \times 100$$

Where w_1= Weight of sample before extraction; w_2= Weight of sample after extraction.

Determination of Crude Protein

The crude protein was estimated according to the method reported by (Jacob *et al.,* 2016). Nitrogen content in the sample was estimated by using micro kjeldahl method. The crude protein was calculated by multiply the content by 6.25. 1 g of the sample was poured into digestion flask, 2 tablets of selenium was added into the sample as catalyst. 12 ml of sulphuric was added and the tube was heated until a clear solution is obtained. The clear solution was transferred into a 50 ml volumetric flask and made up to mark. The digestion of protein leads to the formation of ammonium sulphate solution.

$$Organic\ N + H_2SO_{4(aq)} \rightarrow (NH_4)_2SO_{4(aq)} + H_2O_{(l)} + CO_2 + Other\ sample\ matrix\ by-products$$

10 ml of digest followed by 10 ml of 40 % NaOH solution was pipette into kjeldahl distiller. A conical flask containing 5 ml of 2 % boric acid and 3 drops mixed indicator was placed under the condenser outlet. Upon the completion of the distillation, ammonium sulphate solution produced is converted to ammonia.

$$(NH_4)_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)} + 2NH_{3(g)}$$

Ammonia gas produced condenses and collected as liquid into the conical flask containing the boric acid and mixed indicator.

$$(BOH)_3 + H_2O + NH_3 \rightarrow NH_4^+ + B(OH)_4^-$$

The nitrogen in the distillates was determined by titrating with 0.01 M of HCl. Colour changes from green to pink marks the end point. The amount of nitrogen and crude protein in the sample was calculated using the expression below.

$$\%N = \frac{(S-B) \times Nacid \times 0.014 \times D \times 100}{Weight\ of\ sample \times V} \times 100$$

$$\%\ Crude\ Protein = 6.25^* \times \%N(*.Correction\ factor)$$

Where: S= Sample titration reading; B = Blank titration reading; N = Normality of HCl; D = Dilution of sample after digestion; V = Volume taken for distillation; 0.014 = milliequivalent weight of Nitrogen.

Determination of Crude Fiber

The crude fiber was estimated using (AOAC). Standard procedure. 2 g of the sample was weigh into a conical flask and 200 ml of 1.25 % sulphuric acid solution was added. The sample mixture was heated for 30 minute followed by washing and filtering until the pH is neutral. The residue obtained was transferred into a conical flask and 200 ml of 1.25 % NaOH solution was added, filtration and washing was carried out again until the pH is neutral, the sample was oven dried and weigh after cooling. The sample was placed in a muffle furnace, heated to 55 ℃ for 12 hrs cooled and weigh. The weight of the fiber was calculated using the expression below.

$$Crude\ fiber\ \% = \frac{W_{cd} - W_{ca}}{W_s} \times 100$$

Where w_{cd}= Weight of crucible + dried residue; w_{ca}= Weight of crucible + ash residue; w_{ca}= Weight of crucible + ash residue; w_s= Weight of the sample;

Estimation of the Carbohydrate.

$$\%\ Carbohydrate = 100 - (\%\ Ash + \%\ Protein + \%\ lipid + \%\ fiber)$$

Determination of Vitamin C content

The vitamin C in the fruit pulp was estimated by titration with 2, 6-dichlorophenol-indophenol solution. 2 g of the pulp powder was put into 250 ml conical flask and 100 ml of distilled water was added. The mixture was allowed to stand for 10 minute and filtered into a conical flask, made up to mark. 2 ml acetic acid was added to 5 ml of the sample and titrated with 2, 6-dichlorophenol in phenol dye to a faint pink color which persists for 15 sec (AOAC).

