MPRI-JMBP | INTERNATIONAL JOURNAL OF MEDICAL, BIOLOGICAL AND PHAR. SCI.
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

POTENTIAL OF HAIR GROWTH OIL PRODUCTION FROM OIL EXTRACTED FROM THE PULP (MESOCARP) OF AVOCADO PEAR

OBODOEZE JOSEPH JIDEOFOR[1] AND IGWAGU RUTH CHIDIOGO[2]

Science Laboratory Technology Department, School of Applied Science and Technology, Federal Polytechnic, Oko, Anambra State, Nigeria

Abstract

This project work involves extraction, characterization and production of hair growth oil from avocado pear oil (APO) as carrier oil. Oil extraction from the dried and ground pulp of avocado pear of 0.3mm particle size was done using soxhlet extraction method with n-hexane as extracting solvent at 60°C and 90 minutes. Physicochemical properties of the oil were determined using standard AOAC method (2010). The hair growth oil (HGO) was produced using cold method by mixing a given quantity of the carrier oil (APO) with a given amount of peppermint essential oil, followed by addition of desired fragrance. The percentage oil yield of 15.39% was obtained. Physicochemical properties of the extracted APO were: Colour (dark greenish brown), refractive index (1.4608), specific gravity (0.9182), flash point (220 °C), Saponification value (178.90mgKOH/100g oil), Acid Value (1.23 mg/g), iodine value (77.95g-I/100g oil), peroxide value (1.46meqKOH/g), and pH at 29°C (4.56). The properties of the produced hair growth oil (HGO) were: pH

KEYWORDS: *Hair growth, oil, avocado pear*

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

(5.8), specific gravity at 60 °C (0.898), flash point (230 °C), colour ((light greenish brown) while Sensory evaluation showed that the produce HGO was smooth to touch, mild to the body, and of nice smelling aroma (fragrance) of vanilla fantasy, and very effective in promoting hair growth, decreasing dandruff and mitigate hair brakage and damage. The oil obtained from this study can be considered to be economical for commercial production of oil in Nigeria because of the appreciable yield and the encouraging physicochemical properties, while the produced HGO can be said to be a good hair product with excellent properties.

INTRODUCTION

The oil, food and medicinal properties of avocado have been subjects of intensive research in view of their economic and industrial potential (Ikhuoria and Maliki, 2007; Onuegbu et al., 2011). Avocado contains about 30% oil. The increasing popularity of avocado as an alternative raw material for oil production is induced by its high digestibility coefficient, excellent keeping quality and availability of high values of palmitic, oleic and stearic acids as constituents of the oil. These made the oil, a very important raw material for the production of cosmetics such as soap, facial creams, hand lotions, hair growth oil, and allergic skin softening cream. The lipid content varies from 5 – 25% depending on cultivar (Ogunwusi & Ibrahim, 2016).

Intensive cultivation of avocados for commercial purposes began in California and Florida and later in Israel, South Africa and Chile. World production of avocado increased by 4.3% (over 760,000 tonnes); between 1988 and 1998. The major producers of avocado are Mexico (34%), USA (8%), Dominican Republic (7%), Indonesia (6%), Brazil (4%), Israel (4%), Chile (2.4%). Among all fruits, only the olive (Oleo europa)

and the oil palm fruit (Elaeis guineensis) can rival avocado oil in content (Lewis, 1979). The lipid content is high and confers high industrial utilisation potential on the plant.

The oil is used for hair dressing and is also employed in facial lotions and soap production. It is of great importance to the cosmetic industry as it contains sterol called photosterol which has high penetrating abilities. Avocado oil is easy to emulsify, its low surface tension produces smoothening creams and makes superior cosmetic oil. The impressive list of vitamins found in avocado oil is of benefit to the cosmetic industry as vitamin A helps to prevent the dry skin and vitamin E (Tocopherol) and vitamin B are effective against skin wrinkling.

