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Effect of Chemical Interesterification on the Physicochemical Characteristics and Fatty Acid Profile of Bakery Shortening Produced from Shea Butter and Fluted Pumpkin Seed Oil Blend

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Abstract The objective of this work was to evaluate the effect of chemical interesterification, as a modification process on the physicochemical properties and fatty acid profile of bakery shortening produced from a blend of Shea stearin and fluted pumpkin seed oil. The Shea nut oil was fractionated, and the solid stearin fraction blended with fluted pumpkin seed oil in the following ratios: 30:70, 40:60, 50:50,and 60:40 (Shea stearin: fluted pump seed oil), The blends were stabilized with recommended additives such as; distilled monoglyceride (E471) and preservatives such as; citric acid (E330), BHT (E321), homogenized by continuous stirring and crystalized by cooling at 17°C, then tempered at 23 – 25°C for 48h, to attain a stable polymorphic form, used as non-interesterified blends (NIEBs). Another set of 30:70; 40:60; 50:50; and 60:40 (Shea stearin: fluted pumpkin seed oil), were chemically interesterified with sodium methoxide (CH_3ONa) as catalyst, crystalized, stabilized, and used as chemically interesterified blends (CIEBs).The chemical properties, physical characteristics (including solid fat content), and the fatty acid profile of all the chemically interesterified (CIEB) and the non-interesterified (NIEB) samples were determined. There was no significant ($p>0.05$) change in the peroxide value, iodine value, and the refractive index of NIEBs and there corresponding CIEBs. The acid value, free fatty acids, slip melting point, density, and solid fat content were significantly ($p<0.05$) reduced after interesterification. Interesterification caused rearrangement of triacylglycerol species, resulting in increased unsaturated fraction and reduction in the saturated fraction. Interesterification gave fats with wide plastic range suitable for bakery fats, icing-shortening, filler fats, and all-purpose shortenings.

Keywords: *Shea butter, fluted pumpkin, interesterification, physicochemical, fatty acid profile, bakery shortening*

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1. Introduction

Edible fats are modified to enhance their physical characteristics. This is determined by the chemical composition of the fats, its chain length, degree of unsaturation of the fatty acid residues, and the distribution of fatty acid residues on the glycerol backbone [1]. The fat modification methods commonly used are; blending, fractionation, hydrogenation, and interesterification [2]. Hydrogenation has been the popular method employed for modification of edible fats. However, partial hydrogenation produces fats with trans-fatty acid residues and this has been proven to be detrimental to human health [3]. Interesterification has been considered as an alternative to the partial hydrogenation process that can be used to give fats and oil desired functionality [4,5]. Interesterification process rearranges fatty acids within and between triacylglycerols (TAGs), producing randomly distributed fatty acid residues among the TAGs [6,7]. Unlike hydrogenation, interesterification do not cause isomerization of the fatty-acid double bond. The stability of oils and fats also remains essentially unchanged [8]. Through interesterification, a coarse-crystal, grainy-texture fat can be changed into one with lower melting point, finer crystal size, more plastic, smoother in texture and mouth feel. It can be either chemically- or enzymatically- catalyzed. Chemical interesterification (CIE) is a random process that is less expensive. Depending on the lipase used, enzymatic interesterification (EIE) can be random, regioselective, or fatty acid specific [9].

The recent interest of minimizing the trans- fatty acid content of fat products especially in production of margarine and bakery shortenings has focused attention on vegetable oil with high melting products as a source of solid fat in placed of hydrogenated fats. Shea butter is a vegetable fat, solid and stable at room temperature

(28±2°C), with slip melting point above 35°C, and will remain a solid till 51°C [10]. Its high stearin content of over 47% [11] makes it a ready source of hard stock for the blending and modification process. Shea butter is obtained from the nuts of Shea tree (*Vitellaria paradoxa*), which exist in the wild in most parts of Africa [12]. It is a native of the dry Savanna belt of West Africa [10].

Fluted pumpkin seed oil is a low melting oil, needed to provide wide plasticity and spread ability in the blend. With a melting point of 18.5°C [13], and about 66% polyunsaturated fatty acid content [14], fluted pumpkin seed oil in the blend is expected to improve functionalities, nutrition and health value of the shortening. Fluted pumpkin (*Telfairia occidentalis* Hook F) is a tropical crop that belongs to the Cucurbitaceae family [14].The seeds are high in protein and fat [15].

Bakery fats (shortenings) are tailored fat systems, whose nutritional and functional properties have been modified in order to deliver specific functional needs; as tenderizing agents, facilitate aeration, texture, mouthfeel, carry flavours and colours, provide a heating medium, and structural integrity to pies, breads, pasta and other bakery products [16]. This modification processes affects the physicochemical characteristics of the fat blends, hence impacting desirable consistency and keeping quality on the end product. The objective of this work was to evaluate the effect of chemical interesterification, as a modification process on the physicochemical properties and fatty acid profile of bakery shortening produced from a blend of Shea stearin and fluted pumpkin seed oil.

