EXTRACTION AND CHARACTERIZATION OF BUTTER FROM SHEA NUT

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Abstract

This paper is aimed at the extraction and characterization of shea butter from shea nut. The oil was extracted by solvent extraction method using hexane as the solvent. Statistical analysis using ANOVA was used to test the significance of the extraction process parameters such as temperature, time and particle size on the yield of the oil. The results showed that an optimum extraction temperature (74.3 ^oC), time (74.23 min) and particle size (0.29 mm) gave an optimum yield of 49.575%. The extracted oil was characterized by testing the physiochemical properties and the results revealed tha density (0.938 g/cm^3), specific gravity (0.94), melting point (33 ^oC), refractive index (1.48), iodine value (43.5 mg/kg), saponificatioin value (191.4 mgKOH/g), peroxide value (8.88 meq/kg), acid value (4.91mgKOH/g), pH (6.61), viscosity (81.97 cst) and free fatty acid (2.45%). These results compared favourably well with the acceptable standards for commercial oil. Furthermore, the compositions of the produced oil were verified using Gas Chromatography Mass Spectrometry (GC-MS) analysis. The percentage compositions of the major fatty acid from GC-MS were benzoic acid (0.25%), ethyl oleate (8.40%), oleic acid (13.54%), stearic acid (11.92%), palmitic acid (20.36%), octadecanoic acid (11.38%), hexadecanoic acid (6.90%), 1,3-decaprin (5.18%), α-amyrin (4.71%), and vitamin E (4.05%). The results of both the physiochemical properties and GC-MS analysis revealed that the oil produced can be utilized commercially.

Keywords: Process, Extraction, Characterization, Butter, Shea Nut,

Introduction

The increase demand of shea butter and its product globally has contributed immensely in its traditional household and small scale production in countries

where it is present. This production method is laborious, time consuming and tedious. Also the shea butter obtained is of low grade and quality as result of contamination from either the type of equipment used or the processing method adopted. In other to address all these shortcomings a mechanised shea butter production plant was developed (alhaji et al., 2018)

Shea butter is a high–value shea nut fat used as an edible oil, antimicrobial and moisturiser in the food, pharmaceutical and cosmetic industries, respectively. The annual worldwide export of shea nut from Africa is 350,000 MT of kernels with a market value of approximately $120 million to producing countries. Standard extraction technologies: the traditional, mechanized, enzymatic and chemical methods were used for shea butter extraction. (Iddrisu et al., 2019)

Worldwide, natural vegetable oils and fats are increasingly becoming important in nutrition and commerce because they are sources of dietary energy, antioxidants, biofuels and raw materials for the manufacture of industrial products. They are used in food, cosmetics, pharmaceuticals and chemical industries. Vegetable oils account for 80% of the world's natural oils and fat supply (Asuquo *et al.*,2010).

The search for alternatives to antibiotics is generally a global challenge to the scientific community. Several reasons have been advanced for the need for alternations to antibiotics. This may include toxicity, emergences of resistant variants, allergic among a host of others (Etim *et al.*, 2012).

Shea butter oil (*Butyrospermumparkii*is) a soft paste of melted fat with a milky colour in solid form and brownish when melted. It has a characteristic odour. It contains fatty acid triglyceride and a high amount of unsaponifiable matter, which ranges from 2.5% to 15% (Eka, 1997). This exceptionally rich vegetable extract contains fatty acids, phytosterol and unsaponifiable matter which stimulate the skin's natural renewal process. The composition of the product depends on several criteria particularly the geographical occurence, its botanical origin, handling of the seeds and processing e.g drying time, ripening (Asintoke, 1987). The shea butter fat can also be used in soap making, cosmetics and traditional medicine in many rural areas, (Maranz *et al*., 2004, Alander, 2004).

Shea tree usually grows to an average height of 15m. It produces it first fruit when it is about 20 years old and reaches its full production when it is about 45 years old. It produces nuts for up to 200 years after reaching maturity. The tree grows profuse branches and a thick waxy and deeply fissured bark and that

makes it fire resistant. *Butyrospermumparkii* tree flower between January to April and develops it fruits which ripen and fall down in June to August. The mesocarp of the fruit is eaten and the kernels are extracted for oil (Wayne Kihz, 2001).

Over the past century, a number of synthetic antimicrobial agents have been discovered and developed, but drug resistance and toxicity are still the major hindrances to gaining successful therapeutic outcomes in many instances. Herbal medicines may represent a safe and useful supplement to existing chemotherapeutic therapies for the management of infectious diseases (Etim *et al.*, 2012).

Many researchers have studied the extraction of shear butter from the nut, they include; Asuquo et al., (2010), who reported the physiochemical properties of the shear butter. Their result revealed that there are changes in the physico-chemical composition of the oils as a result of environmental factors such as rainfall, soil fertility, maturatiin period, agronomic practices and genetic substitution. In addition, sonau et al., (2006) had earlier discovered the variation in the physico-chemical properties as a function of the botanical occurrence, botanical origin of the tree as well as handling and processing of the seeds in terms of drying time and ripening.

