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# Nutritive Potentials of Jackalberry (*Diospyros mespiliformis*) Fruit: A Review

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## Abstract

*Diospyros mespiliformis* has long been utilized for its functional and medicinal properties; the fruit of the plant is used as a staple, and its leaves are used as animal feed. However, the purpose of this study was to examine pertinent scientific literature. The review's findings confirmed the bioactive makeup of the plants' leaves, body bark, and roots, as well as the outstanding nutritional potential of the fruit pulp and seed. This indicates that the fruit has an excellent approximate vitamin C content (>34 mg/100g), along with good moisture content (13.11–65.2%), ash content (0.68–2.02%), crude fat content (1.41–19.08%), crude fibre content (0.29–3.37%), crude protein content (1.50–6.01%), and carbohydrate content (31.72-56.55%). It is also rich in minerals including Calcium 40.31- 69.44 mg/100 g, Iron 9.88 - 24.29 mg/100 g, Zinc 0.805 – 2.40 mg/100 g, Magnesium 9.24 – 31.07 mg/100 g. The fruit seed is also rich in mineral and nutritive values. While it has been used locally in the treatment of main ailments including cholera, diarrhea, and ulcers, the roots, bark, and leaves were also reviewed to be rich in phytonutrients.

**Keywords:** *Diospyros mespiliformis*, medicinal plant, Vitamin C, nutritional potential

## Introduction

Fruits have long formed a part of people's diets, offering considerable amounts of fibre, vitamins, and minerals (Rathod & Valvi, 2011). Ancient travelers devoured a broad array of wild fruits for aesthetic and nutritional reasons. According to Duguma (2020), wild fruits are excellent, succulent fruits that grow naturally on farming, fallow, or uncultivated land in addition to the wild. Edible wild fruits have served both nutritional and cultural purposes throughout human history, depending on the growing area (Duguma, 2020). According to a study, wild fruits such as Diospyros mespiliformis (Kanya) currently provide more than a billion people with their daily nutrients (Feyssa et al., 2011). This is because these plants are high in vitamins and minerals, making them a better source of nutrition and providing an economic benefit (Awas, 2007; Feyssa et al., 2011). According to Getachew et al. (2013), most people in rural communities in poor countries, including Nigeria, eat hundreds or thousands of wild edible fruits in large quantities. As a result, these fruits are critical for food security and development in these areas. Many cultural groups in Nigeria use these fruits as additional, seasonal, or survival food sources, therefore they are extensively consumed

throughout the country. The most often consumed product has historically been wild fruit juice, though preparation methods vary by locale and group. In Nigeria, seasonal fruit juices such as those prepared from apples, oranges, pineapples, and grapes are widely available. These fruits are high in fibre, vitamins, minerals, and antioxidants, all of which are beneficial to human health (Jasmine, 2012). Even when the complete fruit is unavailable or unappealing, individuals prefer fruit juice as the most practical option to maximize the nutritious value of fruit (De Moraes Barros *et al*., 2012). Fruit juice can be prepared from the whole fruit or a component of it (pulp, seeds, or pulp extract).

Fruit juices are becoming a more significant component of modern diets in many parts of the world because of their good organoleptic qualities, nutritional advantages, historical background, and ease of preparation. Their energizing health advantages have given them an advantage (Alaka *et al.,* 2003; Ndife *et al.,* 2013). Because they have a fantastic taste and many of the nutrients found in fruits, they serve as nourishing drinks and are crucial to a balanced diet (O'Neil, 2008; Hossain *et al.,* 2012). They are now offered in both freshly packaged and industrially processed forms. In any scenario, it needs to be devoid of impurities and comprise the majority of the ingredients utilized to extract the juice, without any additional sugar or preservatives (Dangoggo *et al.,* 2016). It must be devoid of environmental pollutants that are detrimental to quality and health, such as hazardous metals. Fruit juices include water as well as different amounts of sucrose, fructose, glucose, and sorbitol, among other carbohydrate (Oranusi *et al.,* 2012).

**Review methodology**

To locate pertinent literary articles through Google Scholar, MDPI, and Scopus, a range of filter phrases were used, including *Diospyros mespiliformis*, Kanya, Nutrient composition of *Diospyros mespiliformis*, Medicinal potentials of *Diospyros mespiliformis*, Ethnobotany of *Diospyros mespiliformis*, and evaluation of *Diospyros mespiliformis*. About sixty publications were extracted and categorised based on their applicability to the review topic. Many of the papers were from Asia (Pakistan and India), Africa (Nigeria, Uganda, and South Africa), England, and the United States. This procedure yielded a comprehensive review report, which was utilized in this investigation.

