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PHYSICOCHEMICAL EVALUATION AND FTIR CHARACTERISATION OF THE OIL EXTRACTED FROM AVOCADO SEED

[1]S. Girigisu, [2] A. Salman, [3]F.B. Shittu, [4]A. O. Salawu

[1]Department of Biochemical and Chemical Science, Federal Polytechnic Offa, P.M.B. 420, Offa, Nigeria
[2]Department of General Studies, International Vocational, Technical and Entrepreneurship College, P.M.B 1005, Ajase-Ipo, Kwara State, Nigeria
[3]Department of Science Laboratory Technology, Federal Polytechnic Offa, P.M.B. 420, Offa, Nigeria
[4]Department of Research and Development, Nigeria Institute of Leather and Science Technology, Ilaro Remo Centre, Ogun State Nigeria.

Corresponding author**: ***sadisu.girigisu@fedpoffaonline.edu.ng; Tel.: +2348062852237.

ABSTRACT

Oil from avocado seed was extracted via the AOAC standard method using n-hexane as the extracting agent. The main physico-chemical properties evaluated for includes saponification value, free fatty acid, iodine value, peroxide value, acid value and refractive index. The results revealed that the saponification value (mg KOH/g), acid value (mg KOH/g), iodine value (mg iodine/100g), peroxide value (mg/peroxide/kg), Free fatty acid(%), specific gravity and refractive index were found to be 150.348; 0.366; 3.81g/100g; 14 Meq/kg , 0.1833, 0.88g/cm^3 and 1.447 respectively. The low acid value obtained of the oils shows the oil is an edible one. High saponification value obtained revealed that the oil has great potential in industrial applications such as cosmetics and soap making. The iodine values obtained from this research indicates that it is a non-drying oil and also suggest that the oil contain few unsaturated bonds while low peroxide value is an indication that the oil will have low susceptibility to rancidity and deterioration. The FTIR analysis also reveal the oil to contain basic functional group which include the CH_2 asymmetric stretching of (2855.1 cm^{-1} -2922.2 cm^{-1}), C=O stretching of carbonyl group (1744.4 cm^{-1}) and C-H scissor stretching of alkane (1162.9 cm^{-1}- 1461.1 cm^{-1})

Keywords: cotton seed, oil, extraction yield, physicochemical properties, FTIR

INTRODUCTION

Edible oils from plant sources are of interest in various food applications and industries. They help in providing characteristic flavours and textures required in components of food diet [1]. They can also serve as a source of oleo chemicals [2]. Oilseed crops are major sources of lipids for human nutrition as well as for several industrial purposes. They are defined as those seeds that contain considerably large amounts of oil. The most widely known oilseeds are predominantly from groundnut, soybean, palm kernel, cotton seed, olive, sunflower seed, rapeseed, sesame seed, linseed, safflower seed, etc [3] [4].

It is a generally acceptable fact that oils and fats from seeds and nuts constitute an essential parts of man's diet. Fats and oil, together with proteins, carbohydrates, vitamins and minerals are the main nutrients required by the human body. The chief important of the vegetable oils lies in their food value. Over a long period, oils derived from plant seeds have been playing important roles to provide comfortability in human lives in various

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aspects, they are important in meeting world nutritional demands and are utilized for many food and other industrial purposes [5]. Avocado (*Perseaamericana*) is a subtropical/tropical fruit native to Mexico and Central America, and widely produced and consumed worldwide. It belongs to the *Lauraceae*family and the genus *Persea*, of which there are more than 150 known species [6].

Avocado is considered an energetic fruit with lot of nutritional value since it is rich in protein and contains fat soluble vitamins lacking in other fruits, including Vitamins A and B, and median levels of vitamins D and E. It contains different oil levels in the pulp, thus it is widely used in pharmaceutical and cosmetic industries, and for obtaining commercial oils similar to olive oil, because of their similar fatty acid composition [7].

Solvent extraction is traditionally employed to extract oil from oil seeds, and n-hexane is currently preferred worldwide for its efficacy and availability. Solvent extraction is a simple procedure based on the fact that a solute is distributed in two phases according to the equilibrium ratio, determined by the nature of the component and the two phases [8]. To facilitate oil extraction, seed or grain size is reduced by cracking or rolling (Prámparo, et al., 2003) [9].