2. Materials and Methods

Healthy nuts of the Shea tree were procured from Minna, Niger State, while mature, freshly harvested fluted pumpkin fruits were purchased from Bori market in Rivers State, all in Nigeria. The Shea nuts were cracked and sorted. Fluted pumpkin seeds were dehulled and washed. The Shea kernel and *Telfairia* cotyledons were then oven dried (60°C, 24h) separately in a hot air fan oven (model QUB 305010G, Gallenkamp, UK), ground using a laboratory mill (model MXAC2105, Panasonic, Japan), this was followed by oil extraction as described by AOAC [17].

2.1. Oil refining and Modification

The extracted oil was refined using the procedure described by earlier researchers [18]. The crude oil was heated with 8% $NaOH_{(aq)}$ for 10min with continuous stirring, using a laboratory stirrer (model JKL 2145, REMI Motors, India). The treatment was then washed with warm distilled water and the aqueous phase separated using a separatory funnel. The oil was then dried and bleached using 3% fuller's earth, with continuous stirring at 80°C for 20min. It was filtered at 50°C using Whatman no 4 filter paper.

2.1.1. Fractionation

The Shea nut oil was Fractionated separately using n-Hexane, to obtain liquid, and hard stock, using the method describe by ISEO [19].

Fractions were crystallized at 15°C after which the fractions were separated by filtration, and the solvent distilled out at 65°C. The fraction was heated to dry at 100°C.

The hard stock (solid stearin fraction from Shea butter) and the liquid fluted pumpkin seed oil (SS: FPSO) were blended in the ratio: 30:70, 40:60, 50:50, and 60:40. Each was heated to 70°C, homogenized with recommended additives such as: Distilled monoglyceride (E471, 0.4%), citric acid (E330, 0.17%), Butylated hydroxytoluen (E321, 0.075%), xanthan gum (E415, 0.2%), and sodium benzoate (E211, 0.08%) [20,21], crystalized to 17°C with continuous stirring, using a laboratory stirrer (model JKL 2145, REMI Motors, India) at 300rpm.

The crystalized blend was tempered at 22-25°C for 48h [18], then stored in an opaque, sealed plastic cup at room temperature (28±2°C), and used as non-interesterified (NIEB) blends.

2.1.2. Chemical Interesterification

The hard stock (Shea stearin) and the liquid Telfairia seed oil were first blended at the same ratio of: 30:70, 40:60, 50:50, and 60:40, then interesterified Using the method describe by earlier reporters [22,23]. Sodium Methoxide (CH_3ONa) powder was used as catalyst. To 300g of fat was added 0.3g of CH_3ONa powder, stirred at 85°C for 50min and the reaction was stopped with acidic water(4% citric acid), and the blend washed with dilute basic water (0.1N NaOH) (1:8), three(3g) of bleaching earth was added, stirred thoroughly and filtered through whatman no 4 filter paper. The blends were washed with warm water, and dried. They were further homogenized with recommended additives, stored and used as chemically interesterified (CIEB) blends. Palm stearin-based commercial baking shortening (CBS) obtained from Solive vegetable oil industry, Nsukka Nigeria was used as control.

2.2. Physicochemical Properties

Physicochemical properties such as acid value (AV), iodine value (IV), free fatty acid (FFA), peroxide value (PV), slip melting point (SMP), smoke point (SP), Refractive index (RI) and density (DN) were determined by the method of AOAC [17]. Refractive index was performed using the Abbe Refractometer model 2WAJ (Wincom, China). It was calibrated with distilled water which has refractive index of 1.3330 at 20°C and 1.3306 at 40°C.

Few drops of the dried sample was placed on the prism, closed and allowed to stand for 1-2 min. the instrument and lighting was adjusted to obtain the most distinct reading possible. The refractive index was determined at the specified temperature (40°C).

2.3. Solid Fat Content

The solid fat content-temperature profile was measured using a minispec pulsed Nuclear magnetic Resonance (pNMR) spectrometer (Bruker Spectrospin Ltd, Conventry, UK). The AOCS [24] direct method was used. The sample in NMR tube was first melted at 70°C for 30min, followed by chilling at 0°C for 90min and then held at each measuring temperature of 10°C, 20°C, 30°C, 40°C, 50°C, and 60°C for 30min prior to measurement. The process of melting, chilling and holding of sample were carried out in a pre-equilibrated thermostatted water bath. Samples were run in triplicate and the values were recorded and averaged.

2.4. Fatty Acid Profile

The individual fatty acids in the oil/fats were determine using Gas chromatographic method as described by A.O.A.C [17]. Gas chromatograph (model 7890A Agilant, USA) with flame- ionization detector (FID) was used. Fatty acid methyl esters (FAME) were prepared from the extracted fats/oil. In 50 ml round bottom flasks, 50 mg of each sample was kept in separate flasks and 3 ml of methanolic sodium hydroxide solution (0.5mol/l solution of NaOH in methanol) was added. The reaction medium was refluxed for 10 min; 3 ml of acetyl chloride was added; mixture was refluxed again for 10 minutes and then cooled to ambient temperature; 8 ml hexane and 10 ml of distilled water were added and allowed to stand for 5 min to establish a two phase solution. The upper organic phase was recovered into a vial for GC analysis.

