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Fatty Acid Profile and Oil Yield in Six Different Varieties of Fresh and Dry Samples of Coconuts (*Cocos nucifera*)

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Abstract: The physical and chemical properties of the oil extracted from six (6) varieties of coconut fruits were determined. The oils were brownish, some yellowish when melted, and at times white when solidified. The oils had specific gravity ranging between 0.90 and 0.92. The yield of the oil (% contents) from the ether extract was also analyzed using soxhlet extraction technique. The results showed the oil contents of 88.54% in dry samples and 69.14% in fresh samples. Result of the findings showed a higher percentage of saturated fatty acid content across the entire samples (88.5±0.85% - 97.0±0.37%) in the dry samples, than the unsaturated fatty acid constituents (8.4±0.45% - 9.5±0.30%). The moisture content was higher in the fresh samples than the dry samples. These findings therefore suggest a high percentage oil yield in the dry samples. It is therefore advisable that the nuts be harvested dry if the oil is intended for commercial use.

Key words: Oil yield, fatty acid, cocos nucifera

Introduction

The natural fats and oil are mixtures of glycerides of fatty acids. Fats and oil are naturally occurring organic compounds which belong to a large group of water insoluble substances called lipids. They are insoluble in water and soluble in organic solvents such as ether, chloroform, benzene, turpentine (Anosike, 1994).

World supplies of fats and oil are reported to come from vegetable sources (68.1%), animal fat (28.2%), marine fat (3.8%) (Fox and Cameron, 1984). In Nigeria, there are abundant sources of lipids such as palm oil, coconut oil, groundnut oil, rubber seed oil, cotton seed oil, soya bean oil, camphor seed oil etc.

Lipids are sometimes classified based on their degree of unsaturation. For example, arachidonic acid and linolenic acid. Those ones classified based on the degree of unsaturation include lauric, stearic, myristic palmitic acids etc. (Borgstrom, 1968).

The coconut has been a traditional food in practically all the countries where it is grown, and the quantity of fresh coconuts consumed locally varies from over 90% of the total population, in Thailand to less than 2% in the Philippines (Dendy, 1984).

Coconut play important role in diets in many ways: the tender nut is used for their water, mature nut for cooking and the preparation of sweetmeats, and oil for home consumption. Probably the best known product is coconut milk, the oil-protein-water emulsion obtained when the grated fresh coconut meal (endosperm) is squeezed through a muslin cloth (Dendy, 1984). Ripe or fully mature coconut (ball copra or cup copra) is used in religious and sacrificial offering, occupying a very important place in Hindu.

Through experimental studies on lipids from different oil seeds, the component of these lipids have been obtained. Also efforts have been made to improve both their nutritive value and their utilization for the production of materials for cosmetics: creams, lotions, perfumes, lipstick, eye-shadow, face cream for rapid economic utilization of the oil (Braverman, 1963).

Materials and Methods

Collection and Preparation of Samples before Analysis: A hybrid of coconut variety, PB121 (MYD X WAT) was purchased at NIFOR (National Institute for Oil Palm Research) Benin, Edo State, Nigeria in June, 2002.

Four other samples of different varieties were collected from Efa in Etinan Local Government Area and one varieties from Obot Idim Ibesikpo, Ibesikpo-Asutan Local Government Area, Akwa Ibom State, Nigeria in June, 2002.

