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Effect Of Nut Roasting Temperature, Extraction, Process And Packaging Material On The Storage Properties Of Shea Butter

J.O. Akingbala[1]
E.T. Adebisi[2]
G.S.H. Baccus-Taylor[1]
K.O. Falade[2] &
I.A. Lambert

Shea butter samples from nuts roasted at 140, 160 and 180°C were extracted by the traditional water displacement method, and by mechanical expression, using the screw press. Aliquot of the shea butter from nuts roasted at 160°C was bleached. The bleached and unbleached samples were stored in opaque plastic containers, amber coloured clear glass bottles and clear colourless glass bottles for 28 days at 63°C. Refractive index, free fatty acid content and peroxide value of the butter samples determined at 7-day intervals during storage, increased with increasing duration of storage, and nut-roasting temperature. Shea butter produced by the traditional method had higher refractive index, peroxide value, and free fatty acid content than mechanically extracted shea butter from similarly treated nuts. The opaque plastic container reduced rancidity best, followed by the amber coloured container, and the clear colourless glass bottle during butter storage. Bleaching increased the tendency of shea butter to rancidity.

1. Introduction

Shea butter is fat extracted from shea (*Butyrospermum paradoxum*) nut. It is a plant fat, which is derived by the polymerization of primary product of photosynthesis. It has a degree of saturation of 46.7 and it is solid at room temperature of up to 30^{o}C [1]. Shea butter is used for cooking porridges and as a flavour additive in confectioneries [2]. It is also used in the soap, cosmetic and pharmaceutical industries, in traditional medicine, for fuel, for waxing of fruits, in candle making and as butter substitute [3]. Due to the similarity of its chemical and physical properties it has been suggested as a substitute for the more expensive cocoa butter. Shea butter processing provides approximately 60% of the cash income of women and is a vital source of fat in the Sahel [4].

The process for the extraction of shea butter is still largely traditional and the extracted butter is still mainly stored in calabashes, which are opaque and effectively protect the butter from light. However, calabashes lack several of the properties of modern packaging materials. They are fragile, rigid, and the shapes are not uniform and are therefore difficult to stack. Therefore there is need to determine properties of modern packaging materials that will suit the packaging of shea butter. The objective of this study was to evaluate the effectiveness of non-coloured clear glass bottles, amber-coloured clear glass bottles and opaque plastic containers as packaging materials for shea butter, and the effects of nut-roasting temperature on the storage properties of shea butter.

[1] Department of Chemical & Process Engineering, The University of the West Indies, St. Augustine, The Republic of Trinidad & Tobago. Email: john.akingbala@sta.uwi.edu
[2] Food Technology Department, University of Ibadan, Ibadan, Nigeria

2. Materials and Methods

Shea butter was extracted from shea nuts roasted at 140, 160 and 180^oC by the traditional method and the mechanical press method. An aliquot (100ml) of the shea butter sample, extracted from nuts roasted at 160^oC by the traditional method, was mixed with 5g Fullers earth and heated to 105°C, with constant stirring to bleach. The mixture was maintained at 105^oC for 1h and then filtered to remove the clay [5].

2.1 Physical and Chemical analysis

Refractive index of the shea butter was determined at 40°C using the Abbe refractometer. Peroxide value and free fatty acid content were determined by AOCS methods [6].

2.2 Storage Test

The Schaal accelerated oven storage test [7] was used to test the storage properties of the shea butter samples in clear colourless bottles (CCB), amber coloured clear bottles (ACB) and in opaque plastic bottles (OPB). The shea butter samples were stored for 28 days at 63°C and sub samples were analysed for peroxide value, free fatty acid content and refractive index at 7-day intervals. The experiment was replicated three times.

2.3 Statistical analysis

Data of yields, physical, chemical and storage tests were means of at least three replicates with two duplicate readings. Data were analysed using the Analysis of Variance (ANOVA), and means where different, were separated using Duncan's multiple range test [8].

3. Results and Discussion

3.1 Effects of roasting temperature and extraction method on Refractive index of stored shea butter

Refractive index increased significantly ($p \leq 0.05$) during the Schaal's accelerated storage of shea butter at 63ºC (Fig. 1). The increases depended on roasting temperature of the nuts, the extraction method, whether the fat was bleached and on length of storage. The refractive index has been used as an index of fat storage to determine stability towards rancidity, thermal stability and changes in fat crystalline structure. The refractive index generally increased with increase in the duration of storage, with the bleached sample having the greatest refractive index at 28 days of storage. High levels of increase in the refractive index of fat or oil generally depict a high level of instability of the material. Yen [9] used refractive index to compare the thermal stability of soybean oil with the stability of oils from roasted and unroasted sesame seeds. Arys et al [10] also reported an increase in the refractive index of stored butter and related refractive index to rancidity. Changes in the refractive index of fat may reflect changes in the crystallinity of the fat. The greater increase in the refractive index of the bleached shea butter thus indicates greater instability of the fat to storage. The refractive index increased with the nut roasting temperature for both methods of extraction (Fig.1). However, except for the bleached sample and the mechanically extracted sample from nuts roasted at 160°C, the refractive index of the shea butter samples did not increase significantly ($p \leq 0.05$) until after 14 days of storage. The induction period for the bleached shea butter and the sample extracted mechanically from nuts roasted at 160°C was 7 days during storage at 63ºC.

