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Effect Of Processing Conditions On Yield, Physical And Chemical Properties Of Shea Butter

J. Akingbala[1]
K. Falade[2]
E. Adebesi[2]
G. Baccus-Taylor[1] &
I. Lambert[1]

Shea butter was extracted from nuts roasted at 140, 160 and 180°C for 30 min by the traditional water-displacement method and by using a screw press. Butter yields were determined. Some of the butter was bleached and free fatty acid, peroxide value, melting point, refractive index, specific gravity, smoke point, colour and flavour of bleached and unbleached shea butter were determined.

Shea butter yields increased significantly ($p \leq 0.05$) with increasing temperature of roasting the nuts. The traditional method of extraction yielded more shea butter than the screw press method ($p \leq 0.05$). Shea butter from the traditional method contained significantly higher free fatty acid content, which increased as the temperature of roasting increased. The peroxide value varied significantly with temperature of roasting and method of extraction however, iodine number, saponification number and unsaponifiable matter of shea butter extracted by traditional and by the screw press methods were similar across the temperature gradient and unchanged by method of extraction. Bleaching improved the colour and flavour of shea butter extracted by the traditional method more ($p \leq 0.05$) than it did for butter expressed using the screw press. The physical properties of shea butter (melting point, smoke point, refractive index and specific gravity) were unaffected by temperature of roasting and method of fat extraction.

Keywords: Shea nuts, shea butter, nut roasting temperature, physical properties, sensory Properties.

1. Introduction

Shea butter is a creamy-coloured vegetable fat obtained from the fruit of the shea butter (*Butyrospermum paradoxum* or *B. parkii*) tree [1]. Shea butter has a degree of saturation of 46.7, solidifies at room temperature [2], and is a very useful and economically important indigenous fat of the arid and semi-arid regions of the world [3]. It is used for cooking and as an additive in preparing porridges, as a flavour additive in confectioneries, in soap making, and in cosmetics and pharmaceutical industries [1,4]. Shea butter is used in traditional medicine, for fuel, for waxing fruits, in candle making, and as a butter substitute [5].

Shea butter provides approximately 60% of the cash income of women in the Sahel [6]. However, the traditional process of extraction is very tedious, involving nut gathering, drying and sorting to obtain sound nuts. The nuts are shelled to obtain the cotyledon, which are roasted in a large basin on an open-hearth fire with no control of the roasting temperature. The roasted cotyledons are ground, then hot water (80-90°C) is added and a mash is formed, which

[1] Food Science & Technology Unit, Chemical Engineering Department, The University of the West Indies, St. Augustine, Trinidad, WI
[2] Food Technology Department, University of Ibadan, Ibadan, Nigeria

is worked over with the feet to extract the fat. The process usually takes over an hour of hard work, after which the fat is skimmed off the surface of the water and washed with additional hot water to remove, as impurities, ground shea nut particles. Mechanical expression of butter from shea nut using a screw press will reduce the tedium of the traditional method of shea butter extraction, increase production and probably improve the yield and quality of the shea butter. One important process parameter for obtaining optimum yield and quality of shea butter is the temperature at which the nut is roasted before butter extraction. The objective of this study was to determine the optimum nut-roasting temperature for the extraction of shea butter.

2. Materials and Methods

Dried nuts were obtained from a market in Sepeteri, Oyo State, Nigeria. The nuts were cleaned and shelled to release the cotyledons. The clean cotyledons were roasted at 140, 160 and 180°C respectively for 30min and ground in a hammer mill (8 LAB MILL, Christy and Norris Ltd. Process Engineers) to pass through 1mm aperture. Shea butter was extracted from the ground cotyledon by the traditional method of extraction, as adapted for the laboratory (Fig 1).

2.1 Traditional Extraction of Shea butter

Ground, roasted shea nut cotyledons (500g) was mixed with 300ml water at 90°C with continuous stirring with a glass rod for 20min. A further 300ml of water was added and the stirring continued for 10min. Finally 600ml of water (70°C) was added with stirring for 15min. Shea butter was collected as the water cooled and then washed twice, each time with 400ml of distilled water at ~32°C temperature (Fig. 1).

