IPS Journal of Agriculture, Food Technology and Security
IPS J Agric. Food Tech. Sec., 1(1): 20-25 (2024)
DOI: https://doi.org/10.54117/ijafts.v1i1.28

Assessment of Physicochemical and Fatty Acid Properties of Oils Extracted from Avocado Pear (*Persea americana*) and African Black Pear (*Dacryodes edulis)*

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Abstract

The aim of this study was to assess the physicochemical and fatty acid properties of the oils extracted from avocado pears and African black pears harvested from University of Agriculture Umuagwo. The physical and chemical and fatty acid properties, including oil yield, refractive index, specific gravity, flash point, melting point, viscosity, iodine value, free fatty acid value, saponification value, and peroxide value, were measured. Each analysis was performed in triplicate, and results were analysed using ANOVA Regression analyses of data were conducted. Significant differences among the means were established at ($p<0.05$) using Duncan's multiple range test. Some parameters under physical properties did not differ ($p>0.05$) significantly; pH value for avocado pear oil was 6.94 while that of African pear oil was 6.91, Moisture content for AVPO was 0.51% while that of ABPO was 0.51. There were significant ($p<0.05$) differences in most of the parameters due to specie difference. Free fatty acid value for AVPO-0.526% and that of ABPO- 0.587%. The fatty acids found in avocado oil are predominantly monounsaturated, with smaller amounts of polyunsaturated and saturated fatty acids, while the fatty acid profile of African Black Pear oil revealed it as a good source of monounsaturated fats and some essential polyunsaturated fats. Results obtained showed that avocado pear oil and African black pear oil conformed to standards set by Nigeria Industrial Standards and Standard Organization of Nigeria for vegetable oils and can be used as edible oils and can serve industrial purposes as well.

Keywords: *Avocado pear, African black pear, oil, free fatty acid, peroxide value*

Article History
Received: 26 Aug 2024
Accepted: 06 Sep 2024
Published: 09 Oct 2024

Scan QR code to view•

How to cite this paper: Nwachukwu, C. A., Okoronkwo, T. O., & Arukwe, D. C. (2024). Assessment of Physicochemical and Fatty Acid Properties of Oils Extracted from Avocado Pear (Persea americana) and African Black Pear (Dacryodes edulis). *IPS Journal of Agriculture, Food Technology and Security*, *1*(1), 20–25. https://doi.org/10.54117/ijafts.v1i1.28.

1. Introduction

Avocado known as *Persea americana* is an evergreen tree and can reach heights of up to 20m. The trees are shallow rooted and have poor water uptake and hydraulic conductance. Avocado fruits have greenish or yellowish flesh with a buttery consistency and a rich, nutty flavor (Wang *et al*., 2020). A recent study on avocado pear (*Persea americana)* recorded that the oil yield can vary depending on the part of the avocado used and the extraction methods applied. The oil yield from avocado seeds, for instance, can reach up to 41.3% under optimized conditions, which is relatively high compared to other sources like the Hass variety, which yields around 18.1% (Eze *et al.*, 2023). They are rich in nutrients including healthy fats, vitamins and minerals (Wang, *et al*. 2020; Dreher and Davenport, 2013). Avocados are used in various culinary dishes from salads to smoothies, they are also eaten as dessert (Rodriguez-Snchez *et al.*, 2019). Avocado is beneficial to cardiovascular health and in weight management as it contains healthy fatty acids. Avocado oil also has numerous benefits, largely related to its content of anti-oxidants and healthy fats. (Fulgoni *et al*., 2013). Although they are fruits, avocados have

high fat content of between 71-88% of their total calories about 20 times the average for other fruits. High avocado intake has been shown to have a beneficial effect on blood serum cholesterol levels (Fulgoni *et al.*, 2022)

Avocado varies in weight and size depending on the variety. The edible portion of the avocado is its yellow-green flesh, characterized by a creamy, buttery texture and a subtle nutty flavor Avocado oil is used in food and cosmetic industries (Okiyama *et al*., 2017).

