An improvement process for obtaining higher extraction efficiency and better quality in the traditional processing of shea fat

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SUMMARY

Preliminary heat treatment of kernels as a factor in determining yield in the traditional extraction of shea fat has been investigated. It has been found that when the kernels are roasted for 90 min, a maximum extraction efficiency of 66 per cent can be expected. Steaming the shea kernels raises the extraction efficiency to 84 per cent and the resulting fat has better quality when assessed by the peroxide value. This represents considerable improvement considering that the efficiency of traditional shea fat processing has been rated between 30 to 40 per cent. Moreover, the new rate approaches that which can be achieved by modern screw expellers, i.e. 90 to 94 per cent. Pending the design and production of a rural steaming assembly, the efficiency of the rural shea fat manufacturing process can be raised from 40 to 66 per cent by adopting the modifications suggested.

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RÉSUMÉ

ATA, J. K. B. A.: *Une méthode d'amélioration pour un rendement plus élevé d'extraction et une meilleure qualité des produits lipidiques de Karité dans la transformation traditionnelle.* Un traitement thermique préliminaire d'amandes pour déterminer le taux de rendement dans l'extraction traditionnelle de la graisse de Karité a montré qu'en rôtissant les amandes pendant 90 minutes, il est possible d'atteindre un taux d'efficacité maximum d'extraction de 66%. En passant les amandes à la vapeur, l'efficacité d'extraction monte à 84% et la graisse résultante, évaluée par le teneur en peroxide, est d'une meleure qualité. Il s'agit là d'une amélioration considérable étant donné que le taux d'efficacité de la transformation traditionnelle du Karité se situait entre 30 et 40%. De plus le nouveau taux n'est pas très éloigné des taux de 90 et 94% que les expulsuers à-vis modernes peuvent réaliser. L'adoption des modifications suggérées permettrait de relever le taux d'efficacité du processus de transformation traditionnelle de Karité de 40 à 66%, en attendant qu'un montage rural de passage à vapeur puisse être conçu et produit.

Introduction

The savanna belt of West and Central Africa has large populations of shea trees, *Butyrospermum* sp., which can form the basis of a viable shea fat extraction industry. However, most of the countries in which shea trees are found, export the bulk of their crop whilst a small amount is extracted on a traditional level for consumption by the peasant community. Even though attempts are being made to encourage the extraction of shea fat by modern screw expellers, observations particularly in Ghana show that the traditional system of fat extraction will continue to feature prominently in the food industry of Ghana and other developing countries for the next decade or more.

Roasting is the method generally used for the preparation of the kernel for the traditional extraction of fat. This practice is also observed in the handling of groundnuts and palm kernels for traditional oil extraction. In the case of palm oil extraction, however, boiling of the fruits precedes extraction but this is to recover the palm oil present in the mesocarp. In traditional coconut oil processing, the wet coconut is neither boiled nor roasted.

The historical reasons for the methods adopted in the raw material preparation are uncertain but it is possible that these were handed over from times past. Technologically, there does not appear to be any rationale in the roasting methods used in traditional processing except in the case of groundnuts where the roasting leads to the development of flavour. This is because in the traditional extraction of fat, water is added to the milled mass and with manipulations of heat and cold, the fat phase can then be separated from the non-fatty solid phase with the water forming an interphase. This is unlike modern oil extraction using screw expellers, where it is appreciated that the object of roasting is to reduce the moisture content of the seed which would, otherwise, cause clogging in the expellers. It is also to prevent a high moisture content of the extracted fat. Moreover, it has been shown in the case of palm kernels (Burgoyne, 1951; Stork, 1960; Coursey, 1961; Simmons, 1963) and in the case of shea kernels (Ata, 1978) that roasting increases the discolouration of the fat.

In view of the importance of the traditional method in developing countries, this work has been carried out to reappraise the methods used for preparing the kernel and their effect on yield and quality of the extracted fat, with a view to recommending modifications at that level.

Materials and methods

Sample

Sun-dried shea kernels were obtained from a village in northern Ghana. The samples were clean, showed no visible signs of the growth of micro-organisms and were given various treatments as indicated below.

Batch I

Sufficient quantity of shea kernels were placed in an iron pot, placed over a heating mantle. The kernels were roasted for 1¼ h. Samples were taken at ¼ h intervals and used for the extraction of fat by the traditional method.

