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## Physicochemical Characteristics of Oils Extracted from Selected Underutilized Seeds in Ozoro, Delta State, Nigeria

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**ABSTRACT:** This work focuses on extracting oil from five local seeds using n-hexane in a Soxhlet apparatus. This study was designed to establish the suitability of the oils for domestic and industrial uses. Before extracting the oil, the nearest part of the seeds was inspected. Oils were extracted from selected underutilized seeds such as cashew (CS), orange seed (ORS), watermelon seed (WMS), paw-paw seed (PWS) and cherry seed (CHS) using n-hexane. The oil was analyzed for colour; with conventional techniques, calculate the saponification value, iodine value, acid value, percentage of unsaponifiable matter, and heat of combustion. The findings for proximal structure showed that fat ranged from 7.09 to 60.68% and protein from 17.97 to 31.16%. The levels of acidity, peroxide, iodine, saponification, unsaponifiable materials, and Polenske and density ranged from 1.07 to 5.94 mg KOH/g, 1.89 to 4.00 Meq/kg, 93.18 to 275.55 (MgI<sub>2</sub>/g), 68.41 to 326.16 KOH/g, 2.57 to 7.22 %, 1.37 to 7.44 and 0.74 to 0.87 g/L respectively. Smoke, flash, and fire points range from 75 to 90 °C, 80 to 170 °C and 230 to 300 °C respectively. According to the fatty acid composition, oleic and linoleic acid ranges were 17.14 and 60.63%, respectively. These criteria' values fell within the FAO's recommended range for edible oils. The samples used in the research oils are of high quality and suggested for use in industrial and culinary applications.

## 1. INTRODUCTION

The disposal of waste materials created during food processing is a major issue. Because of the proliferation of termites, these wastes generate ecological difficulties; therefore, research into the potential benefits of these products is critical (Iqbal et al., 2020). Although edible fruit components are processed into a wide range of goods, such as mashed and packaged portions, seeds are often thrown out as waste since there are no profitable applications for them. (Torres-León et al., 2018). Still, they

might be a major chemical source because of their beneficial health effects (Ahmad et al., 2018).

In a broad sense, "oil" refers to any material that, at room temperature, forms a viscous or sticky solution (Agbo et al., 2020). Different fatty acids that are liquid at the same temperature are often used to characterize fats. Lipids, a broader word for phytochemicals that include lipids and oils (Amri et al., 2017). Fatty oils are non-volatile materials that sometimes dissolve in polar solvents and water. They are the fundamental building blocks of nutrition, together with

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protein and carbohydrates, and are extensively distributed in the natural world. To create oils and fats, three molecules of fatty acid and a triol (glycerol) interact chemically (Aremu et al., 2015). With the exception of triglycerides, the pharmaceutical and nutraceutical industries cannot ignore the physiologically intriguing properties and nutritional value of small components (less than 5%) in vegetable oils. They are separated into two groups: glycerolipids (mono- and diglycerides, phospholipids) and non-glycerolipids (sterols, tocopherols/tocotrienols, free fatty acids, vitamins, pigments, proteins, phenolic compounds, water, and so on) (Yara-Varón et al., 2017).

High-quality oil falls into two main groups: (i) Edible oils, also known as food-grade oils, are often used as odorless, low-unsaturated frying oil. However, they are also a common component in a variety of culinary items, especially those that call for a healthy oil. Industrial oils (some edible) are item (ii)- that are not eatable and have also been bred to contain significant amounts of compounds required for certain process industries (Aremu et al., 2015). Seed-derived vegetable oils have been crucial in satisfying worldwide nutritional demands and are used in a number of industrial and food applications (Davies & Peter, 2017). Vegetable oils' primary relevance lies in their nutritional content. Most of the fatty acids, vitamin E, and phytochemicals needed for everyday human health maintenance may be found in edible vegetable oils (Zhao et al., 2021).

To support their commercial use, oils must have their physical characteristics characterized, and these characteristics are closely related to the triacylglycerol composition of the lipids (Pereira et al., 2018). The need for vegetable oil has consistently increased in Nigeria, but manufacturers depend heavily on famous vegetable oils such as palm oil and castor oil to produce a broad range of goods (Nde & Foncha, 2020).