**Botany**

There are numerous English names for *Diospyros mespiliformis*, such as West African Ebony, African Ebony, Jackal Fruit Tree, Monkey Guava, Persimmon, and Swamp Ebony. Diospyros sabienensis Hiern and Diospyros senegalensis Perr. ex A are synonyms of *Diospyros mespiliformis* Hochst. ex. Large deciduous trees like this one are primarily found in the savannah of Africa. Its evergreen cover is dense (Ahmed & Mahmud, 2017). In Africa, the fruit of this tree is a traditional cuisine that is very nutritious. One of the most significant genera in the Ebenaceae family, which has been utilized in traditional medicine for millennia, is undoubtedly *D. mespiliformis*. Antibiotics are found in leaves, roots, stem bark, and fruits, which are also used medicinally in different ways (Galo *et al.,* 2022). A decoction of the leaves is used to treat fever, while the roots and stem bark are employed to assist in childbirth, treat infections like pneumonia, syphilis, leprosy, dermatological problems, and as an anthelmintic. Infections of the skin, arthritis, and headaches are also treated with the leaves. To cure gingivitis, toothaches, and wound dressings to avoid infection, the leaves and fruit are eaten or used as an infusion. The roots and bark are used to cure tumours and mental health issues (Galo *et al.,* 2022).

**Plant descriptions**

With a dense, spherical, buttressed trunk, *Diospyros mespiliformis* is a huge, 15–50 m tall evergreen tree. When cut, the gray-black or black bark turns pink. In young trees, the bark is smooth; in older trees, it is rough and has thin, equal scales. Young branches are pubescent, and green and feature pinkish-white hairs before becoming smooth. With dense leaves, the crown is very branching. The fruit is often bell-shaped, evergreen, with a big calyx, spherical, meaty, green, and hairy when young, and yellowish to orange-yellow and smooth when mature. It also contains four to six seeds. The smooth, lustrous, dark brown seeds have a bean-like form. The flowers are white, broken, and pentagonal. Sessile and hairy, male flowers are grouped in clusters within the leaf axils. According to Ahmed and Mahmud (2017), female flowers are solitary, have short stems, and develop in the leaf axils with five-lobed sepals. According to Jacob et al. (2015), the leaves are hairy, dark green, simple, alternating, and have tiny hairs on the underside of the older leaves. When ripe, the fruit is an orange-colored berry with an expanded sepal (Ahmed & Mahmud, 2017).

**Figure 1:** Description of *Diospyros mespiliformis.* Source: Bingham *et al.* (2024). Frame A: Description of *Diospyros mespiliformis* plant leaves. Frame B: Shows the *Diospyros mespiliformis* plant. Frame B: Description of *Diospyros mespiliformis* mature fruit.

**Ecology of *Diospyros mespiliformis***

Species of Diospyros are large, noticeable trees in many of their natural habitats, including dry forests and lowlands. This species can be found beside riversides, arid savannas, and woods. It favours locations with frequent watering, encourages organic regrowth, and grows more quickly in places without frost. *D. mespiliformis* naturally grows from Swaziland in the south to Ethiopia in the north (Aminu *et al.,* 2021). *Diospyros mespiliformis* is found up to 1350 m, seldom up to 2000 m, in forested savannas and woodland areas. It is also seldom found on the periphery of wetter woods. It is commonly found in riverine woods in many dry climates. There is an eight-month dry season and 300–2,000 mm of yearly rainfall on average. Although it is occasionally found on rocky hillsides, *D. mespiliformis* is typically observed in deeper, more fertile rich soils, termite mounds, and frequently alluvial soils. It was discovered that young trees were prone to fire (Orwa, *et al.,* 2009).

**Ethnobotanical uses**

The tannin found in the tree's leaves, bark, and roots can be used as a styptic to stop bleeding. The roots are believed to be a leprosy cure and are eaten to get rid of parasites (Hyde *et al.,*

2018). In traditional medicine, the most commonly used materials were the bark and leaves. Anaemia, diarrhoea, cough, ulcers, and stomach pain are a few illnesses that are treated. Other conditions include improving the mother's health and birthing and evacuating blood after childbirth. The most popular method of use is drinking the liquid infusion, which is often made by boiling the plant portion or soaking it in boiling water (Gnonlonfin *et al.,* 2018).