Batch II

Sufficient quantity of shea kernels were placed in a horizontal laboratory retort and effectively steamed at 120 °C for 3 h. Several other batches were effectively steamed under the same conditions for 30 min, 1, 2 and 3½ h respectively. The samples were then investigated with respect to fat extraction using the traditional method.

Milling

All the samples were milled in a Christy and Norris laboratory mill. The milled samples were examined for moisture content and their texture observed.

Fat extraction

Fat was extracted from the milled mass by the method used in traditional practice. A sufficient quantity of warm water was added to the milled mass and stirred vigorously with a wooden spatula to form a light slurry. The slurry was heated slightly to ensure that the fat was molten. The mixture was then passed through a sieve and the aqueous phase collected. This was then allowed to cool overnight at about 25 °C which also caused the fatty phase to set as a solid fat above the aqueous phase. The fatty phase was carefully skimmed off into a conical flask and heated under vacuum to expel incorporated moisture. The extracted fat was weighed and the yield of fat calculated on the weight of the treated material. The fat was also examined for its peroxide value. The fat that was skimmed off was labelled as fat practically recovered by using a separating funnel and its weight calculated. This was done to determine the recovery rate and possible sources of losses.

Determination of moisture

Moisture content of the milled shea samples obtained from the roasted, boiled and unheated kernels, were determined by drying weighed samples in a moisture determination pan placed in a laboratory thermostatic oven at 105 ± 1 °C for 2½ h. The samples after drying were cooled in a desiccator, weighed and replaced in the oven for another 30 min with repeated weighing to constant weight.

Determination of fat content

The fat content of samples of the kernels and residual meal were determined after drying, using a soxhlet apparatus and petroleum ether 40-60° BP for 4 h. The amount of fat recovered was calculated as a percentage, on weight basis on the material.

Determination of peroxide value

The peroxide value of the fat obtained from various samples were determined by the I.U.P.A.C. (1964) method. The objective of this was to show whether there was any correlation between the heat treatment and deteriorative effects on the fat extracted from the sample.

Results and discussion

The results obtained with the extraction after roasting and steaming for various time intervals are shown graphically in Fig. 1, 2 and 3. Other observations made are tabulated in Tables 1, 2 and 3.

The results from Fig. 1 show that 90 min continuous roasting is optimum in preparing the shea kernels for maximum fat yield of 30 per cent (calculated on milled mass) or extraction efficiency of 66 per cent based on maximum oil content of 45 per cent in kernel (established from analytical and

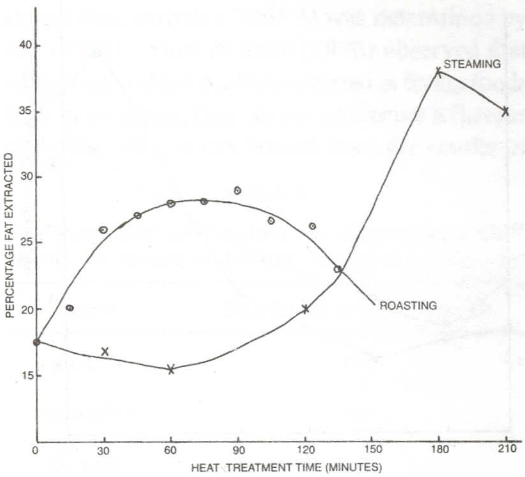

Fig. 1. Comparison of fat extractable from roasted and steamed shea kernels.

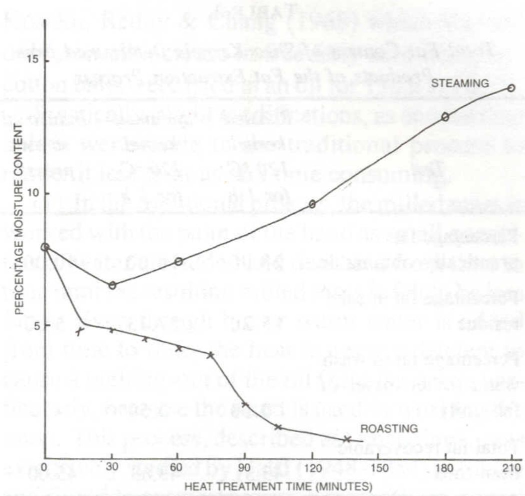

Fig. 2. Comparison of moisture content of the milled mass obtained from roasted and steamed sample of shea kernels.