Divine et al., (2016) in his work, studied and reported the effect of heating time, temperature and solven/solute ration on the quantity and acid number of the oil using microwave assisted extraction method. The result showed an optimum heating time of 23 min, temperature of 75oC and solvent/solute of 4:1.

Prasanna and Rahul (2018) reported and reviewed different methods of extraction of essential oils and studied various parameters such as solvent to feed ratio, temperature, size of the raw materials and time of extraction. The authors inferred that all these parameters have influence on the yield and quality of the extracted oil. They concluded that hydro-distillation method found to be most suitable method for the extraction of essential oils that are temperature sensitive. The multifunctional properties of the shea butter depend strictly on its compositional properties: the peroxide value, moisture content, free fatty acid level and the insoluble impurities. In addition to these properties, the compositions of the shear the components and compositions of the shear need to be studied to evaluate which of the components are responsible for these

multifunction behaviour of the oil. Therefore, this paper dwell on the studies of these components as well as parameters responsible for yield of the oil.

Materials and methods

Preliminary Operation

Dried shea nuts were purchased from Bida, in Niger State. The nuts were cracked and the Shea seed was further sun-dried before it was dried scientifically using Hot Air Seed Dryer to completely remove the water content of the seed at 60^{o}C. The seed was weighed to obtain a constant weight. The dried seed was manually grinded using mortar and pestle to reduce the size. Sieve was used to obtain varying sizes of 0.45mm and 0.90mm of shea particle to enhance effective extraction of the oil

Extraction of Oil from Shea Nut Using Solvent Extraction Method

In the experiment, 30g of 0.45mm particle size of the prepared shea nut particles was placed in a wrapped cloth (handkerchief) in place of the thimble and placed into the received portion of the soxhlet extractor. 150ml of n-hexane was poured into the flask and placed on an electro thermal heating mantle. The soxhlet extractor was connected with a condenser having rubber tubing for inlet and outlet water flow for cooling. A retort stand was used to hold the setup in position and the vent of the condenser was made air tight to stop the escape of the vaporized solvent.

The extraction process commenced by switching on the heating mantle which was regulated to a temperature below the boiling point of the solvent used (n-hexane 60°C and 75°C). The cooling water was allowed to run so as to condense the solvent vapor which comes in contact with the sample (Shea nut particles), the solvent then leaches out the oil from the sample forming a mixture of oil and solvent otherwise known as miscella.

The miscella automatically siphoned back into the boiling solvent in the flask then cycles back leaving oil behind in the flask. It continued until the extraction time was 60mins and 80mins then, the heat supplied was switched off, the setup was allowed to cool for the raffinate in the handkerchief to be removed. The miscella was subjected to evaporation to recover the solvent and oil.

The same procedure above was repeated by for different runs of experiment by varying the sizes(0.45mm and 0.90mm), temperature(60°C and 75°C) and extraction time (60mins and 80mins) and the result was recorded.

Physio-Chemical Characterization

pH Determination:

Two grams (2g) of the sample was poured into a clean dry 25 ml beaker and 13 ml of hot distilled water was added to the sample in the beaker and stirred slowly. It was then cooled in a cold water bath to 25°C. The pH electrode was standardized with buffer solution and the electrode immersed into the sample. The pH value was read and recorded (Akpan *et al.,* 2005).

Moisture Content Determination:

Fifty grams (50 g) of the cleaned sample was weighed and dried in an oven at 80 °C. After every 2 hours, the sample was removed from the oven and placed in the desiccator for 30 minutes to cool. It was then removed and weighed (Akpan*et al.,* 2005).

The percentage moisture in the seed was then calculated from:

$$Moisture\ Content = \frac{(100(W_1 - W_2)}{W_1}\ \% \ldots\ldots 1$$

where;

W_1 = Original weight of sample before drying (g),

W_2 = Weight of sample after drying (g)

Specific Gravity Determination:

The specific gravity bottle was cleaned with acetone, ether and dried in an oven at 60^{o}C. The weight of the empty bottle was taken, after which the bottle was filled with the oil sample and properly covered. The weight was then recorded using a weighing balance, after which the sample was removed from the bottle. The bottle was properly washed and filled with distilled water, after which the weight was taken and finally, the specific gravity was computed using the relationship below (Akpan *et al.,* 2005).

$$\text{Specific Gravity} = \frac{Wo - W}{W1 - W} \ldots\ldots 2$$

where,

W = Weight of empty bottle (g),

Wo = weight of the bottle and oil content (g),
W_1 = Weight of bottle and water content (g).