2.5. Statistical Analysis

All the analyses were carried out in triplicate. Data obtained were subjected to Analysis of variance (ANOVA), differences between means were evaluated using Tukey's multiple comparison test, and significance accepted at $p \leq 0.05$ level. The statistical package in Minitab 16 computer program was used.

3. Results and Discussion

3.1. Chemical Properties of Bakery Shortening Made from Shea Stearin and Fluted Pumpkin Seed Oil Blend (Interesterified (CIEB), and Non-interesterified (NIEB)).

3.1.1. Iodine Value (IV) of Products

Table 1, showed result for chemical properties of bakery fats made from Shea nut stearin and fluted pumpkin seed oil.

The IV ranged from 78.97g/100g in the 60:40 non-interesterified blend to 94.62g/100g in the 30:70 non-interesterified blend. This range of iodine values were all significantly ($p<0.05$) higher than the iodine value of the commercial baking shortening (solive brand) which gave IV of 46.61g/100g. The relatively high iodine values of the Shea butter/FPSO shortening is an indication that the products are rich in polyunsaturated fatty acids.

Iodine value of 91.66g/100g had also been reported for shortening [25].

There was no significant ($p>0.05$) change in the iodine value of the 30:70; 40:60; and the 50:50 blends before and after interesterification. Only the 60:40 blend show significant ($p<0.05$) increase in IV from 78.97g/100g (NIEB) to 79.34g/100g (CIEB) This shows that the iodine value of the non-interesterified blends (NIEB) and that of their corresponding interesterified blend (CIEB) were similar, an indication that interesterification do not significantly affect the iodine value of fats. That is, interesterification do not alter the degree of saturation of fatty acids in the triacylglycerol (TAG).. This observation was supported by earlier researchers [26], they posited that interesterification does not affect the degree of saturation, nor cause isomerization, and that it does not alter the fatty acid profile of the starting blends. Interesterification had been shown to have negligible effect on iodine value, fatty acid composition, and nutritional aspect of the fat. But rather affects melting point, solid fat content, crystal habit, and oxidative stability [18].

3.1.2. Peroxide Value (PV) of the Products.

The PV of the products range from 0.37mEqO_2/kg to 0.73mEqO_2/kg. These values were lower than the maximum allowable standard of 10mEqO_2/kg for edible fats [19], and also lower than the maximum acceptable value of 2.00mEqO_2/kg for margarine and shortenings [27]. There was no significant ($p>0.05$) change in the PV of the NIEBs and there corresponding CIEBs. Pearson correlation of iodine value and peroxide value however gave coefficient of correlation (r) =0.698, and P-value =0.000 (MINITAB 16). This is a positive correlation, showing a high degree of linear relation between IV and PV. It shows that as the iodine value of the products increases, the peroxide value also increases. That is, the higher the degree of unsaturation of the fat blend, the more the tendency for oxidation.

3.1.3. Acid Value and Free Fatty Acid (FFA) of the Products

The acid value (AV) of the products range from 0.028mgKOH/g to 0.103mgKOH/g. These values were significantly ($p<0.05$) lower than the control (commercial baking shortening) which gave acid value of 0.184mgKOH/g. The acid values were all within the safe range, much lower than the maximum acceptable value of 0.6mgKOH/g for edible oil/fats [19] and also lower than the maximum acceptable value of 0.3mgKOH/g for margarine/shortenings [27].

The result of the present study indicates that the products were chemically safe for culinary applications. The acid value and FFA of the CIEBs were significantly ($p<0.05$) lower than that of their corresponding NIEBs. This was probably as a result of the caustic treatment, steam washing, and further bleaching with fuller's earth done during the chemical interesterification process.

3.2. Physical Properties of Bakery Shortening Made from Shea Nut Stearin and Fluted Pumpkin Seed Oil Blend

Table 2 shows the physical properties of bakery fats made from Shea stearin and *Telfairia* seed oil blend.

3.2.1. Density of Products (at 40°C)

Density of the CIEBs ranged from 0.906g/ml (30:70) to 0.910g/ml (60:40), while the density of the NIEBs ranged from 0.914g/ml (30:70) to 0.936g/ml (60:40). This shows significant ($p<0.05$) reduction in density at 40°C after interesterification. The high density observed in the non-interesterified blend is an indication of high fat content, as the density of a fat has a linear relationship with its solid fat content [23,24]. The lower density observed from the CIEBs is a result of random rearrangement of the saturated and unsaturated fatty acids of the TAGs on their glycerol back bone [18,26].

3.2.2. Smoke point (SP) of the products

Smoke point of the CIEBs ranged from 200.33°C to 202.33°C, while that of the NIEBs ranged from 198.33°C to 200.33°C. This shows that the smoke point of the CIEBs increases significantly ($p<0.05$) from that of their corresponding NIEBs. Increase in smoke point of the chemically interesterified blend is probably due to further reduction in FFA content, owing to the caustic treatment and steam washing involved in the chemical interesterification process.

Smoke point of 180°C, 202°C, and 212°C had earlier been reported for vegetable shortening, and venespati [25,28].

