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Assessment of fatty acid profile and sugar content of African black pear (*Dacryodes edulis*) kernel and pulp

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Abstract

This study examines the fatty acid profiles, phospholipid content, phytosterol composition, and sugar concentrations in the kernel and pulp of African black pear (*Dacryodes edulis*) to determine their chemical composition and quality criteria. The results revealed significant differences in the distribution of fatty acids, with the pulp containing more polyunsaturated fatty acids (PUFA, 20.8%) and the kernel containing more saturated fatty acids (SFA, 40.37%) than the pulp (36.41%). The major fatty acids in the kernel and pulp were oleic acid (C18:1) and stearic acid (C18:0). The kernel had a higher hypocholesterolemic/ hypercholesterolemic ratio (H/H) (5.74) than the pulp (3.47), indicating better cholesterol-lowering capacity. Total phospholipid content which is dominated by phosphatidylcholine (PC) and phosphatidylethanolamine (PE), was higher in the pulp (483.34 mg/100 g) than in the kernel (427.82 mg/100 g), according to phospholipid analysis. The pulp contained more phytosterols, specifically sitosterol (125.2 mg/100 g), than the kernel (108.48 mg/100 g). Sugar study revealed that the pulp has higher levels of glucose and fructose, which contribute to its sweeter taste profile. These findings emphasize Dacryodes edulis' nutritional and practical applications in foods and medicine.

Keywords: Fatty acids; Phospholipids; Phytosterols; Sugar; *Dacryodes edulis*

Introduction

The African black pear, scientifically known as *Dacryodes edulis,* is a tropical fruit tree native to Central and West Africa. In some locations, it is also referred to as the African plum, butter fruit, or safou (Oselebe *et al.* 2020). It belongs to the Burseraceae family, and in its native areas, the fruit has immense cultural, economic, and nutritional value. This remarkable plant is receiving global recognition due to its distinct flavour, nutritional properties, and wide range of applications (Tetteh and Asare, 2022). Despite their apparent resemblance, the African black pear differs from the more popular avocado and has unique qualities, particularly its pulp and kernel (Asaah *et al.* 2021). The African black pear tree, a perennial evergreen, prefers warm, humid tropical and subtropical climates. The pulp, the edible component of the fruit, surrounds the seed or kernel. Although this kernel has recently received greater attention due to its potential industrial applications, it is still less important than the pulp, which is the primary component that people value and consume (Mbanga and Nkang, 2021).

African black pear pulp is known for its rich, buttery texture, which becomes softer and more flavorful when heated (Enujiugha and Badejo, 2013). In many African countries, the pulp is roasted, boiled, or softened with hot water before consumption. It is a common component in African cuisine, having a nutty, sour flavour that complements mainstays such as yam, cassava, and maize. Nutritionally, the pulp is high in beneficial components, comprising up to 48% fat and is particularly high in lipids, making it a calorically and energetically dense diet (Okonkwo *et al.* 2018). In contrast to many fruits, which are largely made up of sugars and carbohydrates, the nutritional benefits of the African black pear are comparable to those of avocados due to its fat content (Okonkwo *et al.* 2018).

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The majority of these fats are composed of healthy unsaturated fatty acids, such as oleic and linoleic acids, which are known to promote cardiovascular health and reduce cholesterol levels (Oluwaniyi *et al.* 2017). The pulp promotes bone health, muscle function, and electrolyte balance by containing a moderate quantity of protein and essential minerals such as calcium, magnesium, and potassium (Onwuzuruike *et al.* 2022). The African black pear is also high in vitamins, including vitamin E, an antioxidant that protects cells and promotes skin health, and vitamin C, which improves immune function and skin health (Akusu and Wordu, 2019). Because of these ingredients, *Dacryodes edulis* pulp is frequently considered a nutrient-dense diet, which helps explain why it is becoming increasingly popular outside of Africa in locations where it is available.