Based on the oil content, acid value, peroxide value, iodine content, saponification worth, Polenske value, weight, and unsaponifiable matter, the physical and chemical characteristics of the oils were ascertained, this study concentrates on the hexane-based Soxhlet method of extracting oil from five local seeds. This research was required to assess the oils' physiochemical and fatty acid composition and determine whether or not they were appropriate for use in both household and commercial settings.

## 2. MATERIAL AND METHODS

### 2.1. Collection of samples and extraction of oil

The Cashew fruit, orange fruit, watermelon pod, Paw-paw fruit and Cherry fruit were purchased in Ozoro markets in Delta State, Nigeria. Every chemical used in this investigation was of analytical grade. The cashew seeds were removed and roasted in direct flame to burn off the acid. The residual ash was peeled off to obtain the cashew nut. The roasted nut was dried and milled into flour and stored in zip lock sack prior to further analysis. The orange, watermelon, pawpaw, and cherry seeds were extracted and dried in the oven and milled into flour.

Following that, 50 g of each milled seed was loaded separately into a thimble and placed in the Soxhlet apparatus's refluxing unit with 300 cm<sup>3</sup> of n-hexane as extraction solvent. To get the seed oils, the extracts were de-solventized using a rotary evaporator.

### 2.2. Proximate analysis

Protein, fat, moisture, fibre and ash contents of the seed flours were determined using the methods (Edo et al., 2022). The carbohydrate content was evaluated using the approved differential technique (Nwosu et al., 2022).

### 2.3. Physical properties

The colour and scent of the oils were identified using visual observation and the sense of smell.

### 2.4. Determination of acid value

The acid value was calculated using the procedure outlined by (Varona et al., 2021). 1 gram of the oil sample was dissolved exactly in 150 ml of V/V 95% ethanol and benzene solvent mixtures. The solution was titrated to the endpoint (pink colour of phenolphthalein), persisting for at least 10 seconds with oil methanolic potassium hydroxide solution run from the burette.

### 2.5. Determination of peroxide value

The peroxide value was calculated using the procedure outlined in (Varona et al., 2021). After weighing the oil sample to the closest 0.001 g in a 250 ml conical flask, 10 ml of chloroform was added. The flask was gently swirled to dissolve the oil. Glacial acetic acid (15 ml) was added, then, using a pipette, 1 ml of saturated potassium iodide solution. The flask was immediately stopped, shaken for one minute and placed in a cupboard away from the light for a moment. Furthermore, 75 ml of distilled water was added and vigorously shaken with the addition of 2 drops of 1 percent starch solution. The liberated iodine was titrated to the endpoint. (The disappearance of the last trace of the initial blue colour with 0.01 molar solution of sodium thiosulphate run from a burette serves as the endpoint).

### 2.6. Determination of iodine value

The iodine value was calculated using the procedure outlined by Varona et al. (2021). Five millilitres of chloroform were poured into a dry conical round flask (5 ml) containing solution (Dam's iodine) that had been transported from a burette that had been set up in the fume cabinet. After thirty-five minutes, twenty millilitres of water and five millilitres of freshly prepared potassium iodide were added, and they were thoroughly mixed by gently stirring. The solution was titrated with 0.025 N standard sodium thiosulphate while being continuously stirred to ensure that the two layers were well blended. After adding the solution, a pale yellow colour was created. The starch-containing solution was then added in a drop, and the titration was continued until both phases were colorless.

## 2.7. Determination of saponification value

The saponification value was calculated using the procedure outlined by Varona et al. (2021). In a 50 ml quick fit flask, 1.0 g of the oil sample was weighed to the nearest 0.001 g. With the addition of 0.5 ml of ethanolic potassium hydroxide solution, the reaction mixture was added and vigorously agitated in an electric shaker using a 25 ml pipette. A reflux condenser was then attached to the flask, and the solution was refluxed for 60 minutes using a heating mantle. After refluxing, 0.05 ml percent of an indication of phenolphthalein was added. The solution was then titrated to a colourless endpoint with a 0.5 molar solution of hydrochloric acid. A blank determination was carried out simultaneously under the same condition. Three determinations were carried out for each sample