The vitamin C content was calculated using the expression.

$$Vitamin\ C\ \left(\frac{mg}{1000mL}\right) = 20 \times V \times C$$

Where; V= Titer value of 2,6-dichlorophenol-indophenol

$$C = \frac{Concentration\ of\ Standard\ ascorbic\ acid}{Concentration\ of\ indophenol\ dye\ used}$$

Volume of indophenol used = 11.6

Concentration of standard ascorbic acid = 0.5 mg/ml

Digestion of the sample and mineral content analysis

1 g of the dried powder sample was put into a flask, 12cm^3 of the mixture of concentrated HNO_3, H_2SO_4 and 60% $HClO_4$, was added to the sample in the ratio 9:2:1 v/v. The flask was heated until a clear solution is obtained, cooled and transferred the mixture into a flask and made up to mark (Jacob *et al.,* 2016). After the sample was digested the following mineral were detected using ASS machine. Ca, Mg, K, Na, Zn, Fe, Cu, Pb.

RESULT AND DISCUSSION

Table 1; shows the result of the proximate analysis while Table 2; shows the Vitamin C content of the fruit pulp of *Diospyros mespiliformis*. The moisture content was estimated to be 13.11 ± 0.35 g/100g, the value is higher than that of the seed of the same fruit reported by (Ilouno *et al.,* 2018). It is also higher than that of the fruit pulp of *Dialium guineense, Detarium microcarpum* and *strychnos spinossa*, reported by (Jacob et al.,2016). According to Ilouno *et al.,* (2018). Moisture content influences the deterioration and shelf life of a sample. Ash content is an indicator of mineral elements which are important in human nutrition due to their health benefit. The ash content was estimated to be (2.02 ± 0.17 g/100g). The crude fat obtained in this investigation is (19.08 ± 0.46 g/100g), which is higher than that of *strychnos spinossa* (2.04 ± 0.02 %) and *Detarium microcarpum* (8.85 ± 0.02 %). The value is also, higher than that reported by (Jacob *et al.*,2016) for the same fruit, this variation could be due to the climatic factor. The highest crude fat value reported in this work indicated that the fruit pulp is a good source of oil-soluble vitamins (Jacob *et al.,* 2016). The fibre content of the fruit pulp in this work is found to be (3.37 ± 0.26g/100g), the value is higher than that of the fruit seed reported by (Ilouno *et al.,* 2018). The presence of fibre in foods

helps to ease passage of waste thus preventing constipation. In addition to cleaning the digestive track, fibre also, help in preventing the absorption of excess cholesterol and intake of excess starchy food (Ilouno *et al.,* 2018). The crude protein obtained in this investigation is (6.01 ± 0.37 g/100g). The value obtained is higher than that of the seeds of the same fruit reported by (Ilouno *et al.,* 2018). According to Jacob *et al.*,(2016), protein is an essential component of diet needed for survival of human and animal alike, as they supply the adequate amount of required amino acid for nutrition. The amount of carbohydrate was estimated to be (56.55 ± 0.72 g/100g). The value is lower than that of the fruit pulp of *Detarium microcarpum*, *Strychnos spinosa*, *Dialium guineense,* and *Gardenia ternifolia*. The result obtained in this investigation is similar to the value reported by (Jacob *et al.,* 2016), for the same fruit pulp. The sample with low carbohydrate contents might be ideal for diabetic and hypertensive patients requiring low sugar diet and for those that want to lose weight.

Table1: Proximate composition of *Diospyros mespiliformis* fruit pulp

S/N	Component	Concentration (g/100g)
1	Moisture	13.11 ± 0.35
2	Ash	2.02 ± 0.17
3	Crude fat	19.08 ± 0.46
4	Crude fiber	3.37 ± 0.26
5	Crude protein	6.01 ± 0.37
6	Carbohydrate	56.55 ± 0.72

The data are mean values ± standard deviation (SD) of three replicate

The ascorbic acid (Vitamin C), value of the fruit pulp is 24.56 ± 0.16 mg/100g, is higher than that of the *Diospyros mespiliformis* of the same fruit, *Detarium microcarpum, strychnos spinosa, Gardenia ternifolia* and lower than that of *Dialiumguineone,* reported by (Jacob *et al.,*2016).The value of the ascorbic acid reported in this work is comparable to that of watermelon (23.3 mg/100g). Ascorbic acid is generally used for protein metabolism and collagen synthesis, the amount of ascorbic acid present in the fruit pulp of *Diospyros mespiliformis*, showed that it will contribute to the daily human requirement of dietary intake of the Vitamin. The maintenance of the daily intake of Vitamin c can lead to the prevention of scurvy which is the deficiency disease state of Vitamin C.