African black pear's kernel or seed is known to contain significant nutrients and bioactive substances, it is often overlooked and usually discarded, but the pulp is consumed fresh (Okonkwo *et al.* 2018). However, the kernel or seed has unique properties that could be exploited in both industrial and nutritional settings. Despite having a considerably harder texture and being less palatable than pulp, studies have showed that the kernel is rich in fiber, proteins, and lipids (Onwuzuruike *et al.* 2022; Oluwaniyi *et al.* 2017). Since, its fibre content is high, it could be useful as a food processing ingredient or dietary supplement. The kernel contains significant levels of oils, which have been studied for potential extraction and application in the culinary, pharmaceutical, and cosmetic industries (Tetteh and Asare, 2022). The kernel has been used for a variety of therapeutic purposes in traditional African medicine. Because of its antibacterial and anti-inflammatory properties, kernel extracts are sometimes used to treat wounds, skin infections, and different digestive ailments (Djedje*et al.* 2020). In addition, lauric and myristic acids, which are highly valued for their moisturizing and antimicrobial properties, have brought attention to the oil derived from the African black pear kernel (Nwaogu *et al.* 2024). As a result, kernel oil can be utilized as a natural moisturizer, soap, and cosmetic. Furthermore, researchers found that kernel oil may be used as a biodiesel feedstock, providing an alternative energy source (Nwaogu *et al.* 2024). Therefore, the aim of this study is to assess the fatty acid profile and sugar contents of the African black pear (*Dacryodes edulis*) kernel and pulp. The specific objectives are to : *(a)* determine the fatty acid composition; *(b)* determine the quality parameters and functional quality; *(c)* determine the phospholipids composition; *(d)* determine the phytosterols composition; and *(e)* determine the Sugar concentrations of African black pear (Dacryodes edulis) kernel and pulp.

Materials and methods

Samples collection

The pulp and kernel samples of African black pear (*Dacryodes edulis)* were collected from a farming village in Ogoja, Bekwara LG, Cross–Rivers State Nigeria. The samples were authenticated at the Department of Plant Science and Biotechnology, Federal University of Lafia, Nigeria.

Samples preparation and treatment

African black pear (*Dacryodes edulis*) pulp and kernel samples were properly rinsed thoroughly with distilled water to get rid of any impurities and then filtered through paper. The fruit was sun-dried, separated into pulp and kernel, and ground into a fine powder using a pestle and mortar. The powder was sieved, stored in properly labeled airtight plastic containers, and then taken for analysis.

Analysis of fatty acid profiles

Each sample's oil was transformed into methyl esters using the procedure described by Aremu *et al.* (2019). In particular, 3.4 ml of potassium hydroxide (KOH) solution in methanol (0.5 M) was used to saponify 50 mg of the extracted oil for five minutes at 95^{o}C. After neutralising the reaction mixture with hydrochloric acid (HCl, 0.7 M), 3 ml of boron trifluoride in 14% methanol were added. The resultant mixture was heated for five minutes at 90^{o}C to guarantee full methylation. HP 6890 gas chromatograph (GC) fitted with a flame ionization detector (FID) was used to understudy the fatty acid methyl esters (FAMEs) that were generated. The fatty acids were separated using a polar capillary column (HP INNO Wax, 30 m 0.53 mm 0.25 m) in which nitrogen acted as the carrier gas. The temperature was adjusted to 250^{o}C, it was programmed to rise at a rate of 5^{o}C per minute until it reached 310^{o}C. The temperature of the injector and detector was kept at 310^{o}C and 350^{o}C, respectively. Contrasting the retention durations with those of conventional methyl esters, the FAME peaks were located. Peak areas were calculated for quantitative analysis, and heptadecanoic ester was used as the internal standard to achieve a recovery rate of 0.96.

Functional quality of the oil samples

The function of the lipid fractions was assessed based on the fatty acid proportions in their lipid profiles, analyzed using four compositional indices. The ratio of omega-6 to omega-3 equation (1), hypocholesterolemic/hypercholesterolemic (H/H) ratio, equation (2), (Cunha *et al.* 2019) atherogenicity index (AI), equation (3), and thrombogenicity index (TI), equation (4), (Santos-Silva *et al.* 2002).