Acid Value Determination:

Two (2) grams of the oil sample was dissolved in 50 cm^3 of mixed neutral solvent (25ml diethyl ether with 25ml ethanol carefully neutralized with 0.1M KOH using 1% phenolphthalein solution). The mixture was titrated with 0.1M KOH aqueous solution with constant shaking to faint pink colour (Akpan *et al.*, 2005).

$$Acid\ value = \frac{Titre\ value \times 5.61 \times 0.1}{weight\ of\ sample\ (g)} = mgKOH/g \quad \text{..... 3}$$

***Free Fatty Acid Determination*:**

The amount of free fatty acid (FFA) was calculated as being equivalent to half the value of acid value (Akpan*et al.*, 2005), that is,

$$\text{FFA} = \frac{Acid\ value}{2} = mgKOH/g \quad \text{.....4}$$

***Saponification Value Determination*:**

0.5 M KOH was prepared in 95 % ethanol, 2g of oil sample was weighed and 25ml of 0.5M ethanoic potassium hydroxide was added, 25ml of the blank solution was also measured into a conical flask. The flask was sealed and heated in the oven for 5mins at 105ºC. 1 ml of phenolphthalein was added to the mixture and the resulting mixture was titrated while hot against 0.5 M HCl acid solution. The volume of the acid used to attain the end point was recorded, the blank determination was carried out using the same procedure described above until the colour changes from blue to transparent white, then the volume of acid used was noted, the Saponification value was determined using the relationship below (Akpan *et al.*, 2005).

$$Saponification\ value = \frac{56.1 \times T(Vo - V1)}{M} \quad \text{..... 5}$$

Where,
T= Molarity of the standard KOH solution used (M)
Vo = Volume of acid used for the first titration with oil sample (ml),
V_1= Volume of acid used for the second titration of the blank solution (ml),
M= Mass of the oil sample used (g).

Peroxide Value Determination:

A known weight (2g) of sample was weighed into clean dried boiling tube, 1 gram of potassium iodine (KI) powder was added to the oil and 20ml of the solvent mixture (i.e, glacia acetic acid and chloroform in the ratio 2:1). Then the boiling tube was placed in boiling water bath so that the liquid mixture boils within 30 seconds and allowed to boil vigorously for not more than 30 seconds, the content after boiling was quickly poured into a flask containing 20 ml of 5 % potassium iodine (KI) solution and the tube was washed out twice with 25 cm^3 of water. Then the mixture was titrated with 0.01 M sodium thiosulphate until a colour change was obtained. blank titration was carried out at the same time, the peroxide value was determined using the relationship below (Akpan *et al.*, 2005).

$$Peroxide\ value = \frac{T \times M \times 1000}{weight\ of\ sample\ (g)} \quad \text{.....6}$$

Where

T = titre value of $Na_2S_2O_3$ = Sample titre – Blank titre,

M = Molarity of $Na_2S_2O_3$

Refractive Index Determination:

The refractive index was determined using Abbey refractometers. The glass prism of the refractometer was thoroughly cleaned with alcohol to ensure that it is free from dust, a drop of oil sample was placed on the lower prism and smeared, then closed with the other covering prism and the light source of the refractometers was switched on, while viewing through the telescope. The coarse adjustment knob was rotated until the black shadow appears central in the cross wire indicator and while still viewing through the telescope, the fine knob adjustment was made until the rainbow-coloured fringe which appeared on the black dividing line disappeared, the coarse knob was rotated to give fine adjustment and make the black shadow appear exactly central in the cross wire indicator. The reading under the telescope and that of the fine adjustment knob were noted and divided by 10,000, this value was then added to the value obtained through the telescope to give the value of the refractive index of the oil at room temperature (Akpan*et al.*, 2005).

GC-MS analysis

GC-MS is a unique analysis technique used for identification and quantification which is limited to analytes that are not only volatile and thermally labile but can also withstand the harsh partitioning conditions of the gas chromatograph.

A representative spectral output of all the ascertainable compounds from the empirical sample is displayed by this technique. The Gas-chromatography device has an injection port from where the process is initiated by injecting the sample to that port. After this, evaporation and separation of the components take place one by one and finally this equipment identifies the components present in the corresponding sample. A specific spectral pick is produced for each component which is recorded on a paper chart electronically.

Results and Discussions

Design of Experiment and Statistical Analysis

The experimental design of three process conditions with two levels for each, gave total number of 8 runs of experiment based on full Factorial design. The Statistical analysis was carried out using STATISTICA V10 software. The process conditions considered at high and low levels were: the temperature A, (60 ^{o}C and 75^{o}C), particle size B,(0.45mm and 0.90mm) and extraction time C,(60min and 80 min). The choice of the levels for the process parameters were based on existing literature for the extraction of essential oil using solvent extraction. The full factorial design of the experiment and the yield of the extracted oil is presented in table 3.1.

Table 3.1. Full Factorial Design of experiment

No of runs	Temperature (^{o}C)	Particle Size (mm)	Time (mins)	Yield of oil (%)
1	60	0.45	60	36.0
2	60	0.45	80	39.7
3	60	0.90	60	24.6
4	60	0.90	80	27.3
5	75	0.45	60	42.7
6	75	0.45	80	45.7
7	75	0.90	60	31.0
8	75	0.90	80	33.3

Table 3.1 shows the experimental design of three process conditions. From the table, it was observed that lowest percentage yield of oil was 24.6% at the third run of the experiment where the temperature and extraction time were at low

levels of 60^{o}C and 60mins respectively, and the particle size was at a high level of 0.90mm. It was also observed that the percentage yield of oil was highest (45.6%) at the sixth run of the experiment where the temperature and extraction time were at high levels of 80^{o}C and 80mins respectively, and the particle size was at a low level of 0.45mm. This shows that higher temperature and time favours higher yield of oil, because, at higher temperature, more penetration of the solvent resulted as a result of pore openings resulting in more production. However, at lower particle size leads to higher surface area giving room for more contact between the solvent and the solute.

