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*Full Length Research Paper*

# Physicochemical and microbiological characteristics of optimized and traditional shea butters from Côte d'Ivoire

**Rose-Monde Megnanou*, Sébastien Niamke and Jacques Diopoh**

Laboratoire de Biotechnologies, Unité de Formation et de Recherche (UFR) Biosciences, Université de Cocody, 22 BP 582 Abidjan 22 (Côte d'Ivoire).

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**A comparison was realized between the characteristics of shea butters from local markets in Côte d'Ivoire and optimized shea butters, manufactured in a laboratory, in order to valuate the improvements in quality. Large diversity concerning the colour (beige, grey and yellow), odour (odourless, moderate, fragrant and rancid) and the consistency (soft and hard) was found for the ordinary shea butter while the optimized one presented specific sensorial characteristics (beige or yellow colour, moderate odour and soft consistency). The acid (10.51 and 11.94 mgKOH/g), peroxide (5.77 and 2.79 $mEgO_2$/kg) and moisture content (0.15%) values of the optimized shea butter were much lower than those of the marketed ones which were 12.80 to 17.32 mgKOH/g, 14.70 to 30.88 $mEgO_2$/kg and 3.26 to 14.50%, respectively. Moreover, the optimized shea butters were free from heavy metals (lead and nickel), Salmonella and the microbial (coliforms), yeast and moulds contents were lower compared to the marketed shea butters. In addition, the optimized shea butters had a high unsaponifiable content (17.61%) and some minerals such as calcium (212.26 to 238.85 mg/kg), sodium (84.57 to 136.62 mg/kg), potassium (36.41 to 45.17 mg/kg), magnesium (12.18 mg/kg), zinc (1.90 mg/kg) and iron (1.67 mg/kg).**

**Key words:** Shea butter, *Vitellaria paradoxa,* properties, quality, Côte d'Ivoire.

## INTRODUCTION

The shea butter is a vegetable fat extracted from the kernels of the fruit of *Vitellaria paradoxa*, Sapotaceae (Hall et al., 1996; Pontillon, 1996; Kengue and Ndo, 2003; Elias and Carney, 2004; Schreckenberg, 2004). In *V. paradoxa* producer countries, such as Côte d'Ivoire, the shea butter is generally prepared in traditional condi-tions (in the producing areas) and then forwarded to other areas for its marketing at local markets (Louppe, 1995). These traditional shea butters are increasingly required abroad by cosmetic and pharmaceutical industries, to the detriment of solvent extracted shea butters (Elias and Carney, 2004). However, the numerous and uncontrolled traditional processing techniques are responsible for the wide variability of shea butter quality (Louppe, 1995; Hall et al., 1996; Kapseu et al., 2005; Womeni et al., 2006). Thus, consumers are complaining about the quality of marketed shea butters (Kiyayila, 2002).

Several studies have been undertaken in order to incr-ease shea butter extraction rate but also to improve the shea butter quality using the traditional processing condi-tions (Louppe, 1995; Hall et al., 1996). Attempts were made to incorporate appropriate technology into a num-ber of the processing stages, both to improve efficiency and to reduce the amount and drudgery of the labour, as well as impact on the environment (Hall et al., 1996; Elias and Carney, 2004; Schreckenberg, 2004). Some results relative to the identification of shea trees varieties for pro-ducing shea butter with specified quality were obtained by Maranz et al. (2004). Other researches aimed to det-ermine the factors influencing the quality of fats during their preparation which included shea butter (Louppe, 1995; Hall et al., 1996; Kapseu et al., 2005; Womeni et al. 2006) and cocoa butter (Semmelroch and Grosch 1998; Sanz et al. 2001). Louppe (1995) noted that blan-ching shea nuts improved shea butter quality, while Hall et al. (1996), Semmelroch and Grosch (1998) and Sanz et al. (2001) underlined that the sensorial characteristics of shea and cocoa butters are linked to the kernel roast-