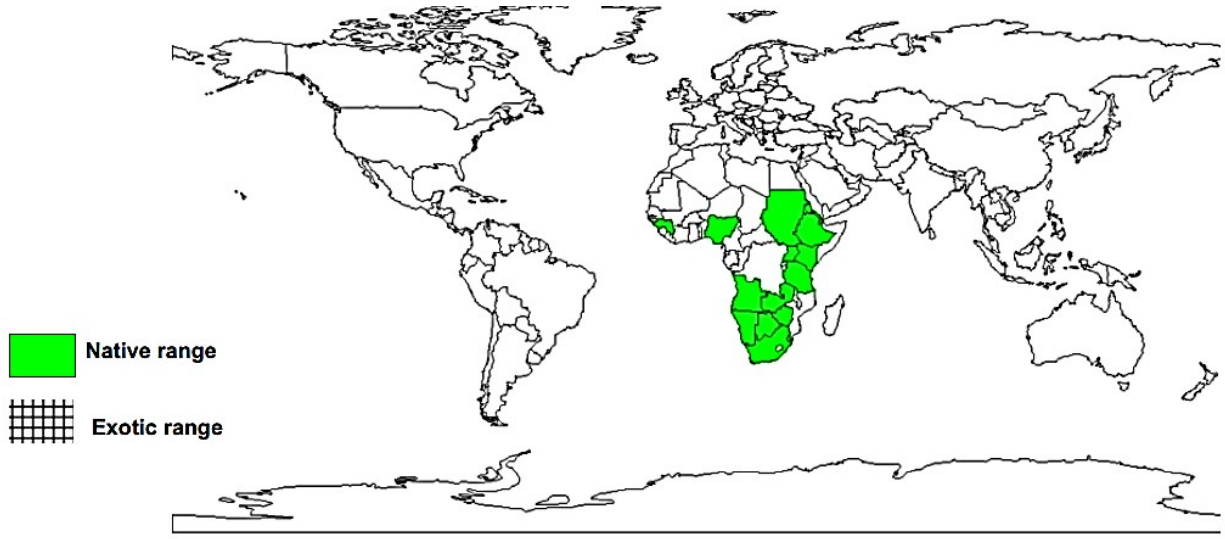


**Figure 2**: Distribution of Jackal berry (Orwa *et al.* 2009)

**Uses of *D. mespiliformis* in Folk and local medicine**

Different cultures employ *D. mespiliformis* for diverse purposes. Research by Gnonlonfin *et al*. (2018) revealed that *D. mespiliformis* is used in Northern Benin in a variety of ways, including decoction, soaking, filtering, powder, boiled residue, ash, vegetable brush toothpick, consuming directly, pounding into small pieces, chew, and consume after converting from wine. Toothpick-brush made of vegetables, ash, powder, and consumption following cooking using coals with soap. The Hausa, Yoruba, Adja, Batonu, Ditamari, and Berba have high ethnobotanical consensus values for maceration, decoction, pounding, filtration, and consuming forms of use but other ethnic groups may have low values (Gnonlonfin *et al*., 2018). According to Mabogo (1990), *D. mespiliformis* is used to treat a variety of illnesses. The bark, leaves, and roots are used to treat ringworm infestation, fever, dysentery, and wound healing. They are also used as a remedy for leprosy. The crushed fruit is applied to treat fungal infections of the scalp. The herb is used to cure erectile dysfunction in men, according to Cheikh Youssef *et al*. (2011). To treat malaria, the bark or leaves are steam-treated (Chinsembu & Hedimbi, 2010). To substantiate the use of *D. mespiliformis* in traditional medicine for pain relief and fever reduction, Adzu and colleagues investigated the antipyretic, analgesic, and anti-inflammatory properties of a methanol extract in rats and mice.

The findings demonstrated the extract's strong antipyretic effects at doses of 50 and 100 mg/kg i.p. (Thomford *et al.,* 2015). In West Africa, the fruit, bark, roots, and leaves are all used medicinally and contain antibiotics. While a decoction of the leaves is used as a medication for fever, ear infections, and wound dressing, the roots and bark are used to halt bleeding and enhance fertility. The bark and roots are used as an anthelmintic, a birth aid, and to cure a variety of illnesses, including dermatoses, pneumonia, malaria, syphilis, and leprosy. Various portions are utilized as psychotropic medication, to cure migraines, diarrhoea, and toothaches (Aminu *et al.,* 2021). The infusion of bark is used to relieve stomach aches. Infections including malaria, pneumonia, syphilis, leprosy, and dermatological conditions are also treated with the bark and roots; they are also used as an anthelmintic and a birth aid (Abba *et al.,* 2016). According to Mohamed et al. (2009), the bark and roots are used as psychiatric medication and to treat tumours. Menorrhagia, diarrhoea, and dysentery are treated with a fruit decoction or extract. A decoction made from the seeds is used to treat headaches, fruit powder is used to treat ulcers, and fruit ash is used to treat fungal skin infections. Chewing on tree branches helps keep teeth clean (Xie et al., 2015). Its seeds are also recognized to offer nutritional benefits for managing excessive cholesterol, which lowers the chance of developing type 2 diabetes, as well as for managing weight (Cabral & Klein, 2017). The leaves have vermifuge, stimulant, moderate laxative, febrifuge, and astringent properties. The leaves are infused and used to treat yaws, syphilis, pneumonia, fevers, and leprosy (NRC, 2008).

**Nutritional Value of the species**

This fruit, which is among the plant sources of food in Africa, can enhance food security, promote rural area development, increase nutrition, and support sustainable management of land. Fruit can be eaten raw, roasted, dried, or fermented to make drinks. Due to their high carbohydrate content, seeds can provide humans with dietary energy. When the traditional crops fail due to drought, the rural population exploits it as a source of food. Oil has the potential to be used in human nutrition and health due to its diverse fatty acid profile. It is mainly utilized as a source of essential fatty acids and as a precursor for synthesizing other vital lipids that play a crucial role in supporting key physiological processes in the body (Chivandi & Erlwanger 2011).