Nowadays, the oil is usually extracted from the pulp using three major methods. These are the extraction method which uses the tube press, the rendering process and solvent extraction process using n-hexane and petroleum ether as extracting solvents (Ogunwusi & Ibrahim, 2016). Hair growth oil is one of the important cosmetic products that can be produce using avocado oil as carrier oil mixed with essential oil such as lavender or peppermint. It is applied to the hair to decrease dandruff, mitigate hair breakage, to detangle hair, to mitigate hair damage etc (Luthfia, Abdul, & Sugeng, 2016).

The future vision is hung on three pillars, namely guaranteeing the productivity and wellbeing of Nigerians, optimising key sources of economic growth and fostering sustainable social development. One of the major raw materials that can be developed for sustainable industrial growth and for export is avocado. Though some researches has been conducted on extraction, characterization, and utilization of oil from avocado, little or no scientific report has been made on the utilization of avocado oil in hair growth oil; thus, this research studies, extraction, characterization, and utilization of avocado oil in hair growth oil.

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

Experimental

Sample Collection and Preparation

The Avocado (*Persea americana* Mill.) fruits were purchased from Eke Awka Market, Anambra State, Nigeria and were authenticated at biology laboratory, SLT Department, Federal Polytechnic, Oko, Anambra State. The avocado fruit samples were left to ripen for 5-7 days at a room temperature of 25°C as described by Villa-Rodriguez (2010) and Ozdemir (2003). The seed, seed coat and skin were removed. The pulps of the ripened fruit were cut into smaller pieces and were placed in ice bags. They were left in the freezer for a couple of days to be frozen. The frozen avocado sample was set into the freeze dry system (A Benchtop Manifold Freeze-drier) for a couple of days until all of its moisture content was removed. The moisture content of the sample, according to Werman et al (1987), was obtained by calculating for the water lost upon the drying process; Eq. (1). The freeze-dried avocado was ground with the use of mortar and pestle, weighed, and contained in a sealed vessel to reduce unnecessary changes and stored in a conducive environment (fridge) until analysis.

$$\%\ \boldsymbol{Moisture\ Content}\ (\boldsymbol{W}) = \frac{\mathbf{100}(\boldsymbol{M_o} - \boldsymbol{M})}{\boldsymbol{M_o}} \qquad (\mathbf{1})$$

Where *M*, ***is*** the final weight of the dried sample and *Mo*, **is** initial weight of the fresh sample.

Oil Extraction

A Soxhlet extractor was set up with n-hexane as the extracting solvent (in 500 cm^3 round-bottomed flask). Fifty grams (50g) of 0.30mm size of the sample (PS) was placed on a weighed and folded filter paper and then placed in a thimble of soxhlet apparatus and extracted with n-hexane at 60°C for 90 minutes. The solvent was boiled gently (using heating mantle), a reflux condenser was fitted (to cool the hot

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

solvent). The condensed hot-solvent soaked the thimble containing the sample. The solvent siphoned into the flask when it reached the top of the siphon tube of the Soxhlet apparatus. The resulting oil and solvent mixture was filtered to remove the suspended solids. Subsequently, the mixture (of the oil and solvent) was placed in a rotary evaporator or distillation apparatus to evaporate the solvent which was collected in the receiving flask, and thus, avocado pear oil (APO) was obtained for subsequent analyses. The percentage yield of the APO was calculated using equation 1.

$$\boldsymbol{Oil\ Yield}\ (\%) = \frac{\boldsymbol{Weight\ of\ Oil}(g)}{\boldsymbol{Weight\ of\ the\ Sample}\ (g)} \qquad (2)$$

Characterization of the Extracted Oil

The extracted oil was characterized for its physicochemical properties using standard methods of AOAC, (2010).

