EFFECT OF SOME PROCESSING PARAMETERS ON THE YIELD OF OIL FROM SHEA NUT.

(Vitellaria parodoxa)

BY

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING.

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

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26/01/2011

Date

CERTIFICATION

This is to certify that the project entitled "Effect of Some Processing Parameters on the Yield of oil from Shea nut (*Vitellaria paradoxa)* Oil" by Itodo, Simon Ikoojo meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary Presentation.

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DEDICATION

This Project is dedicated to Almighty God and to my parents Prince and Deaconess Innocent Yahaya Itodo for all their love and support throughout my education, and also to my brothers Itodo Samuel, Itodo Shadrach and to my dear sister Mrs Joy Ben Solo.

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ABSTRACT

Shea nut belongs to the family of *sapotaceaice* and it is cultivated in central Africa, west Africa and in Nigeria. The north central part of Nigeria produces more Shea trees. In this study some Shea nut processing unit operations were studied to assess its effect on the yield of oil. The unit operations studied were crushing and heating time. The Shea nut for the experiment were collected from Lapai central market and extracted locally into oil in Minna. Two crushing sizes which were obtained by sieve analysis and three roasting time were used. The crushing sizes obtained sample with 2.00mm and 2.36mm particles size. The roasting times used were 30, 45 and 60 minutes.

Crushing size of 2mm and roasting time of 30 minutes gave the highest yield of Shea oil (54%) and also a light cream colour. Shea nut oil at roasting time of 45 minutes and 60 minutes were dark in colour which may not be acceptable in market. Based on this work 30 minutes roasting time is recommended because it activated more oil and produce light cream oil which is acceptable by Shea oil users.

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CHAPTER ONE

1.0 INTRODUCTION

The Shea tree, *Vitellaria paradoxa,* belongs to the family of *sapotaceaie*. The nut of this produces contain 20% to 50% edible fat. The Shea tree population of east Africa is the sub-species milotica which produces more liquid type of Shea fat. The Shea tree population in the west of Africa from Nigeria to Senegal is a tree of the subspecies *paradoxa of vitellana paradoxa* and produces more solid shear butter as it contains more stearic acid (DFSC, 2000; Maranz, 2004).

Shear trees grow in large parts of sub-Saharan Africa. This Shea tree is important for livelihoods of the rural population as it has been for over centuries (Lovett's and Haq, 2000). Almost every part of the tree has its use, for example, the fruit is eaten and the leaves are used as fodder and serves as ingredient alkaline and paints (Lovett's and Haq , 2000).

PLATE 1 SHEA TREE AND FRUIT

1.2 STATEMENT OF THE PROBLEM

A lot of Shea oil manufacturers encounter problems during the course of Shea butter production resulting in poor Shea oil quality and low oil yield from the nuts., However a proper knowledge of the processing factors and investigation into the crushing, roasting and milling stages can improve the yield and quality of Shea oil produced.

1.3 AIM AND OBJECTIVE

The aim of this project is to investigate on the factors that would increase the optimum yield of oil to be extracted from Shea nut by local extraction method. To achieve this, the following objectives were considered. Experiment was conducted to:

- determine the effect of Shea nut weight on oil yield
- determine the effect of particle size on the oil yield

1.4 JUSTIFICATION

This study is relevant to the entire rural populace since it can offer many opportunities for self reliance on local production.

The recent discoveries as a lubricant for machinery. traditional soap facial moisturisers: this serves as a source of income to the industrialist and helps to curb unemployment.

The production of the above product has increased the amount of foreign exchange earning of Nigeria through exportation of this product.

1.5 SCOPE OF STUDY

- The extraction of oil from local Shea nut using different sample weight and particles size
- To determine the quality of extracted oil by local extraction method.

CHAPTER TWO

2.0: LITERATURE REVIEW

The Shea tree is a wide tree. There are ongoing efforts to plant Shea trees in controlled plantations and some results have been encouraging. The Shea tree grows very slowly. It does not produce fruit until it is 15 to 20 years old. When it is young, its existence is threatened by bush fires, burrowing animals or being act by human for firewood and charcoal. The Shea tree is from (7.6 – 22.7 metres) with its many spreading branches. It resembles an oak tree.

Travellers in Africa from as early as the 1300's wrote about the many uses of Shea butter among the central African people. Apparently Europeans did not know about the Shea tree until M. Mungo Park a 25 year old Scot Surgeon, recorded his first observation of it in the late 1790s. He wrote a book, life and travels of Mungo Park in central Africa. He notes the intense activity which accompanied Shea butter processing and the importance of the butter in commerce.

In the 1940s, it was used in margarine. Development of promising uses in cosmetics was interrupted by World War II. In the 1960s, people in Japan and Europe discovered that Shea butter was useful addition to chocolates and pastry. The European Union directive was passed in January of 2003 allowing a percentage of cocoa butter to be replaced by Shea butter in the manufacture of chocolate. (Schreckenberg, 2000).

Historically, Shea butter has been used to treat skin conditions of all kinds. For centuries the collection of Shea fruits and the processing of the nut has been aided solely by water. There are 19 countries where the Shea tree grows and there are many different African tribes within those countries. Details of traditional practice vary, but note the fact

that the Shea tree is a woman-controlled tree. Women in central African countries have displayed the zeal to work. During the last 10 years more and more organisation, both governmental and non-governmental, African and international Communities have shown interest in the Shea butter business. The Ghanaians are known to be the largest producers of Shea butter while Burkina Faso is the world's second largest producers of Karite or Shea nuts. (IRSAT)

Depending on rainfall and other factors, the small west Africa country produces from 40,000 to 80,000 tonnes of Shea nut per year. The project began in 1989 when Rigobert Yameogo, a chemist at the Institute Recherché en sciences Appliqués ET technology (IRSAT), approached IDRC for funding to help improve the working condition of Shea butter producers. Dr Yamego built a manual horizontal screw press that could extract Shea butter from the nuts. The process makes it possible to process up to 30 kilograms of the Shea nut per hour, compared to just 50 kilograms in three days without using the press.