Humans can consume the *kanya* fruit; it has a gritty consistency and a flavour akin to lemon. According to Sumit et al. (2016), they can be dried, crushed into flour, and preserved sometimes. They are also frequently used in the production of brandy and beer. The Ovambo people use the fruit of the jackal, known as eenyandi, to make their traditional liquor, Ombike. Seed oils may be used to produce ALA, which is a metabolic substrate for DHA and EPA. Because DHA insufficiency and other physiological circumstances linked to lower body omega 3 concentrations can cause depression, ALA found in DSM seed oil may be used as a dietary supplement to stop depression from starting and worsening (Chivandi & Erlwanger 2011). One of the most significant natural goods that may be found in nature is forest products. The lives of individuals living in rural areas and even in cities depend heavily on these products. There are numerous traditional and therapeutic uses for *Diospyros mespiliformis*. This study suggests that it could be a source of nourishment for humans. Due to their high carbohydrate content, seeds may one day provide people with a source of dietary energy. The edible fruit is dried and kept for later use, or it can be used fresh in a fermented beverage. It can also be combined with food to make a sort of porridge, or more frequently, with meals. Elephants,

giraffes, black rhinos, elands, and kudus use the fodder leaves, while warthogs, baboons, vervet monkeys, kudus, klipspringers, warthogs, yellow-spotted rock dassies, pigeons, parrots, hornbills, louries, and bulbuls consume the fruits (Orwa *et al*. 2009).

### 3.1 Proximate composition

As shown in Table 1, analysis conducted to determine the approximate makeup of various parts of *Diospyros mespiliformis* reveals varying component ratios and amounts. The fruit pulp's moisture content varies between 13.11 and 65.2% (Ilouno *et al*. 2018; Muhammad *et al*. 2024; Magaji *et al*. 2019). *Diospyros mespiliformis* seed has a moisture content of 9.0% (Ilouno *et al*. 2018), while the root, plant bark, and leaves have varying moisture content (Ebbo *et al*. 2019). These values exceed the 13% threshold needed for shelf-stable foods, suggesting that the fruit pulp may need additional processing, like drying, before being used as a food ingredient. Moreover, the fruit pulp has a higher moisture content compared to other wild fruit seeds such as *Cassipourea congoensis*, *Gmelina arborea*, and *Nuclea latifolia* (Nkafamiya et al., 2007). The amount of moisture in a food sample affects its deterioration and shelf life (Garba *et al.,* 2023). The fruit of *Diospyros mespiliformis* has an ash content ranging from 0.68 to 2.02 percent (Muhammad *et al*. 2024; Magaji 2019), while the stem bark has 11.33 percent, the leaves have 13.16 percent (Ebbo *et al*. 2019), and the fruit seed has 4.75% (Ilouno *et al*. 2018). The amount of ash serves as a mineral element indicator. Because of their pro-oxidant properties and other health advantages, minerals are essential to the human diet. *Diospyros mespiliformis* seeds had an ash level that exceeded the range of 1.5-2.2% for seeds and tubers appropriate for animal feed (Emelike *et al.,* 2015), indicating significant potential and usefulness for the preparation of animal feeds. Fruit pulp was found to have a fat content ranging from 1.41 to 19.08, whereas the seed had a fat content of 2.22, which is less than the >13% fat content of oil seeds like melon and groundnut (Shalaby *et al*. 2020). According to Ilouno *et al*. (2018), fruit pulp has a fibre content ranging from 0.29 to 3.37%, but the seeds have a 2.67 fibre content leaves 2.66, the root was 3.83 and that of the plant bark was 6.83 indicating potential digestive advantage and potential for usage in the development of weaning foods. Foods high in fibre aid in facilitating the transit of waste, hence averting constipation. Apart from clearing the digestive system, fibres also aid in limiting the absorption of extra cholesterol and limiting the consumption of starchy foods (Ahamefula *et al.,* 2014). Although there are benefits to eating foods high in fibre, such as preventing constipation, lowering blood cholesterol, and lowering the risk of certain cancers, it is important to keep fibre intake low for infant nutrition and during the weaning process because high levels of fibre can irritate children's gut mucosa. The fruit pulp had 1.55–6.01% crude protein and the seed had 5.44 g/100 g. *Diospyros mespiliformis* has less protein than other fruit seeds (Nkafamiya *et al.,* 2007), and foods high in protein, such as melon, cowpeas, and soybeans (Ezeagu and Igbebu, 2010; Jacob *et al.,* 2015). While *Diospyros mespiliformis*'s protein content is comparable to that of some leafy vegetables (Agbaire, 2011), it is far less than the daily intake of protein recommended for adults (40–56g) and children (23–36g) (Emelike *et al.,* 2015). As a result, different parts of the plant, such as fruit, seeds, bark, and fodder, when consumed as a staple food or for animal feed, should be supplemented with foods high in protein to prevent deficiency and malnutrition. Protein has inverse connections with blood pressure; in other reports, the protein content is higher than the 0.83 g/kg per day recommended protein quantities (i.e., less than 1.4 g/kg per day) for adults (Emmanuel *et al*., 2021). To reduce the risk of kidney stones in patients who are at risk, a