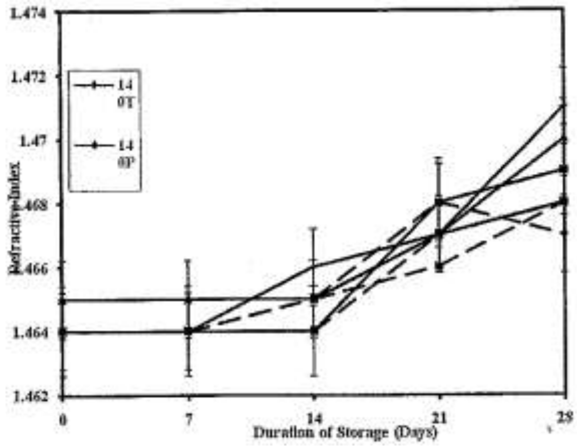

FIGURE 1: Refractive Index of Shea Butter During Storage

3.2 Peroxide value

The peroxide value of unbleached shea butter did not increase significantly ($p \leq 0.05$) until after 14 days of storage (Fig. 2). The higher peroxide values of fats from nuts roasted at higher temperatures and from the bleached fat compared to fat from nuts roasted at lower temperatures may be due to removal, by heat and filtration, of the tocopherol group, and other natural antioxidants present in the fat. The fat extracted by the traditional method had greater peroxide value ($p \leq 0.05$) than that extracted by the press (Fig. 2) especially after 21 days storage at 63ºC. This might be due to lipoxygenase-catalysed lipid oxidation. Gilliard [11] reported that the addition of water to cereal grain whole meal flour causes rapid oxidation of unesterified polyunsaturated fatty acids because of lipoxygenase-catalysed oxidation. The induction period before increase in the peroxide value of the stored shea butter samples was 14 days.

3.3 Free fatty acid

The free fatty acid of the shea butter generally ($p \leq 0.05$) increased during the first 21 days of storage, then decreased except for shea butter extracted by the traditional method from nuts roasted at 140°C (Fig. 3). However, the increase in the free fatty acid content was minimal and not significant ($p \leq 0.05$) in the first 7 days of storage. The decrease in the free fatty acid content of shea butter, between 21 and 28 days of storage might be due to oxidation of free fatty acid to peroxide, resulting in a sharp increase in the peroxide value of shea butter during the same period (Fig.2). The free fatty acid content of shea butter increased significantly as roasting temperature of the nut increased. Shea butter extracted by the traditional method had higher ($p \leq 0.01$) free fatty acid content than shea butter extracted through pressing probably due to hydrolysis, which might have occurred during extraction with water. The bleached butter had the highest free fatty acid content due to the extra heat treatment used for the bleaching process. Furthermore minerals in the clay used for the bleaching process could have induced hydrolysis of the shea butter into glycerol and free fatty acids.

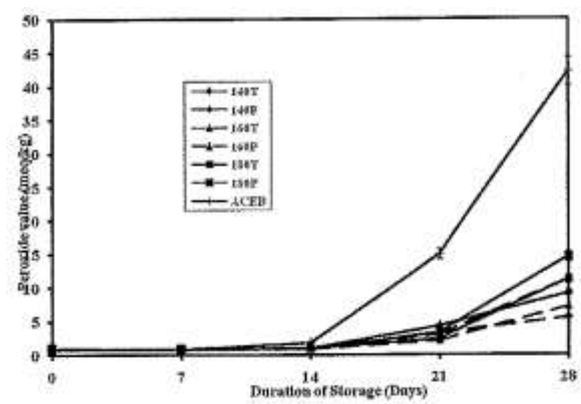

FIGURE 2: Peroxide Value of Shea Butter During Storage

3.4 Effect of packaging material on quality of stored butter

Generally there was increase in free fatty acid, peroxide value and refractive index of shea butter in the three packaging materials, with increasing storage (Figs. 4, 5, 6). The increase was greater ($p \leq 0.05$) in shea butter samples packaged in transparent bottles, than in samples packaged in plastic container. The lower peroxide value, free fatty acid and refractive index of fat stored in plastic containers may be due to the relatively greater opacity of plastic compared with the transparent glasses, since photo-oxidation occurs faster in the presence of light [12]. The relatively higher increases in free fatty acid, peroxide value and refractive index of bleached butter may be as a result of the high bleaching temperature and the removal of natural antioxidants during bleaching [13], also the presence of metals in the clay which would have acted as pro-oxidants. The opaque plastic container offered the best protection from oxidation of the shea butter, as indicated by the lower values ($p \leq 0.05$) of the free fatty acid content, peroxide value and refractive index. The clear amber coloured bottle offered less protection against rancidity compared to the opaque plastic bottle, while the clear colourless bottle was the least protective of the packaging materials.