African Black Pear, scientifically known as *Dacryodes edulis*, is a tropical fruit native to West and Central Africa. It is highly valued not only for its delicious taste but also for its numerous health benefits and versatile oil properties (Oselebe *et al*., 2020). The African black pear (*Darcryodes edulis*) also called African plum or bush butter is an indigenous fruit tree of the rain forest of tropical West Africa. It is commonly referred to as 'Ube' in Nigeria and 'Saaw' in Cameroon. African Black Pear oil, extracted from the seeds of *Dacryodes edulis*, is valued for its nutritional and therapeutic properties. The oil is used in culinary applications, cosmetics, and traditional medicine (Tetteh and Asare, 2022). It is cultivated for its edible fruits and oil extracted from its seeds. It holds cultural and economic significances in West African communities (Asaah *et al*., 2021). The fruit and the oil of African black pear is very nutritious containing essential fatty acids, proteins, minerals and vitamins. The pulpy pericarp of the African pear appears buttery/oily in nature and packed with minerals and nutrients. African pear is characteristically reddish in color while still unripe however, the fruit tends to turn blue-black or violet in color while the flesh is pale to light green once ripen. With an oval shape in appearance, the African pear contains small clustered seeds, enclosed by thin mesocarp. Both the pulp and seeds of the African pear contain reasonable quantity of oil (Mbanga and Nkang, 2021).When in season, the fruit pulp constitutes an important and most cherished delicacy. It is consumed after tenderizing the fresh fruit by either dipping it in hot water or in hot ash and consumed with or without corn in Nigeria (Enujiugha and Badejo, 2013).

African black pear (*Dacryodes edulis)* fruit known in Nigeria especially the Ibo sect as (*Ube*) has been scientifically proven to possess a broad range of medicinal, pharmacological and biological properties that are highly beneficial to human health as they are used to treat various ailments. African Black Pear oil is known for its excellent moisturizing properties, making it beneficial for dry or sensitive skin. It can be used to treat conditions like eczema, dermatitis, and psoriasis. The oil is often used in cosmetics as a natural emollient due to its ability to deeply penetrate the skin, lock in moisture, and promote elasticity (Oselebe et al, 2020). African black pear is Rich in unsaturated fatty acids, particularly oleic acid (omega-9) and linoleic acid (omega-6), which are beneficial for heart health and maintaining cell membrane integrity. Contains Vitamin E, a powerful antioxidant that protects cells from oxidative damage and supports skin health (Tetteh and Asare, 2022). African pear (*Ube*) are believed to be anti-microbial, anti-inflammatory, anti-hypertensive, diuretic, and antispasmodics in nature. Researchers believe that these properties are as a result of the chemical constituents of the pears such as phytochemicals, minerals, sugars, vitamin, lipids and protein (Okonkwo *et al*., 2018).

This paper aims at investigating the physicochemical and fatty acid characteristics of Avocado and African black pear oils harvested in Umuagwo in Imo State.

2. Materials and Methods

2.1 Source of raw materials.

The avocado pear (*Persea americana*) and African black pear (*Dacryodes edulis*) fruits were harvested at full maturity from the farm at the University of Agriculture and Environmental Sciences, Umuagwo, Imo State. The fruits were visually inspected for any defects and stored at ambient temperature for 1-2 days before processing.

2.3 Sample Preparation

The matured fruits of Avocado pear (*Persea americana)* and African black pear *(Dacryodes edulis)* harvested from the school compound were taken to the Food Science and Technology Laboratory of University of Agriculture and Environmental Sciences Umuagwo for oil extraction and analysis. Fresh avocado pears were kept inside black polyethylene bags for four days under room temperature to soften. While fresh African black pears were softened by soaking in warm water at 60-70 ℃ for 5-10mins. The softened pulps were scraped out with stainless kitchen knife. The extracted pulps were oven dried for 2hrs at 70-80℃ cooled, pulverized with electric blender (LG Brand) and used for oil extraction.

The soxhlet extraction method as described by AOAC (2010) was used for oil extraction. A 200g piece of dried pulp was mixed with 50ml on n-hexane, allowed to stand for 30 mins, and filtered using a 200mm mesh filter to separate the cake from the filtrate. The avocado and African pear oils were then recovered separately from the filtrate using a laboratory distillation unit. The extracted oils were poured into a beaker and heated at 60ºC in an oven for 2 h to allow for complete evaporation of the solvent, hexane. The extracted oil samples were stored in appropriately labelled non-transparent bottle at room temperature (20-30 º C) until analyzed.