Analysis of variance (ANOVA)

The result of the ANOVA for fitting the quadratic response surface model by a mean square method are summarize in Table 3.2 The effect, standard error and t-values of the factors were all evaluated. The significance of each of the coefficients are checked from p-values, which also indicates the interaction strength of each parameter. The result is presented in table 3.2

Table 3.2: Effect of Standard error, t-values, and p-values of the factors

Factor	Effect	Std. Err.	t- value	p-value	Remark
Mean/Intercept	35.0375	0.0375	934.3330	0.000681	Significant
A-Temperature(^{o}C)	6.2750	0.0750	83.6670	0.007609	Significant
B- Particle size (mm)	-11.9750	0.0750	-159.667	0.003987	Significant
C- Time (mins)	2.9250	0.0750	39.000	0.016320	Significant
AB	0.0750	0.0750	-1.000	0.500000	Insignificant
AC	0.2750	0.0750	-3.667	0.169501	Insignificant
BC	0.4250	0.0750	-5.667	0.111200	Insignificant
R^2	**0.99997**				
Adjusted R^2	**0.99979**				
Residual	**0.1125**				

Table 3.2 shows the analysis of variance (ANOVA) generated by STATISTICA V10 software. From the table, it could be observed that the p-value for the

mean/intercept was 0.000681, while that for the temperature, particle size and extraction time were 0.007609, 0.003987 and 0.016320 respectively. The p-value of the combined effect of temperature/particles size, temperature/time, particle size/time were 0.5000, 0.1695, 0.1112 respectively. This show that the individual effects of the factors on the percentage yield of the oil was significant since the p-values were less than 0.05, while the combined effects of the factors are insignificant (p-values greater than 0.05). From the Pareto chart in Fig. 3.1, it shows that particle size has the highest effect on the yield of oil. The regression coefficients from table 3.2 was used to for the model equation for the percentage yield of oil.

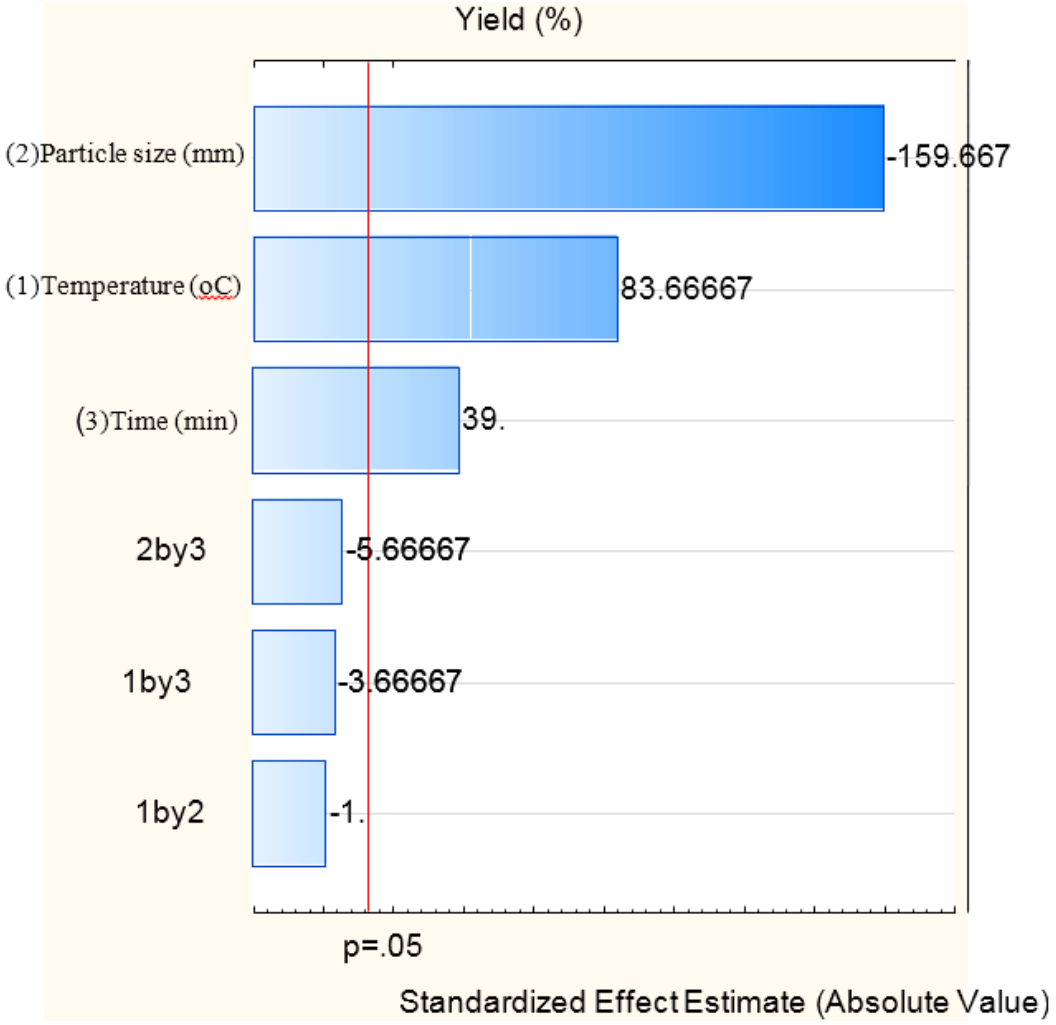


Figure 3.1: Pareto Chart of Standardized Effects Variables

Table 3.3: Regression Coefficients for the Model Equation.

