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Determination of Physico-Chemical Properties and Nutritional Contents of Avocado Pear *(Persea americana M.)*

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Abstract

The physical, chemical and nutritional properties of avocado pear which are relevant to engineering and industrial application were selected for study. These were determined using standard tests and experiments. Four replicates of Fuerte avocado pear specie was used for the analysis. The following physical properties of Avocado pear were studied: shape, size, weight, volume, density, surface area, colour and sphericity. The physico-chemical properties of Avocado Pear oil studied include: Ph value, acid value, Flash point and density. The nutritional contents of Avocado pear determined are: Ash, moisture, protein, Fat (lipid), crude fibre and carbohydrate contents. The results obtained for the physical properties of avocado pear are: oblong (shape), major diameter of 10.075mm,a minor diameter of 8.465mm and intermediate diameter of 9.025mm (size), 0.3825kg (weight), $2.687\times10^{-3}m^2$ (volume), $1051kg/m^3$ (density), $1.63065\times10^{-4}m^2$(surface area), purplish black (colour) and 0.042 (sphericity). The results for the physico-chemical properties of the oil include: 5.7 (pH), 22.44mg/KOH/g(acid value), 108^0C (flash point) and $0.9032g/cm^3$ (density), 0.62% (Free fatty Acid), 37.2 (Iodine value) and 219.20 (Saponification value). The oil yield was 27.12%. The results obtained for the nutritional properties are as follows: Ash content 1.52%, Moisture content 77.72%, Protein 0.94g, Fat (lipid) 12.18g, Crude fibre 6.9g and Carbohydrate 7.4g.

***Keywords:** Avocado, Physico-chemical, Pear, Fuerte, Oil, nutritional.*

1. Introduction

Avocados are native to Central and South America; they have been cultivated in this region since 8,000 BC. In the mid-17th century, they were introduced to Jamaica and spread through the Asian tropical regions in the mid 1800s.

The avocado pear (*Persea americana M.*) is in the flowering plant family of *Lauraceae*. Avocado is colloquially known as the Alligator Pear, reflecting its shape and the leather like appearance of its skin. Avocado is derived from the Aztec word "*ahucatl*''. According to scientific classification, the avocados belong, to the kingdom: *plantae*, division: *magnoliophyta*, class: *magnoliopsida*, order: laurels, family: *lauraceae*, genus: *persea*, species: *americana* with *bionomial* name *Persea americana M.*

Avocados are of dozens of varieties which fall into two categories; Mexico *Guatemalan* and West Indian species which differ in their size, appearance, quality and susceptibility to cold. The most popular type of avocado is the *Hass* variety of the United States, which has rugged, pebbly brown-black skin. Another common type is the *fuerte* which is larger than *Hass* and has smooth, dark green skin and a more defined pear shape.

The avocado pear varies in weight depending on the variety; the edible portion of the avocado is its yellow-green flesh, which has a luscious, creamy, buttery consistency and a subtle nutty flavor. The tree grows to 20 m (69 ft), with alternately arranged leaves 12 cm (4.7 in) – 25 cm (9.8 in) long. The flowers are inconspicuous, greenish-yellow, 5 mm (0.2 in) – 10 mm (0.4 in) wide (Whiley, 2000).

Pear-shaped fruit is 7 cm (2.8 in) – 20 cm (7.9 in) long, weighs between 100 grams (3.5 oz) – 1,000 grams (35 oz), and has a large central seed, 5 cm (2.0 in) – 6.4cm (2.5 in) long.

Avocado is a climacteric fruit, which means that it matures on the tree but ripens off the tree. Avocados used in commerce are picked hard and green and kept in coolers at 38°F to 42°F (3.3°C to 5.6°C) until they reach their final destination. Avocados must be mature to ripen properly. Avocados that fall off the tree ripen on the ground, depending on the amount of oil they contain, their taste and texture may vary greatly. Generally, the fruit is picked once it reaches maturity; Mexican growers pick *Hass*-variety avocados when they have more than 23% dry matter and other producing countries have similar standards. Once picked, avocados ripen in few days at room temperature (faster, if stored with other fruits such as apples or bananas, because of the influence of ethylene gas).In some cases, avocados can be left on the tree for several months, which is an advantage to commercial growers who seek the greatest return for their crop; if the fruit remains unpicked for too long, however, it will fall to the ground (FAO, 2002).

