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THE EFFECT OF EXTRACTION METHOD ON FATTY ACID PROFILE OF TRADITIONALLY AND MECHANICALLY EXTRACTED SHEA BUTTER SAMPLES FROM NASARAWA STATE

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ABSTRACT

Shea butter, a valuable plant fat has been extracted from the nuts of Shea tree. This study aim at determining the effect of extraction method on fatty acid profile of Shea butter samples from four local government areas of Nasarawa state, namely: Akwanga, Kokona, Nasarawa and Lafia. Two different methods were used for the extraction, which were the traditional and mechanical methods. The fatty acid profiles where analyzed using Gas Chromatography-Mass Spectroscopic (GC-MS) analytical method. The results obtained for fatty acid profile for the two extract varies. The butter extracted with the tradition method project three fatty acids which were oleic acid, ethyle oleate, and behehic acid while that of the mechanical methods detected seven fatty acids which were oleic acid, ethyl oleate, stearic acid, palmitic acid, linoleic acid, myristic acid, and pentadecanioc acid. While the traditional method project majorly oleic acid and its esters, the mechanical methods shows more of the fatty acids and their esters. The results of fatty acids profile therefore shows that, the traditional methods used in these region of Nasarawa state for the extraction of shea butter do not release all the fatty acids in the extracts and needs to be modernized so as to obtain shea butter of best quality.

Keywords: Shea butter, Traditional, Mechanical, Fatty acids

INTRODUCTION

Shea butter is a highly valuable product extracted from nuts of Shea tree (*Viterllaria paradoxa).* It was formally known as B*utryspermum paradoxum* Parkii and it belongs to S*apotaceae* family. Shea butter is an important component of most pharmaceutical and cosmetic products. The quality of products derived from Shea butter depends on the quality of Shea butter used. There are two known varieties/subspecies of Shea butter namely "*Paradoxa*" and "*Nilotica"* (Nahm, 2011). Shea butter samples ranged from whitish yellow to grey in color and the tree is widely grown in about 21 states across the country being dominant in Niger and Kwara state. Other state include Nasarawa, Kebbi, Kogi and Ogun (Abolarin, 2017). Shea butter has found application extensively in the food, pharmaceutical and cosmetic industry because of it availability and similarity in triglycerides and fatty acid composition to Cocoa-butter (Nahm*.,* 2011). It has found application in this sector particularly for it moisturizing and healing properties.

Research has shown that parameters such as methods of extraction, solvent used for extraction, environmental influence and geological locations play a significant role in determining Shea butter quality (Ibrahim *et al,* 2019*).* The methods used for extraction varies from region to region and from one producer to another. (Affosi and Orafidiya, 2021). The various stages of processing the nuts during extraction procedures also contribute immensely to shea butter quality and this varies from one state to another.

Nasarawa state, which is located at the north-central regions of Nigeria has been reported by the Nigeria Export Promotion Council (NEPC) and Federal Ministry of Agriculture and Rural Development (FMARD) to be one of the major producers of Shea butter in Nigeria, but the quality of Shea butter analyzed so far has not match standards requirement by organizations as reported by Emmanuel *et al.,* (2022). In order to investigate the problem it is important to compare the extraction methods and their effects on the fatty acids composition of the shea butter. This study hereby aim at accessing the effect of extraction methods on the fatty acids profile of traditionally and mechanically extracted shea butter samples from Nasarawa state.

MATERIALS AND METHODS

Study area: shea nuts were picked from Nasarawa, Akwanga, Karu and lafia local government areas of Nasarawa state as shown in figure 1 below.