2.4 Determination of physical and chemical properties of the oils.

The physical properties- refractive index, specific gravity etc. and chemical properties –saponification value, peroxide value, free fatty acid value/acid value, iodine value etc. were determined by the methods described by AOAC (2010). All experiments were carried out in triplicates.

2.5 Determination of fatty acid profile of the oil samples.

The samples were analyzed using an Agilent system (Agilent technologies 7890A, Network GC-System, Wilmington, USA) and 5977B MSD with Experimental conditions of GC-MS system as described by Zhou *et al*., (2023).

2.6 Statistical analysis

All data obtained were subjected to analysis of variance (ANOVA) using SPSS Statistical Package and Duncan's multiple range test was used to evaluate significant differences among experimental mean values ($p<0.05$).

3. Results and Discussion

Avocado pear recorded a higher oil yield (28. 66%) than African black pear (25.56%), which were significantly ($p<0.05$) different as seen in (Table 1). These values were higher than the value (11.1%) reported by Ikhuoria and Maliki (2007) for pears. The oil extraction method could have been the reason for the difference in the oil yields. The oil yield of the African black pear (25.56%) was higher than the value (11.94%) reported by Ajayi and Oderinde (2002) which could be as a result of extraction method or species of the pear.

There were no significant ($p>0.05$) difference in the moisture contents of the oil samples. The moisture contents were quite low and will not support hydrolytic rancidity.

The pH values of avocado pear oil and African pear oil (6.94 and 6.91) did not differ ($p>0.05$) significantly. Oils are generally considered to be neutral with pH values close to seven (7). The pH values are important in determining the stability and shelf life of oils and oil products (Shahidi, 2020). The values recorded for the viscosities of avocado pear oil and African black pear oil were low and in the range of 1.433 and 1.342 respectively. The low viscosities of these oil samples were in line with the works of Nwachukwu *et al*. (2019) on bullet pear oils (1.420-1.440) and could be as a result of some degree of unsaturation associated with pear oils. Low viscosity points to unsaturation of oils, while high viscosity shows the potential of the oil to polymerize (Philip, 2003; Welter, 2004). A drying oil has the potential of becoming viscous, and forming a membrane when exposed to air. Semi drying oils becomes more or less oxidized relative to the drying oils, while the non-drying oils are slowly attacked by atmospheric oxygen, but remains liquid though with considerable increase in viscosity even when oxidation takes place at ordinary temperatures (Welter, 2004). Therefore avocado pear oils and African black pear oils can be classified as either drying or semi-drying oil.

The specific gravity of African black pear oil was (1.12g/ml) and differed ($p<0.05$) significantly from that of avocado pear (0.920g/ml). The value recorded for the specific value of African black pear oil was in line with the works Akusu and Wordu, (2019) who reported a value of 1.11 g/ml. The value of specific gravity recorded for avocado pear oil (0.920g/ml) in line with the value of 0.920g/ml recommended by the Standard Organization of Nigeria for edible oils (SON, 2000). Therefore avocado pear oils can serve similar purpose as edible oils.

The results show variations in refractive indices of oils extracted from avocado and African black pears- $1{,}465^0$C and 1.455^0C. These values were in line with the values recorded by Nwachukwu *et al*., 2023 for raw and toasted *egusi* and *ogbono seed* oils; 1.440-1.460. These values were in agreement with the findings of Welter, (2004) on the refractive index of refined vegetable oils (1.46). Refractive index is said to be related to degree of unsaturation, fatty acid and conjugated bonds. Refractive index has been shown as one of the most important aid for classifying fatty oils in terms of its purity and application. It is closely related to the nature of the product (i.e. molecular height and degree of unsaturation. The refractive indexes of the samples studied are within the range of those reported for most conventional edible oils (Codex Alimenterius, 1993; NIS, 2001),

There were significant ($p<0.05$) difference in the smoke point value of avocado and black pear oils. The smoke point value of avocado pear oil (100.20ºC) was in line with the value (103.8ºC) reported by Martin *et al*, 1987, and that of the African pear oil was determined to be 183ºC which compared favorably with the value of 185ºC reported by Adedokun and Onuegbu, 2011.