$$\omega - 6/\omega - 3\ Ratio = \frac{\sum \omega - 6\ fatty\ acid}{\sum \omega - 3\ fatty\ acid} \quad (1)$$

$$\frac{H}{H} = \frac{C18{:}1\omega 9 + C18{:}2\omega 6 + C20{:}4\omega 6 + C18{:}3\omega 3 + C20{:}5\omega 3 + C22{:}5\omega 3 + C22{:}6\omega 3}{C14{:}0 + C16{:}0} \quad (2)$$

$$AI = \frac{C12{:}0 + 4\,(C14{:}0) + C16{:}0}{\sum MUFA + \sum \omega - 6 + \sum \omega - 3} \quad (3)$$

$$TI = \frac{C14{:}0 + C16{:}0 + C18{:}0}{0.5(\sum MUFA) + 0.5\,(\sum \omega - 6) + 3(\sum \omega - 3) + \frac{\sum \omega - 3}{\sum \omega - 6}} \quad (4)$$

Phospholipids analysis

The phospholipid content of the pulp and kernel samples was determined using the methods described by Aremu *et al*. (2016) and Aremu *et al*. (2021). A 0.01 g sample of the extracted fats was placed in a test tube and dried completely under a nitrogen gas stream. Subsequently, 0.04 ml of chloroform was added, followed by 0.10 ml of a chromogenic solution. The mixture was heated in a water bath at 100°C for about one minute and then allowed to cool. Once cooled, 5 ml of hexane was added, and the tube was gently agitated several times. The solvent and aqueous layers were separated, and the hexane layer was collected and concentrated to 1.0 ml for analysis by gas chromatography using a flame photometric detector.

Phytosterol analysis

Phytosterol analysis was conducted following the AOAC (2007) method. A measured portion of the extracted oil from each sample was placed in a screw-capped test tube. Saponification was performed at 95°C for 30 minutes using 3 ml of 10% KOH in ethanol, with 0.20 ml of benzene added to prevent immiscibility. Afterward, 3 ml of deionized water was added, followed by the extraction of non-saponifiable materials with 2 ml of hexane. This extraction process was repeated three times, each lasting 1 hour and 30 minutes, to ensure thorough sterol extraction. The hexane extracts were concentrated to 1 ml for gas chromatographic analysis, and 1 µl was injected into the gas chromatograph injection port. Sterol peaks were identified by comparison with standard sterols

Determination of sugar content

The sugar content of African black pear pulp and kernel samples *(Dacryodes edulis)* was determined using Lane and Eynon's method, as well as the FAO/WHO (1991) guidelines. All chemicals used were of analytical grade and sourced from British Drug Houses (BDH, London, UK).

Statistical Analysis

Data were evaluated using analysis of variance (ANOVA) using the SPSS Statistical Package. Duncan's multiple range test was used to identify significant variations between experimental mean values ($p<0.05$).

Results and discussion

Fatty acid composition (%) of African black pear (Dacryodes edulis) kernel and pulp

The fatty acid composition of the African black pear *(Dacryodes edulis)* kernel and pulp in Table I revealed a distinct profile, suggesting its nutritional and industrial potential. Total fatty acids are uniformly distributed at 100% in both kernel and pulp, although their individual compositions differ greatly. Saturated fatty acids (SFA), such as palmitic acid (C16:0) and stearic acid (C18:0), dominated the kernel and pulp, with stearic acid being especially plentiful in the kernel (28.92%), indicating its potential for applications requiring solid fat. SFAs may be linked to obesity, heart disease, and other maladies, however in the soap producing industry, SFAs have numerous benefits such as increasing soap hardness, allowing the soap to last longer. People with sensitive skins have difficulty with tallow soaps, thus they look for soaps derived from more subtle sources (Kochhar and Ghatak, 2020). Minor SFAs, such as arachidic acid (C20:0), behenic acid (C22:0), and lignoceric acid (C24:0), appear in trace amounts, contributing to the overall lipid diversity without dominating the profile. Monounsaturated fatty acids (MUFA) are led by oleic acid (C18:1), which represents a significant proportion (45.29% mean value) of the total fatty acids, with slightly higher levels in the kernel (48.91%) compared to the pulp (41.66%). This high oleic acid content places African black pear alongside oil-rich fruits like olives, known for their heart-healthy properties (Chinwe *et al.*, 2024), this fatty acid is also known for promoting heart health by reducing LDL cholesterol levels (Osagie *et al.* 2021). Palmitoleic acid (C16:1) and erucic acid (C22:1), while less abundant, though higher in pulp sample, when compared to the value reported for African black pear by Chinwe *et al.* (2024), it is higher in this study in the range of 0.82% to 0.13%. They add to the monounsaturated lipid profile, with their presence indicating potential for niche in industrial applications. Both fruits contain linoleic acid, with pulp at 19.69% higher than kernel at 9.56%. Linoleic acid is an essential polyunsaturated fat, beneficial for skin and brain function (Bora *et al.* 2022). The linoleic acid content found in African black pear in the report of Chinwe *et al.* (2024) was 12% which is in the same range as those found in this study.