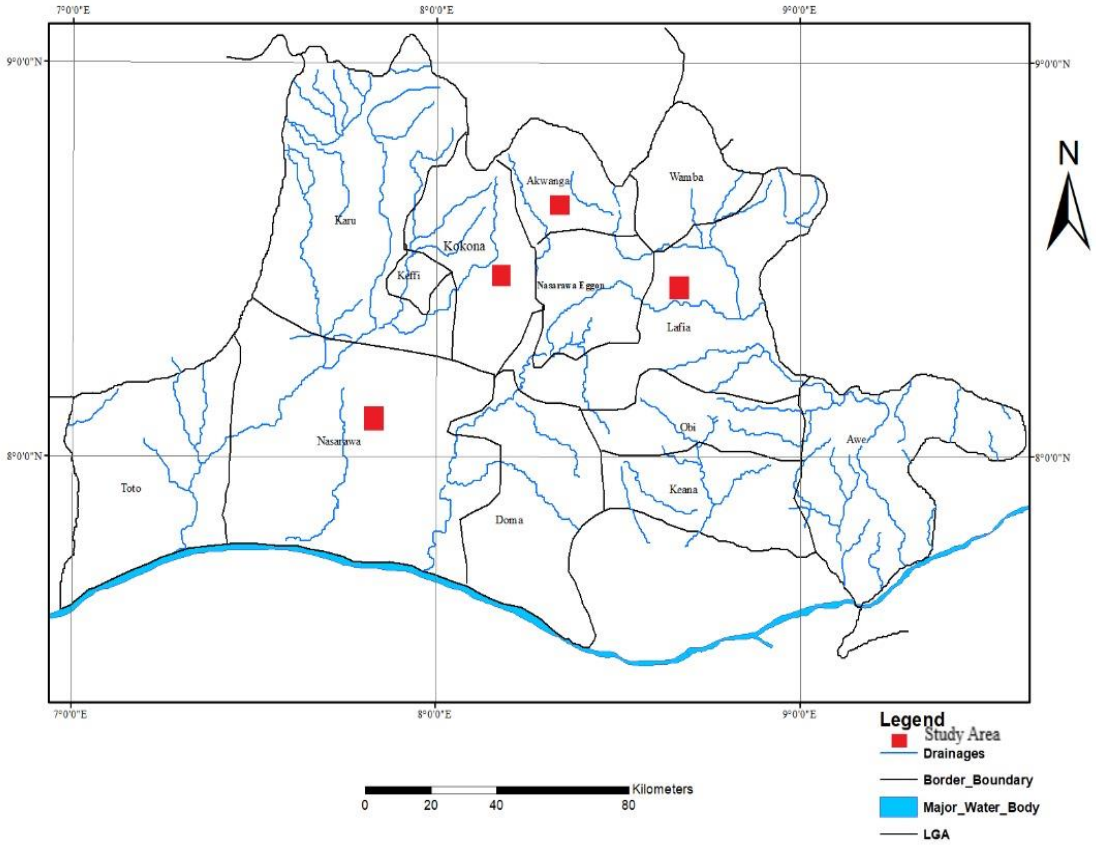

Figure 1: Topographical Map of Nasarawa State Showing the Sample Location Points

Sample identification

The shea nuts were identified at the herbarium unit in the Department of Biological Sciences, Faculty of Science, Kaduna State University, and a Voucher no. KASU/BSH/4557 was assign.

Sample pre-treatment

The shea nuts were harvested in the months of July 2023, it was allowed to dry under the sun for 3 days in order to avoid mold contamination of the nuts. The samples were pre-treated according to the method described by Abdul–Mumeen (2013).

Traditional Method of extraction of shea butter

Five kilograms (5 kg) of the sorted kennels were soak in warm water for two days, this was done to soften the kennels for easy pounding and to remove dirt from the kennels. The kennels were pulverized to reduce the size before milling. After pulverization, the small size kennels were scoop out of the mortar into a plastic bowl and taken to the mill where it was ground into paste. The paste was transferred into a large plastic bowl and two liters of cold water was added to it. Kneading was carried out vigorously and continuously with the hand for 20 minutes. The kneading process continued until the color of the paste, which was initially brown, turns grey. Five (5) liters of cold water was added to the paste and the grey fluffy matter (fat) separated from the water. It was seen floating on the water. A wooden spoon was used to scoop out the grey fluffy matter. It was then washed thrice with two (2) liters of cold water to eliminate impurities. It was transferred into a clay pot and heated at medium heat using an electric hot plate for 15 min. The grey fluffy matter, melted on heating and some residue particles settled at the bottom of the pot while a clear oil layer was seen at the top. The clear oil was decanted into a clean pre-weigh stainless plate and was allowed to cool at room temperature. It solidified into solid Shea butter on cooling (Abdul-mumeen, 2019).

Mechanical Extraction Procedure

The mechanical extraction of the Shea kernels was carried out at the National Research Institute for Chemical Technology (NARICT) Zaria. The shea kernels were oven dried for 48 hours at 60 °C after which it was ground into small particles and sieved using mesh to obtain < 2.06 mm particle size. Four (4) kilograms of the sieved sample were weighed and poured into the press cage cylinder. Thereafter the sample shea kernel was compressed by the compression piston using the hydraulic press machine (HPM) at a pressure of 8MPa for 20 mins. The extracted shea butter was then collected in the output pan and weighed to determine it yield using the formula in equation described by Akingbala *et al,* (2006).

The GC-MS Fatty Acid Analysis.

The analyses was done with a Shimadzu TQ8040 gas chromatography coupled with a Mass Spectroscopy (GC-MS) detector system. The column was packed with SH-RXi-5Sil MS-type fused silica capillary column. The ovens temperature was programmed from 80 ºC to 300 ºC. at different times. Helium gas was used as the carrier gas while Argon gas was used as the Collision Induced Dissociation (CID) gas in the mass spectrometry (MS). The ion source temperature was set as 200ºC and 250ºC as interface temperature. A column flow of 1.69 mL/ min was used. The Mass spectra were compared with the NIST14s mass spectra library, and this was done at the National Agency for Food and Drugs Administration (NAFDAC) Kaduna.