*Corresponding author. E-mail: megnanour@yahoo.fr. Tel: 08.83.41.54.//.01.08.90.47.

ing time. Kapseu et al. (2005) and Womeni et al. (2006) showed that the drying time and roasting time of shea nut kernels affected the physicochemical quality of shea butters. Furthermore, several seminars and others meeting were carried out in some producer countries (Faso, Côte d'Ivoire, Mali and Senegal) and this led to the harmonization and the establishment of standards for traditional processing shea butter (Prokarité, 2006). However, suitable traditional conditions for shea butters with characteristics that are in conformity with these standards have not yet been given.

The present study sought to validate the shea butter obtained in optimal traditional conditions (optimized shea butter) in Côte d'Ivoire. Some physicochemical and microbiological characteristics of optimized shea butters were compared with those of ordinary shea butters of Côte d'Ivoire local markets.

## MATERIALS AND METHODS

### Biological material

Ordinary shea butters were collected from the principal markets of several towns located in *V. paradoxa* region in the North of Côte d'Ivoire (Bondoukou, Dabakala, Katiola and Korogho) and from Abidjan district and areas (Abobo, Adjamé, Anyama, Bingerville, Dabou and Yopougon). Optimized shea butters were prepared in the laboratory, in optimal conditions of the traditional processing currently used in Dabakala (town in the north of Côte d'Ivoire). The shea fruits used for the experimentation at laboratory were obtained from Dabakala.

### Chemicals

Microbiological analyses powders: PCA (Plate count agar), YGC (Agar with yeast, glucose and chloramphenicol), SS (Agar *Salmonella-Shigella*), Mueller-Kauffmann, TS (Trypton salt), Rappaport-Vassiliadis and Kligler-Hajna were from Bio Rad. VRBL (Agar violet red blue and lactose), Hektoen and EPT (Eau peptonée tamponnée) powders provided from Diagnostic Pasteur, Scharlau Microbiologie and Bio-Mérieux, respectively.

The standard solutions (1 g/l) of calcium, copper, iron, lead, magnesium, nickel, potassium, sodium and zinc) used for mineral analysis were from Fisher.

All the other reagents (sulphuric acid, chlorhydric acid, nitric acid, Sodium hydroxide, Isobutanol, etc.) used were analytical grade and provided from Panreac.

### Methods

#### Ordinary shea butters collected from markets

Samples (164 samples of shea butters) were obtained from the different markets. They were conserved and transported in an icebox containing ice cubes, following the international norms (ISO/CEI 17025) described in 2000 by the European Union. At the laboratory, the different samples were numbered according to their origins (market, town and area).

#### Determination of sensorial characteristics of shea butters

The sensorial characteristics (colour, odour and consistency or texture) of shea butters samples collected from markets were determined by four expert tasters who are familiar to shea butters, able to distinguish and precise the odours and colours. The colour was determined by placing a knob of shea butter on a white sheet. The odour of the shea butter was defined by inhalation. The consistency was assessed by mashing a knob of shea butter between the fingers.

The different samples of shea butters (ordinary and optimized) were melted at 40°C and then mixed according to colour, before analyses. The different aliquots of shea butters for each test were conducted in every part of the solid mixed shea butters (at the bottom, in the middle and at the surface). The tests were performed in triplicate and the values given in all tables, are the averages with the standard deviation.

#### Determination of physicochemical characteristics of shea butters

The iodine, peroxide and saponification values were determined by using the European pharmacopoeia norms described in 2002. The acid value was obtained by Cooks and Van Rede method as described by Ocho (1999).

The unsaponifiable content was evaluated by the French norm numbered NF T60205 (2001). Thus, the unsaponifiable fraction was carried out by extracting 5 g of shea butter in hexane, after saponification with 25 ml of potassium hydroxide 2 N in alcoholic solution.

The moisture content was determined by AOAC (1981) method by dehydration of 5 g of shea butter and drying in an electric oven (80°C) up to a constant weight.