2.2 Extraction by the screw press

Ground roasted cotyledon (500g) was weighed into a pouch made of muslin cloth and heated in an oven at 70°C for 30min to melt the fat. The butter was expressed with a prototype screw press mechanical fat extractor developed by the Federal Institute of Industrial Research Oshodi, Nigeria. The butter expressed was collected in a pre-weighed beaker, which was re-weighed to obtain butter yield by difference (Fig 2).
Portions of the shea butter samples were bleached with Fuller's earth as described by Oboh and Aworh [7].

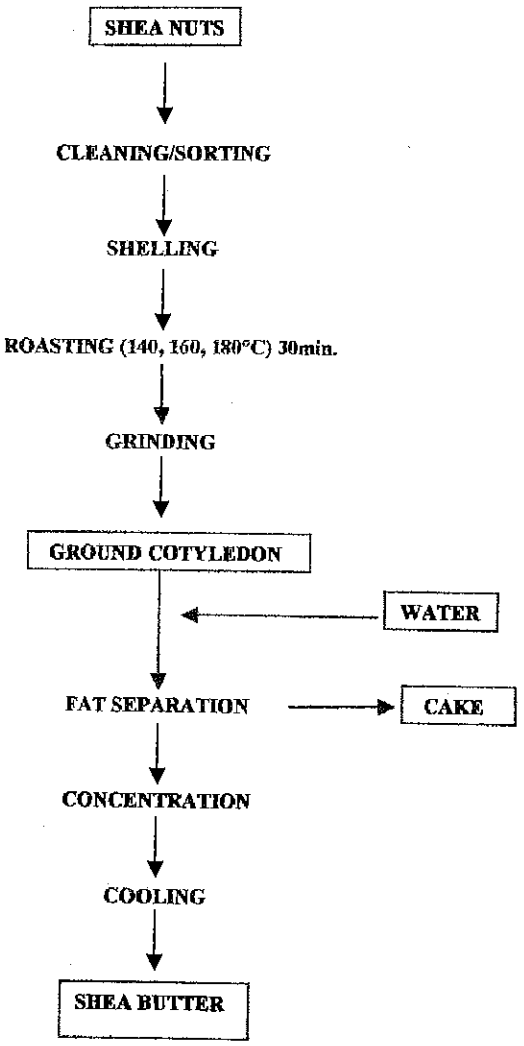

Figure 1: *Traditional Shea Butter Extraction Method*

2.3 Chemical analysis

The proximate chemical composition, crude protein (N x 6.25), crude fibre, ether extract, ash and moisture content of the shea nut

were determined [8]. Moisture content, ether extract, saponifiable and unsaponifiable matter of shea butter, was determined using A.O.A.C. methods [8]. Iodine value using Wij's titration method, and peroxide value of butter was determined as described by Pearson [9]. Carbohydrate was determined by difference.

