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# Effect of Storage, Solar and Oven-Drying on the Characteristics of African Pear (Dacryodes edulis) Pulp Oil

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## ABSTRACT

*African pear pulp oil samples extracted from oven-dried (40°C). Solar-dried (40-45°C) and room temperature-stored (26°C) African pear (Dacryodes edulis) fruits were examined for selected physical and chemical characteristics. The oven-dried pear oil exhibited a normal green colour the solar-dried pear oil had a deep-green colour and the room temperature-stored pear oil was sparkling green. All the oil samples had a liquid physical state at room temperature after extraction. After fourteen (14) days of storage, the oil from the oven-dried African pear solidified, the solar-dried pear oil became semi-liquid while that held at room temperature remained liquid. The chemical analyses of the oil samples indicated that there were significant differences ($p<0.05$) in the FFA (0.790 - 1.692 as % Oleic acid). Saponification value (437.58-577.83mgKOH/g). Peroxide value (46.40-69.60mEqO$_2$/g). Iodine value (87.59 -96.86gI$_2$/100g) and unsaponifiable matter(5-15%). There was no difference in the values obtained for specific gravity.*

***Keywords***: *African pear pulp oil, oven-dried, solar-dried.*

## INTRODUCTION

African pear (*Dacryodes edulis*) is a well-known plant in West Africa. The fruits are edible and the bark, leaves, stem and roots are employed for a variety of purposes. The fruit pulp may be cooked or eaten raw. Cooked pulp of the fruit has a texture similar to butter. Oil from the fruit is rich in amino acids and triglycerides and can augment common household oils (Omonhinmin, 2014). African pear is cultivated in large quantities in South-Eastern Nigeria and other African countries like Cameroon, Sierra Leone, Uganda, Liberia and Zaire (Isaac *et al.,* 2014). The fruit pulp of African pear is well-known for its richness in protein, fat, fibre, minerals and essential amino acids (Adedokun & Onuegbu. 2011). The African pear fruit is one of the sources of vegetable oil which has been ignored over the years and has remained untapped (Anegbe *et al.,* 2005). The fruits of the African pear tree are rich in high-quality non-greasy edible vegetable oil (44-69%), and this qualifies the fruit along with copra. cotton seeds. peanuts and palm fruits as oil seeds (Okaka *et al.,* 2002). Adequate development of this oil could contribute to the resolution of the increasing demand for vegetable oils for surface coatings and other industrial applications (Isaac *et al.,* 2014). This is because seed oils from plants are exploited commercially for soap manufacture and in the paint industry (Onwuka. 2005). However, because of the high perishability of the African pear fruit, high percentages of' fruit losses are incurred annually (Hez *et al.,* 2009).

Considering the great concern to produce and preserve all sources of vegetable oil origin, many measures have been employed to control spoilage and post-harvest losses of' fruit and vegetables (Wills and Guiding, 2015). Although the African pear fruit is non-climacteric but highly perishable and its post-harvest deterioration affects the pulp, making it difficult to preserve, as it spoils within 6 days of harvest. This situation adversely affects the quality of oil extracted from such fruit pulp. In Cameroon, African pear fruits are traditionally preserved by boiling and sun-drying the pulps. Hence, drying preserves the fruit pulp, though with consequent change in the quality of the pulp oil. The main objective of this work is to determine the effect of solar and oven-drying of the African pear fruit pulp on the physicochemical characteristics of the extracted oils.

## MATERIALS AND METHODS

The fruit of *Dacryodes edulis* were purchased from *Ekeonunwa* market, Owerri. They were collected in fresh, wholesome and matured states. The fruits were divided into three portions for the three treatments (room temperature storage Oven-and solar drying). Two parts were cleaned, decorticated the seeds dislodged and the pulp sliced into small sizes for easy drying and extraction after the inner leathery skin covering the mesocarp was scraped off. One portion of the sliced pulp was solar dried at 40-45°C for 72 hours to a moisture content of 10%. The other portion was oven-dried at 40°C for 24 hours to 8.33% moisture content. The dried pulps were differently macerated into a fine paste using a Kenwood electric blender. Likewise also, the room temperature-stored pear fruit samples were cleaned, decorticated, the seeds dislodged and pulp blended with a kenwood electric blender into a paste after three days storage at 26°C. The oil was extracted using n-hexane. The method of extraction was solvent extraction as described by Pearson (1976). 1,100g each of the room temperature-stored African pear fruit pulp, solar-dried *Dacryodes edulis* fruit pulp and the oven-dried *Dacryodes edulis* fruit pulp were weighed out and put in three separate vessels respectively; n-hexane was added (three times the volume of pulp) to cover the surface level of each product. Aluminum foil was used to seal each vessel after proper mixing with a stirring rod. Thereafter, the vessels were separately sealed with cellotape to avoid evaporation. Each mixture was left overnight at room temperature to enable the oil to dissolve in the solvent. The oil-solvent mix was filtered out using a clean muslin cloth. The fruit pulp oil was separated from the n-hexane using a simple distillation apparatus.