The mineral content of the shea butter was determined by spectroscopy atomic absorption with a spectrophotometer *SpectrAA-5*. Shea butter (1 g) was mineralized in a mineralizing oven (J.P. Selecta, s.a. N$^{er}$ 0346540) at 550°C, for 24 h, as described by Biego et al. (2004). The mineralization temperature increased progressively (50°C by 30 min) from 50 to 550°C, and then stopped the process 24 h later.

The method of Hamilton and Rossel (1986) was used to obtain the melting point value of the shea butter. Melted shea butter (2 g) was poured into a Pasteur's pipette and frozen overnight. The pipette containing shea butter was then put in an icy bain-marie (0°C) which was heated until the frozen shea butter starts melting. The temperature of the bain-marie was then read on a thermometer first kept in the bain-marie.

The refractometric value (index) was read at 40°C with a digital refractometer Atago RX-5000 (Cat. N$^{er}$ 3251).

#### Determination of microbiological characteristics of shea butters

The microbiological analysis concerned the presence of *Salmonella* and counting microbial organisms such as aerobic mesophile bacteria (on PCA for 72 h), total coliforms (on VRBL at 30 °C for 24 h), thermotolerent coliforms (on VRBL at 44°C for 24 h), yeast and moulds (on YGC at 25°C for 72 h). The different methods used for these analyses are described by the French standards numbered NF V 08-052 (1997), NF V 08-051 (1999), NF V 08-050 (1999), NF V 08-060 (1996) and NF V 08- 059 (2002), respectively. For the principal suspensions (or mother suspensions), 10 g of melted shea butter (market or optimized) were added to 90 ml of peptone buffer water.

#### Preparation of the optimized shea butters

The optimized shea butters were manufactured in laboratory. The traditional manufacturing process used here, is currently employed in Dabakala to prepare marketed shea butters. Shea kernel paste was boiled in two equivalent volumes of solution (water or a decoction of *Cochlospermum tinctorium* roots).

**Table 1.** Biochemical characteristics of marketed and optimized shea butter from Côte d'Ivoire.

| | Colour | Iodine value ($mgI_2$/100g) | Peroxide value ($mEgO_2$/kg) | Unsaponifiable content (%) | Acid value (mgKOH/g) | Saponification value (mgKOH/g) |
|---|---|---|---|---|---|---|
| **Marketed shea butter** | **Beige** | 28.53 ± 0.75 b**c** | 17.92 ± 0.50 **a** | 1.44 ± 0.03 **b** | 12.80 ± 0.30 **ab** | 198.24 ± 1.30 **a** |
| | **Yellow** | 31.42 ± 0.9 **b** | 14.70 ± 0.47 **b** | 1.68 ± 0.02 **b** | 14.97 ± 0.33 **a** | 168.80 ± 1.10 **b** |
| | **Grey** | 30.78 ± 0.8 | 30.88 ± 0.55 | 1.88 ± 0.02 | 17.32 ± 0.24 | 204.08 ± 1.10 |
| **Optimized shea butter** | **Beige** | 24.60 ± 0.15 **c** | 2.79 ± 0.05 **d** | 17.61 ± 0.25 **a** | 11.94 ± 0.05 **b** | 196.10 ± 0.15 **a** |
| | **Yellow** | 43.23 ± 0.15 **a** | 5.77 ± 0.05 **c** | 17.61 ± 0.25 **a** | 10.51 ± 0.55 **c** | 197.13 ± 0.05 **a** |

Where: values given are ± the standard deviation. Values with different letters underlined significant difference.