This work is almost effortless; a pressure of 20 kilograms on the driving bar that activates the wheel is enough to create a force of 40 tonnes at the end of the piston. From 1992 to 1995, the ease of use and output of this press were tested by local women. By the end of 1995, 40 presses had been delivered to Shea butter producers. A prototype power driven press is being designed by Dr Yameogo. The short term objective is to motorize all of the presses used by the groups of women who are producing quantities for export.

In 1998, IDRC approved a third project on Shea butter. Getting rid of the bad odour from Shea butter is necessary so that it can produce a high quality cosmetic and food item produced not only for export but for local consumption. To promote this application, professor Kassamba is adapting the odour eliminator" a machine used to volatilize odorous substances) and the "fractionators"(a machine that allows the separation of butter into liquid and solid fractions) to the production process.

Relevant work done in this area is "Shea nut and butter in Ghana". Opportunities and constraints for local processing. In 2008, a frame work of a larger research project which was about rural farmers and entrepreneurship in Ghana. In total 15 students linked to the University of Wageningen were involved in the overall project.

In the upper west region of Ghana, research on Shea nut production system was conducted while are Tamale (Northern region) and in Accra. The research on local trade and export of cosmetic Shea butter products was carried out. All research was based on structural interview. Beside from research institutes, traders or from local authorities, one of the main concerns expressed by various authors is then noticing an aging trend of Shea tress which they account to the shortening of fallow periods due to land pressure and population growth. If needs for money is high on a short term, another opportunity is to invest in Shea kernels in the harvest season and sell them in the dry season, as prices might rise up to three fold in the dry season as compared to the harvest season. The hypothesis that these women and men trading in bulk Shea butter on the local market have problems in meeting up to the standards of Shea butter set by the buyers.

The exporting industry in Shea nuts and butter is showing an increasing trend and because of the larger demand, more women organise themselves in Shea butter extraction or trading groups instead of operating individually. The National Association of Shea farmer, processors and Buyers has been established 2007 in Ghana. Their aim is to have a Shea board separate from the cocoa board, and to be able to focus more on the opportunities and making improvements within the Shea market.

According to Yidana (2008), fifty years ago the household consumption of Shea butter as edible fat could be estimated to 60% compared to other edible oils. Also skin care products are getting increasingly popular compared to Shea butter as a skin cream.

2.1 Processing of Shea nut into Shea butter

This is a fatty extract from the seed of the Shea tree. It is a thick and rich butter extract from the kernel of the Shea tree located throughout African Savannah. Shea butter can be extracted in different ways. Method of extraction can differ from community or region. For example, in Ghana the nuts are boiled to stop germination while in Burkina Faso the nuts are buried into the ground to stop the nut from germinating (Lovett's, 2004).

2.1.2 Unit operations of processing Shea kernel into Shea butter.

The processing steps needed for traditional Shea butter extraction are:

a) Breaking

b) Roasting

c) Pounding

d) Grinding

e) Kneading

f) Boiling.

Breaking: This is the first step taken to break the kernel into small pieces so that they are prepared for roasting. Breaking is done with a mortar and pestle.

Roasting: The nut pieces are roasted. When the kernel attains a deep brown colour roasting is stopped. According to Schreckenberg (2004), roasting at a temperature close to 120^0C will lead to maximum butter extracted with the kernel getting burnt.

Pounding: Once roasted, pieces are again pounded with a mortar and pestle to obtain a brown-black paste. The paste is then removed and put in a pot which is then heated to facilitate the grinding step-which is next.

Grinding: The heated black paste is grinded on a flat stone surface this step is indicated as a vital part for the butter extraction process, for the thoroughness at which the grinding is done will be a determining factor for the quantity of butter that is eventually obtained.

Kneading: Before the past is beaten, warm water is mixed into the paste, warm water is added several times during the beating to keep the paste at a relatively high temperature because if the paste becomes too cold, the mass becomes through and beating becomes difficult. During the beating process, the butter should appear as a creamy mass floating on top of the mixture.

Boiling: To obtain butter, the creamy mass is boiled in a cooking pot. Due to the low boiling point of water compared to the butter, the water will evaporate tearing the butter behind. The pot is removed from the fire and allowed a few minutes for the oil to cool down and decant to remove any remaining impurities, leaving clear yellow oil. After this the oil is left to cool down, it will turn into a solid white butter.

Table 2.0 Effects on the Steps of Processing of Shea butter extraction

Step	Effects on the step
1. Breaking	If the sizes of kernels are not reduced to a uniform size, roasting won't be done properly. The finer the prices of the Shea kernels, the more uniform the roasting.
2. Roasting:	Prolonged roasting results to black Shea butter. According to Schreckenberg (2004), roasting a temperature close to 120^0C will lead to maximum butter extraction without the kernel being burnt.
3. Pounding:	For pounding to be successful, the broken roasted kernels must be reduced in size
4. Grinding:	The thoroughness at which the grinding is done determines the quantity of butter that is eventually obtained. The finer the grinding, the more the Shea butter extracts.
5. Beating:	It is necessary to keep the paste at a relative high temperature as a result of beating because if the paste is cold the creamy mass becomes though and beating becomes difficult.
6. Boiling:	If not boiled water would mix up with the butter which makes it creamy. It is necessary to boil so as to remove the water present by evaporation.