Description of the Samples: Eight different varieties of coconut were obtained in its fresh (immature) and dry (fully ripe) conditions.

i) Chowgat Dwarf Green (CDG) (fresh and dry samples). It is characterized by its small size, green husk and short height. Locally known as "Nda Kisong".
ii) Hybrid coconut PB121 obtained by crossing Malayan Yellow Dwarf X West African Tall (fresh and dry samples). It is characterized by its larger size than CDG short and fat stem. It may bear as much as 15-20 nuts per bunch.
iii) West Africa Tall Green (fresh and dry samples). This is most commonly seen in our locality and is marked by its tall trunk and medium sized nuts. It bears fruit

with green colour which turns brown at maturity.

iv) Chowgat Dwarf Orange (fresh and dry samples). This is not widely used for oil production but rather as an ornament because of its bright colour, it is characterized by its thin stem, orange colour nut and fronds.

v) Lakshadweep Ordinary (fresh and dry samples). It has a medium sized trunk and is characterized by its three lines on the husk and has a large brown husk at its later stage and finally turns brown on maturity.

vi) Adaman Giant (fresh and dry samples). Locally know as "Abude". It is medium in height and its name is originated from its exceedingly large nut. It bears 5-9 fruits per bunch. It has a green shell at the early stage and then turns brown at maturity.

Preparation of samples for analysis: The samples were dehusked, labelled and then taken to University of Jos, Nigeria where the analysis took place.

A simple cutter was used to slit each raw coconut open and a knife was used immediately to remove the nut from the hard shell. A portion of the fruit was divided for the determination of the moisture content from each variety. A similar portion from each variety was dried in Gallenkamp air oven at 40-60^{0}C for an oil extraction. The remaining parts were stored in both an oven and fridge for further use.

Analysis of sample: The determination of the moisture content was carried out using AOAC (1975).

Extraction of the Oil from the Kernel: A portion of the oven-dried kernel (copra) was ground into fine particles with a manual grinder. 10g of each of the samples was packed into a weighed filter paper and wrapped with thread. This was then dropped into soxlet apparatus and the oil extracted using petroleum ether (Boiling point 40-60^{o}C).

Determination of Oil Content of the Ether Extract (AOAC, 1975): Ten gram of each of the ground sample was obtained for extraction of oil in apparatus. The oil content in each sample was obtained and the output recorded as the ratio of the weight of the petroleum ether extracted oil to the weight of the sample.

The oil extract was then poured into the round bottom flask of the distillation apparatus, which was fitted to a condenser and clamped at two positions. After the distillation, the oil was obtained in a flask while the petroleum ether was collected with a beaker as it dripped from the condenser.

Determination of the specific gravity of the oil (relative density – British Standard Method of Analysis, 1958): The specific gravity of the oil was determined using density bottle. Some portions of the oil sample in each variety and water was weighed separately at room temperature. The specific gravity was obtained and reported as the ratio of the mass of the oil used to the mass of the water at room temperature.

An aliquot of each of the oil samples was taken into a capillary tube. The capillary tube together with thermometer were inserted into a melting point apparatus. The apparatus was then switched on and the temperature at which the oil melted was recorded. This was repeated for two times to obtain a constant reading in each of the samples.

The temperature at which the oil begins to set was determined by putting some oil in a sterile container and then placed in the refrigerator and the thermometer was also inserted to record the setting temperature.

Determination of fatty acid profile: Detection of Vegetable Fat in each coconut oil based on the presence of saturated and unsaturated Fatty Acids by gas liquid chromatography (BSI, 1958) 50mg of melted fat from each sample was taken in a glass stoppered test tube for the preparation of fatty acid methyl ester. The methyl ester were extracted with petroleum ether (40-60^{o}C) and concentrated under nitrogen before injecting to gas chromatograph. The column temperature was 185^{o}C. The flow rate of carrier gas nitrogen was maintained at 2.8kg/cm^2 (25ml/mins) and chart speed at 1cm/min.

The peaks of concentration in each case with the standard and the unknown samples were matched. The percentage fatty acid constituents were obtained by the display unit of the instrument.

Results and Discussion

The colour of the oil in each sample ranges from yellow to brown at room temperature. The oil was soluble in chloroform and petroleum ether, this solubility was useful in the extraction and isolation of the oil. The setting temperature of all the samples ranged between 16.00 ± 0.01 to 19.40 ± 0.21 being higher than that of unripe paw-paw seed oil of 8.00±0.02^{o}C. The oil also has a specific gravity of between 0.90 to 0.92. This is comparable to that of the early workers (Johnson and Peterson, 1974; Solly and Dass, 1980; Borgstrom, 1968).