**Table 2.** Physical characteristics of marketed and optimized shea butters from Côte d'Ivoire.

| | Colour | Refractometric value | Melting point (°C) | Moisture content (%) |
|---|---|---|---|---|
| **Marketed shea butter** | **Beige** | 1.464 ± 0.01**c** | 35.9 ± 0.5 **a** | 3.36 ± 0.02 **b** |
| | **Yellow** | 1.464 ± 0.01**c** | 34.6 ± 0.5 **b** | 8.36 ± 0.02 **a** |
| | **Grey** | 1.463 ± 0.01 | 34.9 ± 0.5 | 14.50 ± 0.01 |
| **Optimized shea butter** | **Beige** | 1.465 ± 0.00 **b** | 35.0 ± 0.10 **ab** | 0.15 ± 0.01 **c** |
| | **Yellow** | 1.466 ± 0.00 **a** | 33.0 ± 0.10 **c** | 0.15 ± 0.01 **c** |

Where: values given are ± the standard deviation. Values with different letters underlined significant difference

The optimization of this process consisted mainly of blanching fresh nuts and a reduced sun drying time at one week for the nuts (instead of two, three or four weeks in traditional method). The kernels (500 g) roasting time was also reduced to 5 min.

After removing the pulp of shea fruits (10 kg), the fresh seeds were dipped in two equivalent volumes of boiling water for 20 min and then put on plates for sun drying for one (1) week. Once the hulls of the dried nuts were removed, the kernels were chopped finely with a kitchen chopper and then roasted at 120 to 150°C for 5 min (by part of 500 g). The roasted kernels were ground with an electric grinder (moulinex) and the kernels paste was boiled for one hour in 2 equivalent volumes of distilled water for the beige shea butter and 2 equivalent volumes of a decoction of *C. tinctorium* roots (1 kg of roots boiled for one hour in 10 litres of distilled water), for the yellow shea butter. The floating oil of the boiling solution was collected and dehydrated by heating it for 5 min. The 2 different samples of optimized shea butters (beige and yellow) were stored at 4°C, in clean packages.

Biochemical, physical, mineral and microbiological characteristics of both beige and yellow optimized shea butters was performed in triplicate.

#### Statistical analysis

The statistical analysis of the results was done by frequencies and averages comparison ($Chi^2$ test) with the SPSS logician version 10.0

The comparison between treatments was realized by the analysis of variance (ANOVA) with a mean of 95%. Each significant ANOVA test, completed with the test of Fischer (LSD) led to homogeny groups.

## RESULTS

### Characteristics of Shea butter collected from markets

Samples of shea butters collected from local markets in Côte d'Ivoire presented a high diversity concerning the sensorial characteristics (colour, odour and consistency). This included various colours (beige: 29.63%, grey: 2.47% and yellow: 67.90%), odours (odourless: 20.99%, moderated: 33.33%, fragrant: 11.73% and rancid: 33.95 %) and consistency (soft: 6.17% and hard: 93.83%). However, the most common shea butters from the different markets were yellow (67.90 %), rancid (33.95 %) and hard (93.83 %) ones, in comparison with the other shea butters.

Statistical tests ($Chi^2$) did not reveal variations in the sensorial characteristics distribution from different areas of collecting areas.

Tables 1 and 2, show that the physicochemical characteristics varied with the colour of the shea butter. The yellow shea butter had the highest iodine value (31.42 $mgI_2$/100g) and mineral content, and the lowest peroxide value (14.70 $mEgO_2$/kg), in contrast to the grey shea butter which had the lowest minerals content and the highest acid (17.32 mgKOH/g), peroxide (30.78 $mEgO_2$/kg) and moisture content (14.50 %) values. The beige shea butter had the lowest acid (12.80 mgKOH/g) and moisture content (3.36 %) values.

In general, these shea butters collected on local markets contained heavy metals as lead (4.84 to 91.60 mg/kg) and nickel (1.27 to 3.07 mg/kg) (Table 3). They also presented high microbial contamination such as aerobic mesophile bacteria ($2.7\times10^{+5}$ bacteria/g of shea butter) total coliforms ($2\times10^{+2}$ bacteria/g of shea butter), yeast and moulds ($10^{+4}$ germs/g of shea butter) and sometimes *Salmonella* (10 bacteria/g of shea butter). These microbial contents were greater than the microbiological international standard for edible fats (Table 4).