safe level of protein in the diet should be consumed; in terms of cancer, it has been reported that women with breast cancer who consume higher amounts of protein in their diets have a higher chance of surviving the disease. The amount of carbohydrates in leaves, which are primarily used as animal feed, was 55.03%; in contrast, the amount of carbohydrates in seeds used to produce local oil was 31.72%; and in fruit pulp, which is typically consumed as a stable and medicinal substance, the amount of carbohydrates was 26.55 - 31.72 %. These results indicate a rich source of carbohydrates and can be compared to foods high in carbohydrates, such as cereals, which have 72–90 g/100 g (Adewusi *et al.,* 1995). The proximate composition of *Diospyros mespiliformis* is shown in Table 1.

**Table 1.** Proximate composition of *Diospyros mespiliformis*

| Proximate Component | Fruit pulp | Seed | Root | Bark | Leaf |
|---|---|---|---|---|---|
| **Moisture (%)** | 13.11-65.2 | 9 | 3.33 | 11.33 | 14.83 |
| **Ash (%)** | 0.68-2.02 | 4.75 | 13.16 | 22.66 | 13.16 |
| **Crude fat (%)** | 1.41-19.08 | 2.22 | 1.16 | 1.83 | 3 |
| **Crude fiber (%)** | 0.29-3.37 | 2.67 | 3.83 | 6.83 | 2.66 |
| **Crude Protein (%)** | 1.50-6.01 | 5.44 | 3.9 | 5.51 | 11.49 |
| **Carbohydrate (%)** | 31.72-56.55 | 76.33 | 73.99 | 50.96 | 55.03 |

Source: Ilouno *et al.* (2018); Ebbo *et al.* (2019); Muhammad *et al.* (2024); Magaji (2019)

**Mineral composition of *Diospyros mespiliformis***

Certain plant parts, like those of *Diospyros mespiliformis*, are said to be a great supply of vital mineral elements including magnesium, calcium, and potassium, which are necessary for several bodily physiological processes (Falowo, 2021). The nutritional value, acceptability, and potential therapeutic benefit of wild fruits can be attributed in part to the mineral elements that are present but are frequently overlooked. The body needs elements including calcium, potassium, magnesium, and iron for several physiological processes. The buildup of minerals in different fruit species varies depending on soil type, plant species, and weather conditions. Scientific study of diverse wild plants and their fruits provides information about their mineral composition (Danzomo *et al.,* 2024). Minerals are necessary nutrients that are present in the body in trace amounts or parts per million (Falowo, 2021). They are essential because they all play vital roles in the body's metabolic processes, and their absence can produce deficient symptoms in animals (Falowo, 2021). Ca, K, Na, and Mg are examples of macro (major) minerals that are required for nutrition. Calcium (40.31–69.44 mg/100g), iron (9.88–24.29 mg/100g), zinc (0.805–2.4 mg/100g), magnesium (9.24–31.07 mg/100g), potassium (8.44–56.43 mg/100g), sodium (14.45–39.547 mg/100g), Manganese (3.15 mg/100g), copper (1.74–30.30 mg/100g), and lead (5.063) were found to be present in the mineral content of *Diospyros mespiliformis* fruit (Ilouno *et al*. 2018, Magaji 2019; Muhammad 2024). The mineral content evaluation of the seeds of *Diospyros mespiliformis* indicates 180.26 mg/100g of calcium, 90.49 mg/100g of iron, 0.97 mg/100g of zinc, and 92.18 mg/100g of magnesium (Ilouno *et al.,* 2018). Consequently, more research is required to assess and provide a comprehensive mineral content of the plants' fodder, roots, and bark to aid in the development of functional products. The mineral composition of the *Diospyros mespiliformis* is depicted in Table 2.