The melting point of the oil ranged between 25^{o}C to 26^{o}C for all the samples. This range is generally lower than the melting point of Butter (36^{o}C), Palm oil (39^{o}C) Palm Kernel oil (29^{o}C), Lard (43^{o}C), (Fox and Cameron, 1984). The moisture content is seen to be higher in fresh samples than the fully ripe ones. The moisture content which is often used as an index of stability and quality as well as a measure of yield and quantity of solid food is generally lower for dry nuts. This is suitable compared with the result obtained by various workers (45-46,76) in fully ripe nuts (Johnson, 1987).

Table 1: Result and some physical properties of different varieties of coconut

Varieties of coconut	Sample Type	Specific Gravity (SG)	Setting Point (SP)	Moisture Content %	Oil Yield (%)
Chowgat Dwarf Green (CDG)	Fresh	ND	ND	55.61	49.25
	Dry	0.90	18.0±0.02	48.25	57.61
Hybrid PB121	Fresh	ND	ND	51.83	49.34
	Dry	0.91	16.8±0.01	46.59	65.15
West African Tall Green	Fresh	ND	ND	57.22	69.14
	Dry	0.91	19.4±0.21	44.55	71.04
Chowgat Dwarf Orange	Fresh	ND	ND	61.34	45.26
	Dry	0.92	16.0±0.01	44.71	66.59
Lakshadweep Ordinary	Fresh	ND	ND	40.27	50.83
	Dry	0.91	18.5±0.01	40.01	78.71
Adaman Giant	Fresh	ND	ND	58.70	55.51
	Dry	0.91	18.5±0.01	32.40	88.54

ND - Not Detected

Table 2: Fatty acid profile of different varieties of coconut

Variety of coconut	Sample Type	Caproic	Caprylic	Capric	Lauric	Myristic	Palmitic	Stearic	Total Saturated
Saturated									
Chowgat	Fresh	0.10±0.01	4.60±0.12	4.00±0.11	43.00±0.11	13.10±0.01	5.40±0.02	0.10±0.01	70.55±0.30
Dwarf Green	Dry	0.30±0.02	5.6±0.01	9.50±0.02	45.00±0.01	17.00±0.01	10.50±0.21	3.40±0.14	91.30±0.43
Hybrid	Fresh	0.10±0.01	4.50±0.02	4.30±0.13	40.00±0.13	14.00±0.03	5.5±0.10	0.10±0.01	73.30±0.41
PB121	Dry	0.40±0.01	5.60±0.01	9.50±0.02	40.00±0.13	13.5±0.13	10.0±0.32	3.00±0.02	83.5±0.85
West African	Fresh	0.20±0.01	8.50±0.02	9.00±0.01	40.00±0.01	12.50±0.01	10.00±0.10	2.50±0.10	84.20±0.37
Tall Green	Dry	0.50±0.01	9.00±0.02	9.50±0.01	45.00±0.20	9.50±0.01	10.50±0.01	2.50±0.10	88.00±0.37
Chowgat	Fresh	0.10±0.01	4.60±0.01	4.00±0.02	44.00±0.11	15.00±0.01	6.00±0.01	2.50±0.02	76.40±0.20
Dwarf Orange	Dry	0.50±0.01	5.5±0.02	9.50±0.02	40.00±0.01	16.00±0.01	10.50±0.14	3.40±0.14	86.40±0.35
Lakshadweed	Fresh	0.10±0.01	5.40±0.01	4.70±0.01	44.00±0.11	14.00±0.12	10.40±0.11	2.00±0.20	80.60±0.37
Ordinary	Dry	0.40±0.01	10.0±0.01	9.50±0.01	38.00±0.02	18.00±0.01	10.0±0.01	3.10±0.01	90.50±0.09
Adaman Giant	Fresh	0.20±0.01	5.40±0.10	4.70±0.10	43.00±0.10	15.50±0.03	10.50±0.40	2.50±0.01	82.70±0.76
	Dry	0.40±0.01	9.00±0.01	7.00±0.01	40.60±0.01	16.50±0.20	10.50±0.01	3.50±0.01	89.50±0.27