3.2.3. Slip Melting Point (SMP) of Products

Slip melting point of the NIEBs ranged from 36.33°C to 47.33°C while that of their corresponding CIEBs ranged from 34.33°C to 40.33°C. This shows that interesterification significantly ($p<0.05$) reduces the melting point of fats. Earlier researchers had also reported reduction in SMP of a 50:50 blend of palm oil/PKO (PO: PKO) shortening, from 48.33°C to 36.67°C after chemical interesterification [7].

High positive correlation was observed between the SMP and density. The Pearson coefficient of correlation (r) = 0.708, and P-value = 0.000. Meaning, as the melting point of the fat increases, the density also increases.

3.2.4. Refractive Index (RI) of the Products

Refractive index of the Shea stearin/*Telfairia* seed oil bakery shortenings were significantly ($p<0.05$) higher than the control (CBS), with RI of 1.448. There was however no significant ($p>0.05$) difference in the RI of the CIEBs and that of their corresponding NIEBs. This is an indication that interesterification do not alter the RI of fats.

There is a high positive correlation between the RI and IV, with coefficient of correlation (r) = 0.931, and P-value=0.000. This indicates that iodine value (IV) increased with a corresponding increase in refractive index (RI).

Table 1. Chemical properties of bakery fat made from Shea butter and Telfairia seed oil blend (Non-interesterified, and chemically interesterified blends)

FAT BLEND	IV (g/100g)	FFA (%)	AV (mgKOH/g)	PV ($mEqO_2$/kg)
NIEB1 (30:70)	$94.62^{a}\pm0.37$	$0.019^{cd}\pm0.006$	$0.035^{cd}\pm0.011$	$0.73^{a}\pm0.252$
CIEB1 (30:70)	$93.78^{a}\pm0.36$	$0.014^{d}\pm0.001$	$0.028^{d}\pm0.002$	$0.70^{a}\pm0.200$
NIEB2 (40:60)	$92.30^{b}\pm0.36$	$0.023^{cd}\pm0.005$	$0.047^{cd}\pm0.009$	$0.70^{a}\pm0.200$
CIEB2 (40:60)	$92.62^{b}\pm0.37$	$0.019^{cd}\pm0.006$	$0.037^{cd}\pm0.011$	$0.67^{a}\pm0.153$
NIEB3 (50:50)	$88.92^{c}\pm0.37$	$0.051^{b}\pm0.005$	$0.103^{b}\pm0.010$	$0.57^{a}\pm0.252$
CIEB3 (50:50)	$89.28^{c}\pm0.36$	$0.023^{cd}\pm0.006$	$0.047^{cd}\pm0.011$	$0.57^{a}\pm0.252$
NIEB4 (60:40)	$78.97^{d}\pm0.37$	$0.051^{b}\pm0.008$	$0.103^{b}\pm0.016$	$0.37^{a}\pm0.116$
CIEB4 (60:40)	$79.34^{e}\pm0.37$	$0.028b^{c}\pm0.001$	$0.056^{c}\pm0.002$	$0.37^{a}\pm0.153$
CBS	$46.61^{f}\pm0.73$	$0.084^{a}\pm0.001$	$0.184^{a}\pm0.001$	$0.37^{a}\pm0.058$

Values are means ± standard deviation of triplicate samples.
Mean values bearing the same superscript in the same column do not differ significantly ($p>0.05$)
Key: IV= iodine value, FFA= free fatty acid, AV= acid value, PV= peroxide value
NIEB1= Non-interesterified blend of 30:70 (Shea stearin: fluted pumpkin seed oil)
CIEB1= chemically interesterified blend of 30:70 (Shea stearin: fluted pumpkin seed oil)
NIEB2= Non-interesterified blend of 40:60 (Shea stearin: fluted pumpkin seed oil)
CIEB2 = chemically interesterified blend of 40:60 (Shea stearin: fluted pumpkin seed oil)
NIEB3=Non-interesterified blend of 50:50 (Shea stearin: fluted pumpkin seed oil)
CIEB3= chemically interesterified blend of 50:50 (Shea stearin: fluted pumpkin seed oil)
NIEB4=Non-interesterified blend of 60:40 (Shea stearin: fluted pumpkin seed oil)
CIEB4= chemically interesterified blend of 60:40 (Shea stearin: fluted pumpkin seed oil)
CBS= commercial bakery shortening (Solive).

