Nutritional and anti-nutritional composition of *Diospyros mespiliformis* and *Hyphaene petersiana* fruits from Namibia

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ABSTRACT

Wild fruits play an important role in the well-being of many people in Namibia. Two wild fruits namely, *Diospyros mespiliformis* Hochst. ex A. DC (Ebenaceae) and *Hyphaene petersiana* Klotzsch ex Mart. (Arecaceae) were analyzed for proximate, nutritional and anti-nutritional composition. The proximate results showed that the moisture content ranged between 8.3-12%, crude fat (0.1-0.45 mg/g), crude protein (1.6-2.6 mg/g), carbohydrate (4-5.3 mg/g), and ash content (3.3-6 mg/g). The mineral contents of the studied fruits were: calcium (5.01-20.33 mg/kg), potassium (94.8-245.94 mg/kg) and sodium (2.80-11.65 mg/kg). Trace elements such as iron (0.14-2.44 mg/kg) and zinc (0.17-0.19 mg/kg) were also detected. Anti-nutrient values were lower than those for established toxic values. High levels of saponins (2.46 mg/g), tannins (0.10 mg/g) and phytate (0.12 mg/g) were detected in *H. petersiana* pulp, and oxalate (0.04 mg/g) was detected in *D. mespiliformis* pulp. However, these anti-nutritional factors were within established safe consumption limits. The results of this study signify that the two fruits have high concentrations of essential minerals and low anti-nutrients; thus their consumption is recommended, especially in poor settings.

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1 Introduction

Fruits are regarded as the main sources of minerals, fiber and vitamins, which provide health benefits and nutritive values (Rathod and Valvi , 2011). Wild fruits play an important role in the daily life and wellbeing of many people in rural and urban areas in Namibia. In many countries, cultivated fruits are favoured over wild fruits (Chakravarty et al. , 2016). However, due to their high cost, cultivated fruits are less accessible in poor communities. In Namibia where there is inadequate irrigation infrastructure, cultivated fruit trees are not readily available because of dry conditions in most parts of the country. Wild fruits on the other hand are easily accessible, but their lack of nutritional information hamper their informed consumption (Oibiokpa et al. , 2014). Many reports have shown that some wild fruits have good or even high nutritional values compared to cultivated fruits (Kumar , 1991; Cheikhyoussef et al. , 2011). However, some of these fruits may contain anti-nutritional factors which when consumed in large quantities can be harmful to the body (Rathod and Valvi , 2011).

Most consumers of wild fruits are unaware of either the nutritional composition or the toxicity levels of the fruits. Therefore, it is vital that wild fruits be studied to determine whether they contain the right amount of nutritional and anti-nutritional factors. Some of the anti-nutritional factors commonly found in fruits are: tannins, saponins, alkaloids, glucosinolates, cyanide, phytates and oxalates. They interfere with nutrients and mineral absorption, digestion and utilization (Rathod and Valvi , 2011; Umaru et al. , 2007). This usually triggers

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conditions associated with mineral deficiency; for example rickets and the formation of kidney stones (Choudhary et al. , 2013). When consumed in large quantities, anti-nutritional factors also cause discomfort and stress in humans and animals.

Diospyros mespiliformis Hochst. ex A. DC (Ebenaceae) and *Hyphaene petersiana* Klotzsch ex Mart. (Arecaceae) are two of the wild fruits consumed widely in northern parts of Namibia (Mutshinyalo , 2007; Sullivan et al. , 1995). *Diospyros mespiliformis* is commonly known as jackal berry (English), omwandi (Oshiwambo), omunjande (OshiHerero) (Mutshinyalo , 2007). It is a tree that grows up to 16 m high. Its fruits are almost spherical, up to 25 mm in diameter; fleshy yellow to purple when ripe (Curtis and Mannheimer , 2005). In Africa, it is widely distributed in countries such as Senegal, Ethiopia, Kenya, South Africa, Swaziland, Nigeria and Namibia (Maitera et al. , 2018). In Namibia, the plant is mainly found in northern regions stretching from Kunene to Zambezi (Curtis and Mannheimer , 2005). It is valued for its fruits and consumers enjoy the ripe fruit while fresh or dried. Fruits are also eaten by birds and animals (Roodt , 1998).