Table I. Fatty acid composition (%) of African black pear (*Dacryodes edulis*) kernel and pulp

Fatty Acid (%)	Kernel	Pulp	Mean	SD	CV %
Myristic Acid (C14:0)	0	0.85	0.43	0.43	100.00
Palmitic Acid (C16:0)	10.47	17.46	13.97	3.5	25.05
Margaric Acid (C17:0)	0	0.04	0.02	0.02	100.00
Stearic Acid (C18:0)	28.92	17.01	22.97	5.95	25.90
Arachidic Acid (C20:0)	0.56	0.54	0.55	0.01	1.82
Behenic Acid (C22:0)	0.42	0.34	0.38	0.04	10.53
Lignoceric Acid (C24:0)	0	0.17	0.09	0.09	100.00
Palmitoleic Acid (C16:1)	0.33	0.82	0.58	0.25	43.10
Oleic Acid (C18:1)	48.91	41.66	45.29	3.63	8.02
Linoleic Acid (C18:2)	9.56	19.69	14.63	5.07	34.65
Linolenic Acid (C18:3)	0.84	1.11	0.98	0.13	13.27
Erucic Acid (C22:1)	0	0.25	0.13	0.13	100.00
Total	100	100	100	19.25	562.34

SD=Standard deviation; CV=Coefficient of variation

Quality parameters and functional quality of African black pear (Dacryodes edulis) kernel and pulp

The quality parameters of African black pear (*Dacryodes edulis*) kernel and pulp highlight a distinct yet complementary fatty acid composition, underscoring their nutritional and industrial potential. Saturated fatty acids (SFA) are slightly higher in the kernel (40.37%) compared to the pulp (36.41%), as indicated in Table II with a mean value of 38.39% and low variability (CV 5.16%). This moderate SFA level ensures stability, particularly in the kernel, making it suitable for applications that require resistance to oxidation, such as frying and storage (Fulgoni *et al.* 2022). On the other hand, because health-conscious diets seek lower saturated fat intake, the pulp's decreased SFA level might make it more appealing for dietary use. The fatty acid profile is mainly concentrated by monounsaturated fatty acids (MUFA), with the kernel having a greater MUFA content (49.24%) than the pulp (42.73%). This results in a mean value of 45.99% with low variability (CV 7.09%). The MUFA/SFA ratio of 1.20, which reflects this steady MUFA prevalence, shows a healthy balance that is similar to oils like olive oil, which are well known for their cardiovascular advantages (Nwachukwu *et al.* 2023). The kernel's high MUFA content indicates that it is suitable for oxidatively stable industrial and nutritional applications. With a mean value of 15.82% and higher variability (CV 31.48%), polyunsaturated fatty acids (PUFA) are substantially many in the pulp (20.8%) than in the kernel (10.84%). This demonstrates the pulp's exceptional ability to supply essential fatty acids (EFA), which are vital for human health, especially for brain function and inflammation reduction (Djuricic *and* Calder 2021; Cunha *et al.* 2019). This balance is shown by the PUFA/SFA ratio (0.42), where pulp contributes more to this vital nutrient profile. A similar pattern can be seen in total EFAs, which are larger in pulp (20.79%) than in kernel (10.4%), highlighting the pulp's significance as a dietary source of these vital nutrients. The total unsaturated fatty acids (UFA), comprising MUFA and PUFA, are consistently high across both kernel and pulp, with 60.08% in the kernel and 63.53% in the pulp, yielding a mean of 61.81% and minimal variability (CV 2.80%). This high UFA level confirms the nutritional value of the fruit, as unsaturated fats are associated with improved heart health and other metabolic benefits (Mbanga and Nkang, 2021). The proportion of MUFA to PUFA in the pulp and kernel is in line with their respective functions: the pulp's higher PUFA content meets nutritional requirements, while the kernel's MUFA richness helps it to maintain oxidative stability (Cunha *et al.* 2019). The kernel and pulp are further distinguished by the oleic/linoleic (O/L) ratio, which shows a significantly greater value in the kernel (5.12) than in the pulp (2.12.). The kernel's higher O/L ratio indicates greater stability, which makes it more appropriate for industrial processing and storage. On the other hand, the pulp's increased linoleic acid content is reflected in its lower O/L ratio, which increases its importance as a vital source of important fatty acids (Aremu *et al.* 2016).