Table 2. Physical properties of Bakers fat made from Shea stearin and Telfairia seed oil blend (non-interesterified, and chemically interesterified)

FAT BLEND	DN (g/ml) at 40°C	SP (°C)	SMP (°C)	RI
NIEB1 (30:70)	$0.914^{d}\pm0.001$	$200.33^{abc}\pm0.58$	$36.33^{de}\pm0.58$	$1.461^{a}\pm0.002$
CIEB1(30:70)	$0.906^{f}\pm0.001$	$202.00^{ab}\pm1.00$	$34.33^{e}\pm1.53$	$1.461^{a}\pm0.000$
NIEB2 (40:60)	$0.927^{c}\pm0.001$	$199.00^{cd}\pm1.00$	$42.67^{bc}\pm1.53$	$1.460^{a}\pm0.001$
CIEB2 (40:60)	$0.906^{f}\pm0.000$	$202.33^{a}\pm0.58$	$36.33^{de}\pm0.58$	$1.461^{a}\pm0.001$
NIEB3 (50:50)	$0.932^{b}\pm0.001$	$199.00^{cd}\pm0.00$	$44.33^{ab}\pm1.53$	$1.460^{ab}\pm0.000$
CIEB3 (50:50)	$0.908^{e}\pm0.001$	$201.67^{ab}\pm1.16$	$39.67^{cd}\pm0.58$	$1.460^{ab}\pm0.000$
NIEB4 (60:40)	$0.936^{a}\pm0.001$	$198.33^{d}\pm0.58$	$47.33^{a}\pm1.53$	$1.459^{b}\pm0.002$
CIEB4 (60:40)	$0.91^{c}\pm0.001$	$200.33^{bc}\pm0.58$	$40.33^{c}\pm1.53$	$1.459^{b}\pm0.001$
CBS	$0.906^{f}\pm0.001$	$190.33^{e}\pm0.58$	$44.33^{ab}\pm0.58$	$1.448^{c}\pm0.002$

Values are means ± standard deviation of triplicate samples.
Mean values bearing the same superscript in the same column do not differ significantly ($p>0.05$).

3.3. Solid Fat Content (SFC)

The SFC is the amount of fat crystals in the fat blend, and is responsible for many product characteristics, including general appearance, ease of packing, organoleptic properties, spreadablity, oil exudation, lubrication, and dough aeration [26,29].

In Figure 1, Figure 2, Figure 3, and Figure 4, the SFC of the bakery shortenings reduced significantly after interesterification, giving curves with desired plastic range, which compared with that of the commercial shortening. The SFC of all the interesterified blends (CIEB1, CIEB2, CIEB3, CIEB4) and the 30:70 non-interesterified blend (NIEB1) are all within the recommended solid fat range; ≥20% at 25°C and 5 – 15% at 40°C for bakery shortening [30,31]. Baking shortening performs optimally with a SFC between 15% and 25% at the working temperature of dough [32]. Presence of sufficient SFC is necessary at the dough proofing temperature, to strengthen the dough and provide gas retention [29], and to provide lubrication for cake leavening [33]. These views are in accordance with those of other researchers that a SFC of 15% to 25% at the working temperature is desired for better creaming performance in cake [34]. The adjustment in SFC of the CIEBs to a lower and desired range was enhanced by the rearrangement or randomization of acyl residues in triacylglycerols (TAGs), during interesterification.

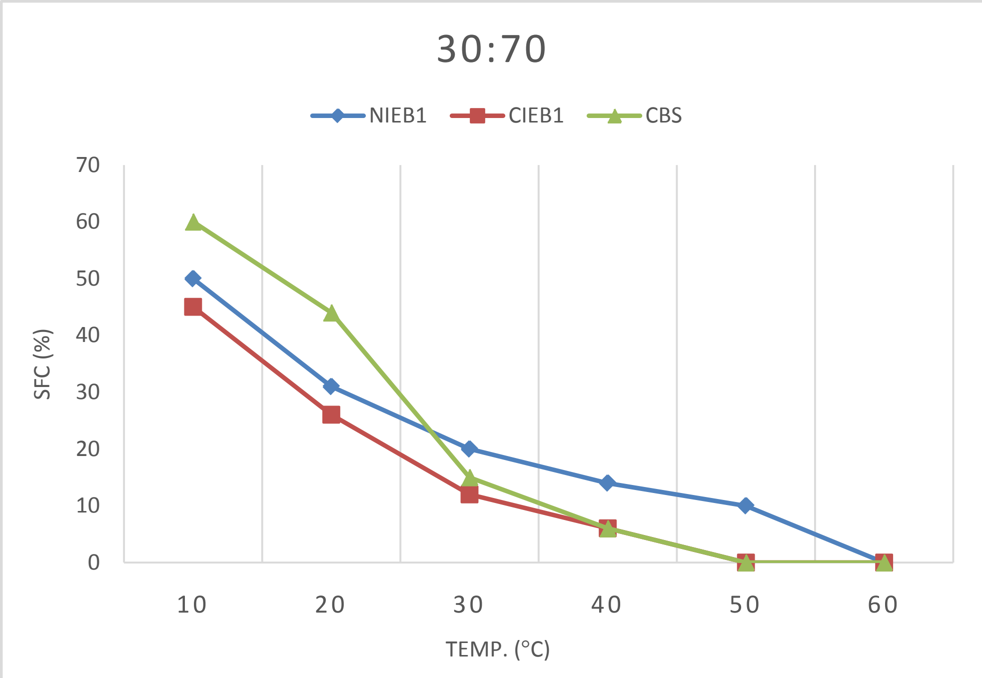

Figure 1. Solid fat content – temperature profile of 30:70 blend (Shea stearin: fluted pumpkin seed oil), interesterified and non-interesterified