In northern Namibia, the fruits are pounded and the powder is mixed with millet meal to make a delicious porridge called oshihenyandi (Hailwa , 1998). Phytochemical studies done on *D. mespiliformis* reported the presence of anti-nutritional factors such saponins, tannins and alkaloids in the leaves, stem bark and roots (Ebbo et al. , 2015; Shagal et al. , 2012). Although it is most valued for its fruits, *D. mespiliformis* also has medicinal functions. Leaves are used for treating gingivitis, toothache, malaria, fever, wounds, sleeping sickness and helminths (Cheikhyoussef et al. , 2011; Adzu et al. , 2002; Shagal et al. , 2012). The stem bark is used to treat coughs and leprosy (Adzu et al. , 2002). The leaves, fruits and roots are used to treat dysentery; this is associated to the presence of tannins in these plant parts (Roodt , 1998).

Hyphaene petersiana commonly known as makalani palm and omulunga in Oshiwambo belongs to the palm family Arecaceae. It is usually single stemmed plant but occasionally grows into a multi-stemmed palm tree that grows up to 10 m high. Fruits are spherical brown nut, about 50 mm in diameter, single seeded and always occurs in large bunches (Curtis and Mannheimer , 2005). The plant is mainly found in the north-central regions of Namibia. The core of a young trunk is used as a vegetable. The fruits are eaten when dry. The leaves are used in various ways: weaving baskets, mats and hats, for making skirts, pots, basins, arrow shafts and sieves (Roodt , 1998). They are also used for thatching roofs and as a source of fuel. Threads stripped from the edges can be used as dental floss and ropes are made from the leaf yarns. When tapped the palm produces a sap which is made into a beverage. Fruits from both *D. mespiliformis* and *H. petersiana* are used to make a strong alcoholic beverage known as ombike (Hailwa , 1998).

Although *Diospyros mespiliformis* and *Hyphaene petersiana* fruits are widely consumed, studies on the nutritional status of these fruits are limited. To our knowledge, no nutritional and anti-nutritional analysis has been done on *H. petersiana* fruits. The aim of this study was to evaluate the proximate nutritional and anti-nutritional content of *D. mespiliformis* and *H. petersiana*. Results from this study may help to add value as well as encourage consumption of these fruits in Namibia and beyond.

2 Materials and Methods

2.1 Sample collection and preparation

Dried fruits of *Diospyros mespiliformis* and *Hyphaene petersiana* were collected from Oshana Region in Namibia. Fruits under study were collected in such a way that plants were not damaged and approval to conduct the research was obtained from the University of Namibia, Department of Chemistry and Biochemistry (FPG.SCI/17/08/287). The pulp and peels of *D. mespiliformis* fruits were analyzed separately; this is due to the fact that certain people eat the whole fruit including the peels while others prefer to eat the pulp only. The pulp and not the peels of *H. petersiana* fruits was analyzed because people normally do not consume the peels. The peels and seeds of the

fruits were removed by hand picking. The samples were then ground into a powder using a blender and stored separately in closed containers until analysis.

2.2 Anti-nutritional factors

2.2.1 Oxalate

Total oxalate was determined according to Day and Underwood (1986) method with little modification. Approximately 1 gram of powdered sample was dissolved in 75 mL of 15N H_2SO_4. Using a magnetic stirrer, the solution was stirred for 1 hour and then filtered. The filtrate (25 mL) was then titrated with 0.1 N KMO_4 solutions until a pink colour that persisted for about 30 seconds appeared. Oxalate content was calculated using the formula outlined in Ugbaja et al. (2017).