Avocados are good source of Vitamin K, dietary fiber, Vitamin B6, Vitamin C, Folate and copper. Avocados are also a good source of potassium: they are higher in potassium than a medium banana. Avocado also contains essential nutrients such as carbohydrates, sugar, soluble and insoluble fiber; avocado is also good source of oil containing monounsaturated fat; its oil contents varies depending on its varieties and the period of extraction of oil by cold-press process. Avocado is a rich source of mineral (Batista *et al*, 1993)

When ripe, the colour of the skin is purplish black; the edible flesh of the fruit constitutes 65%, seed is 20% and the skin is 15% which makes up the total weight of the fruits.

Although they are fruits, avocados have a high fat content of between 71% to 88% of their total calories - about 20 times the average for other fruits. High avocado intake has been shown to have a beneficial effect on blood serum cholesterol levels (USDA, 2009).

About 75% of an avocado's calories come from fat, most of which is monounsaturated fat. They are rich in B Vitamins, as well as Vitamin E and Vitamin K. They have high fiber content among other fruits - including 75% insoluble and 25% soluble fiber. A fatty triol (fatty alcohol) with one double bond, avocadene (16-heptadecene-1-2-4-triol), is found in avocado (Naveh *et al*, 2002).

The nutritional value of avocado pear makes it a good raw material for cosmetics industries; the avocado oil serve as a high source of nutrients in the production of cosmetics to enhance the skin's good looking condition (Le poole, 1995).

Avocado oil has also been successfully expelled from sundried, destined avocado fruit using a screw press. In principle, a screw press is a continuous screw auger designed to gradually increasing pressure as it is conveyed through a barred cage. Disrupted or distorted oil cells act as capillaries which are reduced in volume as pressure is applied and the oil is expelled.

Hydraulic pressure uses the principle of gradually increasing pressure on the incoming material as it progress through the interior of a closed barrel; oil extracted in this manner is traditionally called "cold pressed" oil (Carr, 1997).

Solvent extraction is the recent method of extracting oil from crops, hexane has become the solvent of choice for solvent extraction because of high stability of the solvent , low evaporation loss, low corrosiveness, little greasing residue and better odour and flavor of the extracted product. Solvent extraction has several drawbacks, including high capital equipment cost and operational expenditure. The primary prerequisite for solvent extraction for oil is the rupturing of the seed or feed material to render the cell wall more porous. Diosady *et al*, (1983) reported that complete rupturing of the cell wall is necessary for rapid solvent extraction and that the shape of the idioblast cell of avocado fruit became irregular and rough-shape after hexane extraction. According to Lewis *et al*, (1978), using petroleum ether for an extraction time of four hours, yielded an oil of 74-75%.

Avocado oil is situated in the edible flesh of the fruit; the oil contains monounsaturated fatty acids making it an excellent component of a healthy diet; avocado oil is triacylglycerol with minor amounts of fatty acid and up to 1.5% unsaponifiable matter. It is similar to olive oil in many respects but has a higher betal – sitosterol content and lower level of squalene and polyphenols (Naveh *et al*, 2002).

The increasing economic importance of food materials together with the complexity of modern technology for their production, handling, storage, processing, preservation, quality evaluation, distribution, marketing and utilization demands a better knowledge of the significant physical and chemical properties of the plant materials.

Avocado pear is a fruit that is not common but possesses meaningful physico-chemical properties and nutritional contents. It has a wide range of application and great potentials. This study therefore will provide useful and meaningful data in the development of new methods of processing, handling and storage of the crop since available information on basic physical and nutritional properties of the crop is limited.

The study of the physicochemical properties and nutritional contents of avocado pear is an attempt to provide meaningful data for engineering analysis and the design of oil extraction machines. The data generated will give designers accurate and appropriate view towards the fabrication of machines.

2. Materials and Methods

2.1 Materials

Samples of *Fuerte* avocado pear used for this analysis were obtained from Lokoja, Kogi state, Nigeria; the fruits were thoroughly screened to remove the bad ones. Plate 1 shows the pictorial view of ripe avocado pear.

2.2 Methods

2.2.1 Shape

To determine the shape of avocado pear, tracing of the longitudinal and lateral cross section of the material was done, this was compared with shapes on the charted standard as described by Mohsenin (1986); using the charted standard , descriptive terms were used to define the shape of the product over four replicates.

2.2.2 Size

Determination of the size of Avocado Pear was done based on the method described by Mohsenin (1986).

2.2.3 Weight

This is the weight of Avocado Pear in kg unit and counted numbers of avocado pear (N). The weight of avocado pear was determined using electronic weighing machine.

The weight of avocado pear was then calculated using the formular:

$$W = \frac{M(kg)}{N} \qquad (1)$$

where,

W = Weight of avocado pear
M = Mass of avocado pear from the scale
N = Number of avocado pear counted.