2.1.3 Shea nut processing

The Shea fruits are collected which now go through five processing steps before they are placed in storage, put out for sale or before butter can be extracted from them.

The process of obtaining dried kernels is depicted schematically in figure 2.1:

2.1.4: Steps in processing freshly picked nuts into dried kernels

Removal of pulp: After the nuts have been collected, the pulp of the Shea fruit is removed. The pulp contains high amounts of sugar that encourages the growth of fungi which decrease oil content of the kernel. So the purpose of the removal of pulp is to prevent further growth of fungi.

Boiling: After de-pulping the nuts are boiled to terminate the germination of the nuts. The germination process starts within a few days after they have fallen to the ground and leads to the formation of fatty acids, which result in poor Shea butter quality and can cause bad taste. According to the JICA (2007) prolonged boiling of the fruit tends to destroy desirable natural compounds that keep the kernel in good condition.

Drying nuts: When boiling is finished the nuts are left on the ground or on the roof for a couple of days to dry in the sun. At the end of these drying steps, the moisture contents of the nuts will be approximately 8% of the weight (JICA, 2007). Shea nut turns black if not dried properly. Poorly dried or black nuts fetch lower prices on the market than well dried kernel.

Removal of Shell: These nuts are well dried when they produce rattling noise when shaken. At this point, the shell can be easily removed by hand after the nut is cracked. Cracking of the shell is done either by gently pounding the Shea nuts with a mortar or stone.

Drying of kernels: The kernels are then dried for another 3 to 5 days, after this moisture contents in kernel should be another 1% of their weight (JICA, 2007).

Table 2.1: Effects on the steps of processing Shea nut

After the Shea nuts are collected, the nuts undergo five processing steps before they are placed in storage. And the effects of the steps are as follow:

Step	Effects on the step
1. De-pulping	The pulp contains high amount of sugar which encourages the growth of fungi which decreases the oil content of the kernel.
2. Boiling	It is important we boil so as to eliminate the germination process of the nuts. If not boiled, it leads to the formation of free fatty acid which results in poorer Shea butter quality and can also cause a bad taste. It is necessary you boil for 45 minutes only because prolonged boiling of the fruit destroys the desirable natural compounds that keep the kernels in good condition.
3. Drying Nut	If Shea nuts are not dried properly, the nuts will turn black. Poorly dried or black nuts fetch lower prices on the market than well dried kernel. It is advisable that the moisture contents of the nut should be approximately 8% of the weight (JICA, 2007).
4. Removal of shell	It is important that the shell is removed so as to proceed to the next step of processing which is drying of kernels.
5. Drying kernels	If kernels are not dried for another 3 to 5 days, fungi might start growing in the nut so it is important that the moisture contents in kernels should be about 1% of the weight (JICA, 2007)

2.2 Oil Definitions

Oils are water soluble substances of plants and animals which consist predominantly of mixture of esters of fatty acids. The structures are illustrated below:

Glycerol + Fatty acid = Glycerides (esters)

2.2.1 Classification

Oils are classified based on sources and physical properties. The classes are as follows:

Fixed oil: They are derived directly from plant and animals, those in animals are obtained from milk and body tissues while plant oil are obtained from fruits and seeds, example include soya bean, cotton seed oil, sunflower seed oil, fish oil, etc.

Mineral oil: They are distilled from petroleum and slide deposits, they include paraffin oil, fuel oil and most lubricating oils like heavy spindle oil, vacuums oil, heavy oil, etc.

Synthetic oil: They are derived from chemical conversion of fatty acids to esters. Oil has been obtained from biochemical conversion of carbohydrate to fatty acid which consequently esterifies to oil.

2.3 CHARACTERISTICS OF FATS AND OILS

2.3.1 Physical Properties

Colour: The colour of oils and fats is essential in assessing gravity and determining the degree of bleaching. The darker the colour, the poorer the quality of oil, There are methods for determining colour, most of which were developed for a specific product or group of products.

Melting point: This is the temperature at which a solid of a pure substance changes to liquid, since oil are mixed triglycerides, they melt over a range of temperature because of combined effects of the variation in the degree of unsaturation.

Viscosity: This is resistance that fats and oil to flow when subjected to a shear stress. The viscosity increases slightly with increase in the average molecular mass and in the degree of unsaturation of the fatty acids. The actual differences however are very small. For example, castor oil has a viscosity which is much greater than that of the most other fatty oils; hence it is used as lubricant.

Solubility: This is the ability of a substance to form a solution with another substance. The solubility of fats and oils plays a part in determining the immiscibility curve of acid or fats in various solvents. This curve may be used for checking purity, most fats and oils are miscible with such solvents as benzene, hexane and petroleum ether, etc.

2.3.2 Chemical Properties

Acid value: The acid value is a measure of free fatty acids judging quality of raw oil and for determining the quality of alkali required for alkali refining of oil at minimal saponification.

Iodine value: Iodine value is a measure of the degree of unsaturation of the oil; it is given by the number of milligrams of iodine absorbed per gram of oil sample. The greater the total unsaturation, the higher is the iodine value.

Saponification value: This is the number of milligrams of potassium hydroxide (KOH) necessary for saponifying one gram of the oil, saponification value increases with decrease in the average molecular mass of the oil. Saponification value also gives the actual amount of alkali required by a given oil or fat (Williams, 1996).

CHAPTER 3

3.0: MATERIALS AND METHODS

3.1: MATERIALS.

The Shea nut used was gotten from the Lapai village market which was carefully sorted out to prevent decayed nut from being used. All other materials used were gotten locally in Minna emirate Niger state.

