academicJournals

Vol. 8(2), pp. 64-74, February 2014
DOI: 10.5897/AJFS12.139
ISSN 1996-0794 ©2014 Academic Journals
http://www.academicjournals.org/AJFS

African Journal of Food Science

Full Length Research Paper

A two –year seasonal survey of the quality of shea butter produced in Niger state of Nigeria

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Accepted 29 January, 2014

Low quality of shea butter has continued to be a major challenge in the shea tree value chain. The quality and identity characteristics of market-ready shea butter produced by family-based processors, the highest contributors to the butter output in Nigeria were studied using standard methods of analysis for two consecutive fruiting years to ascertain the consistency in quality status. This was with the view to determining the suitable market segment the butter could serve. The result generally show significant inconsistencies in both quality and identity parameters within and among the villages and zones studied for the two years. The free fatty acid (ffa), acid value, peroxide value, anisidine value, iodine value, moisture, dirt unsaponifiable matter, saponification value ranged from 5.40±0.14 to 13.45±0.44, 10.50±0.22 to 27.06±0.04, 3.50±0.02 to11.17±0.06, 1.72±0.03 to 4.75±0.08, 38.67±0.68 to 60.37±0.57, 0.56±0.02 to 0.40±0.03, 0.86±0.04 to 1.72±0.01, 5.90±0.04 to 9.27±0.06, 193.0±0.72 to 224.67±0.67 while in the second year, the range were correspondingly 5.26±0.05 to 10.13±0.06, 9.19±0.05 to 20.17±0.12, 2.24±0.01 to 8.07±0.08, 2.08±0.25 to 5.03±0.0.2, 36.97±0.21 to 60.57±0.42, 0.21±0.02 to 0.84±0.03, 0.50±0.03 to 1.46±0.03, 6.60±0.10 to 10.09±0.11 and 189.07±2.06 to 236.5±0.66. The mean values computed for the villages did not approximate the data obtained by pooling and analysing the samples from the respective zones very well. The present status of the butter quality did not describe a particular trend and only suits the local market.

Key words: Fat, shea butter, quality parameters, *Vitelleria paradoxa.*

INTRODUCTION

Fats and oils are important macromolecule component of plant and animal tissue. They provide a more concentrated source of energy than do carbohydrates and proteins (Akoh, 1995). The various fats contribute to the physical and functional properties (solubility, viscosity, rheology, melting behaviour, emulsification, body, creaminess, heat conduction carrier of lipophilic vitamins and flavorants) of most products and nutritional (satiety, calories, essential fatty acids source) and health benefits aspects of food) (Akoh, 1998). Global demand for oils and fats to feed the ever growing world population has continued to grow. For example, since year 2000, when the European Union (EU) allowed chocolate makers to substitute up to 5% of cocoa butter in their chocolate with other vegetable fats such as palm oil or shea butter (Cassiday, 2012), the exports of shea butter have increased dramatically. There are several commercial sources of oils and fats such as shea kernel currently being exploited.

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The Shea tree (*Vitelleria paradoxa)* is multipurpose and highly valued not only for the economic and dietary significance of its cooking oil, but also for the fruit pulp, bark, roots and leaves which are used in traditional medicines and for the wood and charcoal used for building and cooking fuel (USAID, 2005). Shea trees grow wild across a 5000 km wide belt of savannah (Maranz and Wiesman, 2003), (Masters et al., 2004) including most West African countries and further east in Uganda, Sudan and Ethiopia (Chalfi, 2004; Goreja, 2004). Among these countries, Ghana and Burkina Faso are the main shea nut exporters (Walter et al., 2003) while Nigeria with the highest shea tree density is the highest producer although 70% of the shea fruits rot away in the bush due to poor collection mechanism (Adgidzi, 2008). As a natural resource controlled by women and children (Elias and Carney, 2007), the shea tree supports the nutritional, economic and health of the rural families and sustains indigenous plant and animal diversity (The Shea Project, 2008). Processing shea kernel into butter, as a venture, has the potential and capacity to contribute to the world economy and total vegetable fats production when properly harnessed. Shea exports from Africa are now estimated to have grown to an annual maximum of 150,000 t of dry kernel with a current market value of approximately 30 million United State Dollar (USD) with prices around 200 USD per ton free on board West African Port (USAID, 2005). The summary of detailed data on the production and export volume of shea produce of the major west African producers up to 2005 have been provided by Nikiema and Umali (2007).The export market is however strictly regulated by high quality standards for shea butter depending on the user industry (USAID, 2005).

However, due to the fact that shea tree is exploited in the wild, proper and sustainable harnessing is fraught with a lot of challenges beginning from picking of the fruit from the bush through storage to marketing of the products. The problems posed by the methods of collecting shea fruits, processing and the great diversity in the shea fruits result in diverse quality and identity characteristics of the butter produced. These variations in the physico-chemical compositions of vegetable oils have often been attributed to environmental factors such as rainfall, soil fertility, maturation period, agronomic practice and genetic substitution (Maranz et al., 2003; Sonou et al., 2006). The methods of processing shea fruits into nuts and butter specifically varies from family to family and from community to community (some communities add local antioxidants or deodorants during processing to extend the shelf life and reduce the unpleasant odour respectively) (Personal communication), hence the wide variation in the quality of butter from the shea belt (Masters et al., 2004). There are also the problems of the use of inconsistent raw materials (water, shea nut), dirty utensil and work environment (normally under a shea tree), lack of quality control and poor butter storage facilities. Nahm (2011) and Carette et al. (2009) have painstakingly documented the comprehensive list of attendant problems associated with shea kernel processing in Ghana.

At present, shea butter is in high demand in the international market hence attracts a premium price. Generally, according to Food and Agricultural Organization wherever there is a commodity that attracts a premium in the market and has either high value or high-volume sales, there is a propensity for some people to engage in illegal activity in order to make higher profit. These nefarious activities usually involve violating food standards and labelling regulations by misleading the purchaser as to the true nature, substance or quality of the goods demanded. The offence can also take the form of adulteration, which generally involves the dilution of a commodity with less expensive materials or overrate cheaper as if it was a food of greater value (Food and Agricultural Organization). The implication of all this is that food authenticity problems can create enormous harm in the marketplace. These problems include public health problems, defrauding of consumers, dwindling sales of a product when a fraud is detected, distortion in market competition etc (Food and Agricultural Organization).