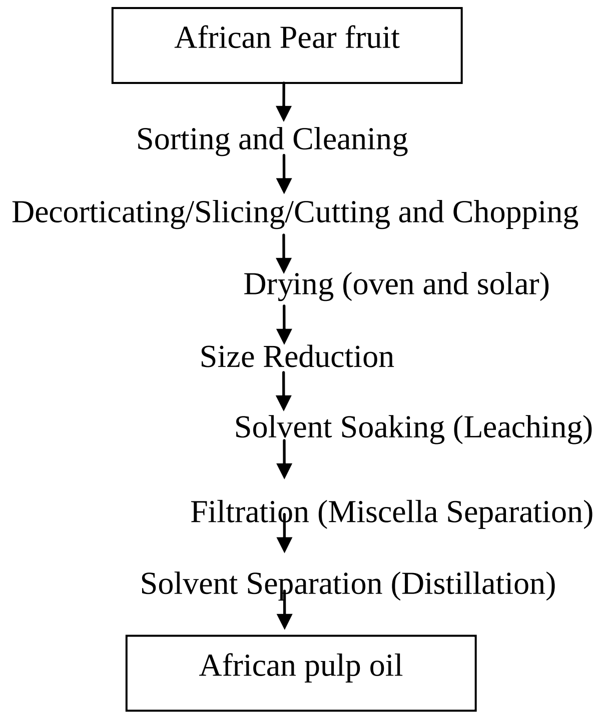


Figure 1: Flow diagram for African pear pulp oil extraction.

**Analysis**

The free fatty acid value (FFA), peroxide value, saponification value, unsaponifiable matter and iodine value were obtained using the methods of Nielsen (2002). Onwuka., (2005) and Nzelu *et al.,* (2012). The colour and appearance were based on physical appearance. *Free fatty Acid Value*: To 2g of liquid fat sample in a conical flask. Neutralize with 25ml of ethanol, 25ml of diethylether and 1ml of 1% phenolphthalein indicator were added. The resulting mixture as titrated with 0.1M NaOH and the percent FFA calculated thus:

% FFA (as Oleie acid) = $\frac{V \times N \times 0.282}{W} \times 100$

1

Where FFA = Free fatty acid (g/100g) expressed as Oleic acid

V = Volume of NaOH titrant (ml)

N = Normality of NaOH titrant (mol/dm$^3$)

0.282 = MW of Oleic acid (g/mol)

W = Weight of sample taken

*Peroxide Value*: 1g of oil was weighed into a clean, dry boiling tube and while still liquid, 1g of powdered potassium iodide and 20ml of solvent mixture (2 volume glacial acetic acid + 1 volume chloroform) were added. The tube was placed in boiling water so that the liquid boils within 30 seconds and was allowed to boil vigorously for not more than 30 seconds. The contents were quickly poured into a flask containing 20ml potassium iodide solution (5%) and the tube was twice washed with 25ml water and titrated with 0.002M sodium thiosulphate solution using starch as indicator (titration = A ml). A blank titration was performed at the same time (titration = B ml)

Peroxide value (Meq $O_2$/kg) =

$$\frac{(A\text{-}B)\ (N)\ (1000)}{Wt\ of\ sample\ (g)}$$

N = normality of sodium thiosulphate

*Iodine Value*: 5 ml of oil was placed in a conical flask and 10 ml of carbon tetrachloride added and the mixture vigorously shaken. 20 ml of Wij's Solution was added to the mix, covered with a stopper moistened with potassium iodide solution and allowed to stand in the dark for 30minutes. Thereafter, 15 ml of potassium iodide (10%) and 1000ml of water were added and thoroughly mixed. The resulting combination was titrated with 0.1M sodium thiosulphate solution using starch as indicator (titration = *a* ml). A blank titrated was conducted (titration = *b* ml).

Iodine value = $\frac{(b - a) \times 1.269}{Weight\ of\ sample\ (g)}$

*Saponification Value*: 2g of the oil was placed in a conical flask and exactly 25 ml of alcoholic potassium hydroxide solution, and some anti-bumping granules were added. Thereafter, a reflux condenser was attached and the flask and its contents were heated in boiling water for 1 hour with frequent shaking. 1ml of phenolphthalein (1%) solution was added. The excess alkali was titrated hot with 0.5M hydrochloric acid (titration = *a* ml). A blank titration was performed at the same time (titration = *b* ml).

