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RESEARCH ARTICLE

Comparative study and quality characteristics of coconut oil from two different species

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ABSTRACT

This study was carried out to investigate the physiochemical properties of oil extracted from two varieties of coconut (*Cocosnucifera*). Oil was extracted from tall coconut variety (Sample A) and dwarf coconut species (Sample B) using hot extraction method. The oil samples were evaluated for their physiochemical properties using standard methods. The result obtained showed that the oil had specific gravity of 0.9171kg/m3 for Sample A and 0.9175kg/m3 for Sample B, density of 0.8936g/cm3 for Sample A and 0.8940g/cm2 for sample B, acid value of 13.20mg NaOH/g for Sample A and 16.00mgNaOH/g for Sample B, free fatty acid of 6.60mgNaOH/g for Sample A and 8.00mgNaOH/g for Sample B. iodine value of 48.22mg/g for Sample A 50.76mg/g for Sample B and peroxide value of 30.00meq/100g for sample A and 22.00meq/100g for Sample B. It was concluded that the oil produced from dwarf coconut fruits has acceptable physicochemical properties although the high free fatty acid in the oil may make them prone to rancidity.

Keywords: Coconut, Hot Extraction, Oil, Physicochemical properties

1. INTRODUCTION

The coconut (*Cocosnucifera* Linn) is a tropical monocotyledon plant which belongs to the order Arecaceae and family palmae. It is widespread throughout the tropics, typically being found along sandy shorelines. It has been spread largely by man but also by natural means [1].

Cocosnucifera palmae is a large palm, growing up to 30 meters (98 ft) tall, with leaves 4–6 meters (13–20 ft) long, and pinnae 60–90 cm long. Coconut is one of the most extensively grown and used nut in the world and is rated as one of the most important of all palms [2], [3].

The coconut is the most extensively grown and used nut in the world and the most important palm. It is an important commercial crop in many tropical countries, contributing significantly to their economies. The chief product is copra, which is the source of coconut oil used for making soap, cooking oils and margarine. Much of the seed kernel is consumed locally for food [4]. Coconut is called the fruit of life due to its numerous nutritional and health benefits [5]. The cavity of the

endosperm contains watery fluid called coconut water which is rich in vitamins, amino acids, enzymes, minerals, sugars, cytokins and auxins [6].

The coconut meat contains an average of 48.0% - 62% moisture, 59% volatile matter, 35.5% oil and 16.5% oil free residue [7]. Although coconut meat contains less fat than many oil seeds and nuts such as almonds, it is noted for its high amount of medium chain saturated fat [8]. About 90% of the fat found in coconut meat is saturated, a proportion exceeding that of foods such as lard, butter and tallow. Like most nut meats, contains less sugar and more protein than popular fruits such as banana, apples and oranges; it is relatively high in some mineral such as iron, phosphorous and zinc [1].

According to Mansor TST *et al*., (2012)[9] virgin coconut oil (VCO) is defined as the oil resulting from the fresh and mature kernel of the coconut (*Cocosnucifera* L.) through mechanical and natural means, either with the use of heat or not provided that it does not lead to alteration or transformation of the oil. Virgin coconut oil (VCO) is the miracle oil for health, beauty and strength. It has abundant utility in the functional food health, food pharmaceuticals, nutriceuticals, infant foods and cosmoceuticals and thus has multifunction and uses in human life. The health and benefits that can be derived from consuming VCO have been recognized in manu parts of the world. One of the emerging applications of VCO is its medical use and functional benefit to human health. Coconut oil in its virgin form is clear in colour and has a distinct coconut flavor and aroma. VCO may mean the minimally processed product which has not undergone any further processing such as refining, bleaching and deodorization. It can be produced either from processing of fresh coconut meat, coconut milk or coconut milk residue [10].

Coconut oil contains mainly saturated fatty acids (SFA) (93%) with lauricacide being the most prevalent fatty acid present. It also contains medium chain fatty acids (MCFAs) consisting of caproicacid, caprylic acid, capric acid and lauric acid that can be easily burned for energy rather than being stored in the body. Coconut oil possesses antiviral, antibacterial and antiprotozoal properties due to the presence of lauric acid and capric acid fatty acids [11]. Monounsaturated and polyunsaturated fatty acid are less in coconut oil (7-8%) and hence, it is highly stable towards oxidation and eventually provides longer shelf-life for the food products prepared in it [12]. Coconut oil also contains minor components like tocopherols, tocotrienols, phytosterols and phenolics which are the natural antioxidants [13].