Increasing in the intake of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in omega-6/omega-3 ratio is important since EPA is particularly effective in regulating oil production, making it useful in formulations targeting acne-prone and oily skin. Its role in reducing collagen

degradation and protecting against UV damage makes it a valuable component of anti-aging and photoprotective products and DHA contributes to the repair and regeneration of damaged skin tissues. It is used in healing creams and treatments for scars, burns, and skin recovery post-cosmetic procedures. Its inclusion in products also helps improve skin smoothness and elasticity (Huang *et al.* 2018). The ω-6/ω-3 ratio in the pulp sample is higher than in the kernel sample, as shown in Table III, Omega-6 fatty acids play a critical role in maintaining the skin's barrier function. Linoleic acid, the primary ω-6 fatty acid, helps restore the lipid matrix of the epidermis, reducing trans-epidermal water loss and improving skin hydration. It also has anti-inflammatory properties, making it beneficial in treating conditions such as eczema, psoriasis, and acne. In cosmetic formulations, ω-6 is included in moisturizers, serums, and anti-aging creams to enhance skin elasticity and softness (Ojha *et al.* 2024). Furthermore, a high hypocholesterolemic/hypercholesterolemic (H/H) index in oils indicates improved cholesterol metabolism and greater production of high-density lipoproteins (HDL), making such oils more beneficial for human consumption (Santos-Silva *et al.* 2002). The hypocholesterolemic/hypercholesterolemic ratio (H/H) values were found in kernel 5.74 and pulp 3.47, though kernel H/H value is higher than that of pulp. These elevated values indicate that the fatty acid composition of the oil from both the kernel and pulp is highly beneficial for enhancing cholesterol profiles, positioning it as a heart-friendly option. In a study by Abd El-Baset *et al.* (2024) the H/H value ranged from 8.084- 13.759 which in range with this current study. Another study by Stoyanova and Romova (2024), the H/H value was 7.0. Waste seeds from *Nicotiana tobacum* L which corroborates with this study on higher values of H/H. Previous research has indicated that oils with atherogenicity index (AI), thrombogenicity index (TI) values less than 1 can be included in a healthy diet (Abd El-Baset *et al.* 2024; Cunha *et al.* 2019; Pinto *et al.* 2018). Therefore, considering the findings in Table III, consuming these vegetable oils can be regarded as a healthy diet.

Table II. Quality parameters of African black pear (*Dacryodes edulis*) kernel and pulp

Parameter	Kernel	Pulp	Mean	SD	CV %
Total SFA	40.37	36.41	38.39	1.98	5.16
Total MUFA	49.24	42.73	45.99	3.26	7.09
Total PUFA	10.84	20.8	15.82	4.98	31.48
DUFA	9.56	19.69	14.63	5.07	34.65
Total UFA	60.08	63.53	61.81	1.73	2.80
MUFA / SFA	1.22	1.17	1.20	0.03	2.50
PUFA / SFA	0.27	0.57	0.42	0.15	35.71
Total EFA	10.4	20.79	15.60	5.20	33.33
O / L	5.12	2.12	3.62	1.50	41.44

SD=Standard deviation; CV=Coefficient of variation

Phospholipids composition of African black pear (Dacryodes edulis) kernel and pulp

