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PROXIMATE, MINERAL AND ANTI-NUTRITIONAL COMPOSITION OF JACKAL BERRY (*DIOSPYROS MESPILIFORMIS*) SEEDS

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ABSTRACT
The dried seeds flour of *Diospyros mespiliformis* was assessed for proximate, mineral and anti-nutritional composition using standard procedures. The results obtained from the proximate analysis were: moisture content (9.00 ± 0.00 g/100g), ash content (4.75 ± 1.06 g/100g), crude fat (2.22 ± 0.37 g/100g), crude fibre (2.67 ± 0.76 g/100g), crude protein (5.44 ± 0.88 g/100g), carbohydrate (76.35 ± 0.58 g/100g) and energy value (345.45 ± 0.58 kcal/100g). The mineral analysis showed that calcium is the most abundant element in the sample (180.26 ± 0.76 mg/100g), followed by magnesium (92.18 ± 1.24 mg/100g) and iron (90.48 ± 0.98 mg/100g) while zinc was the least (0.97 ± 0.73 mg/100g). The anti-nutritional factors analysed were oxalate (0.004 ± 0.00 mg/100g), phytate (0.880 ± 0.13 mg/100g), alkaloids (16.780 ± 4.29 mg/100g), flavonoid (29.300 ± 0.63 mg/100g), tannin (0.040 ± 0.98 mg/100g) and saponin (31.450 ± 2.12 mg/100g). The results from this study showed that the seeds of *Diospyros mespiliformis* has nutritional value comparable to conventional food crops, and can be used to replace calories and nutrients that could otherwise be derived from them during scarcity. However, further processing may be required when used as animal feed.

Keywords: *Proximate, Seeds, Anti-nutritional, Diospyros mespiliformis, Mineral*

INTRODUCTION

Despite the abundant agro ecological resources and diversity, food insecurity, scarcity and malnutrition are still major problems faced in Nigeria. These in part is due to the dramatic increase in population, and lack of crop diversification caused by concentrating on the consumption of fewer crops (Baldermann *et al*., 2016). Food security exists when the food produce is safe, have high nutritive value, in addition to been accessible, affordable and available in the required amount and form (Chakraborty and Newton, 2007). Some cultivated food crops may become scarce and expensive at the beginning of the planting season or during famine, especially for those low income earners. As a consequence, they experience high level of malnutrition and poor health. This has urged scientist to screen for the wild edible fruit trees with potential to complement staple food.

Like cultivated crops, many wild edible fruit trees are seasonal and most of their fruits and fruit seeds become available at the end of the year or at the beginning of the dry season. Some may even last throughout the dry season (Arensen, 2015). This is important as the fruits and their seeds can serve as food until the cultivated crops become fully available hereby, promoting dietary diversification. Many of these wild fruits are not only comparable to the cultivated crops; some have higher nutritional values (Umaru *et al*., 2017). However, many wild fruit seeds lack recognition as significant contributors to human diet in both the rural and urban areas.

Diospyros mespiliformis commonly known as jackal berry or African ebony belongs to the family Ebanaceae. It is a deciduous tree that can grow up to 25m in height (Abba *et al*., 2015). The tree is characterized by dense foliage with leathery, dark green leaves. However, the young leaves in spring are reddish in colour (Abba *et al*, 2012). Flowering of the tree occur during the rainy season but fruit ripening takes place in the dry season (Chivandi and Erlwanger, 2011). The fruit is popularly known as *Kanya* among the Hausa speaking people of Northern Nigeria. When ripe the fruit is yellowish to orange in colour and has a sweet lemon-like taste. It is eaten raw by children and adults or may be dried and kept for later use. Animals like jackals, baboon and monkeys also feed on them (Akinyemi and Kayode, 2012). There are about 4-6 seeds per fruit which are usually brown in colour and bean-shaped (Chivandi and Erlwanger, 2011). Research on *Diospyros mespiliformis* has focused on the medicinal use of the leaves, stem, bark and roots (Adzu *et al*., 2015; Belemtougri *et al*., 2006; Sadiq *et al*., 2013; Jigam *et al*., 2012; Adeniyi *et al*., 1996) with little information on the nutritional composition of the fruit seeds. This study therefore aims to determine the proximate, mineral and anti-nutritional composition of *Diospyros mespiliformis* fruit seeds in an attempt to show that the fruits seeds have potential to boost food security, improve human nutrition and possibly those of animals.

MATERIALS AND METHODS

Ripe fruits of *Diospyros mespiliformis* were harvested around villages in Dutsin-Ma Local Government Area of Katsina State, Nigeria. The fruits were dried and the seeds obtained manually from their pods. The dried seeds were then crushed and milled to powder using a mechanical grinder, sieved with 0.5mm size sieve and stored in a clean vessel at 4^0C before analysis.

Proximate Analysis

Moisture, Ash, crude fiber, crude fat and carbohydrate content were determined using the method of AOAC (2005). The crude protein was determined by method described by Onwuka (2005).