Apart from the above properties, virgin coconut oil have been traditionally used to enhance the beauty and promote the growth of trees, refine and moisturizes the skin conditions as well as being used as ailments for minor illness such as diarrhea and skin inflammation [9].

Nevin and Rajamohan (2010) [14] discovered that wound healing rate was increased on skin of rats treated with topical VCO. Lans (2007) [15] reported that *Cocosnucifera* was also used as an “ethonomedicine” to treat gastrointestinal problems and minor cuts, injuries and swelling. The lauric acid, a medium chain fatty acid

component in VCO showed potential use as anti-obesity treatment [16] as it increases energy expenditure, directly absorbed and burnt as energy in the liver, resulted in early stages and thus leading to weight loss.

Recent studies have focused on the characterization of oil extracted from coconut using different methods [9, 17]. However, there is no report in the literature on the characteristics of oil extracted from different species of coconut fruit. According to Waziri *et al*., (2013) [1], the two major species of coconut in Nigeria include hybrid dwarf coconut and West African tall coconut. There is therefore, need to compare the yield and quality of oil extracted from these species of coconut. The findings from this study will bring to limelight, the qualities of the oils extracted of these coconut species which may be helpful to the producers of selection of the most potent hybrid for oil extraction. The aim of this study is to extract and characterize oil from two species of coconut fruits.

Coconuts are generally classified into two general types: tall and dwarf. On very fertile land, a tall coconut palm tree can yield up to 75 fruits per year, but many often yields less than 30 fruits mainly due to poor cultural practices. In recent years, improvements in cultivation practices and breeding have produced coconut trees that can yield more fruits. It is found throughout the tropic and sub-tropic area, the coconut is known for its great versatility as seen in many domestic, commercial, and industrial uses of its different parts including the dietary use of its parts by many people [18]. Coconuts contain a large quantity of "water" and when immature they are known as tender-nuts or jelly-nuts and may be harvested for drinking and this differentiates them from any other fruits. When mature they still contain some water and can be used as seed nuts or processed to give oil from the kernel, charcoal from the hard shell and from the fibrous husk. A lot of products are directly or indirectly made from coconuts. These include whole coconut copra, coconut oil, coconut oil cake, coir, desiccated shredded coconut, coconut skin milk and coconut protein [2]. Coconut can also be used to produce desired texture in cookies, candies, cakes pies, salads and desserts. It is commercially viable because of its rich nutritive values [19-21]. George, (1993) [22] reported that Coconut water is composed of many amino acids, nitrogenous compounds, inorganic elements, organic acids, sugars and their alcohols, vitamins, growth substances (Cytokines and auxins) and many other unknown components. Abdul hameed and Zafar, (2011) [23] also reported on the physicochemical properties of coconut meat and water from three varieties (tall, dwarf and Hybrid) and showed high percentages of mineral elements especially sodium and potassium in the studied varieties. Coconut water has also been reported as rehydration fluid in diarrhoea. Oral rehydration has been recommended for patients with diarrhoea to replace the fluid loss from gastrointestinal tract [5]. Jackson *et al.,* (2004) [24] reported that fat, protein, soluble solds, acidity and turbidity increased steadily with maturity, while pH and ash showed variation throughout maturation. Ewansiha *et al.* (2012) [25] evaluated the proximate and mineral composition of the coconut shell and reported that the shell can be

an effective material precursor in water and waste treatment among other uses. This study therefore, was designed to quantify the physicochemical and nutritional values of coconut kernel for human consumption and animal feeds.

The study aimed to produce oil from two species of coconut and compares it on the basis of its quality characteristics.

2. METHODS AND MATERIALS

2.1. Sample Collection

Ten heads each of different species (dwarf and tall coconut species) of coconut fruits were obtained from Eke Ekwulobia main market in Aguata Local Government Area of Anambra State, Nigeria. The fruits were packaged in a clean polythene bag and carried to the Department of Food Technology Federal Polytechnic Oko for further processing and analysis.

2.2. Sample Preparation

2.2.1. Extraction of Coconut Milk

The method of Jayasundera and Fernando (2014) [26] was adopted in the production of coconut milk with little modification. Ten heads of coconut were shelled and scrapped using kitchen knife. The scrapped coconuts were cut into small sizes and were milled using electric blenders. 1 litre of water was added during the process. The mixture was pressed and filtered using muslin cloth. The resulting coconut milk was packaged in a clean container prior for further use.

2.2.2. Extraction of Coconut Oil

Hot press method described by Hamid *et al*. (2011) [27] was used in extraction of coconut oil. Two litres of boiled/hot water was added to the coconut milk with constant stirring. The mixture was allowed to stand for 4 hours to separate. The floating oil was scooped and heated further to evaporate the remaining water. The oil obtained was packaged in a clean container prior to further analysis.