2.2.2 Phytate

Phytate was determined following the method described by Rathod and Valvi (2011). About 4 gram of sample was soaked in 100 mL of 2% HCl for 5 hours with constant stirring. The solution was filtered, then 25 mL of the filtrate was mixed with 0.3% of NH_4SCN before titration with 0.41M $FeCl_3$. A brownish-yellow colour that persisted for 5 minutes indicated the end point.

2.2.3 Tannin

Tannin content was determined using the method described by Oibiokpa et al. (2014). About 0.5 gram sample was dissolved in 50 mL of distilled water. The solution was boiled gently for 1 hour, thereafter filtered and the residue washed with distilled water. The volume of the filtrate was adjusted to 50 mL. To the extract (45 mL) 2.5 mL Folin Denis reagent and Na_2CO_3 were added. The samples were then allowed to stand in a water bath at $25°C$ for 5 minutes. Absorbance of extract mixture of each sample was measured at $760nm$ wavelength spectrophotometrically. Working standards of 0.02 mg/mL, 0.04 mg/mL, 0.06 mg/mL, 0.08 mg/mL and 0.1 mg/mL and 0.12mg/mL were prepared using water as diluent and then used to plot the standard curve.

2.2.4 Saponins

Saponin content was determined using the method described by Rathod and Valvi (2011) with modifications. The sample (10 gram) was extracted with 100 mL of 20% aqueous ethanol for 12 hours while shaking at $55°C$. The filtrate was re-extracted with 100 mL 20% aqueous ethanol. The extract was then reduced to 40 mL to which 20 mL diethyl ether was added in a separatory funnel to collect the aqueous layer. The pH of the aqueous solution was adjusted to 4.5 using NaOH and then extracted twice with 60 mL n-butanol. The butanolic extract was washed twice with 10 mL of 5% (w/v) NaCl and evaporated to dryness in a fumehood to produce crude saponin which was weighed.

2.2.5 Alkaloids

Qualitative screening of alkaloids was done. Ground sample (1 gram) was stirred with 15 mL of 1% HCl solution for 2 hours. It was then heated in boiling water bath for 10 minutes and filtered. The filtrate was then pipetted into four different test tubes, each containing 2 mL and the sample was tested for the presence of alkaloids using Dragendroff's, Mayer's, Wagner's, and Hager's reagents, respectively. As alkaloids were not detected in the samples, no quantitative experiments were performed.

2.3 Proximate analysis

2.3.1 Moisture content

Moisture content was determined by oven drying method as described by Gul and Safdar (2009) with modifications. About 1.5 g of the sample was placed into a crucible that was pre-dried in an oven for 30 minutes and weighed. Mass of the crucible plus sample was noted as W_1. The crucible containing the sample was placed into an oven at $100^{\circ}C$ with occasional weighing until a constant weight was obtained (12 hours). Weight of crucibles with dried sample was noted as W_2. Moisture content was then determined using the formula:

$$\% \text{ moisture} = \frac{W_1 - W_2}{\text{Weight of sample}} \times 100.$$

2.3.2 Ash content

An empty crucible was placed in a furnace for an hour at $550^{\circ}C$. It was then cooled in a desiccator and then weighed (W_1). The mass of 1.3 grams of moisture free sample plus the crucible were weighed and recorded (W_2). Crucible was then placed in a furnace at $550^{\circ}C$ for 3 hours. Complete oxidation of all organic matter in the sample was determined by appearance of gray-white ash. The weight of crucible plus ash were recorded (W_3) hence the amount of ash recovered was determined. Percentage ash was calculated using the following formula:

$$\% \text{ ash} = \frac{W_3 - W_1}{\text{Weight of sample}} \times 100.$$

2.3.3 Crude fat

Crude fat content was determined following a method described by Oibiokpa et al. (2014). About 2 grams of sample (W_1) was weighed into pre-weighed beaker (W_2). The oil was extracted using hexane for 1 hour at $20^{\circ}C$. The extract was then dried at $105^{\circ}C$ for 30 minutes in an oven. Then the beaker and its content were allowed to cool down and weighed (W_3). Fat (%) was calculated using the following formula:

