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EXTRACTION AND EXTRACTION CHARACTERISTICS OF THE OILS OF AVOCADO PEAR, AFRICAN PEAR AND AFRICAN ELEMI

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ABSTRACT

The prepared pulp samples of avocado pear, African pear and African elemi were first analyzed for ash, moisture, fibre, protein, carbohydrate and oil contents. The oil contents from avocado pear, African pear and African elemi pear were extracted using petroleum ether as solvent. The extraction was carried out using the soxhlet extractor apparatus and the oils were characterized for viscosity, specific gravity, saponification value, acid value, free fatty acid, ester value, glycerine, iodine value and peroxide value. The oil content of avocado pear was 38.97%, African pear was 67.26% and African elemi was 36.83% comparatively.

NB: Results shown in this work are the average of three experimental runs for each sample.

1. Introduction

Persea americana (Avocado pear) is a buttery fruit that grows mainly in tropical regions of many countries. So many varieties of avocado pear exist, but the most common variety is the Hass avocado pear. The avocado is a climacteric fruit which matures on the tree but ripens when harvested. (Ikhuoria & Maliki, 2007).
According to the American Restaurant Association, the rate of avocado pear consumption in the pharmaceutical industry is growing at a healthy rate. In Africa, Kenya is recorded as the highest exporter of avocados. Seventy two thousand (72,000) tons of avocados valued at approximately $118 million were exported. Nigeria is still quite below the growing avocado demand. (Musa et al., 2016). Unfortunately, most of avocado production is done in rural areas the southern and central parts of Nigeria such as Imo, Anambra, Enugu, Ebonyi, Delta, Cross River, Osun and Oyo that have about 10% of natural vegetation. (Dreher, 2013).
Dacryodes edulis (African pear) is a drupe which has a length variation of 4-12cm and there are two major varieties of African pear which are the Dacryodes edulis and the Dacryodes parvicarpa. Dacryodes edulis has a larger fruit whereas Dacryodes parvicarpa has smaller fruits. (Adepoju et al., 2019).
In west and central Africa, African pear fruit benefits those who are malnourished and poor. It is also softened and eaten with corn, usually enjoyed by everyone. The increase in fruit demand is threatened by the increasing deforestation. (Isaac & Ekpa, 2014).
Canarium schweinfurthii (African elemi) is originally from tropical Africa especially places like Nigeria, Angola, Mali, Uganda, etc. The fruit contains one triangular shaped seed covered by a purplish

green pulp. It is sometimes mistaken for African pear because of their close resemblance. The fruit is about 2.5 – 3.7cm long bluish black. (Oluwale, 2012).
The study is aimed at determining the proximate analysis of the samples and also characterizing their oils to know their domestic and industrial uses.

2. Methods and materials

Sample preparation
The fruits were purchased from relief market owerri, Imo state. The seeds were further separated from their pulps. The pulps were cut into tiny pieces to allow for faster drying and separated into three different trays. The three samples were sundried for 14 days to ensure complete drying after which they were ground with electric blender and stored in a glass bottle.
Proximate Analysis

- Determination of moisture content (Abdullah et al., 2013)

This was done by gravimetric method. 5g of sample was poured into a previously weighed petridish. The sample was dried in the oven at 105^{o}C for 3hours. It was cooled in the desiccators and weighed. This process was repeated until a constant weight is obtained. The weight of the moisture lost is calculated as a percentage of the weight of sample analyzed, given by the mathematical expression below;

$$\%moisture\ content = [(w_2 - w_3)/(w_2 - w_1) \times 100 \quad (1)$$

where w_1 = weight of empty petri dish
w_2 = weight of petridish + sample before drying
w_3 = weight of petridish + sample dried to constant weight

- Determination of total solid (dry matter)

$$\%total\ solid\ (dry\ matter) = 100 - \%moisture\ content \quad (2)$$

- Determination of ash content(Abdullah et al., 2013)

This was done by furnance incineration method. 5g of the processed sample was poured into a previously weighed porcelain crucible. The sample was burnt to ashes in a muffle furnance at 550^{o}C. It was then cooled in a desiccator and weighed when it was completely ashed.

$$\%ash = [(w_2 - w_1)/weight\ of\ sample] \times 100 \quad (3)$$

where w_1 = weight of empty crucible
w_2 = weight of crucible + ash

- Determination of Crude Fibre content(Abdullah et al., 2013)