2.3. Determination of Percentage Oil Yield

The percentage oil extracted was determined according to the method reported Mansor *et al.* (2012) [9] as shown in the equation 1:

$$\% \text{ oil yield} = \frac{(W1-W2)}{W1\times 100} \quad \text{...eq. 1}$$

Where,
W1 = Weight of sample
W2 = Weight of oil extracted

2.4. Characterization of oil samples

The peroxide value was determined following the method reported by Kyari (2008) [21]. Into a 250 cm^3 Erlenmeyer flask, 1.00g of the oil sample, 1.00g of potassium iodine and 20 cm^3 of solvent mixture (glacial acetic acid/chloroform, 3/2 by volume) were added and the mixture was heated and allowed to boil for one minute. The hot solution was then poured into a flask containing 20 cm^3 of 5% potassium iodine. Thereafter, 3 drops of starch solution were added to the mixture and titrated with 0.025 N standardized sodium thiosulphate. The peroxide value was determined using the equation 2:

Peroxide value (Meqkg oil)

$$N = \frac{(S \times B)}{\text{Sample Weight}} \times 1000 \quad \text{...eq. 2}$$

Where;
S = vol. in cm^3 of $Na_2S_2O_3$,
N = normality of $Na_2S_2O_3$
W = weight of oil sample (g)

2.5. Determination of Acid Value

This was determined according to the method described in the study of Sani *et al.* (2014) [4]. From each sample, 2.00g was weighed into a conical flask. Afterwards 5cm3 of chloroform was added and a mixture of 25 cm^3 diethyl ether and ethanol 1:1 (v/v) was also added. Few drops of phenolphthalein indicator were also added and the mixture titrated against 0.1M KOH. The end point was noted when the pink colour appeared, and persisted for 30 seconds. The acid value was calculated using equation 3:

$$\text{Acid value} = \frac{\text{Titre}}{\text{Weight of sample used}} \times 561 \quad \text{..eq.3}$$

Where:
S = vol. in cm^3 of sample
B = vol. in cm^3 of blank
N = Normality of KOH (56.1)

2.6. Determination of Saponification Value

Saponification value was determined according to the method described in the study of Sani *et al.*, (2014) [4]. From the oil sample, 2.00g was weighed in a conical flask and dissolved with 5 cm^3 of chloroform, 25 cm^3 of 0.5M alcoholic KOH was added. The flask was corked and the mixture was refluxed for 30minutes. The mixture was then transferred into a conical flask, few drops of phenolphthalein indicator were added and it was titrated against 0.5M HCI until the pink colour disappeared indicating the end point. The saponification value was calculated using equation 4:

$$\text{Saponification value} = \frac{\text{b-a}}{\text{M of sample}} \times 28.05 \text{ .. } \textit{eq.4}$$

Where,
a = sample titre value,
b = blank titre value
m = molarity of the HCL and
28.05 = molecular weight of KOH

2.7. Determination of Iodine Value

This was determined according to the method described in the study of Sani *et al*. (2014) [4]. From the oil sample, 0.30g was dissolved in 10 cm^3 of chloroform in 100 cm^3 glass stoppered flask. 25 cm^3 to 10% KI was then added and the mixture was titrated against 0.1M sodium thiosulphate with few drops of starch as indicator. A blank titration was also carried out. The iodine value was calculated using equation 5:

$$\text{Iodine value} = \frac{\text{b-a}}{\text{M of sample}} \times 1.269 \quad \text{...eq. 5}$$

Where,
a = sample titre value,
b = blank titre value
w = weight of sample used (g)

2.8. Determination of Specific Gravity

Density bottle was used in determining the specific gravity of the oil as described by Mansor *et al*. (2012) [9]. A clean and dry Stoppered bottle of 25cm3 capacity was weighed (W_0) and then filled with the oil, stoppered and reweighed to give (W_1). The oil

was then substituted with distilled water after washing and drying the bottle and weighed to give (W_2). The specific gravity was calculated by equation 6:

$$\text{Specific gravity} = \frac{W_S}{W_W} \quad \text{...eq. 6}$$

Where,
W_S = weight of known volume of sample (gm)
W_W = weight of equal of water (gm)

2.9. Statistical Analysis

All analyses were conducted in duplicates with SPSS version 22. Data were subjected to analysis for variance, and Duncan multiple range test was used to separate the means.