Determination of density and specific gravity

A clean empty specific gravity bottle was weighed on an electronic balance and the mass (W_1) noted. It was then filled with the oil, in turn, at the required temperature and its mass (W_2) and volume noted. The mass of each oil (W_s) was the difference between W_2 and W_1. The density of oil, ρ, was calculated using the equation:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \qquad (3)$$

The bottle was washed, dried and filled with equal volume of water at the required temperature and the mass (W_3) was noted. The mass of water (W_w) was the difference between W_3 and W_1. The specific gravity of biodiesel was determined using the equation:

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

$$\text{Specific gravity} = \frac{\text{Weight of Oil}}{\text{Weight of equal volume of water}} = \frac{W_2 - W_1}{W_3 - W_1} \quad (4)$$

Determination of Refractive Index

Refractometer was use in this determination. Few drops of the sample were transferred into the glass slide of the refractometer. Water at 30°C was circulated round the glass slide to make its temperature uniform. Through the eyepiece of the refractometer, the dark portion viewed was adjusted to be in line with the intersection of the cross at no parallax error. The pointer on the scale pointed to the refractive index. This was repeated and the mean value noted and recorded as refractive index.

Determination of pH

pH meter ELE model 3071 was used. It was standardized using a buffer solution. The pH meter electrode was then dipped into a measuring cylinder containing 80ml of the oil sample to be analysed and the corresponding reading obtained was recorded.

Determination of Acid Value and Free Fatty Acid

Acid value was determined by tittrametric method of pearson (1970). 5ml of the oil sample was weighed accurately into a conical flask and dissolved with 10ml of carbon tetrachloride's, few drops of phenolyphthalain indicator was added and then the solution was titrated with 0.1m alcoholic potassium hydroxide until a pink color appeared and persisted for some times (ten seconds), the titration was repeated two times and average titer obtained.

The acid value was calculated as follow:

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

$$Acid\ Value = \frac{Vol\ of\ KOH\ \times Normality\ \times Molar\ Mass}{Weight\ of\ the\ Oil} \quad (5)$$

Determination of Saponification Value

Five grams of oil sample was transferred into 250 ml flask fitted with reflux condenser and 50ml of 0.1M alcoholic KOH solution was added into the flask. The content was refluxed over a water bath for 1 hour and the flask was removed from water bath. The inner wall of condenser was washed into the flask. Three drops of phenolphthalein indicator was added and titrated with 0.1M HCl until the solution becomes colourless. Blank titration was also carried out and the saponification value calculated thus:

$$Saponification\ Value\ = \frac{(b-a) \times 561 \times M}{Weight\ of\ Sample} \quad (6)$$

Where: a = Volume in ml of HCl run down in text experiment.
b = Volume in ml of HCl run down in the blank experiment.
M = Molarity of KOH.
561= Constant (Normality)

Determination of iodine value:

Iodine value was determined by the titrametric method of Pearson (1970). One gram of the oil sample was placed into a 500ml glass – stoppered iodine flask, 25 ml of CCl_4 and 25 ml of wij's solution were added into the 500ml flask containing the oil with the help of a vacupet. The stopped flask was allowed to stand in dark for 2 hours. Twenty millilitres of potassium iodine solution was added; 100 ml of water was then added with shaking. The excess of iodine was titrated with 0.1M Sodium thiosulfate solution using starch as indicator. The

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

blank experiment was performed simultaneously by repeating the entire procedure without using the oil. The iodine value was calculated as:

$$Iodine\ Value = \frac{(b-a) \times M \times 126.9}{Weight\ of\ Sample} \quad (7)$$

Where:
a = Volume in ml of sodium thiosulfate run down in the first test experiment
b = Volume in ml of sodium thiosulfate run down in the blank experiment
M = Molarity of sodium thiosulfate.
126.9= Constant

Determination of Peroxide Value

Peroxide value was determined by the titrametric method of Pearson (1970). 1g of the oil sample was weighed into a conical flask and 1g of powdered potassium iodide with 20ml of solvent mixture (Glacial acetic acid and chloroform) were added. This was placed in boiling water for 30 sec. the content was then poured into a flask containing 20ml of 5% iodine solution. The flask was then washed out with 25ml of distilled water and titrated with 0.002m sodium thiosulphate solution using starch as indicator. A blank was also prepared alongside the oil samples. The peroxide value is given by the formular:

$$Peroxide\ Value = \frac{(V_0 - V_1) \times M \times 1000 meq/kg}{Weight\ of\ Oil} \quad (3.8)$$

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

Production of Hair Growth Oil

The characterized oil was further refined ready to be used as carrier oil for production of hair growth oil.

