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RESEARCH ARTICLE

Physical, Proximate and Sensory Properties of Cake Produced using Shea Butter as Shortening

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Abstract:

Background:

Shea butter is the under-consumed vegetable fat and oil. Making shea butter a part of food components in confectionaries would increase its utilization.

Objective:

In this study, the cake was produced by incorporating shea butter as shortening.

Methods:

Shea butter to margarine ratio was 100: 0, 50:50, 40:60, 30:70, and 0:100%, and additional cake samples were produced using flashed shea butter. Standard methods determined the physical and proximate properties of the cake samples, while 25-member panelists did the sensory evaluation. Statistical significance was done at $p<0.05$. The height, weight, and volume of the cake samples ranged from 3.2 to 3.9 cm, 39 to 50 g, and 625 cm^3 to 1026 cm^3, respectively. The ranges of moisture, fat, protein, carbohydrate, crude fiber, and the ash content of cakes were 13.7-17.3, 24.3- 30.7, 4.4-8.6, 43-50, 0.10-1.10, and 2.9-3.9%, respectively. The energy value of cake samples in kcal ranged from 440 to 471.

Results:

There was no significant difference ($p>0.05$) in the height and volume of the cakes produced from 100% shea butter and 100% margarine. The fat, crude fiber, and ash content increase with the increase in Shea butter substitution. There was no significant difference in the taste and appearance of cake samples from 100%, 70%, 60%, and 50% margarine.

Conclusion:

Cake samples produced with 60% margarine and 40% shea butter were the most liked by the consumers. Acceptable cakes can be produced by the inclusion of up to 50% shea butter as part of the shortening.

Keywords: Cake, Shea butter, Shortening, Margarine, Fat and oil, Sensory.

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1. INTRODUCTION

Shea butter is underutilized when comparing its availability with its percentage contribution to edible fat and oil. Among other factors, poor sensory quality and low acceptability have been associated with food products from shea butter. This behavior is because fat contributes significantly to the organoleptic characteristics, micro and macrostructure of confectionaries [1].

One of the major confectionaries that utilize shortening is cake. The cake can be categorized based on size; an example of such is the queen's cake, which is of a small size usually intended for individual consumption [2]. However, the quality of cakes is not very dependent on the sizes but its composition and production processes. During cake production, fat imparts tenderness, soft structure alongside flavor enhancement [3]. Creaming and emulsifying capacity of shortening in cake production have been reported to be the two most critical properties needed [4]. Majorly, fat is used in baking traps and retains air in the protein and starch structures of cakes [5]. On the other hand, fat has an influence on the color, aroma as well as serves as a medium of heat transfer [6, 7].

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Shea butter, a product from the nut of the African shea tree (*Vitelaria paradoxa*), has off-white or ivory-colored characteristics [8]. Shea butter has been commonly used mainly as edible oil, medicinal ointment, and as a raw material in soaps, margarine, pomade, and drug production [9]. Ifesan *et al*. [10] reported the use of Shea butter in the production of bread-spread. The occasional use of shea butter in the chocolate industry as a substitute for cocoa butter was reported by Maranz *et al*. [11]. These uses could be attributed to both its physical, functional, and compositional characteristics.

Garba *et al*. [12] reported a high postharvest loss of shea butter, while a more significant percentage of the remainder was exported at low prices locally. Commercial utilization of Shea butter would significantly improve national economic development. Its use in food would contribute to the gross domestic product of Nigeria and other producing nations. Despite the availability and low cost of shea butter [9], limitation in its use for baking processes has been caused by its off-flavor characteristics. Therefore, the present work studied the physical, proximate, and sensory properties of cakes produced from using shea butter at different percentages with and without commercially available margarine as shortening.

2. MATERIALS AND METHODS

2.1. Materials

Flour, sugar, commercially available margarine (Simas), eggs, baking powder, and shea butter were purchased from the sango market, Saki, Oyo State, Nigeria. Baking equipment and facilities of the bakery unit of The Oke-Polytechnic Saki, Oyo State, were used for queen's cake production.

2.2. Cake Production

Queen's Cakes were produced using the method described by Ceserani and Kinton [13]. The method is as briefly described in Fig. (**1**). The percentage of complementation levels of shea butter and margarine is presented in Table **1**. Shea butter treated with heat (Flashed shea butter) was also used for cake production. Formulations for cake production for various samples are presented in Table **2**.