3. RESULTS AND DISCUSSION

The result of the physiochemical properties of oil extracted from coconut species is shown in table 1. The specific gravity of the oil sample was 0.9171 and 0.9175 for sample A and B respectively. Similar value of specific gravity varying from 0.9152 to 0.9187 was reported by Kamariati *et al*., (2008) [10] for virgin coconut oil collected from ten Malaysia market.

Sani *et al*., (2014) [4] reported a slightly higher specific gravity of 0.95 for coconut oil. The slight variation in these results could be attributed to the differences in the species of coconut used as well as the processing method employed.

The relative density of the oil sample was the same with approximate value of 0.894g/cm3. This value is quite lower than 0.9185 – 0.9194 reported by Kamariah *et al.,* (2008) [10]. This relative density of vegetable oils is a quality parameter that is dependent on temperature; thus when temperature is increased, the density of oil decreases and vice versa [28].

The result in Table 1 showed that sample B (dwarf coconut variety) has higher acid value (16.00mg NaOH/g) than that of sample A (13.20mg/NaOH/g). This result is not in agreement with the report of Sani *et al.,* (2014) [4] who reported an acid value of 0.79mg/KOH/g for coconut oil. The varied result could probably be due to differences in species of the coconut oil.

According to Njoku *et al.* (2010) [29], Acid

Table 1. Physiochemical properties of oil extracted from different species of coconut

Parameters	Sample A	Sample B
Specific gravity	0.9171	0.9175
Density (g/cm^2)	0.8936	0.8940
Acid value (mg naoh/g)	13.20	16.00
Free fatty acid (mg/naoh/g)	6.60	8.00
Iodine value (mg/g wijis)	48.22	50.76
Peroxide value (meq of peroxide 100g)	30.00	22.00

Sample A: Tall coconut species
Sample B: Dwarf coconut species

value serves as an indicator for edibility of oil. It is the Mg/NaOH required to neutralize the free fatty acid in 1g of oil. The acid value is used to measure the extent at which glycerides in oil are decomposed by lipases and other actions such as light and heat and that its determination is often used as general indication of the condition and edibility of oil [30].

In general, the lower the acid value, the more its acceptability for edibility purpose. Therefore the acid value of sample A indicates its acceptability for edible purpose since it is slightly low when compared to that of sample B.

Free fatty acid (FFA) is the measure of mg of sodium hydroxide required to neutralize the fatty acid present in 1g of fat [9]. The free fatty acid of the oil samples in this study are 6.60mg/NaOH/g and 8.00mg/NaOH/g for sample A and B respectively. These values are quite higher than range of values (0.29-0.4gmg/KOH/g reported by Marina *et al.,* (2009) [31]. These FFA are formed from the hydrolysis of an ester by lipase or moisture [32] and contributes to the off taste and aroma in oils [9]. High percentage of FFA in crude oil is undesirable because they result in high losses of neutral oil during refining [4].

The iodine value of the oil samples are 48.22mg/g for sample A and 50.76mg/g for sample B. These values are higher than 4.10-4.30 g/g reported by Mansor *et al.,* (2012) [9] and 5.6-7.3% reported by Kamariah *et al.,* (2008) [10]. The differences in these values could be reasoned by different extraction methods and the titration precision on each measurement.

According to Kamariah *et al.,* (2008) [10], iodine value is measure of total unsaturation of oils. In all, the iodine value of the samples was high owing to the low degree of saturation of the coconut oils. This highlights the high likeliness of the oil to become rancid from lipid oxidation [33]. The iodine value could have effect on overall quality parameters such as shelf life of the oils, appearance as well as the taste and smell.

The peroxide value of the sample A and B were 30.00 meq/100g and 22.00meq/100g respectively. Sani *et al*., (2012) [4] reported lower peroxide value of 10.00meq/100g. peroxide value is a measure of oxidation rancidity of oil, which is the addition of oxygen across the double bonds in unsaturated fatty acid in the presence of enzymes or certain chemical compounds [4]. High peroxide value is associated with higher rate of rancidity, the values obtained in this work is indicative that the oil sample has high chance of becoming rancid.

4. CONCLUSION

The result of this study has shown that these coconut species (Sample A and Sample B) can be a good source of oil because they have moderate oil content. The quality attributes of the oil samples showed that they have acceptable physic-chemical properties. However, the high level of peroxide value of sample A indicates that the oil may not be shelf stable as they may undergo rancidity resulting in development of off flavours. Thus Sample B (dwarf coconut species) has more acceptable physiochemical properties.

This study recommends further research on other physiochemical properties of the oil as well as storage stability of the oil samples.

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NA

6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

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