2.2.4 Volume and density

Water displacement method was used to determine the volume of the product due to its irregular shape (Mohsenin, 1986). Using the expression given by Mohsenin (1986), the volume and density were determined.

$$volume = \frac{weight\ of\ displaced\ water\ (kg)}{weight\ density\ of\ water\ (^{kg}/_{m^3})} \qquad (2)$$

2.2.5 Surface area

The surface area of avocado pear was determined using the graph paper method (Mohsenin, 1986).

2.2.6 Colour

The colour of avocado pear was determined by reflectivity and absorptive character using electromagnetic radiation.

2.2.7 Sphericity

The measurement of sphericity of avocado pear was determined by obtaining the values of the major, minor and intermediate diameter of the avocado pear as described by Mohsenin (1986).

The sphericity was then calculated using:

$$S = \frac{(bc)^{\frac{1}{3}}}{a^2} \qquad (3)$$

where,

S= Sphericity
a = Major diameter
b = Intermediate diameter
c = Minor diameter

2.2.8 Selected physicochemical properties of avocado pear oil

The Ph, Flash Point and Density of the oil were determined by the methods described by Gregory (2005). The Free fatty acid, Saponification, acid and iodine values were determined using the official methods of Analysis (AOAC, 1990).

2.2.9 Nutritional value of avocado pear

The Association of Analytical Chemists' (AOAC, 1990) methods was used in the determination of Ash, Moisture content, Protein Content, Fat (Lipid) Content, Crude Fibre Content and Carbohydrate content.

3. Results and Discussion

3.1 Results

The results obtained for the physicochemical and nutritional contents of avocado pear are presented in Tables 1-3.

3.2 Discussion

3.2.1 Physical properties of avocado pear

Table 1 shows the shape of avocado pear as oblong, a shape in which the diameter of the vertical axis is greater than the diameter of the horizontal axis. The size of avocado pear was determined with respect to its major, intermediate and minor diameter of 10.075mm, 9.025mm and 8.465mm. Manuwa and Muhammad (2010) reported that the size of fruits decreases with an increase in moisture content.

The average weight of avocado pear was determined to be 0.3825kg using four replicates; this is close to the value of 0.374kg of *Hass* variety of avocado as reported by FAO, (1997).

The value of density obtained is 1051kg/m^3, on comparing this with the value of 987kg/m^3 reported by FAO (1997), it can be observed that the value is greater due to different species and environmental factors.

The surface area obtained for avocado pear is 1.63065×10^{-4}m^2. The colour of ripe avocado pear was determined to be purplish-black. This the same as the colour of *fuerte* avocado reported by FAO (1989).

The sphericity of avocado pear was determined to be 0.042; on comparing with the sphericity of cashew nut (0.75), it was discovered that cashew nut has a roundness ratio greater than *fuerte* avocado pear.

3.2.2 Physicochemical properties of avocado pear oil

From Table 2, the pH value of avocado oil was determined to be 5.7 this shows the slightly acidic nature of the oil, it compares favourably with the value of 5.5 reported by Bizimana *et al*, (1993).

The density of avocado oil was determined to be 0.9032g/cm^3 this is close to the value of 0.9006g/cm^3 obtained by Martin *et al*, (1987).

The refractive index was determined to be 1.23; this falls within the range of values reported for some seed oils, 1.48 for *Teleferia occidental* seed oil, 1.47 for soybean and 1.47 for corn (Sodeke, 2005).

The oil yield was determined to be 27.12%; this is higher than the value of 9.1% reported by Ikhuoria and Maliki (2007). Mason (1981) reported that the oil content of avocado pear varies from species to species.

Whiley (2000) reported that Avocado oil is used as edible oil, lubricant in engines and in cosmetics due to its regenerative and moisturizing properties.

The Free fatty acid (FFA) was determined to be 0.62%, this is an important variable in considering the quality of oil because the lower the FFA, the better the quality of the oil. Ikhuoria and Maliki (2007) reported a value of 0.37% for Avocado oil and added that the lower the FFA, the more its edibility. Therefore, the low value (0.62%) obtained in this study makes the oil suitable as an edible oil.

The Iodine value obtained was 37.86 g/100g; this value is lower than the 42.66g/100g reported by Ikhuoria and Maliki (2007). According to Ikhuoria and Maliki (2007), iodine value gives an indication of the degree of unsaturation of oils, higher iodine values can be attributed to high unsaturation.