**Table 3**. Mineral composition of marketed and optimized shea butter from Côte d'Ivoire.

| | Samples | Copper | Iron | Lead | Nickel | Zinc | Calcium | Sodium | Magnésium |
|---|---|---|---|---|---|---|---|---|---|
| **Marketed** | **Beige shea butter** | 15.23 ± 0.01 | 28.76 ± 0.05 | 10.12 ± 0.02 | 3.07 ± 0.01 | 28.05 ± 0.01 | 289.50 ± 0.01 | 70.96 ± 0.01 | 19.39 ± 0.01 |
| | **Yellow shea butter** | 5.82 ± 0.01 | 67.17 ± 0.05 | 91.60 ± 0.02 | 1,27 ± 0.01 | 34.35 ± 0.01 | 340.65 ± 0.01 | 95.90 ± 0.01 | 88.74 ± 0.01 |
| | **Grey shea butter** | 0.00 | 4.45 ± 0.05 | 4.84 ± 0.02 | 2,03 ± 0.01 | 19.50 ± 0.01 | 38.78 ± 0.01 | 50.82 ± 0.01 | 0 .00 |
| **Optimized** | **Yellow shea butter** | 7.15 ± 0.01 | 1.67 ± 0.01 | 0.00 | 0.00 | 1.90 ± 0.02 | 238.85 ± 0.05 | 136.62 ± 0.02 | 12.18 ± 0.02 |
| | **Beige shea butter** | 0.95 ± 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 212.26 ± 0.05 | 84.57± 0.02 | 0.00 |
| | **Shea kernel** | 3.30 ± 0.01 | 30.65 ± 0.01 | 0.00 | 0.00 | 9.97 ± 0.02 | 2151.8 ± 0.05 | 739.58 ± 0.05 | 1425.60 ± 0.05 |
| | **Root of *C. tinctorium*** | 12.95 ± 0.01 | 83.89 ± 0.01 | 0.00 | 0.50 ± 0.01 | 11.24 ± 0.02 | 1649.90 ± 0.05 | 696.32 ± 0.05 | 1177.95 ± 0.05 |

Where: values given are ± the standard deviation.

**Table 4**. Microbiological characteristics of marketed and optimized shea butters from Côte d'Ivoire.

| Identified germs | Microbiological norms | 3 × Microbiological norms | Marketed shea butter | Optimized shea butter |
|---|---|---|---|---|
| Number of aerobic mesophiles bacteria/g | $< 1\times10^{+4}$ | $< 3\times10^{+4}$ | $2.7\times10^{+5} \pm 10^{+3}$ | $< 1\times10^{+4}$ |
| Number of total Coliforms /g | < 25 | < 75 | $2\times10^{+2} \pm 10^{+1}$ | < 25 |
| Number of yeast and moulds/g | < 10 | < 30 | $1\times10^{+4} \pm 10^{+2}$ | < 10 |
| Number of S*almonella* /g | 0 | 0 | 10 | 0 |

### Optimized shea butter characteristics

The optimized traditional shea butter prepared using water presented a beige colour. But this butter prepared with decoctions of *C. tinctorium* roots, was yellow in colour. However, both of them had a moderate odour and a soft consistency.

Concerning the physicochemical characteristics of both beige and yellow optimized shea butters, the acid (11.94 and 10.51 mgKOH/g, respectively), peroxide (2.79 and 5.77 $mEgO_2$/kg, respectively) values and the moisture content (0.15 % for both) were relatively low, while the unsaponifiable content was very high (17.61 % for both) (Tables 1 and 2). Considering each colour, it was noticed that the optimized yellow shea butter had the highest iodine, peroxide and refractometrical values, but the moisture and unsaponifiable content, the acid and saponifiable values were practically similar (Tables 1 and 2).