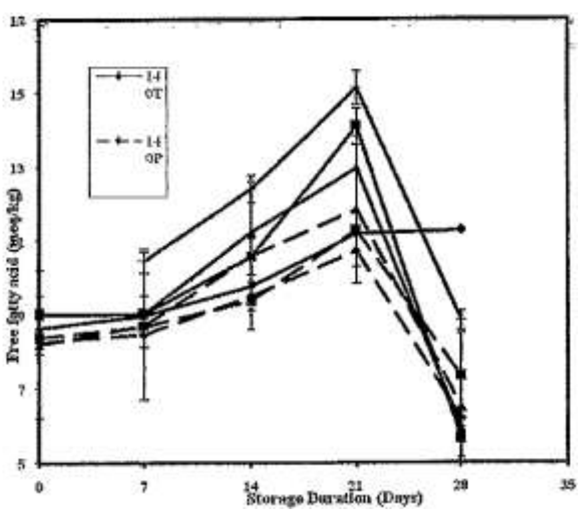

FIGURE 3: Free Fatty Acid Content of Stored Shea Butter

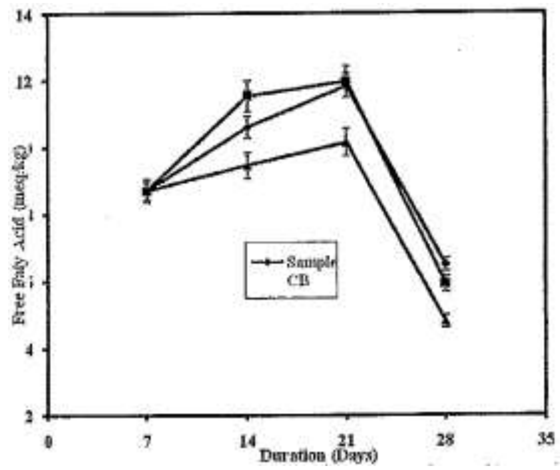

FIGURE 4: Influence of Packaging Material on Free Fatty Acid Content of Stored Sheabutter

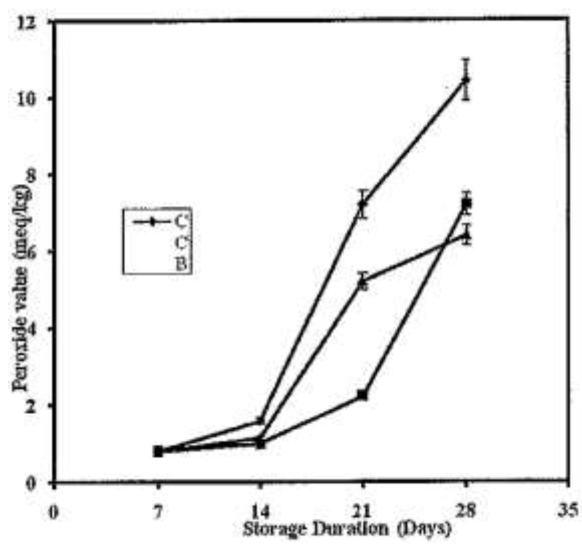

FIGURE 5: Effect of Packaging Material on Peroxide Value of Stored Shea butter

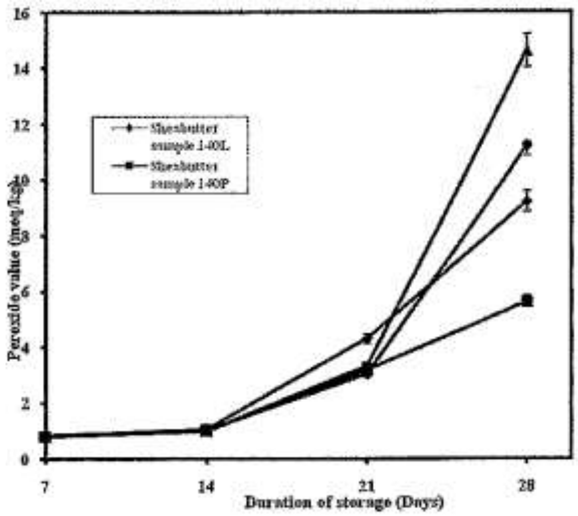

Figure 6: Effect of Roasting Temperature on Peroxide Value of Stored Sheabutter

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