Table 3.1 List of Materials /Equipment

s/no	Equipment Materials	Manufacturers	Sources
1.	Cooking pot	Towers (stainless)	Bosso Market
2.	Fire wood (charcoal)	Locally made	Bosso market
3.	Water	Natural	Public H_2O supply
4.	Stop clock	G.shocks	FUT Minna Basketball court.
5.	Coal pot (stove)	Locally made	Bosso market
6.	Mortar & Pestle	Locally made	Bosso market
7.	Basket sieve	Locally made	Bosso market
8.	Milling machine	Mechanical fabricated	Bosso milling centre
9.	Sieve shaker	Mechanical fabricated	Agric Eng Lab (fut.)
10.	Buckets (plastic)	Factory made	Bosso market

3.2: Method of Extraction of Shea Oil

This method described by (Senyo— Kpelly), 2007 is the most commonly used example of processing of premium quality Shea Butter. This method would be used in this research work. For Quality butter begins with quality Shea nut. For best result, all processing steps should be done and completed within 24 hrs and utensils used must be rust free and void of toxic or undesirable materials that are dangerous to human health.

3.2.1: Steps in Processing

Washing and sorting → Crushing → Roasting → Milling → Kneading → Cold water separation →Packaging.

3.2.2 **Washing and sorting:** All the nut were washed and rinsed several times with clean warm water so that possible oil emitted from bad nuts can be gotten rid off . The cleaned nuts were dried under the sun for about two (2) hours due to the intensity of the sun. After when this was done, the bad and black nuts were separated from the good ones.

PLATE 2 WASHING AND SORTING

3.2.3 **Crushing of the nut:** The nuts were crushed into smaller potions by a pestle and mortar and was later pounded to get a uniform size for roasting. The bigger pieces of the nuts were crushed the second time. Re-crushing gives more even materials for roasting.

PLATE3 CRUSHING

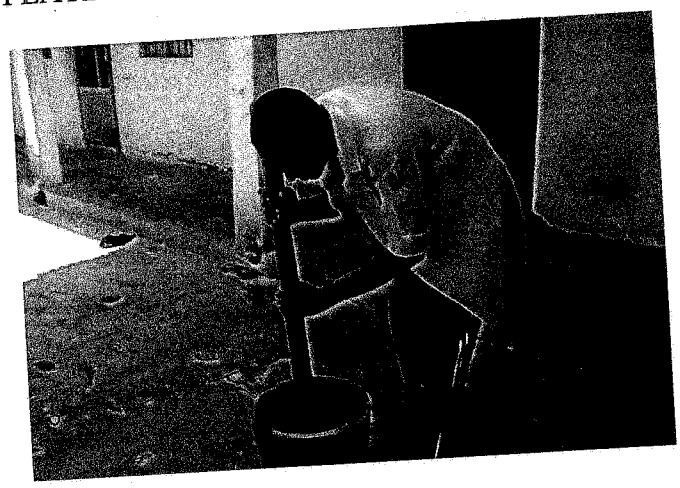

PLATE 4 POUNDING

3.3 **Roasting of crushed nuts:** The crushed nuts were roasted immediately after crushing for 45 minutes due to its moisture level in the Shea nuts. A clock was used to time the roasting. The Shea nuts were roasted in a pan on an open fire when the nuts were ready; a little water was sprinkle to the sample which gives a popping sound indicating that the roasted nuts are ready for milling stage.

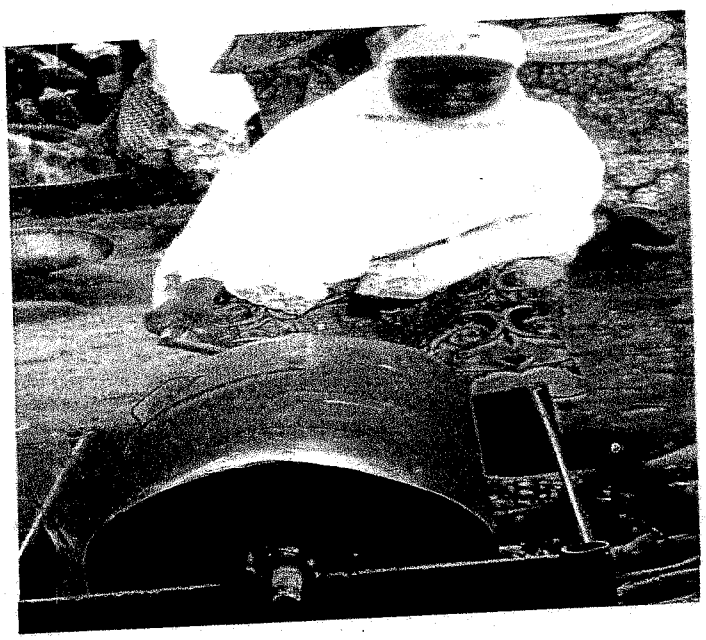

PLATE 5 ROASTING

3.3.2 **Milling of Roasted nut:** The nuts roasted was allowed to cool down completely for 2 hours, due to the temperature of the roasted nuts and then milled into a fire paste. The finer the paste the more oil which could be extracted through kneading.

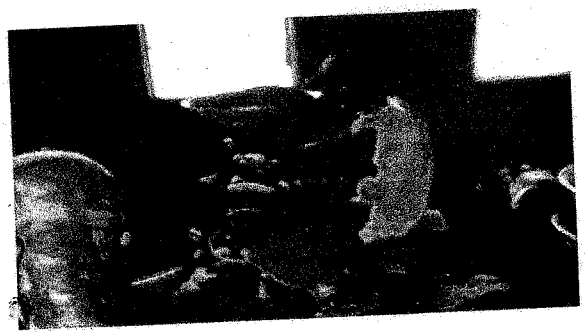

PLATE 6 MILLING

3.3.3 **Kneading:** After the past has cooled down completely, cold water is added and churned with finger sufficiently to get smooth and uniform dough. The mixing continues as small amounts of cold water added from time to time to get a smoother texture. Kneading was done in a uniform direction so as to avoid breaking the momentum. The final kneading was vigorous and breaks the emulsion completely.