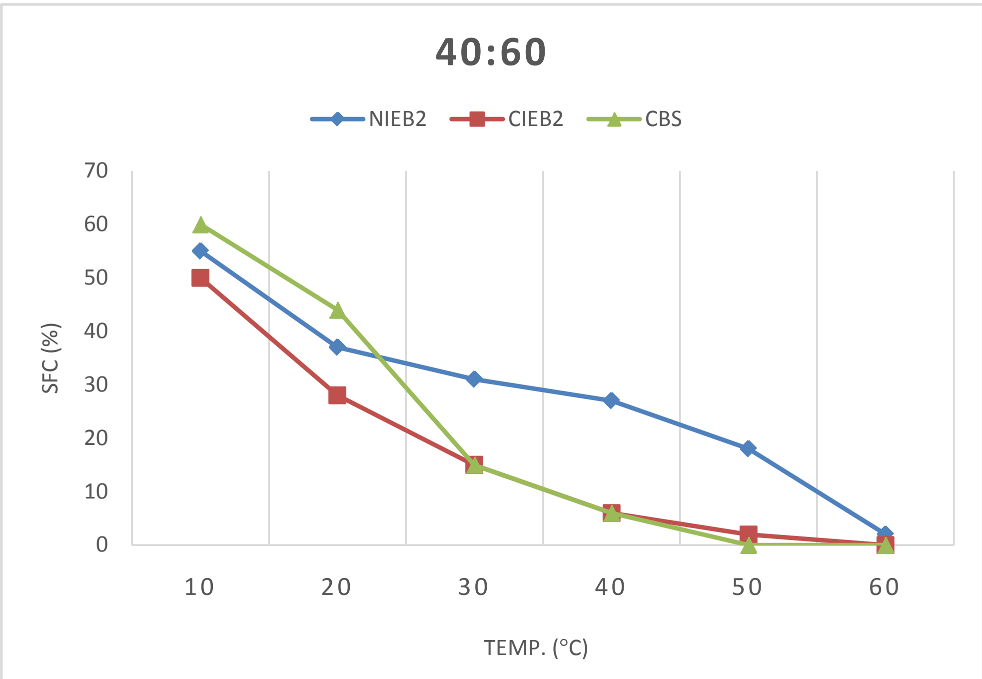

Figure 2. Solid fat content – temperature profile of 40:60 blend (Shea stearin: fluted pumpkin seed oil), interesterified and non-interesterified

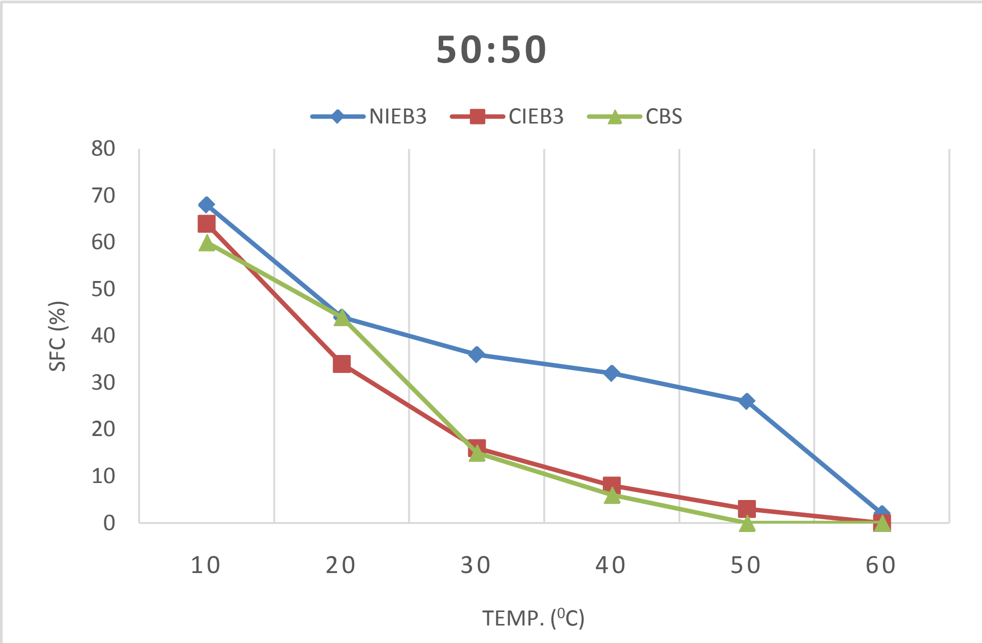

Figure 3. Solid fat content – temperature profile of 50:50 blend (Shea stearin: fluted pumpkin seed oil), interesterified and non-interesterified