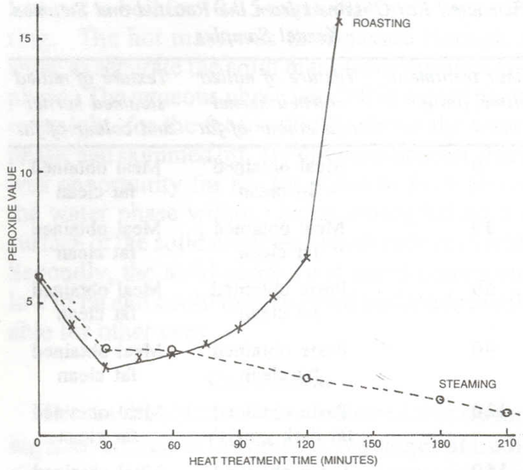

Fig. 3. Comparison of peroxide value of fat obtained from roasted and steamed shea kernels.

processing data). Three hours of steaming, however, produced an oil yield that was calculated to produce an extraction efficiency of 84.40 per cent. Other observations (Table 2) indicated that the steamed samples of shea kernel did not form a paste on milling.

The samples roasted beyond 45 min formed

TABLE 1

Total Fat Content of Shea Kernels Determined from Products of the Fat Extraction Process

Test	Roasted kernel 120 °C for 1 h	Steamed kernel 120 °C for 1 h	Industrial screw press*
Percentage fat practically obtainable	28.00	16.00	40.00
Percentage fat in cake residue	15.20	27.13	5.00
Percentage fat in wash water (other losses of fat - nil)	0.10	0.50	-
Total fat recoverable from shea	43.31	43.63	45.00

* From trial processing of Shea Kernels at the Tamale Division of Vegetable Oil Mills (GIHOC) by Ata, (1977).

TABLE 2

Other Observations Made on the Milled Mass and Extracted Fat Obtained from the Roasted and Steamed Kernel Samples

Heat treatment time (min)	Texture of milled roasted kernel and colour of fat	Texture of milled steamed kernel and colour of fat
0	Meal obtained fat clean	Meal obtained fat clean
30	Meal obtained fat clean	Meal obtained fat clean
60	Paste obtained fat clean	Meal obtained fat clean
90	Paste obtained fat clean	Meal obtained fat clean
120	Paste obtained fat dark greyish	Meal obtained fat clean
150	Paste obtained fat dark greyish	Meal obtained fat clean
180	-	Meal obtained fat clean

pastes typical of such materials and resembling peanut butter. This behaviour appears to be related to the moisture content of the heat treated material. From Fig. 2, there is an indication that 4 per cent moisture content is the level above which a paste of the description of peanut butter cannot

TABLE 3

Analytical Data on Shea Kernels

Moisture (%)	8.0
Fat content (soxhlet) (%)	44.5
Free fatty acid (oleic) of oil extracted (soxhlet) (%)	6.7
Peroxide value of oil extracted	6.0
Free fatty acid (oleic) of oil extracted by improved method (steaming) (%)	6.8

be formed with shea kernel samples. This inability of the milled mass to form a paste due to a high moisture content of the kernel does not, however, appear to be critical in the recovery of the fat from the meal as indicated in Fig. 4. Observations also indicated the fat obtained from all the steamed kernel samples were clean and untainted with the products of browning reactions whilst the fat obtained from roasted samples, particularly those roasted beyond 2 h, were seriously tainted with browning compounds (Table 2). Fig. 3 shows that the peroxide value of the fat obtained from the

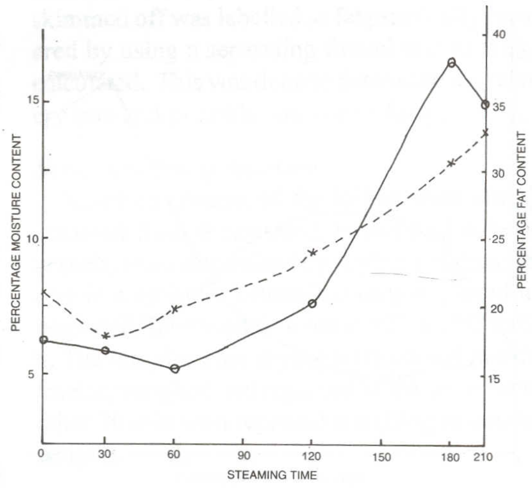

Fig. 4. Moisture in kernel and extractable fat content of kernel on steaming.

roasted kernel, rose with the length of time of roasting. With the steamed samples, however, the peroxide value of the fat decreased with steaming time. Views on the effect of escaping steam on the quality of oils high in moisture and heated to high temperatures are conflicting. Freeman (1969), however, postulated that the escaping steam provides a blanket which protects the oil from oxidation.