PLATE 7 KNEADING

3.3.4 **Cold water separation:** A large amount of cold water is poured into the mixture and stirred completely to cause a gray oily scum to rise and forces more fat to float on the cold water. The fat floating on the surface of the water was collected into another bowl. The kneaded butter was boiled after 2 hours of collection. In the spectrum , kneaded butter that had exceeded 3 hours was avoided so as not to destroy the quality of the butter gotten

3.3.5 **Boiling:** The fat collection was boiled on fire so as to remove water (dehydration) and then separate cake residue still left in the fat from the kneading stage. To avoid the cake residue from burning, the heat applied was reduce completely which the oil was allow to stand for one hour and then the decant oil was put into another pot for second boiling. The second stage boiling helps to dehydrate the fat completely. The heat used was little and was monitor very closely. The warm liquid fat was filtered through a microfilm into a plastic bowl. The filtered liquid fat was allowed to cool down and solidify.

PLATE 8 BOILING

3.3.6 **Packaging and storage:** The butter gotten was packaged in an air tight, rust free and water proof container. The butter was stored in a cool and dry place so as to avoid the butter from melting.

PLATE 9 PACKAGING

3.4 Experimental Procedure

Shea nuts of weight 20000g was crushed into smaller pieces with the aid of mortar and pestle. The crushed nut was sieved and was divided into two (2) samples which were 10000g of sample 1 and another 10000g of sample 2. 10000g of sample 1 was sub-divided into 3 categories while sample 2 was also sub-divided into 3 categories which were timed at 30 minutes, 45 minutes and 60 minutes each. These also were repeated for sample 2 which was also timed at 30 minutes, 45 minutes and 60 minutes each. After this was done, sample 1 and sample 2 were roasted inside a cooking pot on a coal stove (abacha stove). After roasting sample 1 for 30 minutes, 45 minutes and 60 minutes they were allowed to cool down for 2 hours. This was also repeated for sample 2.The roasted nut samples were again milled with a milling machine into fine paste. After which the paste was allowed to cool down for 4 hours and the paste samples were kneaded continuously while a little quantity of water was mixed with the kneaded paste to allow easy beating so as to keep the paste at a relative high temperature. During the beating the creamy mass floating on top of the mixture was collected into another empty container. The creamy mass was washed twice before final boiling so as to remove unwanted contaminant compound from the butter. Due to the lower boiling point of water compound from the butter, the water evaporated leaving the butter behind, then the pot was removed from the fire and given a few minute for the oil to cool down decant to remove any remaining impurities, leaving a clear yellow like oil. After this the oil was left to cool down which later turn into a solid white butter.

Table 3.3 Schematic overview of processing steps butter extraction

Steps	Objective	Quantity used	Estimated Time	Resources used	Used tools	Expected Quality
Breaking	Reduce size of kernel for uniform roasting	10kg of kernels	3/4h – 1h	-	mortar and pestle	The finer the pieces, the more uniform the roasting
Roasting	makes grinding easier	9kg of kernel pieces	1¼h	fire wood	boiling pot	prolonged roasting leads black Shea butter
Pounding	Reduce size of broken roasted kernels to make grinding easier	9kg roasted pieces.	52mins	-	mortar and pestle	-
Grinding		8kg paste with pieces	45mins	firewood	Grinding stone and cooking pot	the finer the grinding, the more the Shea butter extract
Beating	Extract Shea butter	8kg paste	1h – 1½h	Luke warm water 10L	Metal basin	-
Boiling	Vaporise left water	5 to 6kg creamy mixture	30mins	firewood	boiling pot	-

3.4 PROCESSING FACTORS TO BE CONSIDERED IN THIS EXTRACTION.

3.4.1 Crushing: 10000g sample 1 and 2 nuts were crushed to obtain a uniform size. Sample 1 was crushed once and sample 2 was also crushed. A sieve shaker was used so as to know the diameter of the crushed nuts for various samples.

Materials used in crushing

- Electrical powered nut cracker.
- Plastic containers.
- Stop clock
- Pestle and mortar.

All these above materials were gotten from the Minna central market except the electricity powered nut cracker which was gotten from Akimi milling centre and the stop clock was also gotten from the fut. basketball court.

Table3.4.1 Variations to be considered while roasting the crushed Shea nut size.

Variation	Sample 1	Sample 2
Diameter of sieve		
Weight of nut before crushing		
Weight of nut after crushing		
Time of crushing.		
% efficiency of crushing.		

Efficiency of crushing= $\frac{weight\ of\ material\ output}{weight\ of\ material\ input} \times 100$

Source: modification and performance evaluation of various unit of operation (PGD 2002 Agric engineering)

3.4.2 ROASTING: sample 1 and sample 2 were roasted for 30 minutes, 45 minutes and 60 minutes respectively on a frying pan.

Materials used in roasting operation.

- Firewood
- Frying pan
- Stop clock
- Abacha stove
- Weighing balance.

All these above materials are locally made except from the weighing balance which was gotten from biochemical lab.

Efficiency of roasting= $\frac{weight\ of\ nut\ before\ roasting}{weight\ of\ nut\ aftyer\ roasting} \times 100$

Table 3.4.2 Variations to be considered while roasting are as follows.

Variations	30 minutes	45 minutes	60 minutes
Weight after roasting.			
Weight before roasting.			
Time given for heat to circulate.			
% efficiency of roasting.			