Standard quantity:

Ounce (28.35g) of avocado oil (AO) goes with 5 drops of peppermint essential oil (Carli, 2020). Thus, 17.01g of avocado oil was mixed with about 3 drops of peppermint essential oil to obtain powerful homemade hair growth treatment oil. About 3 drops of a desirable fragrance (Vanilla fantasy) was added to the oil to enhance the aroma.

Characterization of the Hair growth Oil

Test for the pH of the Produced Hair Growth Oil

2g of the produced hair growth oil sample was poured into a clean dry 25ml beaker and 13ml of hot distilled water was added to the sample in the beaker and stirred slowly. It was then cooled in a cold-water bath to 25°C. The PH electrode was standardized with butter solution and the electrode immersed into the sample and the pH value was read and recorded.

Determination of specific gravity

The method applied previously for determination specific gravity of oil was used to determine the spefic gravity of the HGO.

Determination of Flash Point (Cleveland Open Cup Method)

This test was carried out based on ASTM standards, ASTM D92. The test cup was filled with the test sample. The thermometer was then positioned into the test sample. The test sample was heated. The test flame was lighted and adjusted to 3.2 – 4.8mm. When the temperature is at least 28°C below the expected flash point of the sample, the flame pointer was switched on to pass the flame across the cup. The flash

point was then recorded when an instantaneous flash occurs on the application of flame, (Annual Book of ASTM Standards, 2010).

Determination of Colour

The colour of the produced hair growth oil was observed with ordinary eye and later, the colour was conventionally measured using the manually operated Lovibond ® Tintometer. One manual/visual colorimeters was used for color measurements of produced hair growth oil.

Sensory Evaluation

Sensory evaluation was carried out and judged by a consumer panel team consisting of six students (four girls and two boys) and five staffs (three young lady and two gentle men) of federal polytechnic Oko, Anambra State, in order to evaluate the quality and acceptability of the hair growth oil based on colour, appearance, fragrance, texture, and efficacy. The texture was determined by feeling with the hands, while the functionality of the produced HGO was determined by applying to the hair.

Results and Discussion

The oil yield of avocado pear (15.39%) may be considered economical for commercial production of oil in Nigeria. Oil fraction with saponification value of ≥ 180mg KOH/g had been reported to possess low molecular weight fatty acid (AOAC, 1990). Therefore, Avocado pulp oil (APO) which has saponification value of 178.90 mgKOH/g (Table 1) can be said to have low molecular weight fatty acid which implies that they may be useful in soap making. Acid value indicates whether the oil is in good non-degradable state or not. Good quality edible oil has an acid value less than 4 mg KOH g^{-1} (Zhang et al., 2015). According to AOAC, (1990) the maximum acceptable level for acid

value is 4mgKOH/g oil. Below this value simply means that the oil is acceptable. From Table 1, APO has acid value of 1.23mgKOH/g, which is within the standard range. Hence, the APO is in good non-degraded state which can be used for daily consumption.

Table 1: Physicochemical properties of Avocado Pear Oil

Parameters	Values
Color	Dark greenish brown
pH (at 29.1 °C)	4.56,
Specific gravity at 60°C	0.9182
Flash point (°C)	220.00
Refractive index at 30°C	1.4608
Saponification value (mgKOH/100 g oil)	178.90
Acid Value (mg/g)	1.23
Iodine value (gI_2/100g oil)	77.95
Peroxide value (meqKOH/g)	1.46