This was done by the Weende method. 5g of the processed sample was boiled in 150mls of 1.25% H_2SO_4 solution for 30mins under reflux. The boiled sample was washed in several portions of hot water using a twofold muslin cloth to trap the particles which were returned back to the flask and boiled again in 150mls of 1.25% NaOH for another 30mins under the same condition. After washing in several portions of hot water, the sample was allowed to drain dry before being transferred to a weighed crucible where it was dried in the oven at 105^{o}C to a constant weight. It was then burnt to ashes in a muffle furnace. The weight of fibre is given by the weight of the sample analyzed, given by the expression below;

$$\%crude\ fibre = [(w_2 - w_3)/weight\ of\ sample] \times 100 \quad (4)$$

where w_2 = weight of crucible + sample after boiling, washing and drying
w_3 = weight of crucible + sample as ash

- Determination of oil content(Abdullah et al., 2013)

The solvent extraction gravimetric method was used. 5g of the sample is wrapped in a porous paper (whitman filter paper) and put in a thimble. The thimble is placed in a soxhlet reflux flask and mounted in a weighed extraction flask containing 200mls of petroleum ether the upper end of the reflux flask is connected to a water condenser.
The solvent (petroleum ether) is heated. It boiled, vaporized and condensed into the reflux flask. After a while, the sample in the thimble was covered with the solvent which extracted the fat. The sample remained in contact with the solvent until the reflux flask filled up and siphoned over, carrying its oil extract down to the boiling flask. This process is allowed to go on repeatedly for 4hrs before the defatted sample is removed, the sample recovered and the oil extract is left in the flask. The flask containing the oil extract was dried in the oven at 60^{o}C for 30minutes (to remove the residue solvent), cooled in a

dessicator and weighed. The weight of the fat extract was determined and expressed as a percentage of the weight of the analyzed sample and is given by the expression below;

$$\%oil = 100 \times [(w_2 - w_1)/weight\ of\ sample] \quad (5)$$

where w_1 = weight of empty extraction flask
w_2 = weight of extraction flask + oil extract

- Determination of Protein content(Abdullah et al., 2013)

This was done by the Kjeldahl method. The total N_2 is determined and multiplied with factor 6.25 to obtain the protein content.
1.0g of processed sample was mixed with 10mls of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added to it before it was heated in a fume cupboard until a clear solution was obtained (i.e the digest) which was diluted to 100mls in a volumetric flask.
10mls of the digest was mixed with equal volume of 45% NaOH solution in the Kjeldahl distillation apparatus. The mixture was distilled into 10mls of 4% butanoic acid containing three drops of mixed indicator (bromoscressol green/methyl red). A total of 50mls of distillates was collected and titrated against 0.02N EDTA from green to deep red end point. The N_2 content and hence the protein content is calculated using the formula below;

$$\%protein = \%N \times 6.25 \quad (6)$$

$$\%N_2 = \left(\frac{100}{W} \times \frac{N \times 0.4}{1000} \times \frac{V_t}{V_a}\right)^T \quad (7)$$

where W = weight of sample
N = normality of tyrant (0.02 H_2SO_4)
Vt = total digest volume (100mls)
Va = volume of digest analyzed (10mls)
T = titre value of sample
B = titre value of blank

- Determination of Carbohydrate content(Abdullah et al., 2013)

It was calculated using the formula below;

$$\%carbohydrate = 100 - \%(protein + fat + ash + moisture\ content \quad (8)$$

Characterization of Extracted oils

- Determination of Acid Value (Isaac B., & Adejumo, 2010)

25ml of diethyl ether (petroleum ether) was mixed with 25ml of ethanol (neutralized solvent). 1ml of phenolphthalein solution was added. 1g of oil was weighed and dissolved in the neutralized solvent. This was titrated using 0.1M NaOH to a pink end point.