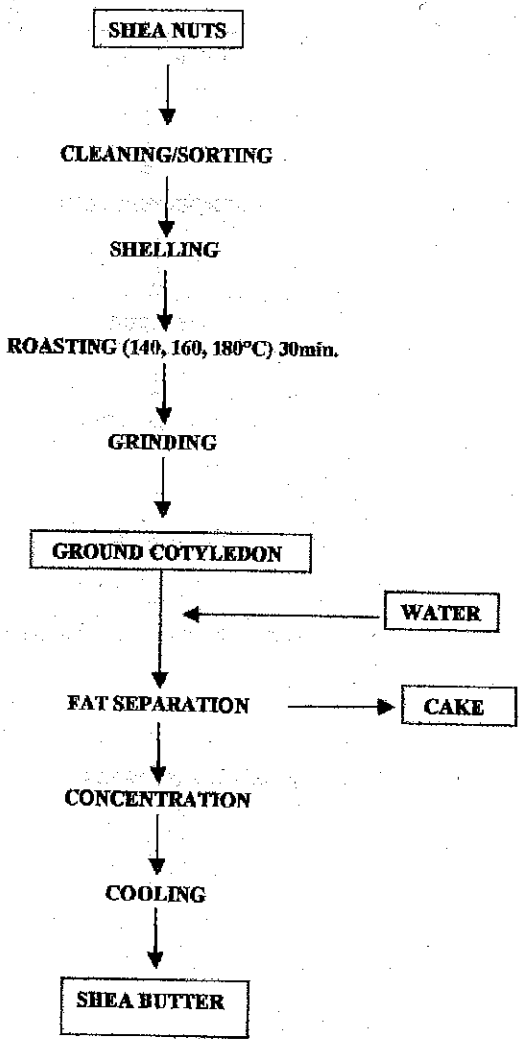

Figure 2: *Extraction of Shear Butter using the Screw Press*

2.4 *Physical analysis*

Yield of shea butter was calculated as percent of the total weight of the nut (d.b.). Specific gravity of shea butter was determined using the specific gravity bottle with a water temperature of 30°C; the refractive index was determined at 40°C with the Abbe refractometer, while melting point temperature and smoke point were determined according to A.O.C.S. methods [10].

2.5 *Sensory analysis*

Colour and flavour of shea butter extracted by traditional method, mechanically (screw press) -extracted shea butter, bleached traditional, bleached screw-press-extracted shea butter samples, and a bleached commercial shea butter sample were scored on a rating of 1-5, where 1 was least desired and 5 was most desired. The shea butter samples were kept molten in a water bath at 40°C, and were presented to each member of the panel in 50ml clear transparent beakers just before the sensory assessment. Refined commercial soybean vegetable oil was scored for comparison. Twelve (12) students of the Food Technology Department, University of Ibadan, Nigeria, made the assessment.

3. Results and Discussion

3.1 *Proximate composition of Shea nut*

Shelled shea nut contains 6.8% crude protein, 5.71% crude fibre, 2.32% ash and 37.3% carbohydrate. Fat content (49.9%) was in the range of 45 to 55% as reported [2].

3.2 *Effect of roasting temperature on yield of Shea butter*

The yields of shea butter by the traditional method were 14.0, 21.0 and 27.2% for nuts roasted at 140, 160 and 180°C respectively and 12.4, 17.2 and 24.0% respectively when shea butter was expressed from the nuts mechanically using the screw press (Fig. 3). The traditional method of extraction gave significantly ($p \leq 0.05$) higher yields of shea butter compared to the screw press method, probably due to inadequate pressure from the press, and unrecovered fat from the cake and the press cloth, due to the low (~35 °C) extraction temperature compared with temperature (90 °C) used for the water extraction. However, yields of

3.4 *Iodine value*

The range of iodine values (48.8 – 50.2 meqkg^{-1}fat) observed for shea butter in this study, presented in Table 1, was lower than the range (53 – 65 meqkg^{-1} fat) reported by Allen and Hamilton [13], for butter from *Butyrospermum parkii*, but was in agreement with the values expected of fat with 55% unsaturated fatty acids of which 50% was C18: 1, and 5% was C18: 2 respectively [14]. The degree of saturation of shea butter was greater than that of soybean oil (14%), groundnut oil (17%), and cottonseed oil (27%), all of which are liquids at room temperatures. Cocoa butter, which has a similar range of melting point (32 - 35°C), compared to shea butter (32 - 55°C), has 35% C18: 1 and 3% C18: 2 unsaturated fatty acids [13]. It has therefore been suggested that shea butter can be used as substitute for the more expensive cocoa butter in the production of confectioneries [4]. The European legislation has since 2000 approved that up to 5% of the cocoa butter in chocolate mix can be substituted for by shea butter during chocolate manufacture [15]. There was no difference between the iodine values of the shea butter samples due to temperature of roasting the nut, or due to extraction method.

3.5 *Peroxide value*

The peroxide value of the shea butter samples ranged from 0.83 to 0.96 (Table 1). The peroxide values are low because of the composition of the unsaturated fatty acids. Hamilton [12] reported that in autoxidation, linoleic acid (C18: 2) is oxidised 64 times more than oleic, and linolenic (C18: 3), a hundred times more than oleic acid. The low amounts of linoleic acid (5%) compared with oleic acid (50%), predispose shea butter to low peroxide value [12]. The peroxide values of butter from nuts roasted at 140 and 160°C were generally similar (Table 1). The possible inactivation of lipases and the members of the tocopherol group of natural antioxidants at about 160°C may account for the significant ($p \leq 0.05$) increase in peroxide value of the fat from nuts roasted at 180°C, extracted by the traditional and mechanical extraction methods.