APO has a low peroxide value of 1.46meqKOH/g. This value does not fall within the standard range of 2-10meqKOH/g as reported by AOAC, (1990). This implies that the oils may be susceptible to oxidative degradation. Iodine value is the measure of the properties of unsaturated organic compound (Pearson, 1981). It indicates the reactivity of double bond. Oil that have low iodine value which fall within the standard range of (80 - 100gI_2/100g) as reported by AOAC,(1990) have low degree of unsaturation and they are classified as the non-drying oil. Whereas oils that have high iodine value have high degree of unsaturation and they are classified as drying oil according to (Atasie et al., 2009). Thus, APO with iodine value of 80.04gI_2/100g (Table 1) have low degree of unsaturation, therefore, it is non-drying oil. The pH of APO was 4.56.0.Therefore, it is of low acidity.

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

Hair Growth Oil

The skin has a pH of around 5.5. So, most personal care products have pH balance of 5.3 – 5.8, and rarely up to 7.0. From Table 2, the pH of the produced hair growth oil (HGO) was 5.18, indicating that the HGO is slightly acidic and safe to be applied to the body without causing harm to the body and its cells, as well as to prevents fungal and bacterial growth in hair and scalp, and keeps the cuticles closed and healthy .

Table 2: Properties of Produced Hair Growth Oil (HGO)

Parameters	Values/Results
Specific gravity at 60°C	0.898
pH @ 30 °C	5.18
Flash point (°C)	230.00
Colour	Light greenish brown
Appearance	Homogeneous
Texture (Feel)	Smooth,
Aroma	Vanilla fantasy
Efficacy	promote hair growth, soothe itchiness, decrease dandruff, mitigate hair breakage and damage

From Table 2, the flash point of the HGO (230 °C) was high enough, therefore, the HGO may be said to be non flammable up to that temperature and can be applied for wide range of temperature. The overall appearance of the produced HGO was homogenous in nature

for the formulations with no visible spots. This implies that the HGO will be easy to apply on the hair and will not leave any visible coloured spot on the hair after rubbing the oil. From sensory evaluation, judged by a consumer panel team, the quality and acceptability of the body cream based on colour, appearance, fragrance, texture, and efficacy was high (above 75% average score). This implies that the cream may have wide acceptability and may be profitable if produced for commercial purpose.

Conclusion

Oil with excellent properties for home, commercial and industrial (cosmetics) purposes in Nigeria can be produced from the pulp of avocado pear. Furthermore, avocado pear oil can be used to produce hair growth oil with exciting properties with benefits of reducing dandruff, mitigating breakage, hair damage, and detangling your hair as well as improve the texture, and make the hair small nice.

Recommendation

The avocado pear oil is recommended to be applied to the hair to improve texture, make the hair stronger and have nice smelling aroma as well as reduce dandruff, mitigate breakage, hair damage, and detangling of hairs. Further studies are recommended to ascertain scientifically the various constituents of APO responsible for its function as good carrier oil in production of hair growth oil. Growth of avocado pear trees and processing of the fruits into oil should be encouraged to create more jobs and revenue to young graduates and the farmer.

REFERENCES

Akintayo, E. T., (2004). Characteristics and composition of *Parkia Biglobbossa and Jatropha Curcas* oils and cakes. *Bioresour. Technology,* 92, 307 – 310.

Akpabio, U.D., Akpakpan, A.E., Matthew, I.E., & Akpan, A.U. (2011). Extraction and characterization of oil from Avocado pear (*Persea americana*) and native pear (*Dacryodes edulis*) fruits, World Journal of Applied Science and Technology, 3, 27-34.

Alpha Aromatics (2017). How to choose the best fragrance for personal care products. Available online at: https://www.alphaaromatics.com/blog/choosing-the-best-fragrance-for-cosmetic-personal-care-products/. [Accessed on 10/12/2019; 07:06:02].

Annabelle, N. W., Joseph K., Allain, R. A., Zac, R. R., & Leakey, B. (2004). Domestication of *Dacryodes edulis*, 2 Phenolypic Variation of Fruit Traits in 200 Trees from Four Populations in the Humid Lowlands of Cameroon. *Food Agric. Environ*. 2(1):340 – 346.