Factor	Regression coefficient	Std. Err.	95% Cnf limit Low	95% Cnf limit High
Mean/Intercept	0.3875	2.7248	-34.2322	35.0072
A-Temperature(ºC)	0.5617	0.0384	0.0737	1.0497
B- Particle size (mm)	-18.5000	1.9076	-42.7382	5.7382
C- Time (mins)	0.3338	0.0358	-0.1208	0.7883
AB	-0.0222	0.0222	-0.3046	0.2601
AC	-0.0018	0.0005	-0.0082	0.0045
BC	-0.0933	0.0167	-0.3062	0.1173
R^2	**0.99997**			
Adjusted R^2	**0.99979**			
Residual	0.01125			

$Y = \beta_o+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_1x_1^2+\beta_2x_2^2+\beta_3x_3^2+\beta_1x_1x_2+ \beta_2x_1x_3+\beta_3x_2x_3$ (3.1)

Where:X_1, X_2, X_3=are the independent variables. Y=the dependent variable β_o=is the offset or constant term or center points while

β_1= is the i^{th} lnear coefficient

$\beta_2$andβ_3=are quadratic and interaction coefficients respectively.

$Yield(\%)=0.3875+0.5617x_1–18.5000x_2+0.3338x_3–0.0222x_1x_2-0.0018x_1x_3-0.0944x_2x_3$ (3.2)

Where:X_1=Temperature, X_2=Particlesize, X_3=Time

Table 3.4: Multiple Regression summary of Optimum Input Parameters

Factor	Coded Parameters	Uncoded Parameters
Temperature (ºC)	0.453332	74.3000
Particle size (mm)	-0.865124	0.2900
Extraction Time (mins)	0.211314	74.2300

Table 3.4 shows multiple Regression summary of Optimum Input Parameters for both coded and un coded parameters. The optimum temperature, particle size and extraction time were 74.30ºC, 0.29mm and 74.23mins respectively.

The optimum oil yield was deduced to be 49.575%. However, the regression model of the shea butter yield in terms of coded factors (Equation 3.1) is suitable for making predictions about the response for given levels of each factor.

The model equation was also evaluated based on the regression coefficients, R^2, Adjusted R^2 of the model because R^2 value is a measure of the adequecy of a model which lies between 0 and 1. and the closer the R^2 value is to 1, the better the model prediction (Montgomery, 2013). The R^2. Adjusted R^2 are (0.99997 and 0.99979 respectively for the model. This implies that 99.997% of the data can be explained or analysed by the model and this high value of (0.99997), suggest the high significance and fitness of the model and that the developed model is very good for predicting the response (Jia *et. al.*, 2018)

The factors that will be maximized the shear butter yield were also evaluated using 3D surface plot to explore the relationship between the three factors on a single plot and to view the x and y factors that produce the desired response values. The surface plots were useful in the regression analysis for viewing the relationship among dependent and two independent factors. The 3D surface plot that depicts the interaction among the factors and their responses shear butter yield are shown in figures 3.2 to 3.4.

Yield(%) = $0.3875+0.5617x_1–18.5000x_2+0.3338x_3–0.0222x_1x_2-0.0018x_1x_3-0.0944x_2x_3$

Optimum Yield(%) = $0.3875 + 0.5617(74.3)–18.5000(0.29)+0.3338(74.23)-0.0222(74.3)(0.29)$

$- 0.0018(74.3)(74.23) - 0.0944(0.29)(74.23)$

Optimum Yield(%) = 49.575%

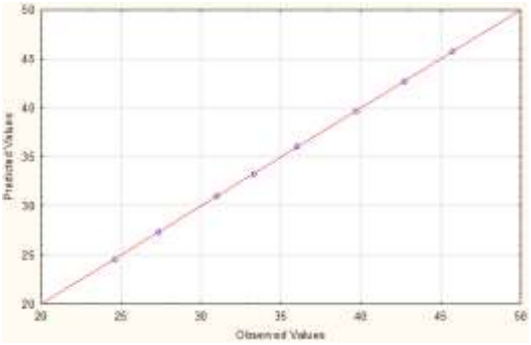


Figure 3.2: A Plot of Predicted values against Observed values of the Standardized Effects for Yield Response.