The main objective of the study is to extract oil from avocado seeds and determine its physico-chemical properties. And to also characterize the oil using FTIR analysis in order to determine the major functional group present in the extracted oil.

MATERIALS AND METHODS

Sample Collection

Mature and healthy fruits of Avocados (Pear) were obtained from Owode Market in Offa Kwara State Nigeria, this was carefully observed and identified at the Biological science Department and was kept at room temperature (25^0C) for 4 days in order for them to ripe.

Sample Pre Treatment

The fruits were washed with de-ionized water, cut open with a knife and the seeds, the pulp (flesh) as well as the peels were manually removed. The pulp were pulp chopped into small sizes and sundried for 2weeks and the seeds was chopped into smaller and sundried and then pulverized with the use of laboratory mortar and pestle. The samples (the dried pulp and the pulverized seeds) were packaged separately in a polyether bags and stored at room temperature.

Equipments / Apparatus

The equipment used to carry out the experiment are Soxhlet extractor, Thermometer, Viscometer, Stirrer, Density bottle, Distilled water, Burette, Pipette, Refractometer, Separating Funnel, Conical flask, Measuring cylinder, Hot plate, Weighing balance, Calorimeter, Beaker, Retort stand and Filter paper and 250ml beakers.

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Reagents Used

Hydrochloric acid, nitric acid, n-hexane, ethanoic potassium hydroxide, diethylether, ethanol, phenolphthalein, chloroform, potassium iodide, 1% starch indicator, de-ionized water, potassium hydroxide, nitric acid.

The reagents used are N-hexane, Sodium hydroxide, Potassium hydroxide, Sulphuric acid, Ethanol, Starch indicator, Sodium chloride, Potassium iodide, Phenolphthalein, Chloroform all of analar grade. The solutions used in this research were prepared with de-ionised water.

Extraction Of Oil

100g of dry chopped avocadoes pear (seed) was weighed into a thimble and placed into the main chamber of the soxhlet extractor. The oil was then extracted from the sample using N-hexane by adopting the method described by [10]. At boiling point of 50-60^{0}C, total extraction was achieved within a period of 4 hours. The oil mixed with the extraction solvent was poured into a round bottom flask set up in a rotary evaporator at 50^{0}C to recover the oil and evaporate the extraction solvent. The oil was placed on a water bath at 50^{0}C for 2 hours to ensured complete removal of the residual solvent then it was stored in a sample bottle for analysis.

Determination Of Physiochemical Properties of Oil

The oil extracted from avocadoes pulp was analyzed for its physicochemical properties by using various standard methods. The colour, odour of the oil at room temperature were noted by visual inspection while parameters such as saponification value, acid value, iodine value, free fatty acid, peroxide value were analyzed following standard method of AOAC [10].

Determination Of Saponification Value

This was carried out using method as described by [11]. 0.5grams of the oil sample was added to excess ethanolic potassium hydroxide. The solution was heated for two minutes to saponify the oil. The unreacted KOH was back-titrated with standardized 0.1M HCl using phenolphthalein indicator. The SV was calculated from the equation.

$$SV = \frac{56.1 \times BS \times N}{W}$$

Where S = Sample Titer Value

B = Blank Titre Value

M = Molarity of the HCl

56.1 = Molecular Weight of KOH

Determination Of Iodine Value (IV)

This method was carried out as described by [10]. 0.1m iodide mono chloride in acetic acid was added to 0.5g of the oil sample dissolved in cyclohexane. The mixture was allowed to stand for ten minutes, to allow for halogenation. 0.19 of K I solution was added to reduce iodine monochloride to free iodine. The liberated iodine was titrated with a standardized solution of 0.1m sodium thiosulphate using starch indicator. The Iodine value was calculated from equation.

$$\text{Iodine value (IV)} = 12.6 \times C \times (V2 - V1) \times M$$

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where, C = concentration of Sodium thiosulphate used, $V1$ = volume of Sodium thiosulphate used for the blank, $V2$ = volume of sodium thiosoulphate used for determination, m = mass of the sample.