The peroxide value of shea butter extracted by the traditional method was greater than that of the mechanically expressed butter when the nut was roasted at 180°C (Table 1).

Table 1 shows that there were no differences due to nut-roasting-temperature or the extraction methods, for saponification value (188.0 – 190.5cm^{3}g^{-1}) or unsaponifiable matter (0.49 – 0.53%) of the shea butter. UNIFEM [6] also observed similarities in the chemical properties of shea butter extracted by the traditional method and by mechanical extraction.

3.6 *Physical properties of Shea butter*

There were no differences in the physical properties -melting point (30 –32 °C), smoke point (218 °C), specific gravity (0.90 – 0.91) or refractive index (1.464 – 1.465) of shea butter from nuts roasted at 140, 160, and 180°C, and extracted by the traditional or screw press methods. The smoke point of shea butter (218°C) was higher than 215°C recommended by A.O.C.S. [10] as the least temperature for good quality frying oil, and can be further increased through refining the oil [15].

3.7 *Sensory quality*

Unbleached, unrefined shea butter had significantly ($p \leq 0.05$) poorer colour and flavour than commercial oil, which had the advantage of refinement (Table 2). However, when refined by bleaching, the colour and flavour of shea butter was not ($p \leq 0.05$) different from that of commercial soybean oil. Flavour has always been a problem regarding acceptance of unrefined shea butter even in areas where the butter is the main source of fat for cooking. Traditionally, frying onions in the butter is used to improve the flavour. The flavour and colour of the pressed sample were poorer than that of shea butter extracted by the traditional method.

Table 1: Chemical Properties Of Shea Butter Extracted By Traditional And Mechanical Methods From Cotyledons Roasted At Varying Temperatures

	Roasting Temperature					
	140°C		160°C		180°C	
Chemical Properties	Traditional Method	Screw Press	Traditional Method	Screw Press	Traditional Method	Screw Press
Free fatty Acids (%)	8.62b	8.26c	9.00a	8.20c	9.02a	8.38c
Peroxide Value (meq kg^{-1})	.88b	.83c	.83a	.83c	.96a	.90b
Iodine Value (meq kg^{-1})	49.3a	50.0a	48.8a	50.0a	50.2a	49.3a
Saponification Value (cm^3g^{-1})	190.0a	190.5a	190.0a	190.5a	188.0a	190.0a
Unsaponifiable matter (meq kg^{-1})	.53a	.50a	.50a	.49a	.52a	.50a

2. Means of three (3) replicates
3. Means with the same letters on a row are not different ($p \leq 0.05$).

Table 2: *Mean [1,2], Sensory of Colour and Flavour of Shea Butter and Commercial Oil Samples*

Samples	Colour	Flavour
Traditional extracted butter[3]	1.7c	1.8c
Screw press extracted butter[3]	1.3c	1.7c
Traditional extracted/bleached butter[3]	3.6a	2.7b
Screw pressed extracted/bleached butter[3]	2.3b	2.3b
Bleached commercial[4] Shea butter	3.0a	2.6b
Commercial vegetable oil[5]	3.7a	3.4a

1. Means of 12 scores
2. Means with the same letters in a column are not different ($p \leq 3.05$)
3. Shea butter samples extracted from nuts roasted at 160°C
4. Commercial shea butter sample obtained fresh from a commercial producer
5. Refined commercial soybean vegetable oil

4. Conclusion

Yields of shea butter increased as nut roasting temperature increased. However the increases in butter yield due to increased nut roasting temperature were accompanied by decreases in butter quality due to increased free fatty acid content and peroxide value. The prototype screw press used for extraction requires a heater mantle that would keep the extractor above the melting temperature of shea butter for more efficient extraction of the butter. In its present form yield of shea butter using the press was lower than obtained for the traditional water extraction method though quality of the mechanically expressed shea butter was better. Sensory quality of refined shea butter compares very well with that of commercial vegetable oil.

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