Although the methods of oils and fats analysis have improved tremendously to a level where overt adulteration and misrepresentation could hardly go undetected, the cheats also devise subtle and sophisticated methods to perpetuate their criminal and detrimental acts. To effectively counter this unwholesome practice, a data bank of typical values of authentic oils and fats is required to enable easy comparison with the samples under investigation in other to confirm the claim or not.

Over the years, there has not been a comprehensive compositional and ancillary data on the Nigerian shea butter and nuts especially what is offered for sale in the market generated within a range of two successive years. Some of the studies carried out earlier were on ad hoc basis and at different times and within small study areas. The history of the sample used in the respective analysis were not comprehensively ascertained and told. Therefore, the sketchy results generated from these studies were difficult to harmonize and less robust to be integrated into other national or regional studies within the West African region. This scenario hinders planning, policy and decision making.

Again, unconfirmed observations of the fruiting cycle show that *Vitellaria paradoxa* give only one good harvest per 3-4 years (Nikiema and Umali, 2007). The local processors understood this cycle event very well hence during the bumper harvest year they pick, process and store the butter to be sold during the lean year (butter for them is more convenient to store than the kernel). In the lean year depending on the availability of fresh shea fruit the processors will either mix the stored butter with freshly processed butter or offer the stored butter as it were for sale in the market. This probably explains why the local processors are usually reluctant to sell freshly processed butter. The exporter will in turn pool the batches bought from different communities and sources prior to export and so on along the chain. In all this, a new product with poor quality results from these blends. The overriding implication of this practice is the likely dissimilarity in the data on the physico-chemical properties of shea butter sold in the market and those from the point of processing.

This study therefore aimed at surveying the quality and identity parameters of market-ready shea butter processed in Niger State, Nigeria with the view to initiating the development of a databank, eliminating adulteration and ascertaining the highest quality possible in the State. The study will also assist in determining the grades and consistency of shea butter produced by the predominant local processors in Niger State, with the view to helping policy and decision makers as well as the end users.

MATERIALS AND METHODS

Study area

The study area was Niger State, Nigeria. It has the highest shea tree density in Nigeria and a lot of advocacy on quality improvement strategies have been done in the state.

Sample collection

Niger State, Nigeria, is divided into three agricultural or political zones namely A, B and C, probably for administrative convenience. For the purpose of this study, 30 samples of shea butter were purchased from ten villages in each of the agricultural zones. The villages selected at random were Agaie,Koriagi, Dibbo, Badeggi, Kausanagi, Lapai, Egbhanasara, Bida, Gangban and Chiji in zone A; Bassa, Gurmana, Erena, Gwada, Zumba/Shiroro, Gawu, Paiko, Babangida, Kwakuti, Kagara in zone B, and Duku, Auna, Nasko, Pandogari, Rijau, Kaboji, Borgu, Dusai, Warari, Gulbin Boka in zone C. The study was conducted during the peak fruiting season in an attempt to minimize the effect of improper processing conditions or over stored kernels carried over from the previous years.

The set of samples characterized in this work consisted of three samples bought from each of the ten villages of the respective three zones. The samples were bought from the women or sellers that were already on their way to the market and have permanent home addresses. This strategy was necessary because based on personal observations, some of these processors usually take the freshly processed butter home and mixed them with the previously processed or stored batches prior to selling at the market. Therefore, buying the butter from them at the processing shed or point may not portray the true quality state of the butter sold at the market. The samples were bought in 2 L (market-ready) packs of plastic buckets of different colours.

The purchased butter samples were transported to the Biochemistry Division, Nigerian Institute For Oil Palm Research(NIFOR), Benin City, Edo State, Nigeria and stored in an air conditioned room (18-22°C) until the analyses were finished.

In order to simulate approximately what a butter merchant that purchases from these women and equally pooled, equal amount (500 mL) of butter from the ten villages in each zone were respectively pooled and analysed. This sample collection was precisely repeated the following peak fruiting period using the previous processors.

Physicochemical analyses

The purchased butter samples were respectively analysed using the standard method of analysis of AOCS (1997) as follows: free fatty acid (FFA) (Ca-5a), moisture (Ca 2c-25), peroxide value (PV) (Cd 8 -90), saponification value (SV) (Cd-3-25), iodine value(wijs) (IV) (Cd 1-25), specific gravity(Cc10b -25), unsaponifiable matter (UM) (Ca 6a 40) and p-anisidine Value(AnV). Acid value was computed by multiplying the ffa value by 1.99 as oleic acid is the predominant fatty acid in shea butter.

Fatty acid composition

Fatty acid methyl esters were prepared with the shea butter by transesterification using the PORIM Test Method (2004). The fatty acid methyl esters of total lipids were analyzed on a Hewlett Packard HP 6890 gas liquid chromatograph (Palo Alto, CA. USA) equipped with a flame ionization detector and a D-B- wax capillary column (30 m × 0.32 × 0.5 nm) (J & W). The column temperature was programmed from 200°C (held for a minute) to 230°C. The injector temperature was 260°C. The carrier gas nitrogen was set at a flow rate of 3.8 ml per minute. Then, the separated fatty acid methyl esters were identified by comparing their retention times with those of reference samples and quantification was performed with the help of an attached integrator.

Statistical analysis

All chemical analyses were performed in triplicate. The data generated were analysed using the SPSS software version 17. Means and standard deviation were computed. The analysis of variance (ANOVA) $P < 0.05$ was performed to find significant differences between means.

RESULTS AND DISCUSSION

Chemical analysis (quality and identity properties) of shea butter from zones A, B and C are respectively presented in Tables 1a, b and c for year 1 while those of the second year were similarly presented in Tables 2a, b and c respectively. Tables 3, 4, 5 and 6 show respectively the summary of the means of the parameters in the zones for the two years, summary of the mean values of the physico-chemical properties of shea butter for the two years, physico-chemical characteristics of pooled butter for the respective zones and fatty acid composition of the pooled butter for the respective zones.

