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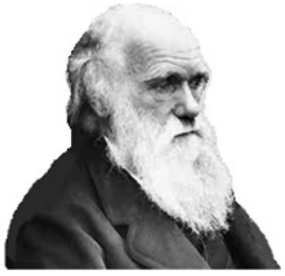

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Extraction of Nigerian Beef Tallow by Wet Rendering Process and its Characterization

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ABSTRACT

Nigeria has relied for several decades on the importation of tallow fat for her industries despite its inconsistence in availability and price in the market The above challenges and the recent soaring value of Dollars to Naira have made it highly necessary for Nigeria to consider the quantum of about 9 tonnes/day of tallow fat sent down the drain in each Nigerian slaughter house. Therefore, this research work has investigated the Physico-chemical quality of Nigerian beef tallow fat obtained by wet rendering of slaughter house waste from Obosi in Anambra State of Nigeria. It was analyzed using AOAC (1990, 1993). The slaughter waste gave 15% yield of tallow fat with 199.5 mg/gkOH, 0.40%, 2.05% of saponification value, unsaponifable matter and Free Fatty Acid (FFA) respectively. The Gas Chromatography (GC) revealed the following fatty acids: 46.65% stearic acid followed by 41.33% palmitic acid and 9.0% oleic acid. The results were found to be agreement with ISO and CODEX-STAN 211(1999) standards. To this end, the quality and usefulness of Nigerian beef tallow has been validated. Hence, investment in this area would help reposition Nigerian slaughterhouse waste matter control strategy, economy and industry.

***Keywords*:** Beef Tallow, Slaughterhouse, Physico-Chemical parameter, wet rendering, Gas Chrromatography

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1. INTRODUCTION

Tallow plays an important role in a balanced diet and in the manufacture of food products by contributing to texture and palatability (Ali et al., 2008). It is a valuable source of concentrated energy and essential fatty acid needed for growth and development (Ali, 2008).

Fats and Oil obtained from animals, olive oil and vegetable oil have been the source of raw materials in modern soap making (Aiwize and Achebo, 2012) while tallow fat is essential in the manufacture of soap especially for texture improvement (Austin, 1984), hardness and easy formation into shape and contains more 16- and 18- carbon fatty acid (Robertson, 2006).

Also, tallow oil has been proved to include palmitic, stearic and oleic acid (Warra, 2013). Beef Tallow has the highest saturated fatty acid profile when compared with alligator fat, Chicken fat, Duck tallow and Lamb meal/mutton fat because it contains three major saturated fatty acids, palmitic (C16:0), Stearic (C18:0) and Oleic (C18:1) acids (Sawangkeav and Ngamprasertsith, 2013) while beef tallow contains approximately the following fatty acid ratio: 2% Myristic, 32% Palmitic, 15% Stearic, 49% Oleic and 2% Linolic acids (Meyer, 1960 and Austin 1984) and has been the major source of fat used in England (Wigner, 1940)

In Nigeria, Tallow fat is used in soap manufacturing industries for toilet soap and hard laundry soap, but it is imported. Hence, tallow fat is among the most costly raw materials in soap manufacturing.

This equally results in inconsistent quality of soap brand in the market as some companies suffer change in quality owing to either scarcity of tallow fat or the high price. Using low cost feedstocks such as rendered animal fats in soap production will reduce soap production cost. In the last years, meat production has increased significantly. World meat production reached 237.7 million tons in 2010, from which 23.9% corresponds to beef (USDA, 2010).

This equally has to increase the residues from animal processing. However, Nigeria has a large market for beef and other animals that are killed in slaughter houses. Little or no concern is given to the quantum of solid waste from these slaughter houses from which tallow fat could be obtained. For example, Anambra state in Nigeria, sustain about 15 slaughter houses of major capacity with over 184,128 live weights killed annually and yielding about 9 tons of tallow from each unit per day with minor increase during festivities (Umeghalu et al., 2012).

Beef tallow is one of the residual materials produced in slaughter houses in Nigeria and it can primarily be utilized in soap production industry. When the slaughter houses are overfilled or overloaded, the extra fat are usually incinerated or disposed in sanitary landfill; but the integrated use of the beef tallow fat from the Nigerian slaughter house could prevent pollution, create a viable industry and employment as well as reduce the cost of tallow fat. As a developing country, Nigeria could ensure that the use of beef tallow in biodiesel production would be highly integrated and made viable since it has gained a global interest in the recent times.