$$\% \text{ ash} = \frac{W_2 - W_3}{W_1} \times 100.$$

2.4 Nutritional content

2.4.1 Mineral analysis

The sample was digested by wet ashing method using a DK8 heating digester (AOAC , 2000; Friel and Ngyuen , 1986). About 0.5 g of the sample was placed into the digestion tube. Then 10 mL of HN_{03} was added to the tube, before placed into the digestion block. The sample was digested at $150^{\circ}C$ for 30 minutes until dense white fumes appeared. The reaction mixture was cooled and 2 mL of 60% $HClO_4$ added to it; heated further to concentrate the extract, cooled and the extract solution was filtered into 50 mL volumetric flask, and if necessary topped with distilled water. The extract solution was subsequently subjected to mineral analysis. Blank solution was prepared in similar manner without the sample being added. Major minerals such as calcium, sodium, chloride, magnesium, potassium, phosphorus, phosphorus and trace elements namely iron, zinc, iodine, fluoride, copper, selenium, chromium, cobalt, manganese and molybdenum were observed using inductive coupled plasma-optical emission spectrometry (ICP-OES) (ICP spectrometer iCAP 6000 Series, Thermo Scientific).

2.4.2 Carbohydrate

A series of working concentration levels: 0.02mg/mL, 0.04mg/mL, 0.06mg/mL, 0.08mg/mL and 0.1mg/mL were prepared using water as diluent. To each of the test tube 1 mL of 5% phenol and 5 mL of 96% sulfuric acid

were added and shaken thoroughly. After 10 minutes of shaking the tubes were placed in a water bath for 15 minutes. The blank was set with 1 mL of distilled water. The sample was prepared by weighing 0.1 grams of each sample into a test tube and 25 mL of distilled water was added. The test tubes were placed in a water bath for 3 hours and then cooled to room temperature. Extract solutions were neutralized by adding solid Na_2CO_3 until effervescence ceases. The final volume was adjusted to 100 mL by adding distilled water. After centrifugation at 3000 rpm for 30 minutes, the supernatant was treated the same as the standard. Absorbance was measured at $490nm$ using UV-vis spectrophotometer (GENESYS20 UV-Vis ThermoSpectronic). Carbohydrate concentrations were determined using the standard curve.

2.4.3 Protein

Tris-HCl buffer (pH 8.0) was prepared (60.5 grams Tris-HCl, 0.05 grams polyvinylpyrrolidone, 0.5 grams cysteine, 0.5 grams ascorbic acid and 85.6 grams sucrose; 400 mL distilled water), to a final volume of 500 mL. The solution was autoclaved for 1 hour and cooled at room temperature. The sample (1.5 grams) was dissolved in 10 mL of previously prepared ice-cold Tris-HCl buffer ($pH = 8.0$). The mixture was stirred for 1 hour followed by sonication for 10 minutes. The reaction solution was centrifuged for 15 minutes at 3000 rpm. The supernatant was centrifuged further for 60 minutes. Proteins were precipitated by adding 2 mL of ice-cold acetone, stored at $-20^{\circ}C$ overnight, and again centrifuged at 3000 rpm for 10 minutes. The formed pellets were washed twice with acetone before being dried at room temperature. For analysis, the pellets were re-dissolved in 4 mL of distilled water and 1 mL of the product was placed into a test tube to which 5 mL Biuret's reagent was added. Bovine serum albumin (BSA) was used as the standard. The absorbance was measured at $540nm$ using a spectrophotometer (GENESYS20 UV-Vis ThermoSpectronic). Protein concentration was determined using a standard curve.