Determination Of Peroxide Value (PV)

This was carried out by the method as described by AOCS [10]. 10g of the oil sample was dissolved in 30ml of glacial acetic acid Chloroform solution was added, then 0.5ml of saturated potassium iodide was added and liberated by the reaction with the peroxide. The solution was than titrated with standardized sodium thiosulphate using starch indicator. The peroxide value (PV) was determined from equation.

$$\text{PV (m Eq/kg)} = \frac{(T-b)\times N\times 1000}{g}$$

where, T = titration volume for sample, B = titration volume for blank, N = normality of thiosulphate used, g = weight of sample

Determination Of Free Fatty Acid (FFA)

This was carried out as described by AOCS (2000). 2g of well mixed sample was accurately weighed into a conical flask in to which 10ml of neutralized 95% ethanol and phenolphthalein were added. This was then titrated with 1.30M of NaOH Shaking Constantly until a pink colour persisted for 30s. The free fatty acid was calculated from equation

$$\%\, Free\ fatty\ acid = \frac{V \times N \times M}{10 \times W}$$

where, V = Volume of titre, N = Normality of NaOH, M = Molar Mass of oil, W= Weight of sample.

Acid Value:

Acid value was determined using the method described by Association of Official and Analytical Chemists (AOAC, 1990). 2g of the extracted avocado oil sample was weighed into a flask and 50 ml of neutralized ethanol was poured into the flask. The contents were mixed together and boiled. It was then titrated with 0.1N KOH to a faint pink colour that persisted for at least 15 seconds. The acid value was calculated as:

$\text{AV} = \frac{56.1\times 10\times T\times 100}{1000\times G}$ where: AV = Acid Value, N = Normality of standard KOH used, T = Titration volume, G = weight of sample

Viscosity Measurement

The viscosity of oil samples before and after frying was measured by an Ostwald Viscometer techniconominal constant 0.05 Cs/c, ASTMAD 445 England. The rate of flow of the oil samples were recorded with a stop watch (Japan, CBM, and Corp QSQ) .

Density Measurement

Density of oil sample was measured by an R.D bottle with a capacity of 10 mL.

Evaluation By FT-IR

FT-IR spectra of oil samples before and after frying were recorded with the help of a Fourier Transform Spectroscopy Model I-R Prestige 21

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Shimadzu. It is used to study the saturation and un-saturation composition of the oil at room temperature.

RESULT AND DISCUSSION

Table 1: Chemical Properties of the Avocado Seed Oil

Physical Parameters	Value / Observation
Colour	greenish yellow
Odour	fruity odour
State at oil at room temperature	Liquid
Saponification Value	150.348 mg/ KOHg
Iodine value I^2g/ 100g	3.81
Peroxide value mEq/KOH/g	14
Free fatty acid (%)	0.1833%
Acid value (mgkoh/g)	0.3666
Refractive index	1.447
Density	0.88g/cm^3
Viscosity	0.075Pa.s

The results showed that avocado seed oil had a low acid value. Oil having low acidity is suitable for consumption which implies that avocado seed oil is edible oil. The results also show that the oil had low peroxide values. This may be attributed to the high stability of the seeds during the extraction process. The iodine value of avocado pulp oil is 3.81 I^2g/ 100g which falls within the range of non- drying oil such as olive oil. This shows that it can be used for soap making and in food processing because of it relatively low iodine value compared to other oil as described by AOAC[10].

Oils are classified into drying (greater than 150 I^2g/100g), semi-drying (125-150 I^2g/100g) and non-drying (less than 100 I^2g/100g).

The FTIR spectroscopy analysis of the extracted avocado pulp oil is presented in figure 1 below, from the figure, it shows the functional group region that have a deep narrow peak with wave number of around 2922.2cm^{-1} and 2855.1cm^{-1} which suggest the presence of CH_2 asymmetric of carboxylic acid. There is another prominent peak at 1744.4cm^{-1} suggesting the presence of aromatic ketone. In the fingerprint region, there is also a variable intensity of wave number 1461.1cm^{-1} in between 1470-1460cm^{-1} which shows the presence of C-H deformation.

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Table 2: FTIR spectral of different functional groups of avocado seed oil.