The flash point of avocado pear oil (263.22ºC) differed significantly ($p<0.05$) with that of African black pear oil (287.32ºC). These values were in line with the works of Ukom *et al*. (2018) for selected vegetable oil brands which were in the range of 229.55ºC to 300.50ºC.

The values for the melting points of avocado pear oil and African black pear oils (33.20^0C and 32.12ºC) differed significantly ($p>0.05$). Melting point of oil is the temperature at which oil transitions from solid to liquid state. Oils with high melting points like palm oil and coconut oils are solids at room temperature and are commonly used in cooking and baking as they are more stable and have a longer shelf life than other oils. (Shahidi, 2020).

There were no significant ($p>0.05$) difference in the amounts of impurities in avocado pear oil and African black pear oil. The little amount of impurities present in the oils could be due to the method of extraction. Impurities may be added purposely to achieve desirable color, odor and flavor (Hawken and Rohe, 2000). Most of the parameters in the chemical composition of the oils as presented in table 2 differed ($p<0.05$) significantly. The acid values obtained in this study showed significant ($p<0.05$) difference. These values were (2. 83mg/KOH and 3.63mg/KOH) for Avocado pear oil and African black pear oils respectively. The acid value suitable for edible purpose should not exceed 4mg/KOH (Musa *et al*., 2012), and the acid values of the oils recorded in this study is in line with the recommended value for edible oils. The low acid values indicate that the triacylglycerol's have not been hydrolyzed, which is an indication of good stability. Oils with low acid values are more edible and acceptable for edible

applications and can be stored for a long period of time (Musa *et al*., 2012).

The saponification values of the avocado pear oil (192.30mgKOH/g) and African black pear oils (184.99mg KOH/g) were significantly ($p<0.05$) different. These values compared favorably with the values of 189.77mgkoH/g for African black pear oil reported by Adedokun and Onuegbu, (2011). The saponification values indicate that the oils can be useful in soap making.

Free fatty acid values obtained for both oils in this study recorded significant ($p<0.05$) difference. Therefore, the low values 0.528% and 0.587% obtained in this work indicates the suitability of the oils for edible purposes.

There were significant ($p<0.05$) difference in the peroxide values of the oils recorded in this study. Avocado pear oil recorded a peroxide value of 8.8mg/100g while African black pear recorded a peroxide value of 11.2mg/100g. A maximum value of 10g Eq/kg has been set as a standard by CODEX Alimentarius Commission for nuts and seed oils (SON, 2000), this indicates that avocado pear oil will be more stable than African pear oils in terms of developing off flavor and odor.

The iodine value obtained from this study for avocado pear oil (33.54g/100g) and that of African black pear oil (47.15g/100g) showed significant ($p<0.05$) difference. The higher the iodine value of oil, the more unsaturated the oil is and the higher the potential of the oil to polymerize (Nwachukwu *et al*., 2019). Therefore avocado pear oil and African black pear oils can be classified as unsaturated oils and can be used as neat fuel. An oil with iodine value of 25-20g/100g will not pose negative effect on engine life if an active maintenance schedule is observed

Table 1: Physical characteristics of avocado pear oil and the African black pear oil.

Parameters	Avocado Pear Oil	African Black Pear Oil
Oil yield (%)	$28.66^{a} \pm 0.00$	$25.56^{b} \pm 0.00$
Moisture content (%)	$0.50^{a} \pm 0.00$	$0.51^{a} \pm 0.00$
pH	$6.94^{a} \pm 0.13$	$6.91^{a} \pm 0.12$
Viscosity	$1.433^{a} \pm 0.12$	$1.342^{b} \pm 0.11$
Specific gravity (g/ml)	$0.92^{b} \pm 0.03$	$1.12^{a} \pm 0.13$
Refractive index at 30°C	$1.465^{a} \pm 0.72$	$1.455^{b} \pm 0.73$
Flash point (°C)	$263.22^{b} \pm 0.30$	$287.31^{a} \pm 0.40$
Smoke point (°C)	$100.30^{b} \pm 0.10$	$183.01^{a} \pm 0.00$
Melting point (°C)	$33.21^{a} \pm 0.02$	$32.12^{b} \pm 0.00$
Impurities (%)	$5.23^{a} \pm 0.01$	$5.22^{a} \pm 0.01$

Values are means ± standard deviation of duplicate samples. Means in the same row with different superscripts are significantly different ($p<0.05$).