3 Results and discussion

3.1 Anti-nutritional factors

The results of anti-nutrient analysis are summarized in Table 11. The levels of phytates and saponins are slightly higher in the peels than the pulp of *Diospyros mespiliformis*. The highest level of oxalate (0.04 mg/g) was observed in *D. mespiliformis*. This value was much lower than what Umaru et al. (2007) reported (2.20-16.20%). This may be attributed to differences in geographical location where different climatic conditions such as temperature, soil type and other factors are experienced (Inbathamizh and Padmini , 2013). The negative effect of oxalate has been reported mostly on calcium absorption. Oxalate can bind to calcium in the food thereby resulting in the shortage of calcium for normal physiological and biochemical roles in the body (e.g. for maintenance of strong bones and teeth). In addition, calcium oxalate, an insoluble compound, may accumulate around soft tissues such as kidney causing kidney stones (Umaru et al. , 2007). It is a positive outcome that the values obtained for the two fruits analyzed in this study were below and/or within the established safe consumption range (100-200 mg/day).

The levels of phytate were slightly higher in *Hyphaene petersiana* (0.12mg/g) than *Diospyros mespiliformis* (0.09mg/g) pulp, but these were comparable to values reported elsewhere that range from 0.41-9.2 mg/100g (Oibiokpa et al. , 2014; Umaru et al. , 2007). Phytate levels of *D. mespiliformis* in this study were higher than that reported by Umaru et al. (2007) which is 9.2mg/100g for *Diospyros mespiliformis*. Phytate may form calcium phytate complexes which inhibit the absorption of Fe and Zn. It binds to the minerals in the gastro-intestinal tract, making the vital minerals unavailable for absorption and utilization in the body (Rathod and Valvi , 2011; Chivandi et al. , 2013).

Tannins were detected in *Hyphaene petersiana* pulp at 0.1 mg/g compared to 0.03 and 0.02 mg/g of *Diospyros mespiliformis* pulp and peel, respectively. The presence of high levels of tannin in a fruit gives a bitter taste. A

study done by Maitera et al. (2018) showed a higher level of tannin in unripe *D. mespiliformis* fruits. High levels of tannin in food affect the body's utilization of protein by binding to exogenous and endogenous proteins which include enzymes of the digestive tract. It also reduces food intake and body growth (Umaru et al. , 2007; Okwu , 2005).

High levels of saponins have previously been reported in *Diospyros mespiliformis* stem bark (Chivandi et al. , 2009) indicating that it may have medicinal properties (Ahmed and Mahmud , 2017). The results of this study show low levels of saponins in both *Hyphaene petersiana* (2.46 mg/g) and *D. mespiliformis* pulp (1.53 mg/g). If consumed in large amounts, saponins can cause gastroenteritis and damage red blood cells ((Rathod and Valvi , 2011). The safe daily consumption range values of the tested anti-nutritional factors are reported to be: phytate (150-1400 mg), tannin (783-1756 mg) and oxalate (100-200 mg) (Kumar et al. , 2010; Lamy et al. , 2016; Norton , 2018; Schlemmer et al. , 2009). Thus the amounts of anti-nutrients reported in this study were within the established safe range.

No alkaloids were detected in both studied fruits. A study by Ebbo et al. (2015) found alkaloids in the leaves, bark and roots of *D. mespiliformis*. The lack of alkaloids in both fruits is a good indication. Even though alkaloids have various physiological activities in human and animals, their consumption in higher dosage can cause adverse health problems.

Table 1: Anti-nutritional factor of Diospyros mespiliformis and Hyphaene petersiana fruits

Fruits	**Anti-nutrients (mg/g)**				
	Phytate	**Oxalate**	**Tannin**	**Saponin**	**Alkaloid**
D. Mespiliformis (pulp)	0.09 ± 0.003	0.04 ± 0.02	0.03 ± 0.003	1.53 ± 0.1	–
D. Mespiliformis (peel)	0.10 ± 0.02	0.03 ± 0.01	0.02 ± 0.003	1.88 ± 0.09	–
H. Petersiana (pulp)	0.12 ± 0.034	0.02 ± 0.02	0.10 ± 0.001	2.46 ± 0.24	–

Key: – not present, mean $\pm$ standard deviations. Data are means of triplicate trials.