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION OF RESULT

4.1 RESULTS

All the tests were conducted in two replicates and the average is presented.

1. **Crushing:** the nuts were crushed uniformly and were divided into 2 samples using sieve analysis.

Table 4.1 Result of crushed samples

Variations	Sample 1	Sample 2
Diameter of sieve	2.00mm	2.36mm
Weight of nut before crushing	10000g	10000g
Weight of nut after crushing	9830g	9720g
Time of crushing	52 minutes	48 minutes
% Efficiency of crushing	98.3%	97.2%

Roasting: the crushed nuts were divided into 2 samples and each sample was roasted for 30 minutes, 45 minutes and 60 minutes respectively.

Table 4.1.2 Percentage of roasting

Variations	30 minutes	45 minutes	60 minutes
Sample 1	80.1 %	79.82 %	79.67 %
Sample 2	80 %	79.79 %	79.55 %

Table 4.1.3 Weight after roasting

Variations	30 minutes	45 minutes	60 minutes
Sample 1	1311.6 g	1307.7 g	1304.1 g
Sample 2	1296 g	1292.7 g	1288.8 g

3. Grinding: The 2 samples of roasted nut were grinded into fine paste.

Table 4.1.4 Percentage of grinding

Variations	30 minutes	45 minutes	60 minutes
Sample 1	67.89 %	67.48 %	67.86 %
Sample 2	68.18 %	67.51 %	67.65 %

TABLE 4.1.5 Weight after grinding-

Variations	30 minutes	45 minutes	60 minutes
Sample 1	890.5 g	882.5 g	885.1 g
Sample 2	883.7 g	872.7 g	872.0 g

Table 4.1.6 Colors of oil produced

Variations	30 minutes	45 minutes	60 minutes
Sample 1	Cream	Dark cream	Deep dark cream
Sample 2	Cream	Dark cream	Deep dark cream

Table 4.1.7 Percentage of oil extracted

Variations	30 minutes	45 minutes	60 minutes
Sample 1	54%	52.85%	52.35%
Sample 2	53.59%	52%	51.36%

4.2: Discussion of Result

During the extraction of Shea oil using local extraction method, the following processing steps was taken into due considerations and these were crushing, roasting and milling operations. The crushed samples were divided into 2 samples which were as a result of the sieve size used; the 2 crushed samples of particle sizes of 2.00mm and 2.36mm had an efficiency of 98.3% and 97.2% with the crushing time of 52 minutes and 42 minutes respectively.

The roasting was divided into 2 samples of particle size of 2.00mm and 2.36mm and each of these samples was roasted for 30 minutes, 45 minutes and 60 minutes respectively. Sample 1 had the percentage roasting efficiency of 80.1% for 30 minutes, 78.82% for 45 minutes and 79.55% for 60 minutes.

The grinding processing was divided into 2 samples and each of these samples for 30 minutes, 45 minutes and 60 minutes were grinded into fine paste which resulted to the percentage efficiency of grinding were Sample 1 produced 67.89% for 30 minutes, 67.48 for 45 minutes and 67.86% for 60 minutes. Sample 2 produced 68.18 % for 30 minutes, 67.51% for 45 minutes, and 67.65% for 60 minutes. The colors of oil produced for sample 1 and 2 were as follows, sample 1 and 2 for 30 minutes produced a cream like butter, for 45 minutes it produced a dark cream like butter and for 60 minutes produced a deep dark butter. This was as a result of the extended roasting time. The percentage efficiency for sample 1 for 30 minutes yielded 54%, 45 minutes for 52.8% and 60 minutes 52.36% while for sample 2 for 30 minutes yielded 53.69%, 45 minutes for 52% and 60 minutes 51.36%. Sample 1 for 30 minutes is recommended for use because of its color and the percentage efficiency during the cause of production.

CHAPTER FIVE

5.0 CONCLUSION

From the result of the analysis carried out on the oil extracted from the local extraction method, the two processing samples considered in the production of Shea oil from Shea nut were varied and its effect on the yield and colors of oil were evaluated. The result shows that the crushing size and roasting time has effect on the yield of Shea oil. Sample 1 which had the sieve size of 2.00mm produced higher yield and also 30 minutes of roasting which was the shortest time of roasting has higher yield. It is also observed that the higher the roasting time, the lower the yield of oil and the quality of oil extracted which is as a result of the black roasted nut due to extended roasting time.

Oil produced locally attracts more market value because Shea users are sure that there are no additives added during the cause of production.

5.1 RECOMMENDATION

Further research is recommended in the following areas:

1. Modification of Shea roaster for efficient roasting
2. The effect of air pollution constituted during roasting process on human health.
3. Characterization of Shea butter manufactured using local extraction method.

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APPENDIX

Total nuts used= 20000g

CRUSHING

Variations	Sample1	Sample2
Diameter of sieve used	10000g	10000g
Weight of nut before crushing	9830g	9720g
Time of crushing	52 minutes	48 minutes
% efficiency of crushing	98.3%	97.2%

Efficiency of crushing= $\frac{weight\ of\ nut\ after\ crushing}{weight\ of\ nut\ before\ crushing} \times 100$

For sample 1= $\frac{9830}{10000} \times 100 = 98.3\%$

For sample 2= $\frac{9720}{10000} \times 100 = 97.2\%$

9830 for sample 1.

Dividing $\frac{9830}{2} = 4915$

4915= sample 1 a1

4915= sample1 a2

To get average of sample 1= sample 1 (a1) + sample 1(a2).

To get average of sample 2= sample 2 (a1) + sample 2(a2).

Diving= $\frac{9720}{2} = 4860.$

4860= sample 2 a.