**Table 2:** Mineral composition of *Diospyros mespiliformis*

| Mineral Elements | Fruit (mg/100g) | Seed (mg/100g) |
|---|---|---|
| **Magnesium (Mn)** | 9.24 – 31.07 | 92.18 |
| **Calcium (Ca)** | 40.31- 69.44 | 180.26 |
| **Sodium (Na)** | 14.45 - 39.547 | - |
| **Zinc (Zn)** | 0.805 – 2.40 | 0.97 |
| **Iron (Fe)** | 9.88 - 24.29 | 90.49 |
| **Potassium (K)** | 8.44 - 56.43 | - |
| **Manganese (Mn)** | 3.15 | - |
| **Lead (pb)** | 5.063 | - |
| **Cupper (Cu)** | 1.74 – 30.30 | - |

Source: Magaji (2019); Ilouno *et al.* (2018)

The high ash content observed in Table 1 is corroborated by the mineral content of *Diospyros mespiliformis* presented in Table 2. Calcium (Ca) was the most prevalent mineral in *Diospyros mespiliformis* fruit and seed, followed by magnesium (Mg), iron (Fe), and zinc (Zn), which was the least prevalent mineral. Because calcium is an essential component in blood coagulation, it is a dietary element that must be included in diets. They also control muscle contractions and act as second messengers in the signal transduction pathway. Apart from being the primary component of bone, calcium is also necessary for the action of numerous enzymes (Koolman & Roehm, 2005).

Mineral content in plant-based raw materials is preferred, particularly when developing meals for young consumers. Minerals are necessary for the growth of the brain, bones, and bodily coordination. Different minerals found in diet have been connected to various health benefits for various bodily systems. According to Kampali and Pali (2004), the amount of magnesium exceeds the adult daily need of 15 mg. In addition to being a cofactor for enzymes, magnesium helps to create bones. In addition to its many biochemical functions as an enzyme cofactor, iron also plays a part in the binding of oxygen to haemoglobin. According to Dosumu *et al*. (2012), children need 10–15 mg of iron per day, women 18 mg, and adults 12 mg. Phosphorus is a vital component of phospholipids, which are essential for the structure of the cellular membrane lipid bilayer. It plays a key role not only in cellular membranes but also in bone health. Additionally, phosphorus is found in various intracellular molecules, including nucleoproteins, nucleic acids, and organic phosphates like creatine phosphate and adenosine triphosphate (ATP). The human body contains approximately 700g of phosphorus, with 80% located in the bones, 9% in skeletal muscle tissue, and 10.9% in the viscera (Emmanuel *et al.* 2021). Muscle abnormalities, metabolic acidosis, encephalopathy, changes in bone mineralization, and cardiac, pulmonary, neurological, and metabolic issues are all brought on by phosphorus deficiency in the body (Emmanuel *et al*., 2021). Due to its importance for bone density, calcium is a crucial mineral for human nutrition. Calcium ions have numerous roles in the majority of metabolic processes, and calcium salts give the skeleton rigidity (Falowo, 2021). The human body has around 99.0% calcium in its bones (Emmanuel *et al*., 2021). For adults, a daily calcium intake of 400–500 mg is suggested. In general, only about 25–30% of dietary calcium is efficiently absorbed, which is somewhat inefficient when compared to other minerals (Emmanuel *et al*., 2021). Sparing action occurs when the body uses Fe more effectively when the amount of calcium in the diet is

sufficient (Falowo, 2021). Most of the potassium's action occurs inside cells, where it is attached to proteins. Together with sodium, potassium affects osmotic pressure and helps maintain a normal pH balance (Falowo, 2021). Since animal and plant tissues are abundant suppliers of potassium, dietary deficiencies are uncommon. The improvement in potassium is more noticeable (69.9%) across the board in the flour sample. This demonstrated the quantitative dominance of potassium over other minerals, such as magnesium, sodium, and phosphorous. Sodium keeps the osmotic pressure of bodily fluids constant, helps transport $CO_2$, and controls the body's water content. Magnesium helps to maintain blood pressure, prevent tooth decay, repair and enhance human growth, and preserve strong bones.

**Phytochemicals and Anti-nutritional Composition of *Diospyros mespiliformis***

Anti-nutritional factors can negatively impact metabolic processes by impeding the body's ability to obtain necessary nutrients. On the other hand, phytochemical evaluation examines the bioactive compounds found in fruits, including antioxidants, phenolic, and flavonoid compounds, which are known to contribute to their health-supporting qualities (Olaide *et al.,* 2019, Jafri *et al.,* 2022). Plants have been found to possess antioxidant and other health-promoting qualities when they include phytochemicals (Akhtar *et al.,* 2018; Jafri *et al.,* 2022). In Table 3, Oxalate (0.004) and Phytate (0.88 mg/1009) are the main anti-nutrients found in *Diospyros mespiliformis* seeds, while Alkaloids (16.78 mg/100g), Flavonoids (29.30 mg/100g), Tannins (0.04 mg/100g), and Saponin (31.45 mg/100g) are the main phytochemicals, according to Ilouno *et al*. (2018). A chelating substance called oxalate forms compounds with calcium ions through binding. A calcium deficit may arise from eating edible seeds that contain high levels of oxalate. Kidney stones have been linked to crystals of calcium oxalate (Agbaire, 2012). There is below 2 % of oxalate in the seeds that might cause poisoning in ruminant animals, hence there may not be any negative health impacts on humans. Parts of plants rich in tannins are known to decrease protein digestibility when they are consumed as a primary food source. (Rahman *et al*., 2013).