Concerning mineral characteristics of these optimized shea butters, both of them contained minerals as calcium (212.26 and 238.85 mg/kg), copper (0.95 and 7.15 mg/kg), iron (0 and 1.67 mg/kg), magnesium (0 and 12.18 mg/kg), potassium (36.41 and 45.17 mg/kg), sod-ium (84.57 and 136.62 mg/kg) and zinc (0 and 1.90 mg/kg). These minerals were also present in the shea kernels and the roots of *C. tinctorium* (Table 3). In addi-tion, these optimized shea butters did not contain heavy metals (lead and nickel). The yellow optimized shea butter was also richer in mineral than the beige one.

Considering the microbiological characteristics, the microbial content of both optimized shea butters (beige and yellow) expressed as aerobic mesophile bacteria (< $1.10^{+4}$ bacteria/g of shea butter), coliforms (< 25 bacteria /g of shea butter), and yeast and moulds (< 10 germs/g of shea butter), were within the limit specified by the microbiological international standard for edible fats (Table 4).

### Comparison between markets and optimised shea butters

The comparison was done only between the yellow and beige coloured shea butters.

The analysis of variance (ANOVA) used to compare treatments showed a significant difference between optimized and markets shea butters (Tables 1 and 2). Indeed, optimized shea butters (beige and yellow) had the lowest acid, peroxide and moisture content values, and the highest insaponifiable content compared to shea butters collected from markets (Tables 1 and 2).

Moreover, optimized shea butters did not contain heavy metals (lead and nickel) and *Salmonella*, and their aerobic mesophile bacteria, coliforms, yeast and moulds were within the limit specified by the microbiological international standard for edible fats, contrary to the shea butters collected from markets.

## DISCUSSION

The traditional shea butters sold on local markets of Côte d'Ivoire present a high diversity concerning the colour (beige, grey and yellow), odour (odourless, moderate, fragrant and rancid) and consistency (hard and soft). This variability could be explained by the various characteristics of these butters, but mostly by the different traditional process used (Elias and Carney, 2004; Schreckenberg, 2004; Kapseu et al., 2005; Womeni et al., 2006). The traditional process is generally without control (Kapseu et al., 2005) . This uncontrolled situation could result in the presence of low quality grey and rancid shea butters. The grey shea butter can be the result of shea kernel over-roasting, while the rancid one can be derive from the spoilt and mouldy kernels (Mégnanou, 2007) . These realities were taken into account, in the process of the optimized shea butter which is beige or yellow with a moderate odour (absence of rancidity) and soft. With these sensorial characteristics, the optimized shea butter is similar to those of Burkina Faso and Senegal which are known and appreciated on the international market under the labels of "Ecocert" and "Alepnatur", respectively (Infocomm, 2004). Thus, the traditional optimized shea butter could also satisfy the consumers of both Burkina Faso and Senegal shea butters. In the same way, this optimized shea butter of Côte d'Ivoire could also be exported since its physico-chemical characteristics are in conformity with the regional standard norms of Africa for the non refined shea butter.

The moisture content, acid and peroxide values of the optimized shea butter were the lowest and were within the international standard, contrary to the marketed shea butters which had a very high moisture content (3.36 to 14.40%), as shown by the analyse of variance (test of Fischer), because of adulteration with water (hall et al., 1996). These improved properties of the optimized shea butter were because of the controlled process.

Blanching of fresh shea nuts should prevent the fats of the kernels from lipolyses and oxidation, while the reduced solar drying time (one week instead of two weeks as usual in the traditional process) prevented mould growth. Moreover, the reduction of the kernel roas-ting time (5 min) facilitated the reduction in acid and peroxide values (Louppe, 1995; Hall et al., 1996; Kapseu et al., 2005; Womeni et al., 2006). Thus, the high acid and peroxide values of marketed shea butter could be associated to the lack of control in the traditional process; in particular, these high values could be explained by the long time of drying for nuts and roasting as for the kernels (Kapseu et al., 2005; Womeni et al., 2006). However, the exposure of marketed shea butters to solar rays and oxygen of air could also explain these high values of acid and peroxide indexes. The exposure of fat in the shea butter in particular to solar rays and the air is speculated to cause reactions of hydrolysis of glycerids and the oxidation of the unsaturated fatty acids (Cruz et al., 1988; Dieffenbac-