4860= sample 2 a2.

ROASTING- First roasting for sample 1 a1

Sample 1	**30 minutes**	**45 minutes**	**60 minutes**
Weight before roasting	1638.3g	1638.3g	1638.3g
Weight after roasting	1310.6g	1307.5g	1303.2g
Time for heat to circulate before roasting	5 minutes	5 minutes	5 minutes
Efficiency (%)	80%	79.80%	79.54%

Efficiency = $\frac{weight\ of\ nut\ after\ roasting}{weight\ of\ nut\ before\ roasting} \times 100$

For 30 minutes= $\frac{1310.6}{1638.3} \times 100 = 80\%$

For 45 minutes= $\frac{1307.5}{1638.3} \times 100 = 79.80\%$

For 60 minutes= $\frac{1303.2}{1638.3} \times 100 = 79.54\%$

ROASTING- Second roasting for sample 1 a2

Sample 1	**30 minutes**	**45 minutes**	**60 minutes**
Weight before roasting	1638.3g	1638.3g	1638.3g
Weight after roasting	1312.6g	1307.9g	1304.9g
Time for heat to circulate before roasting	5 minutes	5 minutes	5 minutes
Efficiency (%)	80.11%	79.83%	79.64%

$$\text{Efficiency} = \frac{weight\ of\ nut\ after\ roasting}{weight\ of\ nut\ before\ roasting} \times 100$$

For 30 minutes$= \frac{1312.5}{1638.3} \times 100 = 80.11\%$

For 45 minutes$= \frac{1307.9}{1638.3} \times 100 = 79.83\%$

For 60 minutes$= \frac{1304.9}{1638.3} \times 100 = 79.64\%$

Percentage (%) average for sample 1 a1+ 1 a2

For 30 minutes $=\frac{80+80.11}{2} = 80.05\%$

For 45 minutes$=\frac{79.80+79.83}{2} = 79.82\%$

For 60 minutes $= \frac{79.64+79.54}{2} = 79.67\%$

Weight average after sample 1 a1 +1 a2

For 30 minutes $=\frac{1310.6+1312.5}{2} = 1311.6g$

For 45 minutes$=\frac{1307.5+1307.9}{2} = 1307.7g$

For 60 minutes $= \frac{1303.2+1304.9}{2} = 1304.05g.$

ROASTING- **First roasting for sample 2 a1**

Sample 1	30 minutes	45 minutes	60 minutes
Weight before roasting	1620.0g	1620.0g	1620.0g
Weight after roasting	1312.2g	1309.9g	1307.0g
Time for heat to circulate before roasting	5 minutes	5 minutes	5 minutes
Efficiency %	80.99%	80.85%	80.68%

$$\text{Efficiency} = \frac{weight\ of\ nut\ after\ roasting}{weight\ of\ nut\ before\ roasting} \times 100$$

For 30 minutes$= \frac{1312.2}{1620.0} \times 100 = 80.99\%$

For 45 minutes$= \frac{1309.9}{1620.0} \times 100 = 80.85\%$

For 60 minutes$= \frac{1304.9}{1620.0} \times 100 = 80.68\%$

ROASTING- **Second roasting for sample 2 a2**

Sample 1	30 minutes	45 minutes	60 minutes
Weight before roasting	1620.0g	1620.0g	1620.0g
Weight after roasting	1279.8g	1275.5g	1270.5g
Time for heat to circulate before roasting	5 minutes	5 minutes	5 minutes
Efficiency (%)	78.99%	78.73%	78.42%

$$\text{Efficiency} = \frac{weight\ of\ nut\ after\ roasting}{weight\ of\ nut\ before\ roasting} \times 100$$

For 30 minutes $= \frac{1279.8}{1620.0} \times 100 = 78.99\%$

For 45 minutes $= \frac{1275.5}{1620.0} \times 100 = 78.73\%$

For 60 minutes $= \frac{1270.5}{1620.0} \times 100 = 78.42\%$

Percentage (%) average for sample 2 a1+ 2 a2

For 30 minutes $=\frac{81+79}{2} = 80\%$

For 45 minutes$=\frac{80.85+78.73}{2} = 79.79\%$

For 60 minutes $= \frac{80.68+78.42}{2} = 79.55\%$

Weight average after sample 2 a1 +2 a2

For 30 minutes $=\frac{1312.2+1279.8}{2} = 1296g$

For 45 minutes$=\frac{1309.9+1275.5}{2} = 1292.7g$

For 60 minutes $= \frac{1307+1270.5}{2} = 1288.8g.$

GRINDING- **First grinding for sample 1(g1).**

Sample 1	30 minutes	45 minutes	60 minutes
Weight before grinding	1310.6g	1307.5g	1303.2g
Weight after grinding	895.1g	890.5g	892.9g
colour	Brown	Dark brown	Deep dark brown
Efficiency (%)	68.29%	68.10%	68.51%

$$\text{Efficiency} = \frac{weight\ of\ nut\ after\ grinding}{weight\ of\ nut\ before\ grinding} \times 100$$

For 30 minutes= $\frac{895.1}{1310.6} \times 100 = 68.29\%$

For 45 minutes= $\frac{890.5}{1307.5} \times 100 = 68.10\%$

For 60 minutes= $\frac{892.9}{1303.2} \times 100 = = 68.51\%$

Second grinding for sample 1(g1).