Because tannins also chelate metal ions, the bioavailability of mineral elements is reduced (Okonwu and Ugiomoh, 2015). This study's measurement of the tannin content of *Diospyros mespiliformis* seeds is less than that of the pulp of the seed analysis (Umaru *et al.,* 2007). *Diospyros mespiliformis* seeds are safe to eat since their saponin content is higher than the 0.5–5% saponin found in grain legumes (Bora *et al.,* 2014) but still falls within the 48.50 mg/100g permissible saponin level established by the World Health Organization (WHO, 2003). Alkaloids are found in plant acids as salt. It is known that high alkaloids can damage cell membranes and nerve impulse transmission.

In comparison to several wild fruits, such as *Persea Americana, Chrysophyllum albidum, Diallium guineense, Dinnettia tripetala, Citrullus lanatus*, and *Annona muricata*, the number of alkaloids was quite high (Anhwange *et al.,* 2015). According to Erdman *et al*. (2007), a high flavonoid intake can impede proteolysis in the gut, lower the absorption of minerals, and reduce glucose intake. In comparison to the flavonoid content of Phoenix dactylifera L., the value of flavonoids found in this research is low (Shaba *et al.,* 2015). Plant materials include phytate, which is phytic acid in a salt form. When phytic acid reacts with minerals like calcium, zinc, iron, phosphorus, and magnesium, insoluble salts are created. Phytic acid, which is generated in the gut during food processing, inhibits the absorption of certain minerals.

In contrast to some wild fruits as described by Umaru *et al.* (2007) green vegetables reported by Agbaire, (2012), the phytate composition in this

study is low. It has been demonstrated that in monogastric animals, diets containing 10–60 mg/g of phytate reduce the bioavailability of nutrients (Thompson, 1993). The quantification of the phenol, steroids, terpenoids, and glycoside content of *Diospyros mespiliformis* fruit pulp is currently lacking in studies. Fruit pulp was subjected to a phytochemical screening, which revealed the presence of flavonoids, alkaloids, saponins, tannins, and steroids (0.84 mg/100g), terpenoids (0.92 mg/100g), and glycosides (0.79 mg/100g) as reported by Danzomo *et al*. (2024). The presence of flavonoids is indicative of powerful, water-soluble, super antioxidants and free radical scavengers; they also have substantial anticancer action, inhibit oxidative cell damage, and offer protection against carcinogens at all stages of development (Omodamiro, *et al*. 2016). The intestinal tract's flavonoids reduce inflammation and heart disease risk, suggesting this plant may have antioxidant benefits. The protective effects of flavonoids on β-cells in rats with diabetes have been documented in diabetes (Kumkrai *et al*. 2015). Many ailments, including diarrhea, rhinorrhea, and leucorrhea, are treated with medicinal herbs high in tannin. Table 3 describes the contents of Phytochemicals and anti-nutrient of *Diospyros mespiliformis*

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**Table 3:** Phytochemicals and anti-nutrient content of *Diospyros mespiliformis*

| Components | Seed (ethanol extract) | Fruit (Methanol extract) |
|---|---|---|
| **Alkaloids** | 16.78 | 0.09 |
| **Flavonoids** | 29.3 | 0.7 |
| **Tannins** | 0.04 | 3.3 |
| **Saponin** | 31.45 | 2.1 |
| **Oxalate** | 0.004 | - |
| **Phytate** | 0.88 | - |
| **Phenol** | - | 0.3 |
| **Steroids** | - | 0.84 |
| **Terpenoids** | - | 0.92 |
| **Glycoside** | - | 0.79 |

Source: Danzomo et al. (2024)

Because deadly diseases like AIDS and many cancers are more common these days, tannins have drawn attention from the medical community. Studies on animals have shown that tannins have potent anti-platelet and anti-hypercholesterolemic effects by reducing the absorption of cholesterol, which helps prevent anti-hyperglycemic complications (Baskaran *et al.,* 2015). According to Baskaran et al. (2015), the compounds known for their antifungal, antimicrobial, anti-yeast, anti-inflammatory, and antidote properties are saponins. Additionally, in rats given hypercholesterolemia, saponins have been demonstrated to total cholesterol lower LDL concentrations while leaving HDL cholesterol concentrations unchanged. They have also been reported to diminish the risk of atherosclerosis in rats. Many studies have been conducted on phenols as potential disease preventives. According to Rice-Evans et al. (1997), steroids have an association with human reproduction and are antioxidants in vitro. The findings from the screening of phytochemicals and micronutrients in kanya lend support to the herb's traditional uses for treating a variety of health issues, as well as to its nutritional value and pharmacological profile. These benefits have long been recognized. Alkaloids are a basic

chemical found in roughly 10–20% of all higher plants, mainly in the form of salt. Tannins are a non-toxic but crucial component of the healing process for wounds (Garba *et al.,* 2023). The plant's potential for antidiabetic effects was linked to the existence of these significant chemicals.