AOAC.(2010). *Official Methods of Analysis of Chemistry,* (16th Edition). Washington D.C: Association of Official Analytical Chemists. Pp23-24

Aremu, M. O., Olaofe, O., &Akintayo, E. T. (2006a). Chemical composition and physicochemical characteristics of two varieties of bambara groundnut (*Vignasubterrenea*) flours. *J. Applied Sciences,* 6(9), 1900 – 1903.

Aromatics Blod (2017). All about avocado carrier oil. Avalaible online at: https://www.newdirectionsaromatics.com/blog/products/all-about-avocado-carrier-oil.html [Access date: 2019/06/15; 0417].

Axe, J. (2018), Top 15 Peppermint Oil Uses and Benefits, for Gut Health, Headaches & More. Available online at: https://draxe.com/peppermint-oil-uses-benefits/ [Access date: 2019/06/15; 06:00].

Carli, B. (2020).Cosmetic Formulatios: A Beginners Guide (7th Ed.). Institute of Personal Care Science.

Dolendo, A. L., Luh, B. S., & Pratt, H. K. (1966). Relation of Fatty Acids Changes to Respiration Rate during Ripening of Avocado Fruit. *Journal of Food Science* 31(3), 332-336.

Eze, T., (2012). Cleaning, cracking, dehulling, decorticating and flaking of oil-bearing materials. *Journal of American Oil Chemists' Society,* 53(6), 271 – 274.

Fakhri, N. A., & Qadir, H. K. (2011).*Journal of Environmental Science and Engineering*, 5, 844 – 849.

Hamilton, C. A., (1999). Analysis of Isoflavone Content in Tempeh, a Fermented Soybean, and Preparation of a New Isoflavone enriched Tempeh. *Journal of Bioscience and Bioengineering* 2005;100: 685-687

Hoffman, G., (1986) Quality control in food industry, food science and technology series of monographs, 2nd edition, Academic Press, London, 2: pp. 407-504.

Husena, R., Andoua, Y., Ismailb, A., Shiraia, Y., Hassanc, M.A. (2014). Enhanced polyphenol content and antioxidant capacity in the edible portion of Avocado dried with superheated-steam, International Journal of Advanced Research, 2(2), 41-48.

Ikhuoria, E. U., & Maliki, M. (2007). Characterisation of Avocado Pear (*Persea Americana*) and African Pear (*Dacryodes edulis*) Extracts. *African Journal of Biotechnology*. 6(7), 950 – 952.

John, M., Graham & Rickwood, D. (1997). Sub cellular Fractionation: A Practical Approach. Oxford University Press, p. 234.

Kenneth - Curl Centric. (2019). Avocado Oil for Hair Growth: Benefits, Step-by-Step Techniques & Recipes. Available online at: https://www.curlcentric.com/avocado-oil/ [Access date: 2019/06/15; 05:41].

Kochhar, S. L., (1998): Economic Botany in the Tropics. 2nd Edition, Macmillan India Ltd, pp 354 – 355.

Lewis, C. E. (1978). Maturity of Avocados – A General Review. *Journal of the Science of Food and Agriculture,* 29, 857 – 866.

Luthfia, I., Abdul, R., & Sugeng, R. (2016).Physico-chemical characterization of Avocado (*Persea americana* Mill.) Oil from Three Indonesian Avocado Cultivars. Research Journal of Medicinal Plants, 10(1), 67-78.

Nielson, S., (2014). "Variations in fatty acid proportions during dessication of (Telfairia occidentalis) seeds harvested at physiological and agronomic maturity". *African Journal Biotechnology*, 2(2), 33-39.

Nourrechni, H., Teoh, B. C., & Clement, L. D. (1992). Viscocity of vegetable oils and fatty acids.*Journal of American Chemical Society*, 69, 1184 – 1188.