Variety of coconut	Sample Type	Arachidonic	Oleic	Linoleic	Total Unsaturated
Unsaturated					
Chowgat	Fresh	0.25±0.01	7.50±0.02	2.90±0.21	10.40±0.23
Dwarf Green	Dry	1.00±0.01	4.9±0.23	2.20±0.01	7.4±0.24
Hybrid	Fresh	0.30±0.01	16.0±0.31	2.00±0.14	18.00±0.45
PB121	Dry	1.50±0.21	8.00±0.20	1.50±0.10	9.50±0.30
West African	Fresh	1.50±0.01	6.50±0.01	2.50±0.02	9.00±0.03
Tall Green	Dry	1.50±0.01	5.50±0.02	1.50±0.01	7.00±0.03
Chowgat	Fresh	0.20±0.01	7.50±0.20	3.00±0.10	10.50±0.30
Dwarf Orange	Dry	1.00±0.10	4.50±0.01	2.60±0.01	7.10±0.11
Lakshadweed	Fresh	1.00±0.00	6.80±0.10	1.40±0.11	8.20±0.21
Ordinary	Fresh	1.50±0.01	7.50±0.02	1.60±0.00	9.10±0.01
Adaman Giant	Fresh	0.90±0.01	9.00±0.02	1.30±0.01	10.30±0.03
	Dry	2.00±0.01	6.40±0.01	2.60±0.03	9.00±0.04

The oil content (crude fat) of oil seeds is of great significance in the determination of the value of the produce for processing. For the kernel, the value is significantly high and cuts across the different varieties considered and also in the fresh and dry samples. These range from the highest value of 88.5% in Andaman Giant to the least of 57.61% in the Chowgat Dwarf Green. The percentage oil yield, in all samples ranged between 57.61 to 88.54%. This is higher than that of groundnut (49.90%), sesame seed (46.90%), and palm kernel (49.00%) (Fox and Cameron, 1984).

The oil yield in dry sample was significantly higher than fresh sample. The highest value in dry sample was 88.54% and in fresh 69.14%. These samples showed a close range with that of Johnson (1987) with fresh having 68.20±0.10% and dry 85.00±0.10%. The values are higher than those of rubber seed oil 23.96% and that of groundnut oil 50.00%.

The characteristic fatty acid constituent in the coconut oil of each variety (Table 2) show no significant difference from those of the earlier workers. The total saturated fatty acid is seen to be much higher than the unsaturated

fats. The total saturated fatty acids ranged between 88.50±0.85% to 97.00± 0.37% in the dry samples. This conforms with 91.00% (Noller, 1965) and 92.00% (Johnson and Peterson, 1974) reported in coconut. The unsaturated fatty acids ranged from 8.40±0.45% to 9.50±0.30% in dry samples. This conforms with 9.00 to 9.10% (Noller, 1965; Johnson and Peterson, 1974) for dry coconut samples.

There is also a slight increase in the unsaturated fatty acid values in the fresh samples. These values decrease gradually as the nut become fully mature which accumulate greater percentage of saturated fatty acids.

Table 2 also show Lauric acid (40.00 to 50.00%) and Myristic acid (13.50 to 18.50%) as the major saturated fatty acids present in coconut oil. This compare with those reported for lauric acid (47.60%) and Myristic acid (15.80%), (Tyler *et al.*, 1977). There are also a mono unsaturated fatty acids: Oleic acid (5.90 to 8.00%) and Linoleic (1.50 to 2.60%).

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