Consequently, this study is centered on investigating the quality of tallow fat from Obosi slaughter house in Nigeria and to compare its quality with fats from other sources.

2. MATERIALS AND METHODS

2. 1. Materials and equipment

2. 1. 1. Materials

The Tallow fat was sourced from Obosi slaughter house in Anambra State of Nigeria. Sodium hydroxide (99%, Sigma-Aldrich), potassium hydroxide (Loba Chemie, GmbH) 85%), methanol (Merck, Germany 99.5 % purity), carbon tetrachloride (chloroform), Wij's solution (iodine monochloride), potassium iodide solution, phenolphthalein (Merck Germany), powdered iodide (Fishon, England), hexane (99% purity, Merck Germany), sulphuric acid (98% min., Sg: 18300 BDH), hydrochloric acid, iodine, glacial acetic acid, iodine tetrachloride, starch indicator, potassium chloride, ethanol.

Figure 1. Samples of Fats material from Slaughter House

2. 1. 2. Equipment

Petri dishes, thermo regulator heater with Stirrer (Heizung chauffage, MGW-LAUDA, D6970, Lauda Konigshoffen, Germany). electric digital precision weighing balance (Ohaus, Adventurer, model –AR 3130), pH meter (Hanna pH meter, model: 02895, India), rotary evaporator oven (model BTOV 1423), veisfar muffle furnance (PEW, Path Electrical Mimbai, India), fenantic portable viscometer (model VL Brookfield Eng. Labline, USA, top load balance (Binatone; model KS-7020),water still (2 Lit/hr,model No: 7652, Medica Inst. Mgt Coy, India), concentric rings, thermostatic water bath (model no; 6801TI, 6 holes, medica Inst. Mgt Coy, India), pH meter, digital (Exstick, India), heating mantle (0-100 °C, Labline sunbine, India) and sohxlet extractor (BEHR, Labor- Technik Ez100).

2. 2. Procedures

2. 2. 1.Tallow Fat Rendering

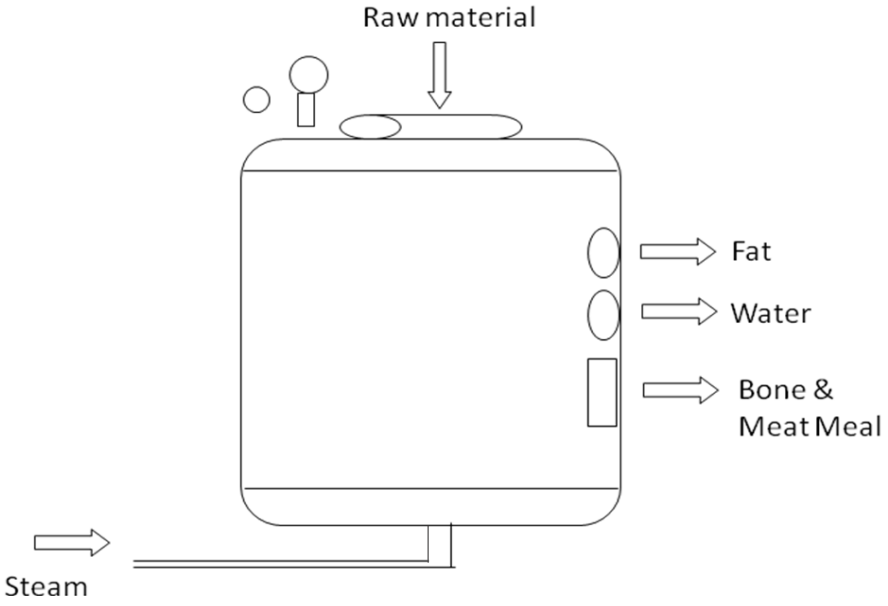

Figure 2. The Sketch of the wet rendering process

The fat was extracted from the tissue by wet rendering as recommended by Austin (1984). A mixture of animal matter: inedible offal, tissues, meat trimmings, waste and condemned meat, bones etc. weighing 50 kg were collected, shredded and reduced in sizes. The whole materials were gathered into a (mild steel) cylindrical vessel of 70 L capacity with 40 kg of water poured into it. The vessel was heated through its jacket by means of steam (1 bar) as a means of effecting batch wet rendering. After 4 hours, the hot water containing fat were tapped off and a repeat of the above process carried out with fresh water for 3 hours to ensure high percentage of fat extraction. Then the two run-offs were collected together in a vessel and allowed to stand for 2 hours before decanting off the top fat layer. A yield of 7.5 kg of fat was recovered after weighing.