## 2.8. Determination of Unsaponifiable matter

The unaponification value was calculated using the procedure outlined by Varona et al. (2021). 4.0 grams of oil seed sample was added to KOH (0.5 M; 50 cm<sup>3</sup>), and saponification was done by heating. Titration with phenolphthalein indicator was carried out on the residue containing insoluble potassium hydroxide. The solution obtained from the neutralization reaction was cleaned three times using alcohol (50%; 10 cm<sup>3</sup>) and 50 cm<sup>3</sup> of ether, leading to the extraction of unsaponifiable matters.

## 2.9. Determination of Polensky value

The Polensky value was determined according to the method described by (Perera et al., 2020). The condenser was washed in three 15 ml volumes of distilled cold water flowing through the graduated cylinder after titrating the dissolved volatile acids. The funnel was placed on a clean conical flask. Three similar condenser washings dissolved the insoluble fatty acids. The alcoholic washings in a clean flask were combined with 5 drops of phenolphthalein indicator solution before titrating with normal sodium hydroxide solution (0.1 N).

## 2.10. Determination of density

The density of the oil was calculated using a density flask in 25 °C, which is the ratio of its weight to volume.

## 2.11. Determination of smoke point

Perera et al. (2020) described the technique to calculate the smoking point. The temperature at which smoke is first seen in laboratory equipment from drafts is known as the "smoke point," and it is a specific temperature at which oil smokes freely.

## 2.12. Determination of flash point

Perera et al. (2020) described the technique to calculate the flash point. The temperature at which volatile chemicals grow quickly enough to ignite but not sustain burning is known as the flash point.

## 2.13. Determination of fire point

The fire point was determined according to the method described Perera et al. (2020). A 25 ml beaker was filled with the oil sample and placed on a heating source (electric heater). A thermometer was vertical suspended in the center of the beaker from the bottom of the bulb appropriately 6.35 mm. The sample was heated rapidly to about 42 °C, and the heat was regulated at a 60 °C increase per minute. A flame was continuously passed on the top point of the beaker until the oil cut fire. The temperature indicated by the thermometer was recorded

## 2.14. Determination of fatty acid composition

The technique described by Perera et al. (2020) was used to determine the content of fatty acids. After removing the fat, it underwent hydrolysis, converting the fatty acids into their methyl derivatives. GC/MS was used to identify the component fatty acids and their concentrations.

## 2.15. Sensory evaluation

The samples were evaluated for various sensory attributes by twenty inexperienced panellists from the Delta State University of Science and Technology's Department of Food Science and Technology. There was a Hedonic scale of 9 points, where 1 was the most disliking and 9 was the most approving (Edo et al., 2022).

## 2.16. Statistical Analysis

The result was given as Mean ± SD. ANOVA was used to ascertain significant differences between means, and Duncan's multiple range analysis ( $p \leq 0.05$ ) was utilized to separate means.

## 3. RESULTS AND DISCUSSION

### 3.1. Proximate composition of the Seed Flour

The proximate composition (Table 1) of the seeds flour ranged from (2.55-5.88; 17.97 – 31.16; 2.48 – 8.18, 2.20 – 25.80, 7.09 – 60.68 and 0.48 – 43.72) g/100g for moisture, protein, ash, fibre, fats and carbohydrate content respectively. The moisture material was lower ( $p < 0.05$ ) than the FAO standard of 10 g/100 g for flour, implying that they will be chemically and microbiologically stable during storage, giving the product an extended shelf life (Tumwine et al., 2019). The protein content was highest in the cashew seed flour (CS) and lowest in the watermelon seed flour (WMS). These findings are consistent with those of (Ola-Davies & Olukole, 2018), who demonstrated that orange seeds had a high protein concentration. The ash content ranged from  $2.48 \pm 0.03$  % in CS to  $8.18 \pm 0.60$  % in PWS (paw-paw seed oil). The high ash content in PWS may be due to the high minerals in paw-paw seeds. The fibre content ranged from  $2.20 \pm 0.02$  % in CS to  $25.80 \pm 0.25$  % in WMS. The fat content ranged from  $7.09 \pm 0.09$  % in PWS to  $60.68 \pm 0.27$  % in CS. The high fat content in CS may be attributed to the high fat content in cashew seeds (Edo et al., 2022). The carbohydrate material