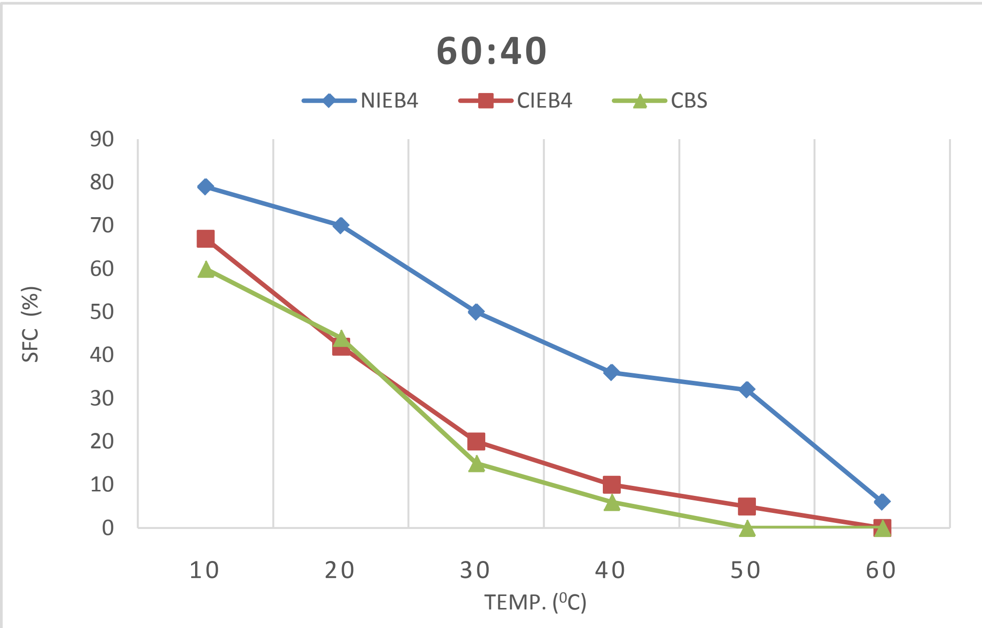

Figure 4. Solid fat content – temperature profile of 60:40 blend (Shea stearin: fluted pumpkin seed oil), interesterified and non-interesterified

3.4. Fatty Acid Profile of Bakery Shortening Produced from Shea Stearin and Fluted Pumpkin Seed Oil Blend.

The total saturated fatty acids in the non – interesterified blend of 50:50 Shea stearin and fluted pumpkin seed oil (SS:FPSO) was 44.0%, while the total unsaturated fatty acid was 56.0%. The total saturated fatty acids in the interesterified blend of 50:50 (SS: FPSO) was 40.4%, while the total unsaturated was 60.6%. This shows a slight increase in percentage unsaturated fatty acid, and decrease in total saturated fatty acids after interesterification. This change compared with that given by earlier researchers [7]. They reported an increase in olein fraction from 31.45% to 32.3% after chemical interesterification of a 50:50 blend of palm oil and palm kernel oil.

Table 3. Fatty Acid profile of Shea stearin/fluted pumpkin seed oil blend (chemically interesterified, and non-interesterified)

FATTY ACIDS (%)		FAT SAMPLES	
		NIEB3	CIEB3
MYRISTIC	(C14:0)	1.0	
PALMITIC	(C16:0)	2.1	1.1
PALMITOLEIC	(C16:1)	7.0	7.1
STEARIC	(C18:0)	40.0	38.1
OLEIC	(C18:1)	11.2	12.0
LINOLEIC	(C18:2)	32.2	33.3
LINOLENIC	(C18:3)	4.8	1.0
ARACHIDIC	(C20:0)	0.4	1.0
EICOSENOIC	(C20:1)	0.1	0.1
EICOSADIENOIC	(C20:2)	0.8	6.0
LIGNOCERIC	(C24:0)	0.1	0.2

Key: NIEB3=Non-interesterified blend of 50:50 (Shea stearin: fluted pumpkin seed oil).
CIEB3= chemically interesterified blend of 50:50 (Shea stearin: fluted pumpkin seed oil).