Saponification Value =

$$\frac{(b - a) \times 28.05}{Weight\ (g)\ of\ sample}$$

*Unsaponifiable Matter*: The method of Nzelu *et al.*, (2012) was adopted.

## RESULTS AND DISCUSSION

The stored African pear pulp oil gave a sparkling green colour on extraction and after 14 days storage, the colour turned to dark green Table 1.

**Table 1: physical characteristic of stored, oven and solar dried African Pear Pulp Oil.**

| Parameters | Stored Pulp Oil | Solar-dried Pulp Oil | Oven-dried pulp oil |
|---|---|---|---|
| Colour | Sparkling green | Dark green | Yellowish |
| State at room temp. | Liquid | Semi Liquid | Solid |
| Specific gravity | 1.007 | 1.004 | 1.007 |
| Molecular weight | 384.62 | 333.33 | 291.26 |

The initial sparkling colour reveals its natural colour and gave evidence of the presence of chlorophyll from the chloroplast which is a natural phenolic substance that oxidizes to brown or darker colour in the presence of oxygen. The solar dried pulp oil was deep-green on extraction and changed to brownish colour after 14 days of room temperature storage. Oven-dried pulp oil as normal green on extraction but turned brown after 14 days of room temperature storage. The change in colour could be because the plant cell was killed by the heat treatment the protein denatured and the magnesium bound in the chlorophyll released. This, according to Potter and Hotchkiss (2007), causes a chemical change of chlorophyll to pheophytin which is brown in colour. The chlorophyll which is a natural phenolic substance results in the formation of O-quinones that polymerize to the brown polymer. The green colour of the oil makes it suitable for cosmetic products while the change in colour is desirable as it reduces the cost of bleaching when oil is used for other food products such as bakery fat, mayonnaise, cooking oils etc. The oil from stored pulp remained liquid at room temperature (26°C). The solar-dried pulp oil was semi-liquid at room temperature while oil from over dried pulp was solid at room temperature after 14 days of storage. For the oil from oven-dried pulp samples, it could be as a result of loss of double bonds due to heat treatment and oxidative processes that cause oils to be saturated. In the case of the solar-dried oil sample, there was no complete loss of double bonds, hence part of the oil remained liquid indicating a combination of saturated and unsaturated fatty acids. Okaka (2010) noted that vegetable oils in general are likely to contain more of the unsaturated fatty acids than the animal fats. Unsaturated fatty acids are more reactive with oxygen at the point of unsaturation. This can occur during heat treatment causing loss of their biological activity from *cis*-to *trans*-forms. The high chlorophyll content could have made the solar-dried pulp oil fatty acid chain unstable, since its presence leads to oxidative process, saturating double bonds and causing the oil to solidify at room temperature thereby increasing the melting point. Eke (2003) noted that the enzymes will only continue to work so long as their particular three-dimensional molecular character is maintained. The added microbial reactions which are favoured by the temperature in the oven-dried pulp oil could lead to total breakdown of all the bonds, saturating the oil, which remained solid at 26°C room temperature. The specific gravity of the oil samples showed no significant difference. This indicates that the different treatments did not significantly affect the oil's mass components. The purity of the oils was not affected as a result of the treatments given to them. Previous studies have noted that variations in the specific gravity of one oil or lat to another are not great. The higher level of free fatty acids indicates more degradation of fat. From the analysis, the stored pulp oil gave more FFA (1.642) indicating higher degradation followed by the solar-dried pulp oil (0.908) and then oven-dried pulp oil (0.790) Table 2.

**Table 2: Chemical Characteristics of Stored, Oven and Solar dried African Pear Pulp Oil**

| | Stored Pulp Oil | Solar Dried Pulp Oil | Oven Dried Pulp Oil | LSD |
|---|---|---|---|---|
| FFA % Oleic acid | $1.692^a$ | $0.908^b$ | $0.790^c$ | 0.41 |
| Peroxide value (mEq Oxygen/g) | $56.40^b$ | $69.60^a$ | $46.40^c$ | 6.37 |
| Saponification Value (mgKOH/g) | $437.58^c$ | $504.90^b$ | $577.83^a$ | 14.58 |
| Unsaponifiable matter (%) | $15^a$ | $10^b$ | $5^c$ | 0.67 |

| | | | | |
|---|---|---|---|---|
| Iodine Value (g Iodine/100g) | 96.86[a] | 87.59[b] | 96.60[c] | 2.79 |

Means with identical letters along the same row are not significantly different at $p<0.05$ level.