The phospholipid composition for the kernel and pulp of African black pear (*Dacryodes edulis*) showed in Table IV revealed a diverse array of biologically significant molecules with important structural and functional roles. The total phospholipid content is higher in the pulp (483.34 mg/100 g) relative to the kernel (427.82 mg/100 g). This highlights the pulp as a richer source of phospholipids, which are crucial parts of cell membranes and play vital roles in metabolic signaling pathways (Ortutu *et al.* 2024). Among individual phospholipids, phosphatidylcholine (PC) is the most abundant, with a significantly higher concentration in the pulp (196.26 mg/100 g) than in the kernel (163.01 mg/100 g). PC is known for its role in lipid metabolism, neurotransmitter synthesis, and maintaining cell membrane integrity (Özcan *et al.* 2023). In the study by Ortutu *et al.* (2024), PC is the second highest phospholipids with phosphatidylcholine (4.02 mg/100 g, 4.52 mg/100 g, 4.22 mg/100 g) in orange pulp. Phosphatidylethanolamine (PE) is the second most abundant, with concentrations of 125.77 mg/100 g in the pulp and 113.29 mg/100 g in the kernel. Other phospholipids such as phosphatidylinositol (PI) and phosphatidic acid (PA) are also present in significant amounts. PI concentrations are slightly higher in the pulp (138.97 mg/100 g) than in the kernel (129.43 mg/100 g). PI is essential in cell signaling and membrane anchoring of proteins. PA, with a mean value of

Table III. Functional quality of African black pear (*Dacryodes edulis*) kernel and pulp

Q/Parameter	Kernel	Pulp	Mean	SD
ω-6/ω-3	11.38	17.74	14.56	3.18
H/H	5.74	3.47	4.605	1.135
AI	0.17	0.33	0.25	0.08
TI	1.23	1.02	1.125	0.105

H/H: Hypocholesterolemic/hypercholesterolemic ratio;
AI: Atherogenicity index; TI: Thrombogenicity index (TI)

16.74 mg/100 g is a precursor for the biosynthesis of other lipids and plays a role in membrane dynamics (Putri *et al.* 2023). Minor phospholipids such as phosphatidylserine (PS), lysophosphatidylcholine (LC), and sphingomyelin (SM) are also detected. PS, involved in cell signaling and apoptosis, has a higher concentration in the kernel (5.22 mg/100 g) than in the pulp (4.01 mg/100 g).

Phytosterol composition of African black pear (Dacryodes edulis) kernel and pulp

The phytosterol composition of African black pear (*Dacryodes edulis*) kernel and pulp showcases a rich profile of sterols, which are plant-derived compounds with significant health benefits, particularly for cholesterol regulation and cardiovascular health. The total phytosterol content indicated in Table V is higher in the pulp (154.02 mg/100 g) compared to the kernel (135.45 mg/100 g), But among the individual sterols, sitosterol is the most dominant, with a concentration of 125.2 mg/100 g in the pulp and 108.48 mg/100 g in the kernel. Sitosterol is known for its ability to bring down LDL cholesterol by inhibiting intestinal cholesterol absorption, making it the primary contributor to the fruit's health-promoting properties. Campesterol and stigmasterol both compounds are slightly more concentrated in the pulp (15.31 mg/100 g for campesterol and 13.03 mg/100 g for stigmasterol) compared to the kernel (14.27 mg/100 g and 12.14 mg/100 g, respectively). These sterols play essential roles in reducing cholesterol levels and supporting overall cardiovascular health. Minor sterols, including savenasterol, cholesterol, and cholestanol, are present in smaller quantities. Savenasterol shows a mean concentration of 0.39 mg/100 g, with higher levels in the kernel (0.441 mg/100 g) than in the pulp (0.34 mg/100 g). Cholesterol and cholestanol are present in negligible amounts, with mean values of 0.06 mg/100 g and 0.05 mg/100 g, respectively. While their levels are low, their presence is notable, as they are precursors in phytosterol biosynthesis. Ergosterol, a sterol commonly found in fungi, is also detected at trace levels, with a mean concentration of 0.01 mg/100 g. It is slightly higher in the pulp (0.0155 mg/100 g) than in the kernel (0.0087 mg/100 g. In a study by Prommaban *et al.* (2020), campsterol was found in guava seed oil at 11.04 mg/100g when compared to the values for pulp and kernel, the campsterol level was higher, same trend was found for sitosterol except for stigmasterol which value was a way higher in the study of Prommaban *et al.* (2020) (297.61 mg/100g) compared to this study. When compared to a study by Beveridge *et al.* (2002), the hexane extracts of *Panax quinquefolium* ginseng and *Cajanus cajan* seed oils contained various phytosterols, including squalene, oxidosqualene, campesterol, stigmasterol, clerosterol, β-sitosterol, β-amyrin, δ(5)-avenasterol, δ[5,24(25)]-stigmasterol, lupeol, δ(7)-sitosterol, δ(7)-avenasterol, 24-methylenecycloartanol, and citrostadienol, all of which were identified in the study. Also, a study by Hassan *et al.* (2015), hexane extracts of *Alyssum homolocarpum* seed oil was abundant with β-sitosterol in value 3.3 mg/g which was lower than that in this current study. Campesterol in the value of 0.86 mg/g, was also lower than that found in this study, which readily transverse the blood-brain barrier (Hamedi *et al.* 2015).