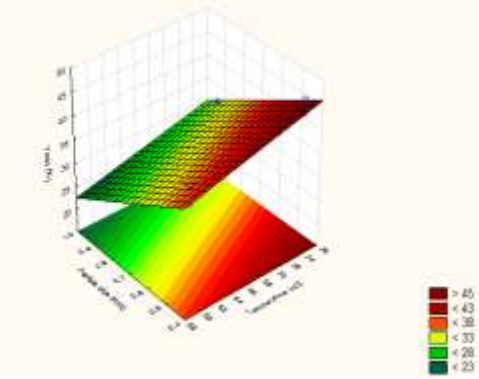


Figure 3.3: Effect of Particle size and temperature on yield of oil

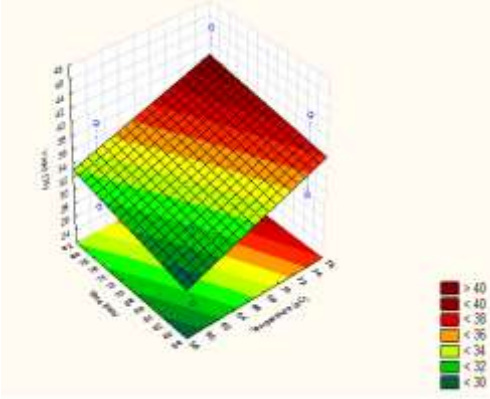


Figure 3.4: Effect of extraction time and temperature on yield of oil

From Figure 3.2, it was observed that decrease in particle size from 1.0-0.4mm with a corresponding rise in temperature from 58ºC-76°C results in a corresponding increase in shea butter yield to attain a maximum yield greater than 45% but less than 50% at 0.4mm and 76ºC This implies that increase in temperature and corresponding decrease in particle size increase the yield of shea butter. Figure 3.3 revealed that an increase in time from 58min-82min with a corresponding rise in temperature from 58 ºC - 76°C results in a corresponding increase in shea butter yield to attain a maximum yield greater than 42% but less than 44% at 82mm and 76^0C This implies that increase in temperature and corresponding increase in time increase the yield of shea butter.

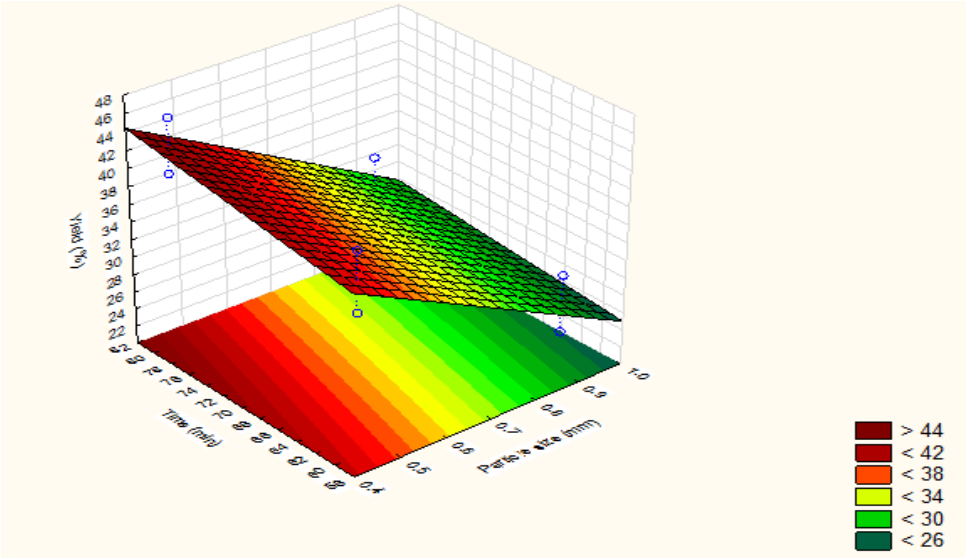


Figure 3.5: Effect of Extraction Time and Particle Size on yield of oil

From figure 3.5, it was observed that the decrease in particle size from 1.0-0.4 mm with corresponding rise in time from 58 min -82 min results with a corresponding rise in time from figure 3.5, it was also observed that a decrease in particle size from 1.0 to 0.4 mm of the shea butter particles favours high yield of shea butter. However, an increase in extraction time from 58 min to 82 min results in a corresponding rise in shea butter yield to attain a maximum yield greater than 44 % but less than 46 % at 0.4 mm and 76 oC. This implies that increase in time and corresponding increase in particle size increase the yield of sheabutter.