Lipase hydrolysis could have taken place in the stored pulp oil even after extraction but halted during the heat process in solar- and oven-dried pulp oil samples. Ihekoronye and Ngoddy (1985) stated that some of the deterioration that takes place during storage of either the raw material from which the fat is obtained or in the fat itself after isolation results in hydrolysis of triglycerides to yield free fatty acid. The peroxide value (mEq Oxygen/g) was highest in the solar-dried oil sample (69.60) followed by the stored pulp oil (56.40) then the oven-dried oil sample (46.40); Nzelu *et al.*, (2012) noted that on storage, peroxide formation is slow at first during an induction period which may vary for weeks, the probable cause of rancidity can he predicted by methods in which the oxidation is accelerated by passing air through the sample or by raising the temperature or both. The high peroxide value of the solar pulp oil may be from the exposure to oxygen (air) during drying which exposes the bound oxygen and, also, due to the temperature of drying (40-45°C). As oxidation takes place, the double bonds in the unsaturated fatty acids are attacked, forming peroxides. For the stored pulp oil, it could he degradation by hydrolysis which in the presence of moisture splits triglyceride into their basic components of glycerol and free fatty acid especially aldehydes, ketones and shorter chain fatty acids. The oven dried pulp oil is free from water content and action of antolytic enzymes. The results show that the saponifications value (mgKOH/g) of the oven-dried pulp oil is higher (577.83) than the solar-dried (504.90) and stored pulp of (437.58) samples. This shows that the oven dried oil sample has lower molecular weight fatty acids while the solar-dried pulp oil sample follows, and then the stored pulp oil sample. Nzelu *et al.*, (2012) explained that the esters of the fatty acids of' low molecular weight require the most alkali for saponification, so that the saponification value is inversely proportional to the mean of the molecular weights of the fatty acids in the glyceride present. The above result explains more of the environment of handling which affects the molecular weight. The increase in the saponifications value of the oven-dried pulp oil could he as a result of loss of volatiles which lowers the molecular weight of the oil and this requires more alkali for saponification to he attained. Therefore, oils having, high proportions of lower molecular weight fatty acids have high saponification value (Ouwuka, 2005) which agrees with the result in Table 2. From the result in Table 2, the room temperature stored pulp oil is more unsaturated, as it is liquid at room temperature and is table to go rancid by oxidation. It is also prone to hydrolytic rancidity favoured by moisture, temperature and lipolytic enzymes (Eke, 2003). The stored pulp oil likely contained moisture and natural enzymes which may attribute to the degradation. The result corresponds with the assertion by Britannica (2017) that the less unsaturated fat with low iodine values are solid at room temperature, or conversely, oils that arc more highly unsaturated are liquids. The oven dried pulp oil sample with the least iodine value (96.60) remained solid at 26°C room temperature. From the analyses, African pear pulp oil could be grouped among the semi and non-drying oils with iodine value range from 80-130 (Britannica, 2017). The high level unsaponifiable matters in the stored pulp oil than the others may be due to loss of volatiles during the heat treatment in both solar-and oven-dried pulp oil samples, as well as the loss of colouring matters and contamination which occurred during the process when triglycerides were broken down by micro organisms to form glycerol and potassium salts of the fatty acids. The loss of these volatiles especially hydrocarbon-like components had shown more in the oven-dried pulp oil due to direct heat treatment. According to Wikipedia (2017), an excessively high proportion of unsaponifiables (>50%) would result in a defective or inferior soap product if used for soap-making. Thus, such may be used for other industrial applications, say paint-making. Nonetheless, the African pear pulp oil samples have a high percentage (6-17%) of unsaponifiable and may exhibit moisturizing, conditioning, vitamin supplying and texturizing functions in soaps produced (wikipedia, 2017).

## CONCLUSION

There were disparities in the qualities of the African pear pulp oil samples due to the effect of the drying treatments. These differences were significantly noted in the peroxide values, free fatty acid, Iodine value and unsaponifiable matters (Table 2). Production of oil from African pear fruit could be a promising solution for any surplus fruit harvested if it is properly handled. The different oil samples could be used in a different ways. Oil from stored pulp contain appreciable unsaturated fatty acids and can be used for margarine production. Oven dried pulp oil can be commercially exploited and used for making soap, paints, cosmetics, candles etc. due to its firmness and proclivity for solidification. Solar dried pulp oil for its colour can be used in cosmetics. The use of any treatment on the pulp before extraction should therefore depend on the end product desired. African pear fruit should not seen only as hunger quenching product or desert but also seen as available product not to be wasted in the season of glut.

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