Dirt

Generally, the dirt contents of the butter samples under consideration were statistically significantly different ($P<0.05$) among all the villages and zones. They were equally outside the specified standards for the international market. The percentage dirt contents in zones for the first year ranged from 0.87±0.01 to 1.71±0.03 for A; 0.86±0.04 to 1.68±0.03 for B while zone C was 0.87±0.03 to 1.72±0.01. In the second year, the ranges of the dirt contents were 0.56±0.02 to 1.12±0.02,

Table 1a. Physico-chemical characteristics of shea butter from Zone A for year (1) 2011.

Parameter	1	2	3	4	5	6	7	8	9	10	Average
FFA	9.47±0.392	8.80±0.290	9.68±0.086	8.57±0.237	5.32±0.251	6.81±0.119	9.74±0.066	6.61±0.087	9.87±0.178	5.4±0.147	8.03±1.76
AV	18.85±0.78	17.51±0.58	19.27±0.17	17.07±0.47	10.59±0.5	13.55±0.24	19.38±0.13	13.16±0.17	19.64±0.35	10.77±0.29	15.98±3.51
DIRT	1.54±0.056	0.87±0.010	0.98±0.025	1.45±0.035	1.45±0.025	1.67±0.074	1.53±0.031	1.71±0.03	1.17±0.02	1.21±0.032	1.36±0.28
MOISTURE	0.06±0.005	0.035±0.001	0.47±0.025	0.5±0.01	0.09±0.001	0.08±0.002	0.43±0.025	0.34±0.45	0.52±0.031	0.08±0.002	0.26±0.23
DENSITY	0.91±0.003	0.91±0.002	0.91±0.002	0.92±0.004	0.90±0.005	0.90±0.002	0.90±0.002	0.91±0.003	0.89±0.01	0.92±0.008	0.9±0.01
PV	4.29±0.015	5.96±0.01	4.45±0.02	5.07±0.02	10.2±0.006	6.75±0.05	8.05±0.038	4.71±0.03	5.8±0.34	4.68±0.04	6.0±1082
AnV	3.76±0.015	4.12±0.015	3.7±0.026	2.94±0.017	4.64±0.071	3.86±0.02	2.98±0.025	2.01±0.025	2.72±0.078	2.08±0.025	3.28±0.84
SV	236.5±0.66	206.83±4.65	215.67±4.04	202.67±2.52	189.83±3.84	193.07±0.95	222.7±2.21	208.67±2.29	196.57±1.56	216.33±0.91	208.88±14.06
IV	40.83±0.21	38.67±0.68	50.53±0.42	42.93±0.31	39.37±0.42	52.63±0.25	40.97±0.50	39.6±0.66	55.77±0.35	45.37±0.40	44.67±5.97
UM	6.84±0.067	7.35±0.093	7.61±0.16	6.86±0.074	7.83±0.031	7.62±0.199	5.98±0.025	6.14±0.057	8.85±0.015	9.10±0.99	7.42±0.99
MP	31 – 36	32 – 38	33 – 38	30 – 37	30 – 35	31 – 37	33 – 35	34 – 38	31 – 37	31 – 36	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages*:* 1=Agaie; 2=Koriagi; 3=Dibbo; 4=Badeggi; 5=Kausanagi; 6=Lapai; 7=Egbhanasara; 8=Bida; 9=Gangban;10 Chiji. Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 1b: Physico-chemical characteristics of shea butter from Zone B for year (1)2011.

Parameter	1	2	3	4	5	6	7	8	9	10	Average
FFA	13.6±0.021	13.6±0.02	13.45±0.44	6.71±0.22	8.07±0.03	8.76±0.4	12.24±0.24	10.18±0.36	8.44±0.05	9.0±0.08	10.39±2.49
AV	26.67±0.04	27.06±0.04	26.77±0.88	13.35±0.44	16.07±0.05	17.44±0.79	24.36±0.47	20.26±0.71	16.8±.010	17.9±0.15	0.55±0.04
DIRT	1.28±0.03	1.05±0.03	1.22±0.07	1.59±0.03	1.38±0.04	0.97±0.07	1.68±0.03	1.40±0.06	0.86±0.04	1.42±0.02	1.28±0.26
MOISTURE	0.08±0.007	0.42±0.03	0.33±0.068	0.50±0.034	0.41±0.021	0.47±0.01	0.29±0.022	0.36±0.044	0.36±0.024	.41±0.048	0.36±0.12
DENSITY	0.92±0.004	0.91±0.003	0.82±0.231	0.91±0.002	0.99±0.006	0.95±0.006	0.95±0.003	0.95±0.003	0.90±0.004	0.95±0.014	0.92±0.08
PV	5.66±0.004	6.55±1.37	4.67±0.04	6.82±0.03	8.34±0.006	9.12±0.03	10.17±0.17	7.61±0.16	8.19±0.03	11.17±.06	7.83±1.93
AnV	3.42±0.006	2.7±0.017	3.10±0.015	2.75±0.025	2.81±0.046	1.90±0.006	3.53±0.035	2.96±0.057	3.62±0.327	4.19±0.183	3.1±0.62
SV	201.13±0.64	190.17±0.25	211.43±0.85	195.13±1.5	230.63±0.56	215.5±0.6	195.6±0.4	214.9±1.05	198.77±0.47	202.5±3.15	205.58±11.95
IV	51.3±0.36	59.9±0.15	49.5±0.53	60.37±0.57	41.2±0.3	45.8±0.363	56.07±0.49	59.87±0.12	44.2±.3	48.5±0.53	51.67±6.79
UM	7.94±0.06	8.33±0.06	9.12±0.13	6.82±0.03	7.63±0.17	8.33±0.08	9.43±0.06	5.93±0.04	7.34±0.07	6.11±0.63	7.70±1.15
MP	31 – 34	32 – 36	32 – 38	31 – 35	33 – 36	34 – 38	34 – 36	33 – 35	30 – 35	31 – 35	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages:1=Bassa; 2=Gurmana; 3=Erena; 4=Gwada; 5=Zumba/Shiroro; 6=Gawu; 7=Paiko; 8=Babangida; 9=Kwakuti;10=Kagara **.** Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 1c. Physico-chemical characteristics of shea butter from Zone C for year (1)2011.