Determination of Energy or Calorific Value

The total energy value of *Diospyros Mespiliformis* fruit seeds in kcal/100g was determined by method described by FAO (2003) as:

Energy Value = (% carbohydrate x 4) + (% crude protein x 4) + (% crude x 9)

Determination of Minerals

The composition of the following minerals Zn, Ca, Fe and Mg were determined by adopting the method of AOAC (2005).

Atomic Emission Spectrometry (AES) using Microwave-plasma atomic emission spectrometer (MP-AES AGILENT 4200) was used. The actual concentration of the individual elements were calculated as:

$$\text{Actual concentration} = \frac{\text{Readings from AES x Dilution factor}}{\text{Weight of sample}}$$

Anti-nutritional Composition

Oxalate content was determined using method described by Onwuka (2005). Saponin content was determined using the method of AOAC (2005). Phytate was determined using Wheeler and Ferrel (1971) method, Tannin content was determined by copper acetate gravimetric method described by Joselyn (1970). Alkaloid and Flavonoid content was determined using Harborne (1980) and Allen *et al*. (1973) methods respectively.

Statistical Analysis

All the analysis were carried out in three replicates and the results expressed as mean ± standard deviation.

RESULTS AND DISCUSSION

Proximate composition

The proximate composition of *Diospyros mespiliformis* seeds is presented in Table 1. The moisture content was 9.00 ± 0.00 g/100g. The value is similar to those obtained by Ezeagu *et al*. (1996). However, it was higher when compared to other wild fruit seeds such *Cassipourea congoensis, Nuclea latifolia* and *Gemlina arboea* (Nkafamiya *et al*., 2007). Moisture content influences the deterioration and shelf life of a sample. Ash content is an indicator for mineral element. Minerals are important in human nutrition due to their pro-oxidant activity and health benefits. The ash content *of Diospyros mespiliformis* seeds was high (4.75 ± 1.06 g/100g) and higher to ash value reported by Ezeagu *et al*. (1996) for the same seed. The value obtained is within the range reported for commonly consumed edible seeds. However, the value did not fall within the range of 1.5-2.2% for seeds and tubers suitable for animal feed (Emelike *et al.,* 2015). Therefore, the seeds cannot be used as animal feeds. The amount of crude fat was 2.22 ± 0.37 g/100g and was much lower to values reported by Ezeagu *et al.* (1996) and Adewuyi *et al*. (2014) with values of 5.46% and 4.72 ± 0.2% respectively. The result revealed that the seeds could not be classified as an oil seed like groundnut and melon (Elinge *et al.,* 2012). The fibre content of the seeds was 2.67 ± 0.76 g/100g. The presence of fibre in foods help to ease the passage of waste thus preventing constipation. In addition to cleaning the digestive tract, fibres also help in preventing the absorption of excess cholesterol and intake of excess starchy food (Ahamefula *et al*., 2014). Crude protein was 5.44 ± 0.88 g/100g. The value obtained is low compared to other fruit seeds (Nkafamiya *et al.,* 2007) and protein rich food like cowpea, soybean and melon (Ezeagu and Igbebu, 2010; Ragab *et al.,* 2004; Jacob *et al.,* 2015).

Table 1. Proximate Composition of *Diospyros mespiliformis* Fruit Seeds

Component	Concentration (g/100g)
Moisture	9.00 ± 0.00
Ash	4.75 ± 1.06
Crude fat	2.22 ± 0.37
Crude Fiber	2.67 ± 0.76
Crude protein	5.44 ± 0.88
Carbohydrate	76.35 ± 0.58
Calorific Value (kcal/100g)	345.45 ± 0.58

The data are mean ± standard deviation of three determinations

However, the value is comparable to some leafy vegetables (Agbaire, 2011). Because the value is far below the recommended daily intake of protein for children (23-36g) and adults (40-56g) (Emelike *et al*., 2015), *Diospyros mespiliformis* seeds when eaten as staple food should be supplemented with protein rich food to prevent deficiency and malnutrition. The amount of carbohydrate was 76.35 ± 0.58 g/100g. The result shows that the seeds are rich source of carbohydrates and can be compared to carbohydrate rich food like cereals with 72-90 g/100g (Adewusi *et al.,* 1995). The calculated energy value was 345.45 ± 0.58 kcal/100g.

Mineral analysis

The result for the mineral content of *Diospyros mespiliformis* seeds is shown in Table 2. The results reveal that *Diospyros mespiliformis* seeds have high mineral content which commensurate with the high ash content in Table 1. The most abundant mineral was calcium (Ca) 180.26 ± 0.76 mg/100g followed by magnesium (Mg) 92.18 ± 1.24 mg/100g, iron (Fe) 90.48 ± 0.98 mg/100g and zinc (Zn) was the least with a value of 0.97 ± 0.73 mg/100g. Calcium is an important nutritional element required in diet as they are indispensable cofactor in blood coagulation. They also act as second messengers in signal transduction pathway and control muscle contraction. In addition to being the major constituent of bone, Ca is required by many enzymes for their activity (Koolman and Roehm, 2005).