bacher et al., 2000). The latest reaction (oxidation of unsaturated fatty acid) could also be responsible for the relatively low iodine values of both marketed and optimized shea butters (Dieffenbacher et al., 2000). But nevertheless, the iodine values of the yellow shea butters were the highest because of the presence of tannins in *C. tinctorium* roots which play the combined roles of dye and antioxidant (Ayeh, 1991). The presence of these tannins could also explain the higher refractometric index and mineral content of yellow shea butters in comparison with the beige ones. However, the higher mineral content of marketed shea butters in comparison to the optimized shea butters could also be the result of the adultery with wood ash and various flours (Hall et al., 1996).

In addition to their interesting sensorial and physicochemical characteristics which are in conformity with the international standards for none refined shea butter, both beige and yellow optimized shea butters were heavy metal (lead and nickel) and Salmonella free. Their microbial content (Coliforms, yeast and moulds) were less than the international standard for edible fat, contrary to the marketed ones which had microbiological contamination which exceeded the standard. It should be important to underline that the presence of heavy metals such as plumb and nickel, and the high microbial content in the market shea butter contrary to the optimized shea butter, could be explained by the exposure to the atmospheric air, smoke of the cars and dust, when these elements could be vectors of microbial germs and heavy metals (Cruz et al., 1988; Roquebert, 1997; Pfohl-Leszkowicz, 2000; Guggenbühl, 2003). In comparison, the optimized shea butters were preserved in a clean package safe from air and dust.

These different characteristics might confer to the optimized shea butter, not only the aptitude of being exported out of Africa, but also the quality of being used by Industrial without refining. This would reduce refining costs, currently required for the traditional shea butters (Leakey, 1999; Kiyayila, 2002). The optimized shea butter could be considered as a response to the needs of industrials since it has been shown that the industrial processing of shea butter is less valuable for cosmetic and pharmaceutical purposes, than the traditional ones (Elias and Carney, 2004).

In addition, the optimized shea butter had improved nutritional and cosmetic containing minerals such as calcium, magnesium, iron, copper and zinc. These minerals are essential for children and pregnant women nutrition, also in hairs, nails and skin care (Gueguen, 2003). This mineral composition represents a high opportunity for rural and poor populations, because shea butter is less expensive than other edible fats (Niankoyé, 2002; Niansenei, 2002; Schreckenberg, 2004). Moreover, with its high unsaponifiable content (17.61%), the optimized shea butter may constitute an important raw material for the cosmetic industry, for example cosmetic products for hair, nails and skin care, and also for pharmaceutical purpose (Pesquet, 1992; Louppe, 1995; Hall et al., 1996; Leakey, 1999; Rossignol-Castera, 2004; Joanny, 2005).

## Conclusion

The marketed shea butters varied widely in colour (beige, grey and yellow), odour (odourless, moderate, fragrant and rancid) and consistency (soft and hard) while the optimized one made under controlled conditions was specifically beige or yellow with a moderated odour and a soft consistency.

The physicochemical characteristics of the optimized shea butter conformed to regional norms (standards) of Africa while the non refined shea butter do not. This was because of adulteration and their exposure to deterioration factors such as solar rays, dust and the air.

The optimized shea butter had improved nutritional content compared to the market samples containing minerals such as calcium, iron, copper, magnesium, sodium, potassium and zinc. Moreover, it's the high content of unsaponifiable fats that will enable it to be a useful raw material for cosmetic, pastry and pharmaceutical purposes.

However, in order to preserve the improved quality of the optimized shea butter, it should be appropriate that it is kept in clean package, safe from heat (solar), air and dust.

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