**Table 1**  
**Proximate composition of the seeds (%)**

Samples	Moisture	Protein	Ash	Fibre	Fats	Carbohydrate
CS	3.00±0.03 <sup>b</sup>	31.16±0.31 <sup>a</sup>	2.48±0.03 <sup>d</sup>	2.20±0.02 <sup>d</sup>	60.68±0.27 <sup>a</sup>	0.48±0.01 <sup>e</sup>
ORS	2.55±0.02 <sup>c</sup>	22.80±0.01 <sup>d</sup>	3.28±0.02 <sup>c</sup>	10.60±0.11 <sup>b</sup>	45.00±0.15 <sup>c</sup>	15.77±0.19 <sup>c</sup>
WMS	3.00±0.04 <sup>b</sup>	17.97±0.03 <sup>e</sup>	3.60±0.03 <sup>b</sup>	25.80±0.25 <sup>a</sup>	48.00±0.30 <sup>b</sup>	1.63±0.01 <sup>d</sup>
PWS	2.50±0.03 <sup>d</sup>	29.07±0.04 <sup>b</sup>	8.18±0.06 <sup>a</sup>	25.60±0.38 <sup>a</sup>	7.09±0.09 <sup>e</sup>	27.56±0.41 <sup>b</sup>
CHS	5.88±0.09 <sup>a</sup>	25.37±0.03 <sup>c</sup>	2.52±0.05 <sup>d</sup>	5.40±0.09 <sup>c</sup>	17.11±0.22 <sup>d</sup>	43.72±0.23 <sup>a</sup>

Values are mean ± standard deviation. Values in the same column with the same superscript are not significantly different at  $p > 0.05$   
CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed

ranged from  $0.48 \pm 0.01$  % in CS to  $43.72 \pm 0.23$  % in CHS (Cherry seed oil). The high carbohydrate content of CHS may be due to the high sugar content of cherry seeds (Blumenthal et al., 2022).

**Table 2**  
**Physical properties**

Sample	Colour	Odor
CS	Light yellow	Pleasant
ORS	Light brown	Pleasant
WMS	Pale amber	Pleasant
PWS	Dark brown	Pleasant
CHS	Light brown	Pleasant

CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed



**Figure 1. The extracted Seed Oils** CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed

### 3.2. Physical Properties of the Seed Oils

Table 2 shows the physical properties of the extracted seed oil samples. All of the extracts were liquid at normal temperatures, indicating that they were all oils. Also, it reveals that the oils possess some unsaturation. The colours of the oils were light yellow, light brown, pale amber, dark brown and light brown for cashew, orange, watermelon, pawpaw and cherry seed oils, respectively. The oils' colours resemble the yellow hue that Bachheti et al. (2012) described for apricot oil, which was shown to fall within the Conventionally Used Oils (CUOs) colour spectrum, which spans from colourless to yellow to dark

brown. According to a group of ten semi-trained panellists who examined the samples, all oils had pleasant odours. Therefore, all of the oils could be used as culinary oils due to their physical appearance and odour. Comparatively, the watermelon seed oil, however, possessed a preferable colour to the others (See Figure 1).

### 3.3. Physio-chemical properties of oil

The physicochemical parameters of the oil are shown in Table 3. Oil content and quality are important markers of an oil source's potential Kazmi et al. (2021). The quantity of acid in an oil indicates its characteristics and suitability for eating and its usability in the production of paint (Wuana & Okieimen, q). The physicochemical characteristics of the seed oils varied significantly ( $p < 0.05$ ) in the current investigation. How much an oil's glycerides have been broken down by enzymes and other physical changes it has undergone is determined by the amount of acid it contains.