Table IV. Phoholipids composition of African black pear (*Dacryodes edulis*) kernel and pulp

Phospholipid (mg/100 g)	Kernel	Pulp	Mean	SD	CV %
Phosphatidylethanolamine (PE)	113.29	125.77	119.53	6.24	5.22
Phosphatidylcholine (PC)	163.01	196.26	179.64	16.63	9.26
Phosphatidylserine (PS)	5.22	4.01	4.62	0.60	12.99
Lysophosphatidylcholine (LC)	0.468	0.68	0.57	0.11	19.30
Sphingomyelin (SM)	0.246	0.316	0.28	0.03	10.71
Phosphatidylinositol (PI)	129.43	138.97	134.20	4.77	3.55
Phosphatidic Acid (PA)	16.14	17.34	16.74	0.60	3.58
Total	427.82	483.34	455.58	28.98	64.61

SD=Standard deviation; CV=Coefficient of variation

Table V. Phytosterol composition of African black pear (*Dacryodes edulis*) kernel and pulp

Phytosterol (mg/100 g)	Kernel	Pulp	Mean	SD	CV %
Cholesterol	0.058	0.069	0.06	0.01	16.67
Cholestanol	0.052	0.057	0.05	0.00	0.00
Ergosterol	0.0087	0.0155	0.01	0.00	0.00
Campesterol	14.27	15.31	14.79	0.52	3.52
Stigmasterol	12.14	13.03	12.59	0.44	3.49
Savenasterol	0.441	0.34	0.39	0.05	12.82
Sitosterol	108.48	125.2	116.84	8.36	7.16
Total	135.45	154.02	144.73	9.38	43.66

SD=Standard deviation; CV=Coefficient of variation

Table VI. Sugar concentrations (g/100 gww) of African black pear (*Dacryodes edulis*) kernel and pulp

Parameter	Kernel	Pulp	Mean	SD	CV %
HMF	6.87E+00	7.11E-06	3.44E+00	3.43E+00	9.97E+01
Ribose	1.19E+00	1.16E-05	5.95E-01	5.95E-01	1.00E+02
Xylose	1.03E+00	6.22E-06	5.15E-01	5.15E-01	1.00E+02
Arabinose	9.05E+00	8.74E-05	4.53E+00	4.52E+00	9.98E+01
Rhamnose	1.29E+00	1.10E-05	6.45E-01	6.45E-01	1.00E+02
Fructose	4.13E+01	7.71E+01	5.92E+01	1.79E+01	3.02E+01
Mannitol	1.08E-04	1.09E-04	1.09E-04	5.00E-07	4.59E-01
Glucose	3.80E+01	7.87E+01	5.84E+01	2.03E+01	3.48E+01
Dextrose	2.22E-05	2.96E-05	2.59E-05	3.70E-06	1.43E+01
Maltose	3.05E-05	3.03E-05	3.04E-05	1.00E-07	3.29E-01
Lactose	1.22E-05	4.02E-05	2.62E-05	1.40E-05	5.34E+01
Sucrose	3.60E+03	3.77E+03	3.68E+03	8.26E+01	2.24E+00
Total	3.70E+03	3.93E+03	3.81E+03	1.31E+02	6.35E+02