Table 2. Mineral Composition of *Diospyros mespiliformis* Fruit Seeds

Element	Concentration (mg/100g)
Ca	180.26 ± 0.76
Fe	90.49 ± 0.98
Zn	0.97 ± 0.73
Mg	92.18 ± 1.24

The data are mean ± standard deviation of three determinations

The amount of Mg is more than the daily requirement of 15 mg for adult (Kampali and Pali, 2004). Magnesium acts as a cofactor for enzymes and is also involved in bone formation. Fe is a cofactor for enzymes and has numerous biochemical role such as in the binding of oxygen to haemoglobin. The daily requirement of Fe for children is 10-15 mg, women 18 mg and men 12 mg (Dosumu *et al*., 2012). Consumption of *Diospyros mespiliformis* seeds can provide these daily requirements. Though the amount of Zn is lower than the daily requirement of 18 mg for adult, it could contribute partially to the overall daily intake of these minerals.

Anti-nutritional composition

Table 3 shows the anti-nutritional composition of *Diospyros mespiliformis* seeds. From the results the seed had 0.004 ± 0.00 mg/100g oxalate, 0.880 ± 0.13 mg/100g phytate, 16.780 ± 4.29 mg/100g alkaloids, 29.300 ± 0.63 mg/100g flavonoids, 0.040 ± 0.98 mg/100g tannin and 31.450 ± 2.12 mg/100g saponin. Anti-nutritional factors have negative influence on metabolic processes, since they hinder the availability of nutrient required by the body. Oxalate is a chelating agent that binds to calcium ion to form complexes. High amount of oxalate in edible seeds can result in calcium deficiency. Calcium oxalate crystals have been implicated in kidney stones (Agbaire, 2012).

Table 3. Anti-nutritional Composition of *Diospyros mespiliformis* Fruit Seeds

Anti-nutrient	Concentration (mg/100g)
Oxalate	0.004 ± 0.00
Phytate	0.880 ± 0.13
Alkaloids	16.780 ± 4.29
Flavonoid	29.300 ± 0.63
Tannins	0.040 ± 0.98
Saponin	31.450 ± 2.12

The data are mean ± standard deviation of three determinations

The amount of oxalate in the seeds is low and may not have any adverse health effects in man. According to Rahman *et al.* (2013) plants with less than 2% soluble oxalate would not result in oxalate poisoning in ruminant animals. When eaten as main source of food, plant parts with high tannin content is known to cause decrease in the digestibility of protein. Bioavailability of mineral elements is impaired as tannins also chelate metal ions (Okonwu and Ugiomoh, 2015). The amount of tannin in *Diospyros mespiliformis* seeds in this study is lower than the valued obtained from analysis of the seed pulp (Umaru *et al*., 2007). The saponin content of many plant seeds have been investigated. According to Bora (2014), the saponin content of grain legumes varies between 0.5-5% dry weights.

The saponin content of *Diospyros mespiliformis* seeds in the study is within the permissible limit of 48.50 mg/100g recommended by WHO (2003). Therefore, *Diospyros mespiliformis* seeds is safe for consumption when use as food. Alkaloids are found as salt of plant acids. High amount of alkaloids are known to disrupt nerve impulse transmission and cell membrane. The amount of alkaloids was relative high compared to some wild fruits like *Chrysophyllum albidum, Persea Americana, Dinnettia tripetala, Diallium guineense, Annona muricata, Citrullus lanatus* (Anhwange *et al*., 2015). Ranging between 0.0097-0.1075 mg/100g. However, the alkaloid value obtained in this study is less than the alkaloid value in some common foodstuff (Adeniyi e*t al.*, 2009). High amount of flavonoid is said to reduce the absorption of mineral, glucose intake and inhibit proteolysis within the gut (Erdman *et al*, 2007). The value of flavonoid obtained in this study is low compared to *Phoenix dactylifera* L. (Shaba *et al*., 2015), but higher when compared with results from other workers (Fila *et al*., 2013; El Anany, 2015). Phytate is a salt form of phytic acid found in plant materials. Insoluble salts are formed when phytic acid combined with mineral element such as calcium, zinc, iron, phosphorus and magnesium. When released during food processing in the gut, phytic acid prevent the absorption of these minerals. The composition of phytate in this study is low compared to some leafy vegetable (Agbaire, 2012) and wild fruits (Umaru *et al.,* 2007). Diet having 10-60 mg/g of phytate have been shown to decrease the bioavailability of nutrients in monogastric animals (Thompson, 1993).

CONCLUSION

In conclusion, the seeds of *Diospyros mespiliformis* have shown to have nutritive values comparable to nutritious food. The seed is a good source of carbohydrate and can provide high food energy. The seeds have potential to improve and diversify diet. However, in period of famine and drought if eaten as staple food, it should be supplemented with protein rich diet to prevent malnutrition and poor health. Though a poor source of zinc, the seed is a good source of calcium, iron and magnesium as the values obtained meet their daily requirements. The result of the anti-nutritional factors suggest that the seed is suitable for human consumption. However, the seeds may be used as animal feeds if further processed.

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