Parameter	1	2	3	4	5	6	7	8	9	10	Average
FFA	11.82±0.10	10.45±0.05	12.12±0.03	8.9±0.01	9.65±0.07	11.24±0.03	5.28±0.12	6.8±0.02	10.7±0.05	9.34±0.02	9.63±2.10
AV	23.53±0.19	20.79±0.1	24.11±0.06	17.7±0.02	19.21±0.13	22.36±0.05	10.5±0.22	13.54±0.03	21.3±0.1	18.59±0.04	0.64±0.02
DIRT	1.62±0.03	1.34±0.01	1.29±0.02	1.56±0.02	1.02±0.02	0.99±0.01	0.87±0.03	1.72±0.01	1.54±0.02	1.65±0.02	1.36±0.3
MOISTURE	0.09±0.01	0.09±0.01	0.38±0.02	0.48±0.03	0.41±0.02	0.56±0.03	0.4±0.03	0.38±0.01	0.6±0.02	0.37±0.02	0.38±0.17
DENSITY	0.89±0.003	0.10±0.003	0.94±0.004	0.94±0.002	0.97±0.003	0.96±0.003	0.98±0.002	0.99±0.001	0.9±0.004	0.9±0.005	0.95±0.04
PV	8.44±0.01	5.95±0.02	10.22±0.03	9.45±0.10	7.26±0.06	7.79±0.04	8.9±0.02	5.5±0.04	3.5±0.02	6.35±0.07	7.34±1.97
AnV	3.56±0.03	2.96±0.02	3.49±0.01	2.87±0.02	1.75±0.02	3.49±0.01	4.55±0.10	3.96±0.02	5.03±0.02	3.36±0.01	3.5±0.88
SV	200.1±0.8	197.77±1.62	210.2±0.92	232.4±1.71	209.93±0.47	189.07±2.06	198.3±0.62	221.27±1.59	204.97±0.50	2.3.2±0.56	206.72±12.15
IV	45.23±0.35	39.8±0.1	43.3±0.92	45.47±1.58	50.73±0.40	43.87±0.38	58.63±0.38	48.07±0.76	40.97±0.21	39.63±0.67	45.57±5.62
UM	8.38±0.04	6.98±0.05	7.95±0.09	6.87±0.06	8.08±0.07	7.93±0.06	8.98±0.04	7.77±0.07	8.89±0.02	9.27±0.06	8.12±0.77
MP	32 - 37	33 – 37	29 – 35	32 – 35	33 – 36	30 – 35	33 – 35	30 – 34	32 – 36	33 – 35	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages: 1=Duku; 2=Auna; 3=Nasko; 4=Pandogari; 5=Rijau; 6=Kaboji; 7=Borgu; 8=Dusai; 9=Warari; 10=Gulbin Boka. Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 2a. Physico-chemical characteristics of shea butter from Zone A for year (2)2012.

Parameter	1	2	3	4	5	6	7	8	9	10	Average
FFA	9.04±0.09	9.50±0.06	9.67±0.03	8.5±0.05	7.41±0.05	6.72±0.03	9.6±0.02	9.4±0.03	8.6±0.03	7.32±0.09	8.58±1.04
AV	18.0±0.18	18.91±0.13	19.25±0.06	16.92±0.10	14.75±0.10	13.37±0.10	19.1±0.04	18.71±0.06	17.12±0.06	14.57±0.17	1.06±0.03
DIRT	0.56±0.02	1.46±0.03	1.2±0.02	0.97±0.03	0.90±0.06	0.57±0.04	1.12±0.02	0.85±0.02	0.93±0.03	0.88±0.01	0.94±0.26
MOISTURE	0.43±0.02	0.53±0.01	0.49±0.02	0.49±0.04	0.46±0.03	0.29±0.02	0.4±0.01	0.44±0.01	0.36±0.02	0.41±0.03	0.43±0.07
DENSITY	0.92±0.003	0.91V0.006	0.91±0.004	0.93±0.003	0.92±0.002	0.96±0.054	0.92±0.003	0.92±0.003	0.91±0.003	0.92±0.002	0.92±0.02
PV	4.67±0.05	5.68±0.04	6.36±0.07	4.38±0.05	3.91±0.06	3.7±0.05	3.9±0.02	4.09±0.03	5.29±0.01	4.9±0.04	4.69±0.84
AnV	2.19±0.02	2.36±0.02	2.17±0.03	1.86±0.03	3.23±0.02	3.32±0.02	1.97±0.03	2.51±0.03	1.93±0.02	2.09±0.02	2.36±0.50
SV	224.67±0.67	199.37±0.64	201.93±0.65	196.3±0.76	199.53±0.90	209.2±0.9	197.3±0.36	213.4±0.61	209.6±0.35	198.87±0.15	205.02±8.76
IV	39.43±0.68	40.67±0.15	50.7±0.46	49.6±0.61	48.73±0.76	46.97±.21	43.77±0.47	50.83±1.02	48.07±0.61	42.37±0.65	46.11±4.11
UM	9.27±0.03	7.1±0.01	8.19±0.03	7.65±0.15	8.29±0.04	9.14±0.05	8.94±0.06	6.93±0.07	7.2±0.04	6.72±0.92	7.94±0.92
MP	33 – 36	34 – 38	31 – 35	32 – 35	31 – 35	33 – 36	31 – 34	34 – 38	31 – 35	32 – 36	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages*:* 1=Agaie; 2=Koriagi; 3=Dibbo; 4=Badeggi; 5=Kausanagi; 6=Lapai; 7=Egbhanasara; 8=Bida; 9=Gangban;10 Chiji. Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 2b. Physico-chemical characteristics of shea butter from Zone B for year (2)2012.