The acid value of Cashew seed oil (CS) ranged from 1.89 mg KOH/g to 5.94 mg KOH/g. The concentration of acid obtained in this study is less than the 3.56 0.20 mg KOH/g reported by (Melo et al., 2019) for *C. albidum* oil and the 3.48 0.06 mg KOH/g indicated by (Yusoff et al., 2020). The peroxide value ranged from  $0.90 \pm 0.01$  Meq/kg to  $4.00 \pm 0.05$  Meq/kg. This figure is less than the quoted value of 290.00 mEqO<sub>2</sub>/kg reported by Tang et al. (2017). The difference may be due to differences in the composition of the different seeds and nuts used in the study as well as the storage conditions. The peroxide concentration shows the oil's quality and long-term stability. It is used to calculate the extent to which oil can deteriorate due to packaging and heating. Rancid oils contain peroxide levels of 10- 20 mequiv O<sub>2</sub>/kg oil, while the Standard Organization of Nigeria (SON) recommends peroxide values of 10 mequiv O<sub>2</sub>/kg oil for edible oils (Edo et al., 2022). The seed oils studied have a lower peroxide value, implying that they will be stable for a long time if properly packaged and stored at a suitable temperature.

The iodine value ranged from  $93.80 \pm 0.57$  g/100g to  $275.55 \pm 5.08$  g/100g. The iodine value observed in this investigation suggests that the oils have a significant amount of unsaturated bonds. The presence of fewer saturated fatty acids is suggested by the high iodine value found for the Cherry seed oil (CHS). The concentration of iodine in oils is a measure of their unsaturation. High unsaturation is associated with high iodine

**Table 3**  
**Physio-chemical properties**

Samples	Acid Value (mgKOH/g)	Peroxide Value (Meq/kg)	Iodine Value (mgI <sub>2</sub> /g)	Saponification Value (mg/KOH/g)	Unsaponifiable matter (%)	Polensky value	Density (g/L)
CS	1.89±0.01 <sup>d</sup>	1.80±0.03 <sup>c</sup>	98.80±1.00 <sup>c</sup>	68.41±0.21 <sup>d</sup>	3.90±0.03 <sup>d</sup>	1.37±0.02 <sup>e</sup>	0.74±0.02 <sup>c</sup>
ORS	1.07±0.03 <sup>e</sup>	1.80±0.02 <sup>c</sup>	93.18±0.57 <sup>d</sup>	98.04±0.48 <sup>c</sup>	2.57±0.02 <sup>e</sup>	7.55±0.08 <sup>a</sup>	0.85±0.02 <sup>a</sup>
WMS	4.14±0.02 <sup>b</sup>	1.90±0.03 <sup>b</sup>	183.08±3.10 <sup>b</sup>	60.69±0.10 <sup>e</sup>	7.22±0.03 <sup>a</sup>	2.79±0.03 <sup>c</sup>	0.77±0.03 <sup>c</sup>
PWS	5.94±0.03 <sup>a</sup>	0.90±0.01 <sup>d</sup>	85.58±0.23 <sup>e</sup>	111.12±1.06 <sup>b</sup>	4.69±0.04 <sup>c</sup>	3.81±0.05 <sup>b</sup>	0.82±0.01 <sup>b</sup>
CHS	3.23±0.01 <sup>c</sup>	4.00±0.05 <sup>a</sup>	275.55±5.08 <sup>a</sup>	326.16±7.14 <sup>a</sup>	6.99±0.02 <sup>b</sup>	2.28±0.02 <sup>d</sup>	0.87±0.01 <sup>a</sup>

Values are mean ± standard deviation. Values in the same column with the same superscript are not significantly different at  $p>0.05$   
CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed

concentration. It is the number of grams of iodine required to saturate 100 grams of saturated fat or oil. Because they cannot absorb iodine, saturated oils and fats have little iodine value. The concentration of Iodine is often used to assess the drying characteristic of oils.