Table 2: Chemical properties of Avocado pear oil and African black pear oil

Samples	Acid value (mgkoH/g)	Free fatty acid (%)	Saponification value (mgKOH/g)	Peroxide value (mg/100g)	Iodine value (g/100g)
Avocado pear oil	$2.83^{b} \pm 0.15$	$0.528^{b} \pm 0.59$	$192.30^{a} \pm 0.25$	$8.8^{b} \pm 0.45$	$33.54^{b} \pm 0.05$
African pear pulp oil	$3.63^{a} \pm 0.04$	$0.587^{a} \pm 0.58$	$184.99^{b} \pm 1.00$	$11.2^{a} \pm 1.00$	$47.15^{a} \pm 0.04$

Values are means ± standard deviation of duplicate samples. Means in the same columns with different superscripts are significantly ($p<0.05$) different.

The values of the fatty acids analyzed in this study differed ($p<0.05$) significantly as shown in table 3. Avocado pear oil contains slightly more oleic acid (62%) than African Black Pear (49%). This fatty acid is known for promoting heart health by reducing LDL cholesterol levels (Osagie *et al*., 2021). African Black Pear has a higher concentration of palmitic acid (33%) compared to avocado (20.11%). Though palmitic acid is a saturated fat, moderate consumption from whole foods like these fruits is generally considered safe (Kochhar and Ghatak, 2020). Both fruits contain linoleic acid, with avocado at 10.17% and African Black Pear at 12.00%. Linoleic acid is an essential polyunsaturated fat, beneficial for skin and brain function (Bora *et al*., 2022). Avocado contains a notable amount of palmitoleic acid (4.33%), which is relatively small (0.13%) in African Black Pear. This fatty acid has potential anti-inflammatory and metabolic benefits (Bora *et al*. 2022). Both fruits contain low levels of stearic acid, a saturated fatty acid with a neutral impact on cholesterol levels (Eze *et al*., 2015).

Table 3: Fatty Acid composition of Avocado Pear Oil and African Black Pear Oil

Parameters	Avocado Pear oil (%)	African Black Pear Oil (%)
Oleic acid	$62.00^{a} \pm 0.01$	$49.10^{b} \pm 0.01$
Palmitic acid	$20.11^{b} \pm 0.02$	$33.00^{a} \pm 0.00$
Linoleic acid	$10.17^{b} \pm 0.13$	12.00 ± 0.12
Stearic acid	$1.20^{b} \pm 0.11$	$5.11^{b} \pm 0.17$
Arachidonic acid	$0.11^{b} \pm 0.00$	$0.27^{a} \pm 0.01$
Myristic acid	$0.59^{a} \pm 0.17$	$0.07^{b} \pm 0.11$
Palmitoleic acid	$4.33^{a} \pm 0.31$	$0.13^{b} \pm 0.01$
Linolenic acid	$0.19^{a} \pm 0.01$	$0.18^{a} \pm 0.02$

Values are means ± standard deviation of duplicate samples. Means in the same row with different superscripts are significantly different ($p<0.05$)

Conclusion

The results on the physicochemical and fatty acid properties of avocado pear and African black pear oils in this study revealed that these oils are comparable to most edible oils found in Nigeria. Most of the quality characteristics of these oils were within the NIS and SON standards for edible oils, and are suitable for some industrial purposes. The results reflected a possible influence of environment and ecological conditions on the physical, chemical and fatty acid properties of avocado and African black pear oils respectively. Therefore, oil extracted from these pears could be used satisfactorily in domestic and industrial purposes.

Competing interests

The authors report no conflicts of interest.

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