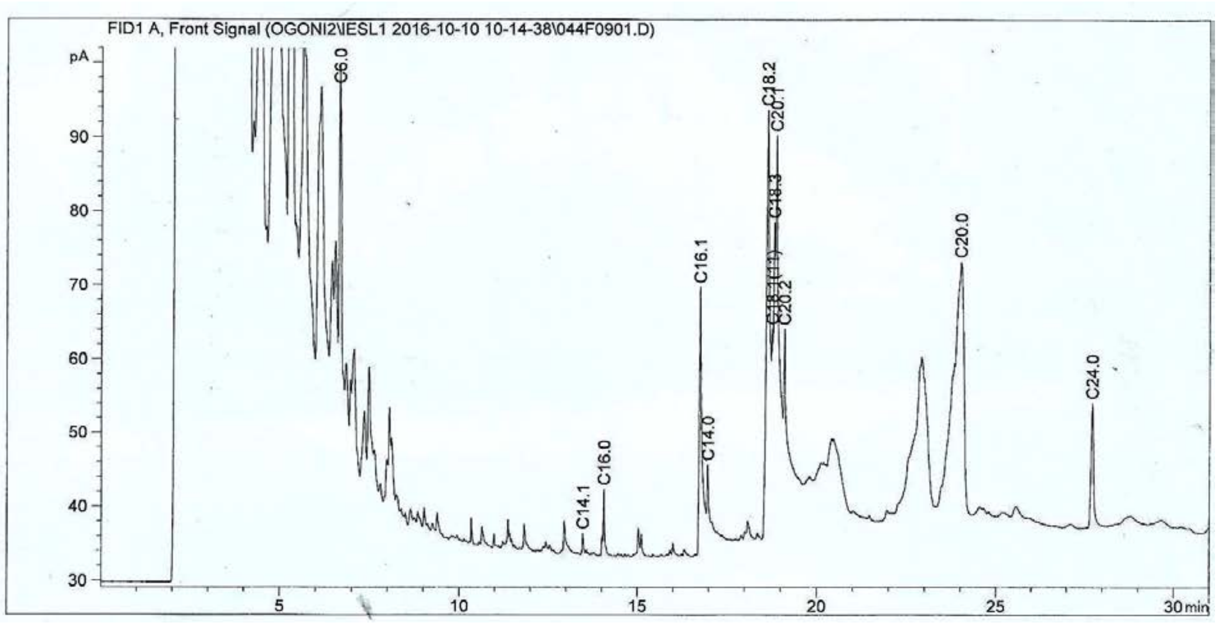

Figure 5. Fatty acid GC Chromatogram of non-interesterified (50:50) Shea stearin/fluted pumpkin seed oil blend.

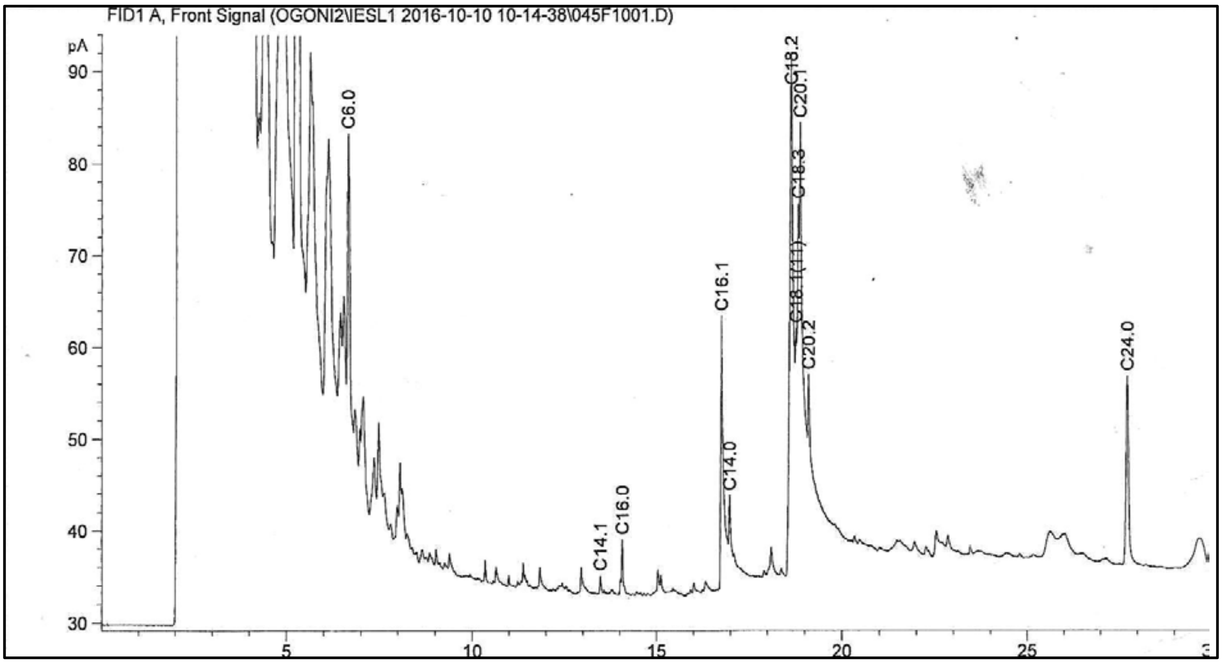

Figure 6. Fatty acid GC Chromatogram of chemically interesterified (50:50) Shea stearin/fluted pumpkin seed oil blend.

4. Conclusion and Recommendation

This study has shown that by modifying a blend of solid, and liquid fat through chemical interesterification, the melting point and solid fat content of the product will be significantly reduced to a desired range. The acid value and free fatty acid of the product was reduced significantly, thus enhancing its oxidative stability. Interesterification did not significantly affect the iodine value of fat blends. It however resulted in slight adjustment in the fatty acid profile of affected blends.

Non-interesterified blend of 30:70 and 40:60 Shea stearin: fluted pumpkin seed oil gave SFC of 14.33% and 27.33% at 40°C, and 50.33% and 55.33% at 10°C respectively. These SFC range is suitable for filler fats and pie crust shortenings.

The chemically interesterified blends gave characteristics that were suitable for a wide range of shortenings. Interesterified blend of 30:70 Shea stearin and FPSO gave a SFC of 5.67% at 40°C and 45.33% at 10°C which is suitable for all-purpose shortening and also as a frying fat. Interesterified blend of 40:60, and 50:50 gave SFC ranging from 6.00% – 8.33% at 40°C and 50.33% – 64% at 10°C. This is a wide plastic range suitable for bakery fats, icing-shortening, filler fats and all-purpose shortenings.

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