HMF = Hydroxymethylfurfural; SD = Standard deviation; CV = Coefficient of variation; ww = wet weight basis

Sugar concentrations (g/100g ww) of African black pear (Dacryodes edulis) kernel and pulp

In Table VI the sugar concentrations (in g/100 g wet weight) in the kernel and pulp of the African black pear (*Dacryodes edulis*) were presented. High Molecular Weight Sugars (HMF)**,** the concentration of HMF (hydroxymethylfurfural) is relatively low, with values of 6.87 g/100g ww for the kernel and a negligible 7.11×10−6 g/100g ww for the pulp suggesting its controlled use in caramelized flavors and colorants for food processing (Vishwakarma *et al.* 2024). The mean concentration stands at 3.44 g/100g. Monosaccharides such as ribose, xylose, arabinose, rhamnose, and glucose are present in moderate concentrations, with glucose levels notably higher in both kernel (38 g/100 g) and pulp (78.7 g/100 g). These sugars are essential substrates in food and beverage industries, supporting flavor enhancement through Maillard reactions and serving as prebiotics in gut health formulations (Wang *et al.* 2024). Xylose and arabinose, in particular, are valuable for producing sugar alcohols like xylitol, commonly used in sugar-free products. The ribose content found in this study 1.19 g/100g ww (kernel) vs 1.16×10−5 g/100g ww (pulp) is higher than those found in (Aremu *et al.* 2021) study. The values obtained for xylose 1.03 g/100g ww (kernel) vs 6.22×10−6 g/100g (pulp), arabinose 9.05 g/100g ww (kernel) vs 8.74×10−5 g/100g ww (pulp). Rhamnose: 1.29 g/100g ww (kernel) vs 1.10×10−5 g/100g ww (pulp) content when compared to Aremu *et al.* (2021) study, the values gotten for this study is higher, which indicate that this study is higher in some sugar content. Fructose and sucrose are major sugars. Fructose showed a notably higher concentration in the pulp (77.1 g/100g ww) compared to the kernel (41.3 g/100g ww). In Aremu *et al.* (2021) study, the concentration of fructose was higher in pulp

sample than the seed, though the fructose contents in both pulp and kernel were higher. Fructose and sucrose levels are notably high, with fructose concentrations of 41.3 g/100 g in the kernel and 77.1 g/100 g in the pulp, and sucrose dominating at 3,600–3,770 g/100 g. Fructose, being sweeter than sucrose, is ideal for low-calorie sweeteners, while sucrose's consistency (CV: 2.24%) highlights its suitability for sugar production in baking, confectionery, and beverages (Dana and Sonia, 2024). Mannitol, though present in trace amounts, offers potential in diabetic-friendly and sugar-free products due to its low glycemic index, while lactose, despite its low levels, could serve niche applications in flavor development and baking stabilization (Dana and Sonia, 2024). The high total sugar content of the kernel (3,700 g/100 g) and pulp (3,930 g/100 g) underscores the fruit's suitability for natural sweetener production and fermentation industries, including bioethanol and organic acid production. These findings reveal the African black pear as a versatile raw material for food, pharmaceutical, and bio-industrial applications. Its sugar profile aligns with the growing demand for plant-based sweeteners and functional ingredients, supporting its commercialization across diverse sectors.

Conclusion

With notable differences in the kernel and pulp, the African black pear (*Dacryodes edulis*) has exceptional nutritional and functional qualities. While the pulp has larger quantities of polyunsaturated and essential fatty acids giving it a richer source of heart-healthy lipids, the kernel is higher in saturated and monounsaturated fatty acids. The pulp's capacity to regulate cholesterol and support cellular processes is further enhanced by its phospholipid and phytosterol levels. Its varied sugar content, especially the pulp's higher quantities of fructose and glucose, makes it a natural sweetener with extra health advantages. These compositional insights underline the need for more research into *Dacryodes edulis*'s bioactive qualities while highlighting the plant's potential as a useful resource for industrial, medicinal, and nutritional uses.

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