Calculation;

$$Acid\ value = \frac{Titrant\ \ value \times 40 \times M}{W} \quad (9)$$

where; $W = weight\ of\ oil$
$M = molar\ strength\ of\ the\ base$

- Determination of free Fatty acid (Isaac B., & Adejumo, 2010)

Free fatty acid could be determined from the same titration as with acid value above.
Hence: 1ml of 0.1M NaOH, 0.282g oleic acid, 0.025g palmitic acid, 0.020g lauric acid.

$$Free\ fatty\ acid = \frac{Titre\ \ value \times 40 \times M}{2 \times W} \quad (10)$$

- Determination of Saponification Value (Isaac B., & Adejumo, 2010)

Reagents: Alcoholic potassium hydroxide solutions (dissolve 35g - 40g potassium hydroxide in 20ml distilled water and dilute to 1L with 95% ethanol. Allow to stand overnight and decant the clear liquid).
0.5M Hydrochloric acid solution
Phenolphthalein indicator. 1% in ethanol (For oil)
Procedure:
2.0g of oil was weighed and put in 250ml flat bottomed flask. 25ml of alcoholic potassium hydroxide solution was added and attached to references luxaire condenser. The system was set up accordingly condensed for 30min until saponification was complete. 1ml of phenolphthalein indicator was added into the hot soap solution and slowly titrated with 0.5N HCl.

Calculation;
$Saponification\ value = \frac{56.1 \times (V_1 - V_2) \times N}{W}$……..…….(11)
where; $N = normality\ of\ HCl\ used$
$W = weight\ of\ oil\ in\ grams$
$V_1 = volume\ of\ HCl\ used\ in\ the\ sample$
$V_2 = volume\ of\ HCl\ used\ in\ the\ blank$

- Determination of Viscosity (Isaac B., & Adejumo, 2010)

Viscosity of the oil was determined using the Brookfield model DV-1 (U.S.A) equipped with a n^o 5 spindle. The sample mixture was stirred for 1 minute at speed of 100 rpm at oil temperature of 40℃. The spindle was allowed to rotate in the oil for 1 minute awaiting the reading on the meter's monitor to be stable.

- Determination of Specific Gravity (Isaac B., & Adejumo, 2010)

Thoroughly wash a 50ml pyrometer bottle (density bottle or specific gravity bottle) with water, dry and weigh. Fill the bottle with 50ml water and weigh. After drying the bottle, fill the bottle with 50ml oil sample and weigh.
Calculation:
$Specific\ gravity = \frac{weight\ of\ Xml\ of\ oil}{weight\ of\ Xml\ of\ water} = \frac{M_2 - M_1}{W_2 - W_1}$……..(12)
where; $W_2 = mass\ of\ density\ bottle + 50ml\ distilled\ water$
$M_2 = mass\ of\ specific\ gravity\ bottle + 50ml\ of\ oil$
$M_1 = W_1 = mass\ of\ empty\ density\ bottle$

- Determination of Iodine Value (Isaac B., & Adejumo, 2010)

Reagents:
Wiji's solution;- Dissolve 8g iodine trichloride in 200ml glacial acetic acid. Dissolve 9g iodine in 300ml carbon tetrachloride. Mix the two solutions and dilute to 1L using glacial acetic acid OR
Dissolve 16.5g iodine monochloride in glacial acetic acid and make up to 1L using glacial acetic acid.
Carbon tetrachloride
10% Potassium iodide solution
0.1M Sodium thiosulphate solution
Starch indicator (10% aqueous solution of soluble starch)
Procedure:
0.4g of oil was weighed into 250ml stoppered conical flask. 10ml of carbon tetrachloride was added to dissolve the oil. 20ml of wiji's solution was added and stopper moistened with potassium iodide solution was inserted. This was mixed by swirling and allowed to stand in the dark for 30 minutes.
15ml of potassium iodide solution was added and the stoppered bottle was shaken vigorously. The sides of the bottle were washed with 100ml of recently boiled and cooled distilled water. 1ml of 10% starch indicator was added and titrated with 0.1N standard sodium thiosulphate solution.
The titre value was obtained on the disappearance of blue black colour and the flasks were shaken vigorously to ensure that the colour had disappeared.
Calculation:
$Iodine\ value = \frac{12.69N(B - S)}{W}$…….(13)
where; $N = normality\ of\ sodium\ thiosulphate$
$B = volume\ of\ sodium\ thiosulphate\ used\ in\ blank$
$S = volume\ of\ sodium\ thiosulphate\ used\ in\ sample$
$W = weight\ of\ sample\ used$
NB: If $B - S$ is greater than B/2, the test shall be repeated using a smaller amount of sample.

- Determination of Peroxide Value (Isaac B., & Adejumo, 2010)

The analysis was carried out in dark cupboard.
1.0g of oil was weighed and dissolved in a mixture of glacial acetic acid and chloroform in the ratio of 2:1 and allowed to stand for 1min in the dark to dissolve the oil. After dissolving, 1ml of 10% potassium iodide was added and allowed to stand in the dark for 1min. 35ml of distilled water was added during which the pink color due to potassium iodide solution was disappears. 2ml of starch indicator (10% starch) was added and the solution turned blue black (this indicates presence of peroxide). The resulting solution was titrated with 0.02N sodium thiosulphate solution.