Parameter	1	2	3	4	5	6	7	8	9	10	Average
FFA	7.50±0.20	8.0±0.04	6.85±0.06	8.36±0.04	4.95±0.06	5.76±0.24	8.68±0.02	10.13±0.06	9.44±0.06	8.18±0.04	7.78±1.53
AV	14.69±0.03	15.85±0.08	13.64±0.13	16.64±0.08	9.85±0.12	11.46±0.49	17.28±0.05	20.17±0.12	18.78±0.11	10.27±0.08	1.12±0.02
DIRT	1.34±0.02	1.03±0.01	1.06±0.03	1.13±0.02	1.09±0.01	1.06±0.01	0.99±0.01	0.5±0.03	1.15±0.02	1.19±0.02	1.05±0.21
MOISTURE	0.54±0.03	0.45±0.02	0.48±0.01	0.63±0.02	0.36±0.02	0.64±0.01	0.56±0.02	0.49±0.01	0.84±0.03	0.69±0.02	0.57±0.13
DENSITY	0.900±0.002	0.900±0.003	0.940±0.007	0.910±0.006	0.990±0.007	0.910±0.002	0.920±0.001	0.970±0.002	0.920±0.002	0.940±0.005	0.920±0.03
PV	7.31±0.02	6.44±0.03	5.65±0.02	4.51±0.09	4.3±0.02	3.99±0.02	7.25±0.05	6.58±0.03	3.79±0.04	4.09±0.02	5.39±1.39
AnV	2.62±0.30	3.86±0.04	4.63±0.12	3.27±0.06	3.06±0.03	4.15±0.05	3.55±0.06	4.75±0.08	3.99±0.02	3.48±0.05	3.74±0.66
SV	193.0±0.72	212.8±0.66	199.0±0.7	202.43±1.62	207.67±0.40	198.03±0.64	210.53±0.25	200.0±0.49	219.47±0.9	216.9±0.56	204.99±8.52
IV	50.6±0.53	36.97±0.21	40.97±0.31	40.33±0.84	52.7±0.3	51.1±0.62	46.2±0.56	45.07±0.67	57.57±0.25	40.07±1.10	45.56±5.56
UM	9.14±0.02	8.93±0.09	7.01±0.08	7.61±0.33	9.58±0.11	6.91±0.17	8.96±0.08	8.6±0.05	7.47±0.04	9.11±0.03	8.33±0.95
MP	31 – 34	33 – 35	32 – 36	33 – 38	30 – 35	31 – 35	29 – 34	31 – 34	33 – 35	33 – 35	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages:1=Bassa; 2=Gurmana; 3=Erena; 4=Gwada; 5=Zumba/Shiroro; 6=Gawu; 7=Paiko; 8=Babangida; 9=Kwakuti;10=Kagara **.** Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 2c. Physico-chemical characteristics of shea butter from Zone C for year (2)2012.

Zone C (2)	1	2	3	4	5	6	7	8	9	10	Average
FFA	8.48±0.11	7.72±0.06	8.3±0.03	7.51±0.07	5.42±0.04	5.92±0.02	8.37±0.03	4.62±0.03	8.74±0.02	5.26±0.05	7.03±1.51
AV	16.88±0.22	15.36±0.12	16.52±0.09	14.94±0.14	10.79±0.07	11.78±0.04	16.65±0.06	9.19±0.05	17.40±0.03	10.47±0.01	1.07±0.02
DIRT	1.26±0.03	0.55±0.04	0.64±0.02	0.73±0.02	1.06±0.03	1.12±0.02	1.07±0.02	0.97±0.03	0.87±0.03	1.26±0.01	0.95±0.24
MOISTURE	0.69±0.02	0.36±0.03	0.67±0.03	0.54±0.02	0.48±0.02	0.23±0.02	0.21±0.02	0.72±0.002	0.41±0.002	0.54±0.02	0.48±0.18
DENSITY	0.9±0.003	0.96±0.049	0.92±0.05	0.92±0.002	0.90±0.003	0.91±0.002	0.91±0.002	0.9±0.002	0.93±0.055	0.91±0.003	1.19±1.5
PV	2.24±0.01	3.26±0.05	3.67±0.02	2.99±0.03	5.67±0.03	4.97±0.03	3.74±0.07	5.22±0.03	4.37±0.06	8.07±0.08	4.47±1.54
AnV	3.17±0.02	2.25±0.03	1.99±0.03	1.72±0.03	2.91±0.03	3.16±0.05	2.81±0.05	2.96±0.03	1.86±0.04	2.63±0.03	2.55±0.53
SV	205.43±1.04	199.4±0.7	216.3±0.96	221.67±0.75	203.17±0.93	213.23±0.76	196.83±0.15	201.47±1.44	206.4±0.96	202.77±3.76	206.67±7.75
IV	49.7±0.56	`51.53±2.05	39.03±0.45	41.7±0.44	43.9±0.1	51.6±0.35	55.6±0.27	60.57±0.42	56.7±0.36	55.97±0.71	50.63±6.86
UM	6.96±0.03	7.98±0.05	8.0±0.10	9.49±0.11	7.91±0.07	10.09±0.11	8.58±0.16	7.96±0.06	6.6±0.10	8.54±0.08	8.21±1.01
MP	33 – 37	31 – 35	33 – 38	33 – 35	31 – 34	32 – 34	33 – 35	33 – 36	33 – 35	34 – 36	
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Villages: 1=Duku; 2=Auna; 3=Nasko; 4=Pandogari; 5=Rijau; 6=Kaboji; 7=Borgu; 8=Dusai; 9=Warari; 10=Gulbin Boka. Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg, MP=melting point,°C.

Table 3. Summary of the means of the parameters in the zones for the two years.