$$\% F = (M_F/M_{SW}) \times 100 \qquad (1)$$

where:

% F = Percentage Fat yield
M_F = Mass of Fat recovered
M_{SW} = Mass of slaughter waste used

Figure 3. Nigerian beef tallow sample

2. 2. 2. Physico-chemical Characterization of Tallow fat

The physic-chemical properties of the fat were determined in accordance with Association of Official Analytical Chemist (AOAC, 1990) method (the acid value by AOAC Ca5a-40, saponification value by AOAC 920:160; iodine value by AOAC 920:158 and peroxide value by AOAC 965.33) while the viscosity was determined by using Oswald viscometer apparatus, the density by using density bottle, moisture content by oven method, the ash content by heating to dryness in Veisfar Muffle furnance and the refractive index by using abbe refractometer (Model: WAY-25, Search tech. Instruments), colour was measured with a Lovinbond 2000 Comparator tintometer ($5^1/_4$ "glass cell Model E) in accordance with AOC, 1993.

2. 2. 3. Gas Chromatographic analysis of Tallow fat

The chromatographic analysis involved the use of GC on perkin Elmer Claurus 600 model, Column: 5" × ¼ " internal diameter (i.d), glass column packed with 10% silica 10 °C on 80-100 mesh chromasorb HP at a temperature of 185 °C (set point of 150 °C and increment of 35 °C) Detector: FID; Nitrogen flowrate: 30 ml/min; Hydrogen flowrate: 20 ib/in^2; Sample size: 0.3 µl Attenuation: $2\times10^{4;}$ Backing off range: ×100

2. 3. Statistical Analysis

All the analyses carried out on the Physico-chemical parameters were done in triplicates and the mean values and standard deviations were calculated and provided

3. RESULTS AND DISCUSSION

Table 1. Physico Chemical Parameter of Nigerian Beef Tallow compared with other oil/fats

Parameter	Results					
	Nigerian BT[1*]	Pakistan BT[2]	Portugalesse BT[3]	Lard[4]	Poultry fat[5]	
Fat yield (%)	15(1.5)	-	-	-	-	
Titre value (°C)	45.50 (2.51)	-	-	-	-	
Colour (Lovibond 1" cell)	off white (10)	-	-	-	-	
Odour	Agreeable	-	-	-	-	
Unsaponifiable matter (g/kg)	0.40(0.004)	-	-	-	-	
Free fatty acid as oleic (%)	2.05(0.21)	0.5-1.0	2.14		1.26	7.51
Iodine value (wij's)	50.34(3.22)	48.65-49.15	45.3	77.9	61.70	
Peroxide value (milli eq. oxy/kg)	4.58(0.66)	3.0-6.5	-	-	7.45	
Saponification value (mg KOH/g fat) 205.50	199.50(3.48)	195-197	-		-	
Specific gravity @ 40°C 0.8768	0.9000(0.007)	-	-		-	
Moisture content (%g / g fat)	0.255(0.05)	0.223-0.246	-	-	0.205	
Viscosity (Kinematic) @ 40% (mm/s)	41.23(1.42)	-	46.37	39.53	41.06	
Acid Value	4.10(2.36)	-	-	-	-	

*Values are means of triplicate determination and Standard Deviations are given in parenthesis
1 - This Study; 2 - Ali *et al* (2008); 3, 4, 5 – Mata *et al*., (2007); BT - Beef Tallow