Calculation:
$Peroxide\ value = \frac{100(V_1 - V_2)N}{W}$ ……(14)
where; $N = normality\ of\ sodium\ thiosphate$
$W = weight\ of\ oil\ used$
$V_1 = volume\ of\ thiosphate\ used\ in\ sample$
$V_2 = volume\ of\ thiosphate\ used\ in\ blank$

3. Results and discussions

Table 1: Proximate analysis of Avocado pear, African pear and African elemi pulps

	Experimental results			Literature results		
	Avocado pear	African pear	African elemi	Avocado pear	African pear	African elemi
Ash (%)	2.07	2.48	5.16	0.38	2.48	3.31
Moisture (%)	10.61	5.93	10.23	70.65	3.35	25.62
Fibre (%)	7.99	13.65	10.14	4.82	13.19	1.65
**Lipid (%)	38.97	67.26	36.83	13.72	35.05	30.06
Crude protein (%)	10.02	10.29	4.81	2.38	13.06	19.31
Carbohydrate (%)	30.34	0.39	32.83	8.05	32.97	20.05

For avocado pear, the moisture content (10.61%) was lower than that reported by Surukite et al. (2013) (70.65%). This indicates that more water was removed and it can also last longer than the one from literature. Ash content from experiment was a bit higher than the one from literature (2.07% and 0.38% respectively). Fiber content, fat, crude protein and carbohydrate were also higher in this work than in literature with values of 7.99 & 4.82, 38.97 & 13.72, 10.02 & 2.38, 30.34 & 8.05 for experiment and literature respectively. This could be as a result of different species of avocado fruit used.

For African pear, the moisture content in experiment is slightly higher than the value in literature (5.93% and 3.35% respectively). There wasn't any difference in ash content (2.48%). Fibre & fat were as well higher than in literature (13.65% & 13.19%, 67.26% & 35.05%) whereas protein and carbohydrate were higher in literature (13.06% & 10.29%, 32.97% & 0.39%) respectively.

And for African elemi, the moisture and protein are higher in literature (25.62% & 19.31% respectively). While ash content, fibre, fat and carbohydrate are higher in experiment (5.16% & 3.31%, 36.83% & 30.06%, 32.83% & 20.05% respectively).

Table 2: Characterization of Avocado pear oil, African pear oil and African elemi oil

	Experimental results			Literature results		
Parameter	Avocado pear oil	African pear oil	African elemi oil	Avocado pear oil	African pear oil	African elemi oil
Color	Dark green	Light green	Yellow	Emerald green	Green	Cloudy green
Viscosity (mPa.S)	100.62	99.55	100.01	35.47	33	96
Specific gravity	0.92	0.89	0.88	0.9	0.9	0.937
Density (g/ml)	0.92	0.89	0.88	0.9	0.9	0.937
Saponification value (mgKOH/g)	138.85	134.64	109.39	218.66	227.205	155.47
Acid value (mgKOH/g)	12.90	10.66	13.46	16.8	7.854	0.94
Free fatty acid (%)	6.45	5.33	6.73	5.4	3.948	0.58
Ester value (mgKOH/g)	125.95	123.98	95.93	201.86	219.351	154.53
Glycerine (%)	6.88	6.78	5.24	11.03	11.99	8.447
Iodine value (gI_2/100g)	47.59	25.06	32.68	42.664	44.079	76.79
Peroxide value (meq active O_2/kg oil)	0.00	25.40	30.00	1.16	8	1.06

From table 2, avocado pear oil was green in color, the African pear oil was light green in colour and the African elemi oil was yellow in color.

Avocado pear oil had the highest viscosity (100mPa.s), while the lowest was African pear oil (99.55mPa.s). This could be due to some factors such as method of extraction, storage, age, degree of saturation and extent of oxidation of the oil being analyzed (Erum, 2017). The high viscosity of avocado is probably due to its lower unsaturation when compared to African pear and African elemi oils because decreasing unsaturation increases viscosity. From literature, the viscosities of avocado pear and African pear at 25^{o}C (35.47mPaS & 33mPaS respectively) was lower than the one from this work while that of African elemi (96mPaS) was within the same range with (100.01mPaS) from this work. Avocado pear oil can be used in body creams as the high viscosity prevents the dryness of the skin when used as a body cream.