Parameter	2011				2012			
	Zone A	Zone B	Zone C	Remark	Zone A	Zone B	Zone C	Remark
FFA	8.03±1.76	10.39±2.49	9.63±2.10	SIG	8.58±1.04	7.78±1.53	7.03±1.51	SIG
AV	15.98±3.51	0.55±0.04	0.64±0.02	SIG	1.06±0.03	1.12±0.02	1.07±0.02	SIG
DIRT	1.36±0.28	1.28±0.26	1.36±0.3	NS	0.94±0.26	1.05±0.21	0.95±0.24	NS
MOISTURE	0.26±0.23	0.36±0.12	0.38±0.17	SIG	0.43±0.07	0.57±0.13	0.48±0.18	SIG
DENSITY	0.9±0.01	0.92±0.08	0.95±0.04	SIG	0.92±0.02	0.92±0.03	1.19±1.5	NS
PV	6.0±1082	7.83±1.93	7.34±1.97	SIG	4.69±0.84	5.39±1.39	4.47±1.54	SIG
AnV	3.28±0.84	3.1±0.62	3.5±0.88	NS	2.36±0.50	3.74±0.66	2.55±0.53	SIG
SV	208.88±14.06	205.58±11.95	206.72±12.15	NS	205.02±8.76	204.99±8.52	206.67±7.75	NS
IV	44.67±5.97	51.67±6.79	45.57±5.62	SIG	46.11±4.11	45.56±5.56	50.63±6.86	SIG
UM	7.42±0.99	7.70±1.15	8.12±0.77	SIG	7.94±0.92	8.33±0.95	8.21±1.01	NS

Abbreviations/Units: FFA=Free fatty acid,%; Density at 40 ºC g per mL; Moisture, %, Dirt, %;SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method),UM=Unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=Peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg. SIG= significantly difference (P<0.05); NS=not significant.

Table 4. Summary of the mean values of the physico-chemical properties of shea butter for the two years.

Parameter	2011	2012	REMARK
FFA	9.35±2.34	7.80±1.50	SIG (P>0.05) There is difference
AV	18.6±4.65	15.51±3.0	SIG (P<0.05) There is difference
DIRT	1.34±0.278	0.98±0.24	SIG (P<0.05)There is difference
MOISTURE	0.33±0.18	0.49±0.15	SIG (P<0.05) There is difference
DENSITY	0.93±0.05	1.01±0.87	NS (P>0.05) There is no difference
PV	7.05±2.04	4.85±1.33	SIG(P<0.05) There is difference
AnV	3.29±0.8	2.88±0.83	SIG (P<0.05) There is difference
SV	207.06±12.69	205.56±8.3	NS (P>0.05) There is no difference
IV	47.30±6.83	47.43±6.01	NS (P>0.05) There is no difference
UM	7.74±1.01	8.16±0.97	SIG (P<0.05) There is difference

Abbreviations/Units: FFA=Free fatty acid, %; Density at 40°C g per mL; Moisture, %; Dirt, %; SV = Saponification value, mg KOH/g; IV=Iodine value, g iodine/100-g sample (WIJS method); UM=unsaponifiable matter, g/kg; AV=Acid value, mg KOH/g; PV=peroxide value, meq oxygen/100-g sample, AnV= Anisidine value (Anv) mg/kg.

Table 5. Physico-chemical characteristics of pooled butter for the respective zones.

Parameter	2011			2012		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
FFA	9.63±0.03	12.41±0.02	11.24±0.01	8.23±0.02	8.02±0.01	7.84±0.02
AV	19.16±0.04	24.70±0.04	22.37±0.03	16.38±0.04	15.96±0.02	15.60±0.02
DIRT	1.10±0.04	1.42±0.02	1.24±0.02	0.91±0.03	0.98±0.02	0.96±0.03
MOISTURE	0.31±0.03	0.39±0.03	0.41±0.02	0.44±0.02	0.59±0.03	0.52±0.03
DENSITY	0.911±0.03	0.923±0.02	0.909±0.02	0.896±0.01	0.914±0.03	0.897±0.03
PV	7.29±0.05	8.85±0.04	7.76±0.03	5.27±0.07	6.14±0.04	5.34±0.04
AnV	2.78±0.04	2.49±0.05	2.47±0.03	1.95±0.05	3.44±0.05	2.84±0.03
SV	196.4±0.03	198.2±0.03	195.4±0.03	198.74±0.02	200.1±0.02	196.5±0.03
IV	41.27±0.03	36.85±0.02	39.43±0.03	36.67±0.03	38.46±0.05	40.29±0.04
UM	6.43±0.03	7.10±0.03	6.57±0.04	5.84±0.02	6. 92±0.02	6.48±0.03
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

Table 6. Fatty acid composition of the pooled butter for the respective zones.

Fatty acid	2011			2012		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
C16: 0	4.30±0.01	3.89±0.02	5.11±0.03	4.14±0.04	3.94±0.02	4.98±0.04
C18:0	42.20±0.3	41.87±0.01	41.90±0.01	41.91±0.02	42.74±0.01	41.83±0.03
C18:1	45.20±0.04	46.12±0.03	45.30±0.01	45.72±0.01	45.09±0.01	45.10±0.02
C18:2	6.20±0.05	5.81±0.04	5.8±0.03	6.01±0.02	5.60±0.02	5.68±0.03
C18:3	0.83±0.05	0.94±0.04	0.69±0.07	0.81±0.03	0.88±0.05	0.74±0.07
C20:0	0.80±0.03	0.84±0.03	0.61±0.05	0.85±0.04	0.67±0.04	0.59±0.05
Total	99.53	99.47	99.41	99.44	99.00	98.92
ANOVA	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

0.50±0.03 to 1.34±0.02 and 0.55±0.04 to 1.26±0.03 for zones A, B and C respectively. Comparison of the respective mean dirt contents for the three zones and the two years span of this study showed no statistical difference (P<0.05) however, there was a general reduction in the average dirt content in the second year (Table 3). Zone A value was reduced from 1.36±0.28 to 0.94±0.26, zone B from 1.28±0.26 to 1.05±0.21 and zone C from 1.36±0.30 to 0.95±0.24. This suggests an improvement in the filtration, clarifying and other ancillary dirt removal procedures along the processing steps (skimming, decanting and scooping) among the zones. Dirt is an important parameter in quality consideration, for example, a butter refiner or end user will lose about 1.36 metric tonnes as dirt for every 100 metric tonnes of butter purchased from zone A. This is in addition to the uncalculated envisaged loss during re-filtration or re-processing. The high content of dirt in the butter, one of the hallmarks of low quality, could be attributed to foreign materials (debris, dust, sand etc.) sticking to the kernels or entering through dirty processing utensils. Strictly speaking, simple improvements in the overall processing practices of butter are capable of minimizing the amount of dirt while ensuring improved consistency in the butter quality.