Frequency $^{cm-1}$	Intensity
723.1	C-H Stretching of finger print region
1162.9	CH_2 Bending
1237.5	CH_2 Bending
1379.1	–C – H (CH_3) Bending (sym)
1461.1	–C – H (CH_3) Bending (sym)
1744.4	–C = O (carboxylic) Stretching
2965.1	CH_2 Stretching (asy)
2922.2	CH_2 Stretching (asy)

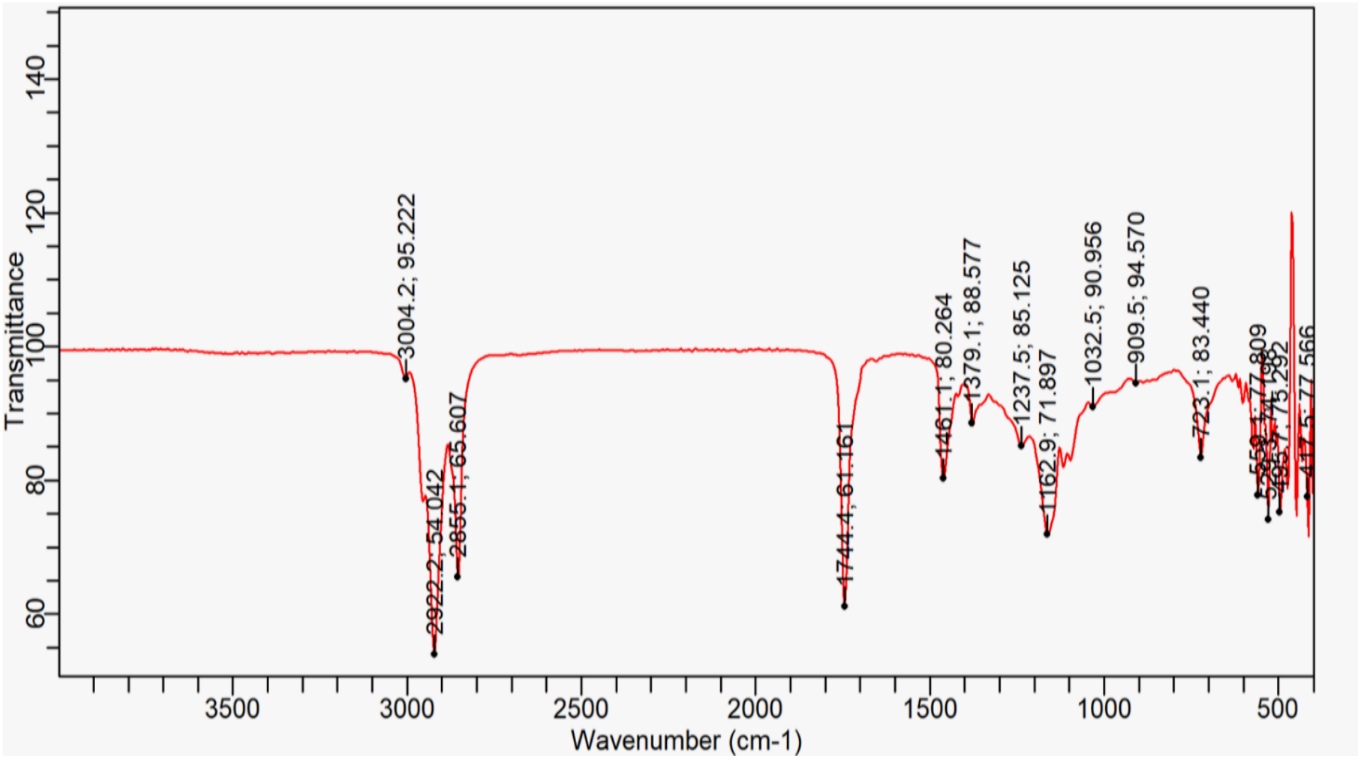

Figure 1: The FTIR spectroscopy analysis of the extracted avocado pulp oil

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Table 3: The result of the elemental composition of the pulverized avocados seeds.

S/N	Elements	Concentration (Mg/ L)	Concentration (mg /kg)
1	Iron (Fe)	1.44	0.72
2	Nickel (Ni)	ND	ND
3	Cobalt(Co)	ND	ND
4	Cadmium(Cd)	ND	ND
5	Lead (Pb)	0.10	0.05
6	Chromium(Cr)	0.25	0.125
7	Manganese(Mn)	0.06	0.03
8	Zinc (Zn)	0.66	0.33
9	Copper (Cu)	0.24	0.12

The table 3 above shows the result of the elemental composition present in avocado seed used in this study. The content of the metals such as iron (Fe), nickel (Ni), cobalt (Co), chromium (Cr), zinc (Zn), lead (Pb), copper (Cu), manganese (Mn) and cadmium (Cd) in edible oil are very important for their toxicology effects on human nutrition and health because of its consumption rate amount.