3.2 Proximate analysis

The moisture and ash content of the fruits of *Diospyros mespiliformis* and *Hyphaene petersiana* was reported as percentage by mass of the sample (Table 2). The results show that both fruits contained low percentage moisture content as the United Nations Food and Agriculture Organization (FAO) reports that the desired final moisture content is 15% for conventionally dried fruits and below 25% for semi-moist fruits like *D. mespiliformis* fruits (Sanz , 1997). Fruits with low moisture content have a long shelf-life and this allows people to eat such fruits long after their season and during times when fresh fruits are rare. On the other hand, fruits with high moisture content have short shelf lives.

Drying food is one of the most common forms of preservation as the removal of moisture prevents the growth and reproduction of microorganisms that cause decay. The low moisture content in both fruits indicate that they can be handled and stored easily after harvesting, especially since these fruits are consumed mostly in the northern regions of Namibia where other forms of preservation such freezing are limited.

Ash content is a measure of the total mineral content in food. Fruit pulps of both plants contain high ash content which is an indication that they are both good sources of minerals. The ash content of fresh food rarely exceed 5% while some processed food can have ash content up to 12% (Marshall , 2010).

Table 2: Anti-nutritional factor of Diospyros mespiliformis and Hyphaene petersiana fruits

Fruits	Nutrition (%)				
	Ash	Carbohydrate	Crude Protein	Moisture	Crude fat
D. Mespiliformis (pulp)	3.3 ± 0.06	4.6 ± 1.18	2.6 ± 0.01	12 ± 0.28	0.11 ± 0.021
D. Mespiliformis (peel)	4.7 ± 0.09	4.0 ± 1.21	1.6 ± 0.04	9.6 ± 0.99	0.45 ± 0.13
H. Petersiana (pulp)	6.0 ± 0.08	5.33 ± 1.45	3.1 ± 2.6	8.3 ± 0.07	0.12 ± 0.045

Key: mean $\pm$ standard deviations, Data are means of triplicate trials.

3.3 Nutritional Analysis

Carbohydrate results highlighted the significance of the fruits under study as the source of energy. Results in Table 2 give evidence to recommend high consumption of the fruits under study because the fruits are rich in carbohydrates. For example, local communities could be motivated to prepare *oshihenyandi* and consume more of these fruits. The results show that *Diospyros mespiliformis* pulp contains 4.6 mg/g while peels contain 4.0 mg/g and *Hyphaene petersiana* contains 5.33 mg/g carbohydrates. These values are comparable to values reported in other studies (6.23 -16.50 g/100g) for different fruits reported by Ugbaja et al. (2017).

Results in Table 2 show that *Hyphaene petersiana* fruits contain protein level of 3.1 mg/g while *Diospyros mespiliformis* pulp and peel contain 2.6 mg/g and 1.6 mg/g, respectively. This reveals that the peel are also rich in proteins, therefore it is of nutritional benefit if *D. mespiliformis* fruits is consumed as a whole without removing the peels. High protein content in *H. petersiana* fruits observed in this study is comparable to results obtained by Sanders (2007) who reported 4.9% protein in fruits. A high level of protein is good because protein is an important source of amino acids and it is required for maintenance and body development. Its deficiency however could result in growth retardation, abnormal swelling of the belly, and collection of fluids in the body. The fruits from both plants are a good source of protein.

The results summarized in Table 3 show that *Diospyros mespiliformis* peels contain higher levels of the tested minerals than its pulp. These results are similar to the ash content. Among the tested minerals, cobalt and molybdenum were not detected in both fruits. Considerable amounts of macronutrients such as calcium, phosphorus, sodium, magnesium and potassium were detected in both fruits. Potassium was found to be the most abundant mineral in both fruits at a concentration ranging from 94.83 to 245.94 mg/kg. This indicates that both *D. mespiliformis* and *Hyphaene petersiana* fruits are a good source of potassium (the recommended daily allowance [RDA] of potassium is 4700 mg/day). Intake of this RDA of potassium is sufficient to lower blood pressure level and decrease the risk of kidney stones (Institute of Medicine , 2005).