Density

The result of density determination generally fall outside the 0.858 and 0.893 range for solid fat but there was significant difference (P< 0.05) among the zones in the first year but no significant difference was observed in the second year of sampling (Table 4). Among the villages, no significant difference was observed save in zones A and C in the first year, and zone B in the second year.

Melting range

The melting range was within the results of earlier researchers like Olaniyan and Oje (2007). The wider melting range observed for the respective villages could be attributed to the butter handling such as melting and re-melting the butter several times.

Moisture

The moisture contents of the butter from the villages in the respective zones were significantly different (p<0.05) both in the first and second year (Tables 1a, b, c and Tables 2a, b, c) results. The lowest and highest moisture contents were found in zone A (0.04±0.00, 0.52±0.03), zone B (0.08±0.01, 0.50±0.03) and zone C (0.09±0.01, 0.50±0.03) in the first year, and A (0.36±0.02, 0.53±0.01), B (0.36±0.02, 0.64±0.01) and C (0.21±0.02, 0.72±0.02) respectively. The mean percentage moisture content (Tables 3 and 4) for zone were: (0.26±0.23) for A and 0.36±0.12 for C (0.38±0.17) for the first year and 0.43±0.07 for A and 0.57±0.13 for B. The second year exhibited significant difference (p<0.05). The percentage moisture obtained in this study fitted into the third grade butter according to UEMOA standards (2006) (0.3-2.0) for unrefined shea butter. This indicates that there is need to improve the drying methods of the processing as well as proper storage system to minimize the moisture content hence upgrading the butter quality. It also shows that butter from zone C is more susceptible to hydrolytic reactions leading to shorter shelf life and high loss to a refiner.

Free fatty acid (FFA)

Free fatty acid (FFA) content of oil or fat offers a simply calculated index of quality, representing in effect the proportion lost to hydrolytic degradation. According to Masters et al. (2004), refining shea butter of 1% FFA will result in a loss of 1% of the original volume of the unprocessed butter. Statistical analysis of the first year data for FFA reveals a significant difference (P<0.05) (Table 1a, b and c). In the first year result of this study, (Tables 1a, b and c), the percentage FFA of zone A ranged from 5.32±0.25 to 9.87±0.178 with an average of 8.03±1.76; zone B ranged from 6.71±0.22 to 13.60±0.02 with an average of 10.39±2.49 while in zone C, the range was 5.28±0.12 to 12.12±0.03 with an average of 9.63±2.10. In the second year (Tables 2a, b and 2c) zone A ranged from 7.32±0.09 to 9.67±0.03 and averaged 8.58±1.04: zone B ranged 4.95±0.06 to 10.13 ±0.06 and averaged 7.78±1.53 while the range in zone C was 4.62±0.03 to 8.74± 0.02 with an average of 7.03±1.51. The lowest FFA percentage of 4.62±0.03 was recorded in Dusai village in zone C in the second year data while the overall highest percentage of 13.60±0.06 was found in Gurmana village of zone B in the first year data. These values recorded in this study were similar to the values reported by other researchers who have worked on Nigeria shea butter (Olaniyan and Oje, 2007). However, the values were well outside the range of even the third grade of the UEMOA standard (2006). When the averages (significantly different(P<0.05) for the zones, were considered for the two years, except for zone A that depreciated in quality, from 8.03 to 8.58 the other two zones appreciated [zone B(10.39 to 7.78) and zone C (9.63 to 7.03)]. This suggests that there were hydrolytic inducing activities along the collection processing and butter storage chain was employed by these set of processors. Shea butter of this range of quality will not attract premium price in the international market hence cannot adequately improve family income and compensate for the drudgery undergone by the processors. This result depicted the range of FFA content (which is generally outside those international market) of shea butter meant to be sold in various markets in Bida, Niger State.

In the case of Acid Value (AV) a statistical interaction was also observed between villages and zones for the quality of shea butter. Statistical analysis demonstrated a significant difference among the entire villages, 3 zones and for the two years. The discussions here followed the trend under FFA section, except that the values of AV were 1.99 multiples of FFA. This is also a clear indication of low quality shea butter.

Peroxide Value (PV)

Peroxides are the intermediate compounds formed during oxidation of lipids which may react further to form the compounds that can cause rancidity while PV determines the extent of fat or oil oxidation by measuring the amount of peroxides present in the oil or fat samples(AOCS, 2009). PV is another vital quality index. The values of this parameter ranged for the first year from 4.29±0.02 to 10.20±0.01 in zone A, 4.67±0.04 to 11.17±0.06 in zone B and 3.50±0.02 to 10.22±0.03 in zone C while in the second year, the ranges were 3.70±0.05 to 6.36±0.07, 3.79±0.04 to 7.31±0.02 and 2.74± 0.01 to 8.07±0.08 correspondingly. The magnitude of the PV exhibited by these butter samples from the respective zones were significantly different (P<0.05). When the mean values (Tables 3 and 4) were considered for the zones and the two years, significant differences existed, in that order, in the two data sets. In the second year, there was a discernable reduction in the mean values, zone A moved from 6.00±1.82 to 4.69±0.84, B from 7.83±1.93 to 5.39±1.36 C from 7.34±1.97 to 4.47±1.54. The generally low values recorded in the second year compared to the first year suggest minimum mixing of freshly processed butter with previously stored butter or an improvement in the processing methods or an increase in the secondary oxidation processes. These values were however within the UNBS standards of 10 milliequivalent oxygen per kilogram oil but about 3-4 times lower than the lowest value of 22.1 reported by Olaniyan and Oje (2007) for Nigerian shea butter. The far reaching implications of these discrepancies in the quality characteristics of Nigeria butter lend credence to the ad hoc and disjointed nature of the researches. Hence, the provision of the history of the kernel used by the various researchers for the experiment is vital in authenticating and, placing and referencing the results of their studies under appropriate categories of data. The result of the oxidation of fat and oil is the development of unpleasant flavours and odours characteristic of the condition known as oxidative rancidity. It has been found that oxidative abused fat can complicate nutritional and biochemical studies in animals because they can affect food consumption under *ad libitum* feeding conditions and reduce the vitamin content of the food. If the diet has become unpalatable due to excessive oxidation of the fat component and is not accepted by the animal, a lack of growth by the animal could be due to its unwillingness to consume the diet. Thus, the experimental result might be attributed unwittingly to type of fat or other nutrient being studied rather than to the condition of the ration (AOCS, 2009). Knowing the oxidative condition of unsaturated fats is extremely important in biochemical and nutritional studies with animals (AOCS, 2009).