Saponification value ranged from  $68.41 \pm 0.21$  KOH/g to  $326.16 \pm 7.14$  KOH/g. The concentration value of saponification indicates the molecular mass of the fatty acid inside the oil. It also indicates if the oil is pure or contaminated (Rafiu et al., 2022). High saponification readings indicate that the oil is free of contaminants. In this study, the saponification value for CHS was greater than the previous values of 193.61 mg KOH/g and 226.02 mg KOH/g, respectively (Deme et al., 2021). The high saponification values obtained for PWS and CHS suggest that the oils could be good for soap making. Unsaponifiable matter ranged from  $2.57 \pm 0.02$  % to  $7.22 \pm 0.03$  %. Substances dissolved in fat that are insoluble in an aqueous solution but soluble in an organic solvent upon saponification are known as unsaponifiable materials.. It is generally recognized that unsaponifiable materials may serve as an excellent lipid stabilizer and a possible source of nutraceuticals. Recent decades have seen a substantial amount of study focused on the unsaponifiables of plant oils and fats due to their many bioactivities, which include antibacterial, anti-inflammatory, and antioxidant capabilities. Thus, compared to many other plant-derived oils, the oils' comparatively high level of unsaponifiables indicates that the seed oils are a viable source of natural ingredients for a variety of uses in the food, cosmetic, and pharmaceutical sectors.

The density of the oils analyzed differed significantly ( $p<0.05$ ). The density ranged from  $0.71 \pm 0.02$  g/L in CS to  $0.87 \pm 0.01$  g/L in CHS. Because the density of an oil increases with increasing molecular weight and unsaturation, a high relative density in the oils could signify high molecular mass and unsaturation in the seed oils (Folayan et al., 2019).

### 3.4. Thermal Decomposition Properties of the Seed Oils

The thermal decomposition characteristics of the seed oils is presented in Table 4. Smoke points ranged from  $75 \pm 0.03$  0C to  $90 \pm 0.05$  0C, with Cashew Seed Oil (CS) having the lowest value while Pawpaw seed oil (PWS) had the highest value. The smoke point of an oil is the degree to which it starts to smoke consistently, resulting in a bluish haze (Enyoh et al., 2017). This

**Table 4**  
**Thermal Decomposition Properties of the Seed Oils**

Samples	Smoke point °C	Flash point °C	Fire point °C
CS	75±0.03 <sup>c</sup>	80±0.02 <sup>e</sup>	230±4.03 <sup>d</sup>
ORS	80±0.02 <sup>b</sup>	85±0.03 <sup>d</sup>	300±1.00 <sup>a</sup>
WMS	75±0.07 <sup>c</sup>	150±0.07 <sup>b</sup>	300±2.00 <sup>a</sup>
PWS	90±0.05 <sup>a</sup>	120±0.03 <sup>c</sup>	260±3.03 <sup>c</sup>
CHS	89±0.03 <sup>a</sup>	170±0.09 <sup>a</sup>	280±3.05 <sup>b</sup>

Values are mean ± standard deviation. Values in the same column with the same superscript are not significantly different at  $p>0.05$

CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed

smoke indicates that the fat has been chemically broken into glycerol and free fatty acids. Oils constituting high short-chain fatty acids (such as lauric acid) have a smaller smoke point than oils with lengthy-chain fatty acids. Flashpoints ranged from  $80 \pm 0.02$  0C to  $170 \pm 0.09$  0C, with CS having the lowest value while Cherry seed oil (CHS) had the highest value. The oil's flash temperature is defined as the flash point of edible oil. Fire point ranged from  $230 \pm 4.03$  0C to  $300 \pm 2.00$  0C, with CS having the lowest value while orange seed oil (ORS) and Watermelon seed oil (WMS) had the highest value. The fire point of an edible oil is the temperature at which oil vapor will spontaneously catch fire in the absence of an igniting source. Self-ignition temperatures define edible oil's fire point (Jung et al., 2018). It could be affected by multiple heating of edible oils at high temperatures.