The Saponification value of 229.4 mg/KOH/g indicates that the oil will be good for soap making. The acid value of avocado pear oil was determined to be 22.44mg/KOH/g, the acid value is the mass of potassium hydroxide (KOH) in milligram that is required to neutralize 1g of the substance, comparing this value with the acid value of 0live oil of 8.8mg/KOH/g as reported by FAO (1997); these shows that avocado oil has higher acid value than olive oil. Acid value is used to measure the quality of oil which must not be too high; Avocado oil can be oxidized if exposed to light and comparing it with cocoa butter, coconut oil, palm oil and olive oil, it can be used as lubricant and plasticizer.

The flash point of avocado pear was determined to be 108^{0}C, this compares favorably with the value of 103.8^{0}C reported by Martin *et al*,(1987); it is lower than the value obtained for canola oil (327^{0}C) , higher than ethanol (16.6^{0}C) and kerosene (38-72^{0}C) as reported by Martin *et al*, (1987). Flash point is an indication of how oil can burn, avocado oil can be used as biodiesel fuel and lubricant in combustion engines since it has a high transportation and storage temperature during combustion.

3.2.3 Nutritional content of avocado pear

From Table 3, the ash content of avocado pear was determined to be 1.52% this is the residue remaining after all the moisture and organic materials have been removed. Comparing with the value of 0.91% as reported by USDA, (2009), the slightly higher value obtained for avocado pear may be due to difference in variety but it falls within the range (0.4-1.68%) reported by FAO (1989) for *fuerte* variety. Also, from literature, ash content for nuts, seeds and tubers should fall within acceptable limits for edible oils (1.5-2.5%) in order to be suitable for animal feed. High ash content in seeds makes it unsuitable for compounding feed.

Moisture content of avocado pear was determined to be 77.72% per 100g of the pulp which is the total percentage present inform of water, it is slightly greater than 70.34% reported by USDA (2009); Oladele and Oshodi, (2007) reported 2.53% moisture content for Jatropha plant and FAO, (1989) reported a moisture content of 8% for Wheat; thus, it is observed on comparing avocado pear with these crops that it has a high moisture content. Thus, the high moisture content of avocado pear is disadvantageous in terms of shelf life because oils with high moisture content are not able to be preserved for a longer period.

Protein content of avocado pear was determined to be 0.94g; this value is close to the values of 2g and 1.72g obtained by USDA, (2009) and FAO, (1989). USDA reported the protein content of some crops as follows: Grape 1.2g, Kiwi 0.4g Lemon 1.1g, Melon 0.6g and strawberries 0.8g.

Fat (lipid) content of avocado pear was determined to be 12.18g per100g, this is close to the value of 14.66g reported by USDA (2009), the slight difference may be due to difference in specie since *Hass* avocado is higher in lipid content than *fuerte* avocado pear, the lipid content of other crops as reported by USDA (2009) are: 0.1g (Apple), 0.3g (Banana), 0.1g (Grape), 0.1g (Melon) and 0.1g (orange); Oladele and Oshodi (2007) also reported lipid content of some other crops as follows, Jatropha (47.13g), Locus bean (11.7g) and cowpea (3.6g).

Bora *et al* (2001) also reported that, avocado has 0% cholesterol level and it decreases the LDL (Harmful cholesterol) level in the body by 22%, it also increases the HDL (helpful cholesterol) level by 11%.

The crude fibre of avocado pear was determined to be 6.90g, this agrees with the value of 6.7g as reported by USDA (2009). USDA (2009) also reported the crude fibre contents for other crops as follows 2.2g (pear), 1.7g (orange), 0.7g (melon), 1.9g (kiwi), 0.7g (Grape), 1.1g (Banana), 2.8g (Lemon). The crude fibre content is a significant component of a diet, it increases stool bulk and decreases the time that waste materials spend in the gastro intestinal tract, it is also used as index of value in poultry and stocks feeds (Oladele and Oshodi, 2007).

Carbohydrate content of avocado pear was determined to be 7.4g per 100g, this is more than the value of 1.9g obtained by Wood (2000), on comparing this value with other fruits such as lemon 9.32g, Apple 11.8g, Banana 23.2g, melon 5.5g, orange 8.5g, strawberries 5.7g, (USDA, 2009); It shows that the value of carbohydrate in avocado pear compares favourably with them. Carbohydrate is a major food substance for animal and human being needed for growth and strong health.

This study was carried out to determine the Physical, Chemical and Nutritional properties of avocado pear. The results obtained for the physical properties of avocado pear shows that it has common properties like other biomaterials needed for processing, handling and storage after harvesting and the nutritional contents shows that it has high moisture content; thus it is a highly perishable fruit which must be stored with care. The Physico-chemical properties of this oil compares favourably with those obtained from other conventional seed oils. It therefore has great potential for domestic and industrial purposes.

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