Anisidine value (AnV)

AnV is another quality parameter that measures the secondary oxidation of fats and oil. The values of this index recorded in this study were significantly different in all the villages of the zones. Whereas the mean values for the zones in the first year were not significant different, they were in the second year. However, when the means of the two years (Tables 3 and 4) were compared, there was significant difference and this signified inconsistency in the quality. The lowest and highest value of 2.94±0.02 and 4.64±0.07 were recorded in village 4 and 5 of zone A respectively. This suggests that the butter samples have undergone through varying degrees of secondary oxidative degradation.

Iodine value (IV)

Fats and oils are made up of triglyceride molecules which may be saturated and unsaturated fatty acids. The degree of unsaturation of a fat, in other words, the number of double bonds present is normally expressed in terms of iodine value of the fat. The iodine value which is an identity parameter rather than quality is the number of grammes of iodine which will react with the double bonds in 100 grammes of fat or oil (AOCS, 2009). In this work, significant difference among the iodine values of butter was observed between villages in the respective zones. There was also significant difference in the mean values of the zones and for the two years study periods (Tables 3 and 4). In zone A and for the first year, the lowest IV of 38.67±0.68 was recorded in Koriagi village while the highest value of 55.77±0.35 in Gbangban; in zone B it was 41.20±0.30 (Gwada) and 60.37±0.57 (Zumba Shiroro) and zone C, 39.63±0.67 (Gulbin boka) and 58.63±0.38 (Borgu) in year two, (Tables 2a, b, c) the ranges for the zones were 39.43±0.6 to 50.83±1.02 for A, 36.97±0.21 to 52.57±0.25 for B and 39.03±045 to 60.57±0.42 for C. These variations in the values for the respective villages, zones and year were significantly different ($p< 0.05$) and similar to the value obtained by other researchers however, the values of Olaniyan and Oje, (2007) were higher. The variations observed in this work could be attributable partly to the intrinsic genetic variation of shea tree and partly due to the processing method particularly when inconsistent poor clarification methods that promote partial fractionation are used. Some of the local processors, in a bid to clarify the butter, allow the freshly produced butter to cool and solidify so that the dirt will be at the bottom of the container. Thereafter, they will scoop the upper layer leaving the predominantly dirty bottom with some portions of high melting saturated fraction. In other words, this implies that the partial inadvertent fractionation has altered the compositions of the said butter sample scooped in favour of the unsaturated fraction.

Saponification value

The saponification value is defined as the amount of potassium hydroxide (KOH) in milligrams required to saponify 1 g of fat or oil under the conditions specified. Based on the length of the fatty acids present in the triacylglycerol molecule, the weight of the triacylglycerol molecule changes which in turn affects the amount of KOH required to saponify the molecule. Hence, saponification value is a measure of the average molecular weight or the chain length of the fatty acids present. As most of the mass of a triglyceride is in the three fatty acids, it allows for comparison of the average fatty acid chain length. As seen from Tables 1a, b, c and 2a, b, c, the saponification value for the majority of the butter samples are in the range of 189.83 to 236 mg KOH/g found respectively in villages 5 and 1 during the first year of this study. This range is typical for fats having predominately fatty acids with a long chain between C16 and C18 because higher saponification values may indicate the presence of shorter chain lengths. The SV values obtained in this study is generally below the values of 237.7 to 261.3 mg KOH/g reported by Olaniyan and Oje, (2007), while some of them fell within the UNBS standards (2004) range 170-190 mgKOH/g.The variation in the SV values may be due to processing, fruit harvesting and kernel storage methods (Lovett, 2004) as well as integrity of the kernels processed and other additives like anti-oxidants.

Unsaponifiable matter (UM)

In general, unsaponifiable matter content of edible oils is about 2% and they include tocopherols/tocotrienols, other phenolics, phytosterols, hydrocarbons, among others (Di Vincenzo et al, 2005; Esuoso et al, 2000). The content of the native unsaponifiable matters varies in different oils and, depends on the extent and methods of oil refining. In this study, there was significant difference in the unsaponifiable matter contents of the butter from Bida. The overall highest and lowest percentage values of 10.09 were obtained in villages 6 in the second year and 5.93 in village 8 in the first year. The differences observed in this study may be due to a combined effect of processing methods used and the highly inherent tree-to-tree variations found in shea tree IPGRI, 2010). Due to the high unsaponifiable matter contents (Table 4) of butter from Bida, Nigeria, the cosmetic industries will prefer to buy shea butter from Bida.

Fatty acid composition

In this study, five major fatty acids were identified which is consistent in similar proportion with the result of other researchers (Okullo et al., 2010; Nahm, 2011). Although there were significant differences among and within the zones, the characteristics relative abundance of the five major fatty acids was not altered. The C18:1 and C18:0 consistently remained the most abundant unsaturated and saturated fatty acids respectively. This also shows no adulteration with other oils or fats.

Conclusion

Overall, this study provides current baseline data on shea butter intended for sale in Niger State Nigeria. The study reveals that the butter quality is low and inconsistently varies from village to village and from zone to zone. The quality of the butter satisfies the local segment of the market because a refiner or other end users will definitely incur irrecoverable loss due to high contents of free fatty acid, dirt, and moisture besides other refining challenges. Besides, initiating and providing a current data bank on shea butter quality in Nigeria has revealed those factors (high dirt, FFA, moisture, peroxide contents) that inhibit Nigeria shea butter from commanding a premium price in the international market. The marginal improvement in the quality parameters in the second year showed that the local processors have capacity for producing high quality butter of international standards.

ACKNOWLEDGMENT

The authors are grateful to the Executive Director, NIFOR, Benin City, Nigeria for funding this work and Mr George Mbaeyi, of the Statistics Division, NIFOR for the statistical analysis.

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