Physical and Chemical Properties of Extracted oil

Table 3.5: Physical Properties of Extracted Shea Oil

S/N	Parameter	Value	Literature Value
1.	pH	6.61	6.2-7.1
2.	Colour	Brownish yellow	Orange - Yellow
3.	Refractive index (40°C)	1.48	1.45 - 1.60
4.	Density (40°C)	0.938	0.906
5.	Specific gravity.	0.94	0.90 - 0.96
6.	Melting point	33^{o}C	34^{o}C - 36°C
7.	Viscosity at 40^{o}C (cSt)	81.97	83.73

Table 3.6: Chemical Properties of Extracted Shea Oil

S/N	Parameter	Value	Literature Value
1.	Saponification Value (mg/g)	191.4	189.9 ± 5
2.	Acid Value (mgKOH/goil)	4.91	2.3 ± 0.6
3.	Free Fatty Acid	2.45	-
4.	Iodine Value (mg/kg)	43.5	58.53 ± 6.1
5.	Peroxide Value(mEq/kg)	8.88	12.85

Table 3.5 shows the physical properties of the oil compared to the literature value. A pH of 6.61 was gotten, this tell that the oil is slightly acidic and the value obtained is within the standard range from literature. The colour of the extracted oil was brownish yellow. The refractive index, density and specific gravity at 40^{o}C were 1.48, 0.938 and 0.94 respectively and they also falls within

the range of the standard literature value. Since the specific gravity of the oil is less than one(1). Hence, this implies that the oil is less denser than water. The melting point of the oil was found to be 33ºC. A flow cup viscometer was used to determine the viscosity of the oil and it was found to be 81.93 centiStoke.
Table 3.6 shows the Chemical properties of the oil compared to the literature value. The Saponification Value obtained was 191.4 mgKOH/g. Hence, this shows that the oil may have a potential for use in soap making and cosmetic industry. The acid value is the amount of KOH in mg that would neutralize the free fatty acid in gram of the oil. The acid value and free fatty acid value were (4.91 and 2.45) mgKOH/goil respectively. The iodine value is a measure the degree of saturation of the oil. The iodine value obtained was 43.5mg/kg. Also, the peroxide value is a measure of its content oxygen. The peroxide value obtained was 8.81mEq/kg. The peroxide value obtained is slightly lower than the literature value. Hence, a lower peroxide value indicates a good quality of oil and good preservation status.

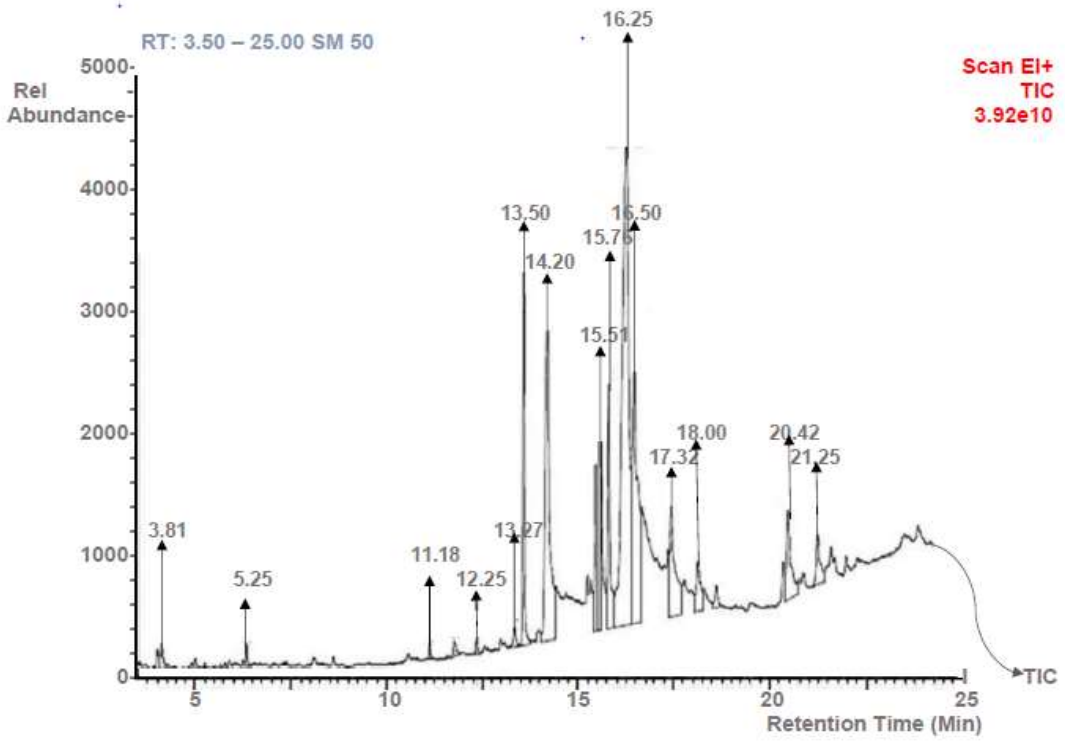
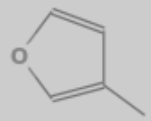
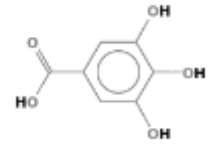
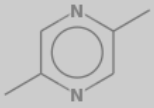
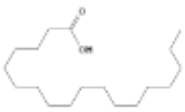