RESULTS AND DISCUSSION

Table 1: Results of fatty acid composition (%) of the Shea butter samples extracted with the traditional method

Name	Oleic Acid	oleic acid (Ethyl ester) (ethyl oleate)	stearic Acid	stearic Acid (Ethyl ester)	Linoleic Acid	linoleic acid (Ethyl ester)	palmitic acid	palmitic acid (Ethyl ester)	myristic (ethyl ester)	pentadecacyclic	behenic acid (ethyl ester)
Formula	$C_{18}H_{34}O_2$	$C_{20}H_{38}O_2$	$C_{18}H_{36}O_2$	$C_{20}H_{40}O_2$	$C_{18}H_{32}O_2$	$C_{20}H_{36}O_2$	$C_{16}H_{32}O_2$	$C_{18}H_{36}O_2$	$C_{16}H_{32}O_2$	$C_{15}H_{30}O_2$	$C_{24}H_{48}O_2$
Sample											
A_T	17.71	52.26	_	_	_	_	_	_	_	_	30.03
B_T	32.91	58.28	_	_	_	8.81	_	_	_	_	_
C_T	_	100	_	_	_	_	_	_	_	_	_
D_T	_	100	_	_	_	_	_	_	_	_	_

Samples A - Samples from Akwanga L.G.A, B - Samples from Kokona L.G.A
C -Samples from Nasarawa L.G.A , D - Samples from Lafia L.G.A

NOTE; The subscript T stand for traditional and M for mechanical

Table 2: Results of fatty acid compositions (%) of the Shea butter samples extracted with the mechanical method

Name	Oleic Acid	oleic acid (Ethyl ester)	stearic Acid	stearic Acid (Ethyl ester)	Linoleic Acid	linoleic acid (Ethyl ester)	palmitic acid	palmitic acid (Ethyl ester)	myristic acid (ethyl ester)	Pentadecacyclic acid	behenic acid (ethyl ester)
Formula	$C_{18}H_{34}O_2$	$C_{20}H_{38}O_2$	$C_{18}H_{36}O_2$	$C_{20}H_{40}O_2$	$C_{18}H_{32}O_2$	$C_{20}H_{36}O_2$	$C_{16}H_{32}O_2$	$C_{18}H_{36}O_2$	$C_{16}H_{32}O_2$	$C_{15}H_{30}O_2$	$C_{24}H_{48}O_2$
Sample											
A_M	-	75.47	_	24.53	_	_	_	_	_	_	_
B_M	-	40.61	59.39	_	_	_	_	_	_	_	_
C_M	13.25	48.81	_	27.88	_	20.75	3.21	6.18	_	_	_
D_M	13.00	32.17	_	10.47	_	4.52	_	34.06	2.62	3.16	_

Discussion

Four fatty acids were identified in samples A_T and B_T as observed in Table 1 while only one fatty acid was found in sample C_T and D_T. The fatty acids that were found in sample A_T were oleic Acid (17.71 %), oleic acid ethyl ester (ethyl oleate) (52.26 %) and behenic acid ethyl ester (30.03 %). The fatty acids that were found in sample B_T were Oleic acid (32.91 %), Oleic acid ethyl ester (58.28 %) and linoleic acid ethyl ester (8.81 %).

From the result obtained, it was observed that the dominant fatty acid in sample A_T and B_T were oleic acid ethyl ester (52.26% and 58.28 %) respectively. Both oleic acid and oleic acid ethyl ester and are naturally occurring compounds in shea butter as shown in this study. Studies by Afosi and Orafidiya (2021), Montowska *et al* (2011), and Humphrey *et al*., (2020), reported that the dominant fatty acid in their shea butter samples were oleic acids.

The third fatty acid that was found in sample A_T is the behenic acid ethyl ester. The concentration of behenic acid ethyl ester obtain for this study is higher than the value reported by Emmanuel *et al*., (2022). According to Emmanuel *et al*., (2022), the value of behenic acid for Nigeria Shea butter ranges from 0.07 % -4.72 %), but this study has shown higher concentration of behenic acid.

The third fatty acid that was found in sample B_T is the linoleic acid ethyl ester also called ethyl linoleate. This was found at a concentration of 8.81 %. This is similar to the studies by Emmanuel *et al.,* (2022), who found linoleic acid values to be within the range 0.10 -8.02 for their study. Also studies by Afosi and Orafidiya (2021), shows the percentage of linoleic acid values to be within the ranges of 6.41-7.16% which vary slightly from the values obtained in this study.