Table 2: Ascorbic acid content of the fruit pulp

S/N	Parameter	Concentration (mg/100g)
1	Vitamin C	24.56 ± 0.16

The data are mean value ± standard deviation (SD) of three replicate

Table 3; show the result of the mineral content of *Diospyros mespiliformis* fruit pulp. The results revealed that the most abundant mineral is Calcium (Ca), 69.44 ± 12.73 mg/100g, followed by Copper (Cu), 30.39 ± 5.83 mg/100g, Magnesium (Mg), 24 ± 22.52 mg/100g, Sodium (Na), 24.45 ± 3.85 mg/100g, Iron (Fe), 9.88 ± 2.136 mg/100g, Potassium (K), 8.44 ± 4.43 mg/100g, Lead (Pb), 5.063 ± 1.253 mg/100g, and the least is Zinc (Zn), 4.63 ± 2.12 mg/100g. Calcium is an important nutritional element required in diet as it is indispensable cofactor in blood coagulation; serve as constituent of teeth and bone. It also serves as second messengers in signal transduction pathway and control muscle contraction. Calcium is needed by many enzymes for their activity (Jacob *et al.,*2016). Copper is the second most abundant element estimated to be 30.39 ± 5.83 mg/100g, the value is higher than that of the same fruit pulp reported by (Jacob *et al.,*2016), the variation may be due to the environmental differences. Copper is an essential element that helps to alleviate cardiovascular and bone disorders, anemia and nervous systems disorder. The concentration of Magnesium in this investigation is 24 ± 22.52 mg/100g. According to the Ilouno *et al.,* (2018), the daily requirement of Magnesium for adult is 15 mg, the amount of Magnesium in the fruit pulp of *Diospyros mespiliformis* is more than the daily requirement of adult. Magnesium acts as a cofactor for enzymes and also involve in bone formation. The concentration of Sodium (Na) is 24.5 ± 3.85 mg/100g. Sodium is important for acid-base stability and osmoregulation in inter-modular fluid. The value of Potassium obtained is 8.44 ± 4.43 mg/100g, Potassium can prevent the severe damage to the kidney. Iron (Fe) obtained in this investigation is 9.88 ± 2.136 mg/100g, Iron is an important micronutrient in the formation of hemoglobin, it also plays vital role in the normal functioning of control nervous system and oxidation of carbohydrate, protein and fat. In order to prevent anemia and other related disorders. Iron is very important in the diet of pregnant woman, nursing mothers, infants, convulsing patients and elderly people (Jacob *et al.,* 2016). The concentration of Zinc investigated is 4.63 ± 2.12 mg/100g. Zinc plays significant role in growth and development. It's also important during stages of growth such as infancy, adolescence and during recovery from illness.

Table 3: Mineral composition of *Diospyros mespiliformis* fruit pulp

S/N	Component	Concentration (g/100g)
1	Calcium (Ca)	69.44 ± 12.73
2	Copper (Cu)	30.30 ± 5.833
3	Magnesium (Mg)	24 ± 22.52
4	Sodium (Na)	14.45 ± 3.85
5	Iron (Fe)	9.88 ± 2.136
6	Potassium (K)	8.44 ± 4.43
7	Lead (Pb)	5.063 ± 1.253

The data are mean values ± standard deviation (SD) of three replicate

CONCLUSION

The fruit pulp of *Diospyros mespiliformis* has shown good nutritive values. The fruit edible portion can be used as Carbohydrate and lipid enhancement for rural communities. It's also rich in Calcium, Copper, Magnesium and Iron. The fruit pulp can serve as a good source of food during the period of famine and draught. It can also serve as a potential raw material for the production of jam and juice.

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