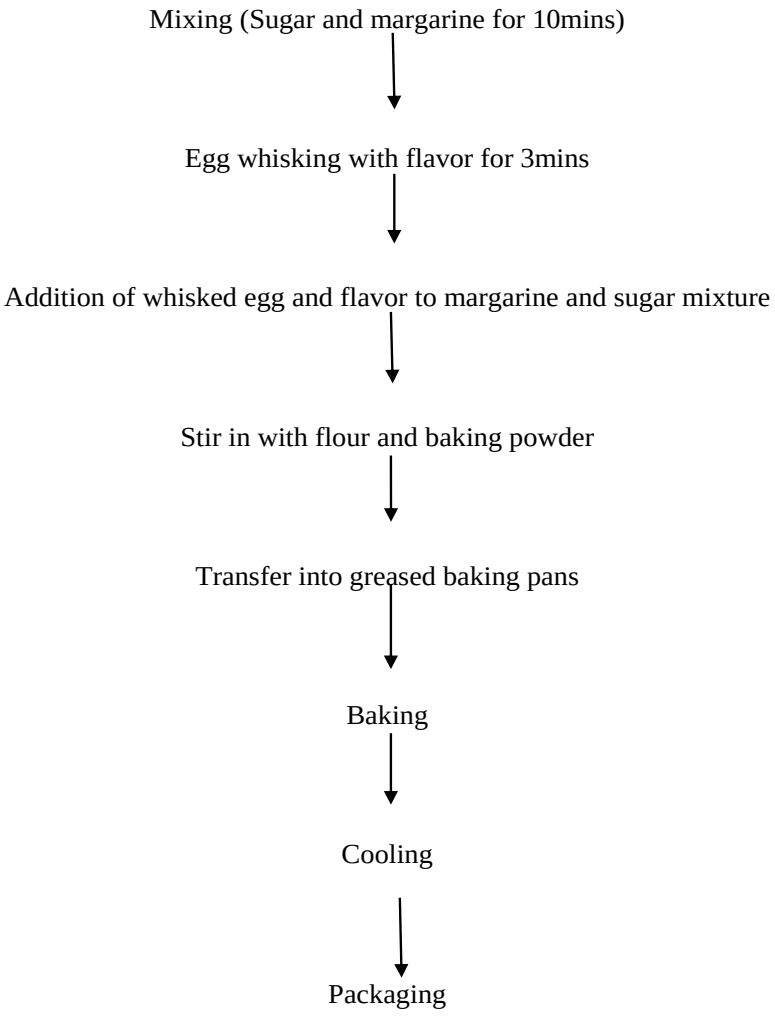

Fig. (1). Cake preparation [13].

Table 1. Shortening mixture of shea butter and margarine.

Samples Code	Shea butter (%)	Margarine (%)
FLS	Flashed Shea butter (100%)	0
ODR	100	0
FF1	50	50
MS6	40	60
SM3	30	70

FLS: Flashed shea butter was obtained by heat treatment of shea butter up to its flashpoint

2.3. Determination of Physical Property of Cake Samples

Weight, height, and volume of the cake samples were the physical parameters measured. The method highlighted by Giami and Barber [14] with slight modification was used to measure the physical characteristics of the cake samples. All physical measurements were taken two hours after baking. The average of five cake samples was recorded for each measurement, and this was done in three replicates for all physical parameters. Digital weighing balance and meter rule were used to measure weight and height, respectively. The queen's cake volume was estimated using the cone equation presented in equation 1.0.

$$\text{Volume of cake } (cm^3) = \pi h\,(d^2 + db + b^2) \quad \textbf{(1)}$$

Where d and b are upper and lower diameters of cake, respectively,

h is the height of the cake and π is 3.142

2.4. Determination of the Proximate Composition of Cake Samples

Queen's cake samples were analyzed to determine the moisture, ash, crude fiber, protein, fat, and carbohydrate. Briefly, the Kjeldahl method, as described by [15], was used for protein determination. Ash content was determined by using a muffle furnace at 600 ^{o}C for 3 hours, while moisture content determination was done by force air draft oven at 105^{o}C for 4 hours [15]. Crude fiber and fat were also determined using AOAC [15], while the Carbohydrate content and energy value were obtained by difference and Atwater factor (4,4,9), respectively.

Table 2. Formulation for cake production

Ingredients	MGR	FLS	ODR	FF1	MS6	SM3
Flour (g)	400	400	400	400	400	400
Sugar (g)	200	200	200	200	200	200
Milk (g)	50	50	50	50	50	50
Flavour (ml)	3	3	3	3	3	3
Egg (g)	300	300	300	300	300	300
Baking powder (g)	5	5	5	5	5	5
Shea butter (g)	0	250	250	125	100	75
Margarine (g)	250	0	0	125	150	175

Adapted from Ceserani and Kinton [13]

2.5. Sensory Evaluation

A twenty-five-member panelist was used to assess cake samples' sensory attributes of appearance, aroma, taste, texture, and overall acceptability. The cake sample sensorial assessment was based on a 9-point hedonic scale quality analysis [16] with 9 representing liked extremely, and 1 representing disliked extremely. The panelists were individuals that are regular consumers of cakes and were neither sick nor allergic to any food. Necessary precautions were taken to prevent carryover of flavor during the tasting by ensuring that panelists rinse their mouth with water after each evaluation.