The result shows that these metals are within the permissible limit of metal ion concentrations required by World Health Organization. Iron, copper and zinc which are essential in human nutrition and play important role in human body are present in relatively high amount in the avocado seed. While the low concentration of lead pb and absence of cobalt, cadmium and nickel implies that the oil is non-toxic to human health.

CONCLUSION

The result of this research shows that the physiochemical properties of the avocado's pulp oil are within specification for vegetable oil, suggesting the possibility of been used as vegetable oil when properly refined. The results of the analysis also showed that avocado oil has a higher saponification value making it suitable for industrial application. Low acid value is an important paramter to determine the suitability of oil for use in industries; hence the low acid value obtained for avocado oil in this study makes it suitable for many industrial applications. Furthermore acid value is used to measure the extent to which glycerides in the oil has been decomposed by lipase and other physical factors such as light and heat.

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RECOMMENDATION

The low acid value obtained for the oils from this research implies the oil is edible. Also the high saponification value obtained coupled with its low iodine content revealed that the oil has great potential in industrial applications such as cosmetics, soap and food processing. Hence, further processing of the oil is required so as to fit into the industrial world. Low iodine values obtained revealed that it is a non-drying oil and also suggest that the oil contain few unsaturated bonds while low peroxide value indicated that the oil have low susceptibility to oxidative rancidity and deterioration

REFERENCES

[1] S. A. Odoemelam , (2005). Proximate composition and selected physicochemical properties of the seeds of African oil bean (*Pentaclethramarcrophylla*). *Pakistan Journal Nutrition*, 4, 382 – 383.

[2] W. H. Morrison, R. J. Hamilton, & C. Kalu(1995). Sun flower seed oil. In; R.J. Hamilton, (ed.) *Developments in oils and fats.* Blackie Academic and Professional, Glasgow, pp: 132 – 152.

[3] A. S., Ajala & S. A. Adeleke (2014). Effect of drying temperatures on physicochemical properties and oil yield of African star apple (*Chrysophyllumalibidum*) seeds.*G.J. E.D.T.*, 3(3):12-16

[4] E. T. Akintayo (2004). Characteristics and composition of *ParkiaBiglobbossa and Jatropha Curcas*oils and cakes.*Bioresour. Technology*, 92, 307 – 310.

[5] A. Idouraine, E. A. Kohlhepp, & C. W. Weber (1996). Nutrient constituents from eight lines of naked seed squash (*Cucurbitapepo*L.). *Journal of Agriculture & Food Chemistry*, 44, 721 – 724.

[6] R. G., Araújo, , R. M., Rodriguez-Jasso, H. A., Ruiz, M. M. E., Pintado &, C. N. Aguilar (2018).
Avocado by-products: Nutritional and functional properties. *Trends in Food Science and Technology*, 80, 51-60

[7] E.W. Bleinroth, J.V. Castro, (1992). In: ITAL. Abacatecultura, matéria-prima, processamento e aspectoseconômicos. 2.ed. SérieFrutasTropicais. Campinas: ITAL., 2: 58-147.

[8] M. Bockish, 1998. Extraction of vegetable oils, In Bockish M. (Eds.), *Fats and oils handbook Champaign*, IL: AOCS Press, 151.

[9] M. Prámparo, M. Mattea & S. Gregory, (2003). Influencia del tipodecontactosólidolíquido en la extracción de aceitesvegetales, *Grasas Y Aceites*, 53(4), 592–597.

[10] AOAC, (2000). Official Methods of Analysis, Association of official Analytical Chemists, Washington, DC, USA, 17th edition.

[11] I. I. Nkafamiya *, H. M. Maina, U. U. Modibbo and D. Haggai (2007). Utilisation potentials of Conorandus panados (Mnizee) fruits and seeds, Int. J. Biol. Chem. Sci. 2(4): 439-447

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