**Vitamin composition of *Diospyros mespiliformis***

Vitamins C, B1, B2, B3, and B6 were proven to be present in *Diospyros mespiliformis* fruit juice using vitamin analysis (Muhammad *et al*., 2024). According to the results, dried fruit pulp had the highest concentration of vitamin C (10.98 mg/100g). Vitamin B2 had the lowest amount at 0.032 mg/100g. According to the recommended daily allowance (RDA) of vitamins for humans, vitamin C is the vitamin most required, with a daily recommended intake of 75 mg. While citrus fruits have long been known to be significant sources of vitamin C with positive effects on humans (Rudge *et al.,* 2012), these results showed that other underappreciated tropical fruits, like *Diospyros mespiliformis*, also contain this important vitamin in relatively high average amounts.

Consuming 90–100 mg of ascorbic acid daily can reduce the risk of non-communicable diseases, and the vitamin C content in Kanya fruit may provide around 60% of the recommended dietary allowance (RDA). Vitamin C, essential for various biological processes, including DNA protection from free radicals and immune system support (Naidu, 2003), is present in Kanya fruit pulp at 24.56–34.38 mg/100g. This concentration is higher than that in *Detarium microcarpum*, *Strychnos spinosa*, and *Gardenia ternifolia*, but lower than in *Dialium guineense*. It is also comparable to the 23.3 mg/100g found in watermelon. The ascorbic acid content in *Diospyros mespiliformis* fruit pulp suggests it can contribute significantly to daily vitamin C intake. Ascorbic acid plays a key role in protein metabolism and collagen production, and a daily intake helps prevent scurvy, a disease caused by Vitamin C deficiency. Table 4 highlights the vitamin content of *Diospyros mespiliformis*

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**Table 4:** Vitamin content of the *Diospyros mespiliformis*

| Vitamin | Fruit Pulp (mg/100g) |
|---|---|
| **Vitamin C** | 24.56-38.34 |
| **Vitamin B1** | 0.147 |
| **Vitamin B2** | 0.04 |
| **Vitamin B3** | 3.187 |
| **Vitamin B6** | 0.207 |

Source: Magaji (2019); Muhammad *et al.* (2024).

It is not surprising that Vitamin C and B are present in the fruit pulp of *Diospyros mespiliformis* because these components are more frequently found in fruits and vegetables. However, the vitamin C value found in this study is lower than the daily recommended intake of 90–100 mg of ascorbic acid, which is needed to lower the risk of non-communicable diseases. Vital for many biological processes in the human body, including protecting DNA from free radical damage and bolstering the immune system, is Vitamin C (Naidu, 2003). Ascorbic acid, another name for vitamin C, is a water-soluble vitamin that is most recognized for its potent antioxidant qualities and immune-system-boosting abilities. Free radicals are unstable molecules formed during normal metabolic processes and in reaction to environmental

stressors like pollution and UV radiation. As an antioxidant, vitamin C helps shield cells from harm caused by free radicals. Through the process of neutralizing free radicals, vitamin C lowers the risk of chronic diseases like heart disease, cancer, and neurological disorders by preventing oxidative stress and the resulting damage to cells, DNA, and tissues. Furthermore, collagen, a protein that creates the structural foundation for skin, bones, blood vessels, and other connective tissues, is synthesized only with the help of vitamin C. For skin suppleness, wound healing, and general skin health, collagen is essential. Therefore, maintaining good skin, minimizing the appearance of wrinkles, and assisting the body's natural aging processes all depend on an appropriate intake of vitamin C. Vitamin C is essential for immune system support in addition to its antioxidant and collagen-supporting qualities. To fight off diseases and foreign invaders, it aids in promoting the growth and functionality of white blood cells, such as phagocytes and lymphocytes. In addition, vitamin C maintains the integrity of the mucous membranes lining the digestive and respiratory systems and improves the effectiveness of the skin's defenses against infections.

**Conclusion**

This review identified that *Diospyros mespiliformis* fruit, seed, body bark, leaves, and roots have highly nutritious value, comparable to a nutrient-dense diet. Fruit can provide a lot of energy from eating and is a wonderful source of ash and carbohydrates. The fruit and seeds can enhance and vary a diet. To avoid malnutrition and ill health, staple foods during times of famine and drought should be supplemented with a diet high in protein. The fruit and seed are rich sources of calcium, iron, and magnesium, even if they are poor sources of zinc since the amounts received satisfy their daily needs. The anti-nutritional factors' outcome indicates that the seed is safe for ingestion by humans. But the seeds could be put to use as animal feeds if further processed. Due to its high vitamin content, low nutrient level, and favourable phytochemical composition, the fruit may also have pharmacological and nutritional benefits. More investigation may be required to produce a reliable assessment of the fruit pulp's and the seed's quantitative phytochemical and antioxidant potential. Additionally, more work can be done to determine how well pulp works as a substitute in food and feed composition fruit.

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