2.6. Statistical Analysis

Data were obtained in triplicates. All results were subjected to analysis of variance (ANOVA) and mean separation was done with Duncan multiple range test at $p < 0.05$ using the SPSS package.

3. RESULTS AND DISCUSSION

3.1. Physical Properties of Cake Samples

The result of the physical properties of the cake presented in Table **3** shows that height, weight, and volume of the cake samples ranged from 2.7 to 3.9 cm, 39 to 50 g, and 625 cm^3 to 1026 cm^3, respectively. The queen's cake samples top and bottom diameters had a range of 6.0-7.1 cm and 3.3 to 3.6 cm, respectively. The lowest value of height (2.7 cm), weight (39 g), and volume (625 cm^3) was obtained when 50% of shea butter was incorporated as the shortening. Aside from when 100% shea butter was used, generally, height, weight, and volume decreased as the percentage of shea butter used increased.

The volume of the cake was highest (1026 cm^3) for cake samples from flashed shea butter. Although Chinma *et al.* [17] reported that weight and volumes of baked products are a function of the bulk density of flour, however, the result of the present study identified the composition of the shortening agent as a factor that influenced weight and volume. This behavior could be linked to the reduced ability of shea butter substitution with margarine level to retain air in the cake batter. There was no significant difference ($p>0.05$) in height and volume of cake produced from 100% shea butter and 100% margarine, whereas flashed shea butter cake had a significantly higher volume, which could be due to its higher ability to trap and retain air in the cake batter [18]. Tireki [3] also opined that shortening used in cake production affects the volume, crumb tenderness, and evenness of the cell structure.

Value of height of cake samples obtained in the present work is comparable to that reported by Kiin-kabari and Banigo [19] on the quality characteristics of cakes prepared from wheat and unripe plantain flour blends enriched with Bambara groundnut protein concentrate where the height of the control of that study was recorded as 3.8 cm.

Table 3. Result of physical properties of cakes.

Samples	MGR	FLS	ODR	FF1	MS7	SM3
Height (cm)	3.4^{bc}±0.3	3.9^{a}±0.2	3.5^{b}±0.2	2.7^{d}±0.1	3.2^{c}±0.2	3.6^{b}±0.1
Weight(cm)	49^{a}±2	42^{b}±4	44^{b}±5	39^{c}±9	40^{c}±4	50^{a}±2
D_1(cm)	6.4^{bc}±0.7	6.9^{ab}±0.6	6.2^{c}±0.4	6.5^{bc}±0.6	6.0^{c}±0.2	7.1^{a}±0.2
D_2 (cm)	3.5^{a}±0.1	3.5^{ab}±0.2	3.6^{a}±0.3	3.30^{b}±0.05	3.4^{ab}±0.1	3.50^{ab}±0.05
Volume(cm^3)	812^{c}±1	1026^{a}±0.5	806.0^{c}±0.2	625^{c}±2	690^{d}±2	973^{b}±2

*mean values in the same column with different superscripts are significantly different at p<0.05. MGR-100% Margarine; ODR-100% Shea butter; FLS-100% Flashed Shea butter; FF1-50% Shea butter +50%Margarine; MS6-40% Shea butter +60% Margarine; SM3-30% Shea butter +70% margarine ; D_1= Top Diameter of Queen's cake; D_2= Bottom Diameter of Queen's cake

3.2. Result of Proximate Composition of Cakes

The moisture content, which is an index of keeping quality, differs significantly (p<0.05) for cake samples from 100% shea butter, 100% flashed shea butter, and 100% margarine. The ranges of moisture content of cakes were 13.7-17.3% in flashed shea butter shortening cake to margarine shortening cake, respectively. The range of moisture content (18.2-21.5%) for cake samples prepared from wheat and cocoyam flour blends reported by Alozie and Chinma [20] is higher than that obtained in the present study. This result could be due to the heat transfer property of shea butter, which allowed the removal of moisture during baking. Since cake samples produced from 100% margarine had a moisture value closed to that reported in the literature [20] (Table **4**).

There was a significant difference in fat, protein, carbohydrate, crude fiber, ash content, and energy value for cake samples from 100% shea butter, 100% flashed shea butter and 100% margarine. The protein content of all cake samples significantly differs at p<0.05, with values ranging from 4.4-8.6% in samples flashed shea butter and margarine, respectively. The fat, crude fiber, and ash content increases with the increase in shea butter substitution. However, protein and carbohydrate content decreases with an increase in shea butter inclusion. Protein and carbohydrate content obtained in the present work was within the range of that reported by Alozie and Chinma [21], while the fat content obtained was higher than that reported in the literature [21]. This result could be due to the use of shea butter in the present study because fat content increases with the inclusion of shea butter. This fact could be linked to the fact that margarine has 80% fat in its composition [22]. And the energy value in kcal ranged from 440 to 472 for samples from margarine and flashed shea butter shortening, respectively.