Sample 1	30 minutes	45 minutes	60 minutes
Weight before grinding	1312.5g	1307.9g	1304.9g
Weight after grinding	885.9g	874.5g	877.3g
colour	Brown	Dark brown	Deep dark brown
Efficiency (%)	67.49%	66.86%	67.23%

$$\text{Efficiency} = \frac{\textit{weight of nut after grinding}}{\textit{weight of nut before grinding}} \times 100$$

For 30 minutes= $\frac{885.1}{1312.5} \times 100 = 67.49\%$

For 45 minutes= $\frac{874.5}{1307.9} \times 100 = 66.86\%$

For 60 minutes= $\frac{877.3}{1304.9} \times 100 = = 67.23\%$

Percentage (%) average for grinding sample 1 g1+ 1 g2

For 30 minutes $= \frac{68.29+67.49}{2} = 67.89\%$

For 45 minutes $= \frac{68.10+66.86}{2} = 67.48\%$

For 60 minutes $= \frac{68.51+67.32}{2} = 67.86\%$

Weight average after grinding sample 1 g1 +1 g2

For 30 minutes $= \frac{885.9+895.1}{2} = 890.5g$

For 45 minutes $= \frac{874.5+890.5}{2} = 882.5g$

For 60 minutes $= \frac{877.3+892.9}{2} = 885.2g$

GRINDING: Second grinding for sample 1(g1).

Sample 1	30 minutes	45 minutes	60 minutes
Weight before grinding	1312.2g	1309.9g	1307g
Weight after grinding	898.5g	883.0g	889.9g
colour	Brown	Dark brown	Deep dark brown
Efficiency (%)	68.47%	67.40%	68.08%

$$\text{Efficiency} = \frac{\textit{weight of nut after grinding}}{\textit{weight of nut before grinding}} \times 100$$

For 30 minutes= $\frac{898.5}{1312.2} \times 100 = 68.47\%$

For 45 minutes= $\frac{883}{1309.9} \times 100 = 67.40\%$

For 60 minutes= $\frac{889.9}{1307} \times 100 = = 68.08\%$

Second grinding for sample 2 (g2).

Sample 1	30 minutes	45 minutes	60 minutes
Weight before grinding	1279.8g	1275.5g	1270.5g
Weight after grinding	868.9g	862.5g	854.2g
colour	Brown	Dark brown	Deep dark brown
Efficiency (%)	67.89%	67.62%	67.23%

$$\text{Efficiency} = \frac{weight\ of\ nut\ after\ grinding}{weight\ of\ nut\ before\ grinding} \times 100$$

For 30 minutes= $\frac{868.9}{1279.8} \times 100 = 67.89\%$

For 45 minutes= $\frac{862.5}{1275.5} \times 100 = 67.62\%$

For 60 minutes= $\frac{854.2}{1207.5} \times 100 = = 67.23\%$

Percentage (%) average for grinding sample 2 g1+ 2 g2

For 30 minutes $= \frac{68.47+67.89}{2} = 68.18\%$

For 45 minutes $= \frac{67.40+67.62}{2} = 67.51\%$

For 60 minutes $= \frac{68.08+67.23}{2} = 67.65\%$

Weight average after grinding sample 2 g1 + 2g2

For 30 minutes $= \frac{898.5+868.9}{2} = 883.7g$

For 45 minutes $= \frac{883.0.0+862.5}{2} = 872.75g$

For 60 minutes $= \frac{889.9+854.2}{2} = 872.05g$

Percentage of oil efficiency for sample 1a and 1b.

Percentage of oil efficiency= $\frac{weight\ of\ oil\ extracted}{weight\ of\ shea\ nut\ used} \times \frac{100}{1}$

Sample 1 a

For 30 minutes= $\frac{882.1}{1638.3} \times \frac{100}{1}$ =53.8%

Sample 1b

For 30 minutes= $\frac{875.6}{1638.3} \times \frac{100}{1}$ =53.44%

Sample 1a

For 45 minutes = $\frac{870.2}{1638.3} \times \frac{100}{1}$ =53.11%

Sample 1b

For 45 minutes = $\frac{862.8}{1638.3} \times \frac{100}{1}$ =52.6%

Sample 1a

For 60 minutes= $\frac{873.4}{1638.3} \times \frac{100}{1}$ =53.1%

Sample 1b

For 60 minutes= $\frac{845.3}{1638.3} \times \frac{100}{1}$ =51.6%

Percentage (%) average for the efficiency of sample 1a and 1b

For 30 minutes = $\frac{53.8+53.44}{2}$ = 54%

For 45 minutes= $\frac{53.1+51.6}{2}$ = 52.85%

For 60 minutes $= \frac{53.1+51.6}{2} = 52.35\%$

Percentage of oil efficiency for sample 2a and 1b.

Percentage of oil efficiency$= \frac{weight\ of\ oil\ extracted}{weight\ of\ shea\ nut\ used} \times \frac{100}{1}$

Sample 2 a

For 30 minutes$= \frac{887.76}{1620.03} \times \frac{100}{1} = 54.8\%$

Sample 2b

For 30 minutes$= \frac{852.0}{1620.03} \times \frac{100}{1} = 52.59\%$

Sample 2a

For 45 minutes $= \frac{835}{1620.03} \times \frac{100}{1} = 51.6\%$

Sample 2b

For 45 minutes $= \frac{849.36}{1620.03} \times \frac{100}{1} = 52.4\%$

Sample 2a

For 60 minutes$= \frac{824.73}{1620.03} \times \frac{100}{1} = 50.9\%$

Sample 2b

For 60 minutes$= \frac{840.1}{1620.03} \times \frac{100}{1} = 51.86\%$

Percentage (%) average for the efficiency of sample 2a and 2b

For 30 minutes $= \frac{54.8+52.59}{2} = 53.69\%$

For 45 minutes $= \frac{52.4+51.6}{2} = 52\%$

For 60 minutes $= \frac{51.86+50.9}{2} = 51.36\%$