The Saponification value (SV) of the avocado oil (138.85mgKOH/g) gave the highest value, African pear oil had SV of 134.64mgKOH/g and African elemi had the lowest with SV of 109.39mgKOH/g. Saponification value is a measure for checking adulterated oil (Abdullah et al., 2013). The SV from literature is quite higher than the ones obtained in this current work (218.66mgKOH/g, 227.205mgKOH/g and 155.47mgKOH/g for avocado pear, African pear and African elemi respectively. Saponification value is inversely proportional to the mean molecular weight of the glycerides in the oil. This means that all the three oils could be good for soap making but that of avocado pear will give a much better and harder soap because of its lower unsaturation.

The Acid value was determined to be 12.90mgKOH/g, 10.66mgKOH/g and 13.46mgKOH/g for avocado pear oil, African pear oil and African elemi oil respectively. According to researchers, the acid value (Oleic acid) of oil for food applications should not exceed 0.4% (Umoti & Okyi, 1987). Acid value is an indication of edibility of the oil. From literature, the AV of avocado pear (16.8mgKOH/g) was higher than that of current work while those of African pear and African elemi were lower than that of current work (7.854mgKOH/g & 0.94mgKOH/g respectively). This could be as a result of oil deterioration and fungi attack on the oil. This shows that the acid value of the three Oils fall outside the nutritional limit.

The free fatty acid value was determined to be 6.45%, 5.33%, and 6.73% for avocado pear oil, African pear oil and African elemi oil respectively. From literature, it was reported to be 5.4%, 3.9%and 0.58% respectively. It is almost within the range for avocado and African pear but quite higher in African elemi. These changes could be due to maturity level of fruits or environmental changes. The free fatty acid is important in determining the suitability of the oil for consumption and domestic purposes (Erum, 2017). The low FFA of oils (<5%) make them suitable as edible oils. African pear oil had the lowest FFA value which was a bit higher than the edible standard, but can also be made edible by refining. Avocado pear oil and African elemi oil had a higher FFA value as a result of hydrolysis. High FFA in oils can cause off flavor during storage due to rancidity.

The iodine content of African pear oil was 25.06 (gI_2/100g) which was the lowest, African elemi (32.68gI_2/100g) and Avocado oil had the highest (47.59gI_2/100g). Iodine value gives an indication of the degree of unsaturation; higher iodine value is attributed to high unsaturation (Isaac B., & Adejumo). The iodine value for avocado pear, African pear and African elemi reported from literature was higher than the ones in this work (50.7gI_2/100g, 44.079gI_2/100g, 76.79gI_2/100g). This can be because of the degree of unsaturation. The low IV of African pear and African elemi could be the reason why they tend to solidify at room temperature due to low unsaturation. The three pear oils can be classified as non-drying oils since their iodine values are less than 100gI_2/100g. Non-drying oils are used for skin

care products, in food, sporting equipment or to condition sporting materials such as leather boots. The European standard recommended maximum iodine value of 120gI_2/100g as feedstock to be used for biodiesel production.

Peroxide values obtained were 0.00meq active O_2/kg oil, 25.40meq active O_2/kg oil and 30.00meq active O_2/kg oil for Avocado pear oil, African pear oil and African elemi oil respectively. Peroxide value is a valuable measure of oil quality and an indication of the ability of oil to resist oxidation (Isaac B., & Adejumo). It is recommended that peroxide value should not exceed 30meq active O_2/kg oil for edible food product. The values reported from literature were lower for African pear and African elemi (8meq/kg & 1.06meq/kg respectively) whereas that of avocado pear was within the range (1.16meq/kg). The oxidation values for African pear oil and African elemi oil were quite high as compared to that of Avocado pear but they are all classified as edible oil.

4. Conclusion and recommendation

Avocado pear pulp oil, African pear pulp oil and African elemi pear pulp oils have varieties of industrial and domestic uses which are as follows;

Due to their high viscosities, they can be a more natural substitute in body creams and lotions to prevent dryness.

Their high Saponification values make them suitable for liquid soaps, bar soaps and beauty bars.

They can serve as a good feedstock for biodesel production and also as non-drying oil (used for shoe polish) due to their relatively low iodine values.

They are quite safe for consumption due to their low peroxide value as well as free fatty acid values.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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