3.3. Sensory Properties of Cakes

Cake samples from 100%, 70%, and 60% margarine were not significantly different (p<0.05) in texture and overall acceptability as assessed by panelists. However, as the percentage of margarine in cake increases, the acceptability of cake samples' texture increases. This could be because shea butter has been shown to have a lesser ability to entrap air in the mixing process with sugar, which is supposed to help in the development of its fluffiness. Also, there was no significant difference in taste and appearance for cake samples from 100%, 70%, 60%, and 50% margarine (Table **5**).

When compared with cake produced from 100% shea butter, cake baked with flashed shea butter is more acceptable in texture, aroma, taste, appearance, and overall acceptability. This could be attributed to the change in flavor characteristics of shea butter brought about by the heating process that took place with the flashed shea butter. Concerning all sensory properties assessed by the panelists, cake samples produced from 60% Margarine and 40% Shea butter were most liked by the consumers. Cake samples with 100% shea butter had the lowest acceptability for texture, aroma, taste, appearance, and overall acceptability. This is in agreement with Fold [23], who reported a noticeable reduction in the acceptability of chocolate produced by using shea butter. Hence, the lowest acceptability of cake from 100% shea butter could be due to the significant difference in the flavor characteristics of the cake sample.

Table 4. Proximate composition of cakes.

Samples	MGR	ODR	FLS	FF1	MS6	SM3
Moisture Content (%)	17.3^{a}±0.4	15.3^{b}±0.3	13.7^{e}±0.6	16.66^{ab}±0.01	15.91^{b}±0.06	15.8^{b}±0.3
Protein(%)	8.6^{a}±0.1	6.0^{e}±0.2	4.43^{f}±0.1	6.8^{d}±0.1	7.4^{c}±0.3	7.8^{b}±0.3
Crude Fiber(%)	0.24^{e}±0.01	1.11^{a}±0.03	0.68^{c}±0.01	0.81^{b}±0.03	0.67^{c}±0.02	0.48^{d}±0.01
Fat(%)	24.3^{e}±0.4	30.7^{a}±0.1	28.1^{c}±0.2	28.80^{b}±0.08	27.69^{c}±0.08	26.1^{d}±0.2
Ash(%)	2.9^{c}±0.3	3.9^{a}±0.4	3.5^{b}±0.5	3.6^{ab}±0.3	3.4^{c}±0.1	3.3^{d}±0.3
Carbohydrate(%)	46.7^{b}±0.5	43.0^{c}±0.7	50^{a}±1	44.0^{c}±0.6	44.5^{c}±0.5	46.3^{b}±0.5
Energy(Kcal)	440^{d}±1	458^{b}±2	472^{a}±1	462^{ab}±2	465^{ab}±2	452^{c}±2

*mean values in the same column with different superscripts are significantly different at p<0.05. MGR-100% Margarine; ODR-100% Shea butter; FLS-100% Flashed Shea butter; FF1-50% Shea butter +50%Margarine; MS6-40% Shea butter +60% Margarine; SM3-30% Shea butter +70% margarine

Table 5. Sensory properties of cakes.

SAMPLES	MGR	ODR	FLS	FF1	MS6	SM3
Texture	7.53[a]	6.11[c]	6.54[bc]	6.61[bc]	7.69[a]	7.04[ab]
Aroma	6.96[ab]	6.00[c]	6.77[b]	7.04[ab]	7.65[a]	6.81[b]
Taste	7.46[a]	6.27[b]	7.04[a]	7.11[a]	7.77[a]	7.27[a]
Appearance	7.88[a]	7.00[b]	7.08[b]	7.31[ab]	7.92[a]	7.27[ab]
Overall Acceptability	7.61[a]	6.81[b]	7.26[ab]	7.23[ab]	8.00[a]	7.38[a]

*mean values in the same column with different superscripts are significantly different at p<0.05. MGR-100% Margarine; ODR-100% Shea butter; FLS-100% Flashed Shea butter; FF1-50% Shea butter +50%Margarine; MS6-40% Shea butter +60% Margarine; SM3-30% Shea butter +70% margarine

CONCLUSION

Cakes were produced from shea butter and margarine mixture as shortenings. From the results obtained, the use of shea butter as shortening in cake production gave products of comparable characteristics with that made from conventional shortening, *i.e.*, margarine, and the panelists well accepted the products. However, shea butter quality may be improved upon by refining to have products that are more acceptable to the consumer, as seen with results obtained for cake produced from flashed shea butter shortening.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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