The concentration of calcium ranged from 5.01 to 20.33 mg/kg. This concentration is much lower than that reported by Jacob et al. (2016) for *Diospyros mespiliformis*. The RDA of calcium is 1000 mg/day (Institute of Medicine , 1997) thus *D. mespiliformis* is a good source of calcium. Phosphorus ranged from 4.48 to 9.46 mg/kg. Both calcium and phosphorus are required in the formation and physical strength of bones and teeth (Soetan et al. , 2010). Micronutrients such as iron (0.14-2.44 mg/kg) and zinc (0.17-0.19 mg/kg) were detected in both fruits. Iron is important in the formation of haemoglobin which is important in transporting oxygen in the blood Jacob et al. (2016). The RDA for iron and zinc is 8 mg/day and 11 mg/day, respectively. The analysis in this study shows that these two fruits contains between 0.14-2.44 mg/kg iron and 0.17-0.19 mg/kg zinc ; therefore consumption of *Diospyros mespiliformis* and *Hyphaene petersiana* fruits may contribute to the daily requirements of these two elements. Communities harvest these fruits from the wild by picking ripe fruits directly from the plants and/or gathering the ones that have fallen to the ground. To harvest sustainably, communities avoid returning to the same source at frequent intervals and the collection is restricted to seasons. In the case of *H. petersiana*, some communities protect the plant when clearing land for cultivation. The fruit harvest on its own does not pose a threat to plant diversity loss (Musaba and Sheehama , 2009). During the harvest process, some

fruits and seeds are usually scattered around the area where the plants grow thus spreading the plant for new growth.

Table 3: Mineral content and standard deviation of the fruits from *Diospyros mespiliformis* and *Hyphaene petersiana*

Minerals	***H. petersiana* pulp (mg/kg)**	***D. mespiliformis* pulp (mf/kg)**	***D. mespiliformis* peels (mf/kg)**
Ca	5.01 ± 0.09	6.00 ± 0.18	20.33 ± 0.04
K	245.94 ± 3.50	94.83 ± 3.06	115.00 ± 0.17
Mg	8.94 ± 0.12	4.43 ± 0.14	3.83 ± 0.01
Na	11.65 ± 0.21	2.80 ± 0.09	3.05 ± 0.01
P	9.46 ± 0.20	4.48 ± 0.11	5.98 ± 0.14
S	2.93 ± 0.07	0.59 ± 0.01	0.74 ± 0.01
Mn	0.04 ± 0.00	ND	0.01 ± 0.00
Mo	ND	ND	ND
Cu	0.00 ± 0.00	0.03 ± 0.00	0.04 ± 0.00
Fe	0.14 ± 0.01	2.44 ± 0.08	0.64 ± 0.00
Co	ND	ND	ND
Se	0.01 ± 0.01	0.02 ± 0.01	ND
Zn	0.18 ± 0.00	0.17 ± 0.00	0.19 ± 0.01

Mean $\pm$ standard deviation for $n = 3$
ND - not detected

4 Conclusion

The study revealed that the fruits *Diospyros mespiliformis* and *Hyphaene petersiana* have low levels of anti-nutritional factors. Regular consumption of these fruits may therefore not likely pose health problems attributed to toxicity. Fruits from both plants showed that they have low moisture and high ash content. They are rich sources of carbohydrates, protein and minerals such as calcium, potassium and sodium. Based on the results, these fruits are highly recommended for consumption as they provide vital nutrients in the body need. Local communities may be encouraged to collect and store these fruits in large quantities for consumption and marketing. They can also be encouraged to cultivate these plants. Since the fruits are usually sun-dried, the process of preserving them is cheaper, easily stored and transported. Dried fruits can thus be sold elsewhere in the country. Further studies on the shelf- life of the fruits under normal and natural storage conditions are recommended.

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