Nwaokobia, K., Ogboru, R.O., & Idibie, C.A. (2018). Extraction of edible oil from the pulp of *Persea americana* (Mill) using cold process method. *World nNews of Natural Sciences: An International Science Journal*, 17, 130-140.

Oderinde, K. A., Ajayi, I. A., and Adewuyi, A., (2009) Characterization of Seed and Seeds oil of *Huracrepitans*and the Kinetics of Degradation of the Oil during Heating, *Electronic Journal of Environment, Agriculture & Food Chemistry* 8(3), 201 – 208.

Oldriches, P. B., Seawright, J. C., Ward, A., Schaffeler, L., & Macleod, J. K. (1995). Isolation and Identification of a Compound from Avocado Leaves which Causes Necrosis of the Acinar Epithelium of the Lactating Mammary Gland and the Myocardium. *Nat. Toxins* 3(5), 344 – 349.

Ogunwusi, A. A., & Ibrahim, H. D. (2016). Economic significance of avocado pear in Nigeria. *Developing Country Studies*, 6(3), 13-22.

Onuegbu, N. C., Adedokun, I. I., Kabuo, N. O., & Nwosu, J. N. (2011). Amino Acid Profile and Micronutrient Composition of the African Pear (*Dacryodes edulis*) Pulp. *Pakistan Journal of Nutrition*, 10(6), 555 – 557.

Ozdemir, F. (2003). *Changes in dry matter. Oil content and fatty acids composition of avocado during harvesting time and post harvesting ripening period*. Retrieved June 10, 2019 from Elsevier: wwwsciencedirect.com.

Overhults, T. J. (1974). Physical and chemical properties of fats and oils.In food oils and their uses.AVI Publ. Co. Inc. Westport.com.USA 2nd edition, pp. 25 – 84.

Ranade, S.S., & Thiagarajan, P. (2015). A Review on Persea Americana Mill. (Avocado) - Its Fruit and Oil. International Journal of PharmTech Research, 8(6), 72-77.

Rueda, A., Seiquer, I., Olalla, M., Giménez, R., Lara, L., & Cabrera-Vique, C. (2014). Characterization of fatty acid profile of argan oil and other edible vegetable oils by gas chromatography and discriminant analysis, *J Chem*, 1-8.

Santana, I., DosReis, L.M., Torres, A.G., Cabral, L., & Freitas, S.P. (2015). Avocado (*Persea americana* Mill.) oil produced by microwave drying and expeller pressing exhibits low acidity and high oxidative stability, Eur J Lipid Sci Technol, 2015, 117, 999-1007.

Smith, l. M., & Winter, F.H. (1970). Research on Avocado Processing at the University of California. *Calif. Avocado Soc*. Yearbook, 54, 79 - 83.

Villa-Rodriguez, J. (2010). *Effect of maturity stage on the content of fatty acids and antioxidant activity of Hass avocado*. Retrieved June 10, 2019 from Elsevier: www.sciencedirect.com.

Yahaya, A. T., Taiwo, O., Shittu, T. R., Yahaya, L. E., & Jayeola, C. O., (2012). Investment in cashew kernel oil production; Cost and return analysis of three processing methods. *American Journal of Economics,* 2(3), 45 – 49.

Vishwa, N.V. (2016). Application of atomic absorption spectroscopy to food sciences (A study on *Persea americana* Mill – Avocado). *World Scientific News* 49(2), 104-116.

Werman, M. J., & Neeman, I. (1987). Avocado Oil Production and Chemical Characteristics. *Journal of American Oil Chemists' Society*. 64(2), 229 – 232.

Weiss, E. A., (2000). Oil seed crops. Second Edition Blackwell Longman Group Ltd. USA, pp. 131 – 164.

Zhang H, Wang Z, Liu O. (2015). Development and validation of a GC–FID method for quantitative analysis of oleic acid and related fatty acids. *J Pharm Anal.,* 5(223–230). DOI: 10.1016/j.jpha.2015.01.005.