**Table 5**  
**Fatty acid composition (%) of the oil**

Fatty acid	CS	ORS	WMS	PWS	CHS
Myristic (C14:0)	0.01	0.3	0.05	0.03	0.33
Palmitic (C16:0)	8.38	15.0	10.06	0.53	10.92
Palmitoleic (C16:1)	0.26	0.1	0.07	15.05	0.05
Margaric (C17:0)	0.13	0.1	3.32	0.33	0.23
Stearic (C18:0)	8.67	1.3	7.31	4.51	4.042
Oleic (C18:1)	60.63	18.8	16.08	17.2	55.26
Linoleic (C18:2)	20.83	63.6	65.61	3.82	23.26
Linolenic (C18:3)	0.20	0.1	0.18	0.33	0.361
Arachidic (C20:0)	0.53	0.3	0.33	0.52	0.56

Values are results of single determination

CS – Cashew nut; ORS- Orange seed; WMS- Watermelon seed; PWS- Paw-paw seed; CHS- Cherry seed

### 3.5. Fatty acid composition of the Seed Oils

Table 5 displays the fatty acid makeup of the seed oils. The oil samples' fatty acid makeup composition varied significantly ( $p > 0.05$ ). The result showed that myristic and margaric acids ranged from 0.01% to 0.32% and 0.1% to 3.32%, respectively. The low myristic acid content of the seed oils makes the oils highly beneficial as high plasma myristic acid concentrations have been associated with a higher risk of ischemic heart disease (IHD) Shramko et al. (2020). Additionally, the outcome showed that oleic acid was the most prevalent fatty acid in all seed oils, with a range of 16.08% in watermelon seed oil (WMS) to 60.63% in cashew nut oil (CS). The oleic acid content of orange seed oil, ORS (18.8%), watermelon seed oil, WMS (16.08%) and pawpaw seed oil, PWS (17.2%) are not significantly different at  $p > 0.05$ . The oleic acid content of ORS, WMS and PWS are higher than the 8.8% reported for coconut oil but comparable to the 16.6%, 22.1% and 22.5% reported for safflower, linseed and palm kernel oils. Additionally, according to Kostik et al. (2013), the oleic acid concentration of CS (60.63%) and CHS (55.26%) is lower than that of olive oils (78.4%) but similar to the 58.5% observed for peanut oil. The high oleic acid content in the seed oils may significantly affect consumer health since oleic acid is associated with a decreased risk of heart disease, cancer, high blood pressure, and cholesterol. Additionally, its ability to heal wounds is being shown (Sales-Campos et al., 2013). Next in terms of content in the seed oils was linoleic acid, which ranged from 3.81% in PWS to 65.61%. Regarding the other fatty acids, only stearic acid (ranging from 1.3 in ORS to 8.67% in CS) and palmitic acid (ranging from 0.53 in PWS to 15.0% in ORS) showed appreciable quantities. Given the significance of essential fatty acids in the human diet, it is advised that the seed oils CS, ORS, WMS, PWS, and CHS be included in the diet as they showed excellent fatty acid profiles. Linoleic acid is referred to be a dietary essential fatty acid since humans cannot synthesize it. The results are consistent with past studies (Kaur et al., 2014).

### 4. CONCLUSION

The study's findings indicated the potential for using the oil derived from certain indigenous seeds as a raw material to make food and personal hygiene products. The physical and sensorial evaluation revealed that cashew nut, orange seed, watermelon seed, paw seed, and cherry seed oils were light yellow, light brown, pale amber, dark brown, and light brown in colour, respectively. All the seed oils studied were found to possess pleasant odours. According to the deductions of this study, all of the seed oils studied have the potential for a wide range of culinary and industrial applications. The concentration of iodine and peroxide values indicated that the oils have a larger saturated fatty acid content and will resist oxidative rancidity. The fatty acid composition showed that the oils are rich sources of essential fatty acids (monounsaturated and polyunsaturated) important in human health. Further study is needed to ascertain the vegetable oils' nutritional indexes and

the production process's sustainability.

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### CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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### ETHICAL APPROVAL

The samples were evaluated for various sensory attributes by twenty inexperienced panellists from the Delta State University of Science and Technology's Department of Food Science and Technology. A nine-point Hedonic scale was used, with one representing the most dislike and nine representing the highest approval.

### AUTHOR CONTRIBUTIONS

JOO, GIE, POA, KAO, MUN, AEO, JJA - Research concept and design, JOO, GIE, POA, KAO, MUN, AEO, JJA - Collection and/or assembly of data, GIE, JOO, MUN - Data analysis and interpretation, GIE, JOO, MUN - Writing the article, GIE, JOO - Critical revision of the article, GIE, JOO - Final approval of the article.

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