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Effect of groundnut paste fineness modulus on the quantity of oil extractable

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ABSTRACT
This work focused on the effect of groundnut paste fineness modulus on the quantity of oil extractable. Three samples of peeled roasted groundnut seeds A, B, and C weighing 14kg each were ground at different machine speeds of 310rpm, 250rpm, and 230rpm respectively. The energy expended in the extraction process using the IAR kneader was found to be 923J, 1043J, and 203J for samples A, B,and C respectively. Results revealed that the extraction efficiency increases as the value of fineness modulus decreases. The results also revealed that the energy requirement decreases as the fineness modulus value decreases.

Introduction

Groundnut is usually grown as annual crop in tropical, sub-tropical regions and warmer areas of temperate regions of the world [1]. The crop is a native of Brazil and believed to have been introduced into Africa by the Portuguese [2]. The plant is made up of many varieties which include: the erect and the runner variety [3]. Groundnut may be grown on flat beds or on ridges and thrives well in warm temperate regions and cannot withstand frost. The seeds germinate within five to ten days after planting. The crop's maturity rate depends on the soil moisture and weather conditions [4]. Groundnut is principally grown for its edible oil and protein rich kernel or seed borne in pods which develop and mature below the soil surface [1]. Groundnut oil is the leading vegetable oil that is processed mostly in the northern part of Nigeria [5]. The oil and fried cake (Kulikuli) are generally sold in bulk to retailers or are retailed by children and adult women. Different oil extractors have been designed and fabricated. However, there is the need to determine the effect of grinding in terms of fineness modulus (paste particle size) on the quantity of extractable oil which is the focus of this work.

Materials and Methods

Materials and Instruments

The following are the materials and the instruments used:

a) Thermometer- for temperature measurement
b) Container- for water
c) Stop clock- for noting time
d) Weighing balance- for weight measurement
e) Volumetric cylinder- for estimating volume of oil extracted
f) Fire wood- for roasting groundnut and frying of extracted oil
g) Milling machine- for mechanical particle size reduction
h) Tachometer- for speed measurement
i) IAR kneader- for oil extraction
j) Stethoscope- for measuring heart rate (beat/minute)
k) Heart ergo meter- for energy calibration of the operator
l) Shelled groundnut seeds- for processing

Material Preparation

Peeled roasted groundnut seeds weighing 42kg was used for the test. The roasted seeds were divided into three equal parts of 14kg each and labeled sample A, sample B and sample C. The three samples were ground at machine speeds of 310, 250, and 230rpm for samples A, B, and C respectively. Sample A was further divided into A1, A2, A3 (4kg each); Sample B was divided into B1, B2, B3 (4kg each) and Sample C was divided into C1, C2, C3 (4kg each).

Size Classification

Tyler's sieve was used to get the particle size characteristics. The sieve size ranges from 3.175 to 0.07366mm. The dried samples of the groundnut paste were used on the Tyler's sieve for the size classification. The paste was oven dried and crushed after extraction of the groundnut oil. Each sample was then shaken on a set of Tyler's sieve. The weight fractions obtained was used to determine the fineness modulus and average particle size for each sample.

Fineness Modulus

Fineness modulus (FM) may be defined as an empirical factor obtained by summing the percentages of the cumulative weight fractions retained on a specified series of sieves, and dividing the sum by 100 [6]. Mathematically, FM is expressed as

$$FM = \frac{\sum PCWFR}{100}$$

Where,
PCWFR = Percentages of the cumulative weight fractions retained on the set of sieves.
FM may be related to the particle diameter D (mm) by the equation

$$D = 0.10414 \times (2)^{FM}$$

The values of D as related to FM for the different samples are presented in Table 1.

Energy Expended in the Oil Extraction Process

The energy expended in the oil extraction process may be obtained from the following equation:

$$W = 2 \times R \times S \times F$$

Where,
W = Work done in Joules
R = Radius of ergometer flywheel in meters

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S = Speed of the ergometer flywheel in rpm
F = Weight of ergometer flywheel in Newton

Oil Extraction Efficiency using the IAR Kneader

The oil extraction efficiency (EE) using the IAR kneader may be calculated using the following equation:

$$EE = \left(\frac{Weight\ of\ oil\ extracted}{Quantity\ of\ paste} \right) \times 100$$

Results

Table 1 shows the oil extraction efficiencies using the IAR kneader for the different samples. It can be seen that sample A has the highest average oil EE of 0.44. From the average oil extraction efficiencies, it is obvious that sample A which has a finer particle size gave more oil with the IAR kneader. The oil EE decreases with an increase in the particle size of the paste. Table 1 also shows the values of FM and the average value of the quantities of oil extracted for each of the samples. It can also be seen that sample A having $FM = 2.68$ yielded the highest amount of oil with an average value of 0.80kg. Table 2 shows the values of energy expended and the time taken in kneading samples A, B and C with the IAR kneader. It can be seen that the energy consumed (work done) increases appreciably with increase in paste particle size.

Conclusion

The effect of groundnut paste fineness modulus on the quantity of oil extractable was the focus of this work. The peeled roasted groundnut seeds (42kg) were divided into three equal samples, weighing 14kg each. The three samples A, B, and C were ground at different machine speeds of 310rpm, 250rpm and 230rpm respectively. The energy expended to extract oil from given samples were A(923J), B(1043J), and C(1203J). It was observed that sample A with a finer particle size has the highest oil extraction efficiency of 44% yielding 0.80kg of processed oil; Sample B has 37% yielding 0.67kg of processed oil while Sample C has 34% yielding 0.61kg of processed oil. The optimum particle size was gotten to have a fineness modulus of 2.68. Sample A is therefore best suited for oil extraction in terms of energy requirement, quantity of oil extractable and the oil extraction efficiency.

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Table 1: Oil Extraction Efficiencies

Sample	Average Quantity of Oil Extracted (kg)	Oil Extraction Efficiency			Average Oil Extraction Efficiency	FM	Average Particle Diameter (mm)
		1	2	3			
A	0.80	0.456	0.441	0.419	0.44	2.68	0.6674
B	0.67	0.389	0.365	0.347	0.37	3.35	1.0619
C	0.61	0.361	0.338	0.324	0.34	4.42	2.2293

Table 2: Energy Expended and Time Taken in Kneading Samples

Sample	Work done (J)				Kneading time (Minutes)			
	1	2	3	Mean	1	2	3	Mean
A	1090	860	820	923	8.50	9.55	10.24	9.43
B	1100	1090	940	1043	8.39	10.45	11.02	9.95
C	1350	1160	1100	1203	9.27	12.30	13.96	11.84