From the results obtained, the decreasing peroxide value could be due to a breakdown of the primary products of oxidation or an expulsion of the primary products of oxidation (determinable by the peroxide method). In practice, this is advantageous because it contributes to producing a fat with very low initial peroxide value. This in turn will reduce the rate at which the oil will oxidise to an objectionable level.

Table 3 shows the analytical composition of the fat extracted from the kernel. The amount of fat in the kernel, determined by standard analytical procedure, confirms that obtained in the processing trials (Table 1). The data in Table 3 show that the free fatty acid did not alter much as a result of the processing. The initial high free fatty acid content is more related to the deterioration that took place during the post harvest storage of the kernel. The increase in free fatty acid of stored shea kernels (Table 4) was determined by Ata (1977). Sims & Stahl (1970) observed that when longer chain acid fats are used in frying foods high in moisture, they do not constitute a flavour problem. This is confirmed from the results of

TABLE 4

Free Fatty Acid Level of Shea Fat Obtained from Shea Kernel on Storage at Ambient Temperature 26-29 °C

Month	*Free fatty acid of extracted fat*
August	1.94
September	3.25
October	9.35
November	18.40

Kosaku, Reddy & Chang (1968) which showed only a small increase in free fatty acid when wet cotton balls were fried in an oil for 150 h at 185 °C

Practically, slight modifications, as enumerated below were made to the traditional process to render it less tedious and time consuming.

(1) In the traditional process, the milled mass is worked with the palm of the hand as small quantities of water are added and decanted from time to time until the resulting milled mass is felt to be less fatty. Even though hot or warm water is added from time to time, the heat is never sufficient to cause a melting-out of the oil from the mass, particularly, because the hand is used in working the mass. This process, described as "kneading", was extensively studied by Halff (1948-1954) in Sudan and found to account for more than 50 per cent of the traditional processing time.

(2) In the laboratory, sufficient quantity of warm water was added to the mass and stirred with a spatula. The mass was then placed on fire in an iron pot to boil for 10-15 min with continuous stirring. The hot mass was then passed through a sieve to separate the solid mass from the aqueous phase. The aqueous phase was left in a cool place overnight, for the fat to solidify above the water phase, and skimmed off. By this modification, there was opportunity for the fat phase to float above the water phase without being entangled on the surface of the solid particles, which reduces yield. Secondly, the solid phase (wet cake) comes out low in fat and could then be dried and made available for other uses.

Conclusion

The results obtained have indicated that steaming shea kernels in the preparative stages of traditional shea fat processing has advantages over the method presently used. Whilst regulated roasting of shea kernels will guarantee an optimum extraction rate of 66 per cent, steaming raises the efficiency to a level approaching that claimed for modern oil mills using screw expellers. By introducing a sieve to separate solids from the liquids and by eliminating the kneading process, which is tedious and time consuming, the operation has been simplified and greater output can be expected from the operators. As a first step, whilst a simple rural steaming assembly is being designed and constructed, the rural shea fat manufacturer, can raise his extraction rate from 40 to 66 per cent by roasting the kernel for a longer period as shown in the results. A flow sheet for the modified process is shown in Fig. 5.

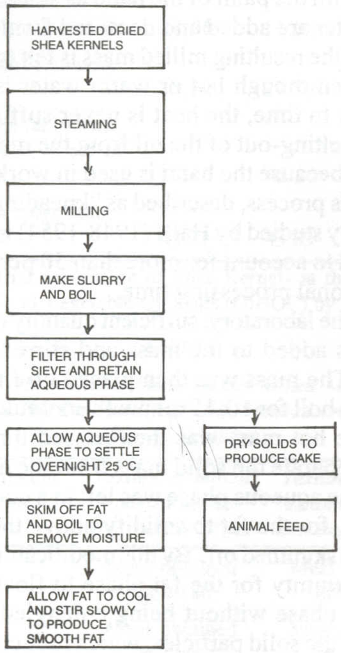

Fig. 5. A flow diagram for an improved method of traditional processing of shea fat.

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