Fig 3.6: GC-MS Chromatogram of Shea butter

Table 3.7: Results of the Analyzed Chromatogram

Peak #	RT	Compound Detected	Mol. Formula	MW	Peak Area %	Comp %wt	m/z	Structures
1	3.81	Furan, 3-methyl-	C_5H_6O	82	0.88	1.64	53, 81, 82	
2	5.25	Benzoic acid, 3,4,5-trihydroxy-	$C_7H_6O_5$	170	0.97	0.25	125,153, 170	
3	11.18	Pyrazine, 2,5-dimethyl-	$C_6H_8N_2$	108	0.99	1.73	42, 81, 108	
4	12.25	11-Octadecenoic acid, (Z)-	$C_{18}H_{34}O_2$	282	1.16	1.29	56, 69, 282	
5	13.27	Methyl stearate	$C_{19}H_{38}O_2$	298	1.18	0.18	74, 87, 298	
6	13.50	Octadecanoic acid	$C_{18}H_{36}O_2$	284	7.18	8.06	43, 73, 284	
7	14.20	Oleic Acid	$C_{18}H_{34}O_2$	282	12.40	13.54	45, 55, 282	
8	15.51	Ethyl Oleate	$C_{20}H_{38}O_2$	310	7.91	8.40	43, 55, 310	

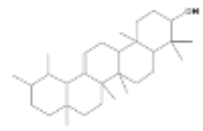
9	15.76	Stearic Acid	$C_{18}H_{32}O_2$	280	10.55	11.92	67, 81, 280	
10	16.25	Palmitic Acid	$C_{16}H_{32}O_2$	256	19.27	20.36	43, 73, 256	
11	16.50	Octadecanoic acid, ethyl ester	$C_{20}H_{40}O_2$	312	10.34	11.38	88, 101, 312	
12	17.32	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330	6.16	6.90	43, 98, 330	
13	18.00	1,3-Dicaprin	$C_{23}H_{46}O_2$	400	4.40	5.18	74, 87, 400	
14	20.42	α-Amyrin	$C_{30}H_{50}O$	426	5.32	4.71	55, 218, 426	
15	21.25	Vitamin E	$C_{29}H_{50}O_2$	430	4.42	4.05	43, 185, 430	

Table 3.7 shows the result of the analyzed chromatogram. The fatty acids obtained from the GC-MS fragments are described as follows; Oleic Acid (also known as cis-9-Octadecenoic acid, cis-Oleic acid, oleate, Elaidoic acid, Metaupon, Delsauere), an unsaturated fatty acid most widely distributed and abundant in nature. It is used commercially in the preparation of oleates and lotions, and as a pharmaceutical solvent Oleic Acid's high lipid count makes it a great moisturizer, and a number of cosmetic companies add it to lotions and soaps in order to boost their ability to nourish the skin.

Palmitic acid (Palmitic acid also known as n-Hexadecoic acid is mainly used to produce soaps, cosmetics, and release agents. These applications utilize sodium palmitate, Hydrogenation of palmitic acid yields cetyl alcohol, which is used to produce detergents and cosmetics.

Stearic acid was also obtained (stearic acid is among the most common saturated fatty acids, is a saturated fatty acid with an 18-carbon chain and has the IUPAC name octadecanoic acid, Stearic acid is mainly used in the production of detergents, soaps, and cosmetics such as shampoos and shaving cream products. Soaps are not made directly from stearic acid, but indirectly by saponification of triglycerides consisting of stearic acid esters. Esters of stearic acid with ethylene glycol, glycol stearate, and glycol distearate are used to produce a pearly effect in shampoos, soaps, and other cosmetic products. They are added to the product in molten form and allowed to crystallize under controlled conditions. Detergents are obtained from amides and quaternary alkylammonium derivatives of stearic acid. Surfactants, cosmetics and personal hygiene products are infact prospects of stearic acid.

Myristic Acid was another fatty acid obtained (also known as Tetradecanoic Acid) is a fatty acid found in the extracted oil. It has a variety of uses in the beauty industry, including as a: Fragrance Ingredient; Opacifying Agent; Surfactant; Cleansing Agent; and Emulsifier One of its primary properties is as a lubricant, due to its high rate of absorption by the skin. The ester, Isopropyl myristate is used in cosmetic and topical medicinal preparations where good absorption through the skin is desired. It is also used as a pesticide-free treatment against head lice which works by dissolving the wax that covers the exoskeleton of head lice, α-amyrin exhibits long-lasting antinociceptive and anti-inflammatory properties. Vitamin E has antioxidant properties. Antioxidants are substances that might protect your cells against the effects of free radicals — molecules produced when your body breaks down food or isexposed to tobacco smoke and radiation. Free radicals might play a role in heart disease, cancer and other diseases

Conclusions

From the result obtained from the work carried out, it can be concluded that;

The percentage oil recovery from seed of Butyrospernumparkii hexane ranges from 27.7% to 45.7% indicating that the oil can be extracted commercially using n-hexane.

The Optimum Conditions for maximizing the oil extraction are temperature (74.3^0C), particle size (0.29mm) and time (74.29mins). The extraction process has an Optimum shear butter yield of 49.575%.

The study showed temperature, particle size and time individually have significant effect on Shea butter yield but the interaction between the factors have insignificant effect on Shea butter yield.

The results of the physiochemical properties of the produced oil fall within the accepted limit values for oil. This shows that the produced oil is good both commercially and domestically.

From the results of GC-MS analysis of the shea butter sample, it can be concluded the shea nut fats have potential in the production of cosmetics, perfumery and pharmaceuticals.

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