In sample C_T and D_T oleic acid ethyl ester was the only fatty acid that was found constituting 100% in both samples as show in Table 1. This high concentration of oleic acid ethyl ester observed in samples C_T and D_T could be as a result of the method used for the extraction of the shea butter.

While three fatty acids, were detected in sample A_T and B_T as discuss above only one fatty acid (oleic acid ethyl ester) was detected in sample C_T and D_T. This result is rare and never has it been reported in the previous researches. It can be concluded that Shea butter samples from Nasarawa and Lafia LGA are excellent source of oleic acid ethyl ester and can be recommended for the pharmaceutical and cosmetic industries

The result of fatty acid composition of mechanically extracted shea butter are presented in Table 2. The results shows that, three fatty acids were identified in samples A_M and B_M. These fatty acids are oleic acid ethyl ester (75.47% and 40.61%) for samples A_M and B_M respectively, stearic acid ethyl ester 24.53 (sample A_M) and stearic acid 59.39 % (sample (B_M). Both samples A_M and B_M has confirmed one of the earliest study by Maranz *et al*., (2004), who reported that oleic acid is the dominant fatty acids in shea butter and both oleic acid and stearic acid are a major component in shea butter. This is confirmed from recent studies by Emmanuel *al*., (2022) who reported the range of oleic acid to be (55.21 -55.99 %) and stearic acid (28.32 -30.80 %), and Afosi and Orafiya (2021) also reported the range of oleic acid (8.61 -64.93%) and stearic acid (11.36-45.01 %) as the dominant fatty acids for their shea butter samples.

Unlike sample A_M, the dominant fatty acid in sample B_M is the stearic acid (59.39%). This is similar to the report by (Ugese *et al*., 2010), who reported the range (45.1 - 49.70 %) for stearic acid in their shea butter samples. Stearic acid was dominant in all their shea butter samples than oleic acid (37.20 -43.40%). Ugese *et al*., (2010) further explains that, stearic acid is a component which gives shea butter it's consistency and determines it end use.

Samples C_M and D_M has shown reasonable number of fatty acids as seen in Table 2. Unlike sample A_M and B_M, six fatty acid acids where found in sample C_M and seven fatty acids were detected in sample D_M. These fatty acids are oleic acid (13.25 %), oleic acid ethyl ester (48.81 %), stearic acid ethyl ester (27.88 %), linoleic acid ethyl ester (20.75 %), palmitic acid (3.21 %), and palmitic acid ethyl ester (6.18 %) for sample C_M. in the same way the fatty acids that were found in sample D_M are Oleic acid (13. 00 %), oleic acid ethyl ester (32.17%), stearic acid ethyl ester (10.47 %), linoleic acid ethyl ester (4.52 %), palmitic acid ethyl ester (34.06 %), myristic acid ethyl ester (2.62 %), and pentadecacyclic acid (3.16 %). Sample C_M has shown higher concentrations in all the fatty acids detected on both (C_M and D_M) samples except for pamitic acid ethyl ester were sample D_M has higher concentration than sample C_M as shown in Table 2. The myristic acid (2.62%) and pentadecacyclic acid (3.16%) were found in sample D_M but not in C_M. Similarly only sample C_M detected palmitic acid (3.21%).

These results were similar to several research on shea butter where the principal fatty acids contained in Shea butter were reported to be within the range oleic acid (34-62%), stearic acid (25-55.7%) palmitic acid (1.9-10%) and linoleic acid (1-10% %) by (Abdul-Hammed *et al*., 2020; Akihisa *et al*., 2010 ; Honfo *et al*., 2012; Davrievx *et al.,* 2010). The dominant fatty acid in sample C_M is the oleic acid ethyl ester and it is consistent with the other samples while sample D_M has shown an exception having the palmitic acid ethyl ester dominating in this case as seen in this study. The concentration of palmitic acid ethyl ester (34.64%) is higher than the range for palmitic acid (2-9 %) reported by Davrievx *et al.,* (2010). In the same way, the linoleic acid ethyl ester (20.75%) in sample C_M as shown in table 4.6, is also higher than the reported range (1-10%) by the same researchers. However, most of the fatty acids detected in sample C_M and D_M are within the stipulated range for shea butter. Hence Shea butter (samples C_M and D_M) produced with the mechanical method conformed to the international standard and can be said to meet the international market standard for Shea butter.

CONCLUSION

The results for fatty acids profiles for the two extraction methods show that shea butter extracted with the traditional method showed fewer fatty acids compare to those observed with the mechanical method. The traditional methods employed in these regions of Nasarawa state for the extraction of shea butter from the kennels do not release all the fatty acids in the butter thereby leading low quality butter. It is therefore recommended that, the tradition method employed in these regions of Nasarawa state for the extraction of shea butter should be modernize so as to produce shea butter with better quality.

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