Table 1 contains the Physico-chemical analytical results of the Nigerian local tallow. The % FFA result indicates high purity level and freshness. It equally implies that the tallow would have longer shelf life since oil and fats with up to 7% FFA are sstisfactroy for use in soap production (Eke et al., 2004). Sawangkeaw and Ngamprasertsith (2013) have reported 3.6-15.0 % (w/w) FFA in beef Tallow. Also with the value obtained in this study being greater than 1.0 %, it suggest that Nigerian local tallow would be good in soap production (Goodrun, 2002, and Emil et al., 2009). The off-white colour, specific gravity result, low unsaponifiable matter (0.4%), high titre value and saponification value (199.50 mg/gKOH) completely agree with Codex Alimentarium Commission (1999) and ISO (1988) standards for edible tallow. The saponification value indicates that the tallow would be very good in candle and soap manufacture (Ali et al., 2008) and contains high molecular weight fatty acids (Ali et al., 2008) and this is validated by the fatty acid profile result obtained. Jaya et al., (2011) equally stated that the equilibrium conversion of triglycerides is affected by various factors especially the feed quality paameters like % FFA and water content.

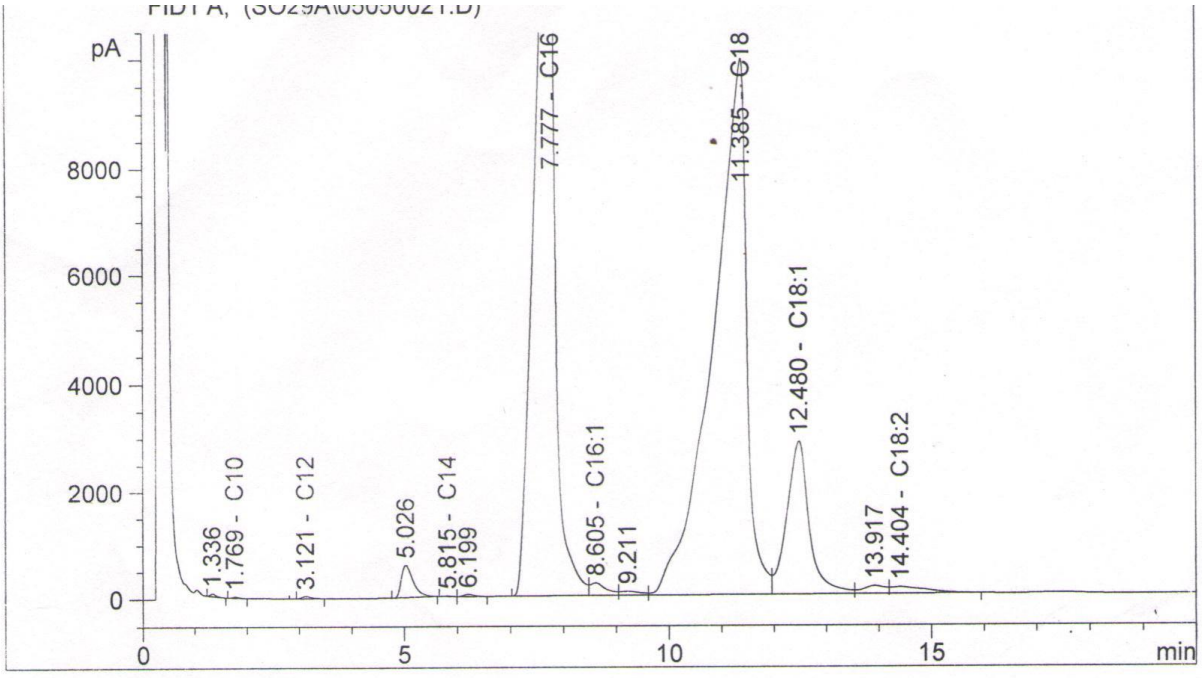

Figure 4. The Chromatogram of the Nigerian beef tallow

Table 2. The Fatty acid composition distribution of Nigerian Beef Tallow

S/n	Fatty Acid	Amount (%) Tallow			Lard		Poultry	
		1	2	3	4	5	6	7
1	Capric acid	0.02	-	-	-	-	-	-
2	Lauric	0.06	-	0.10	-	0.10	-	-
3	Myristic	0.01	12.63	2.80	4.38	1.40	-	3.00
4	Palmitic	41.34	31.63	33.3	39.80	23.60	30.08	30.00
5	Palmitoleic	0.53	-	-	-	-	-	-
6	Stearic	46.65	16.39	19.40	8.69	14.20	5.95	22.00
7	Linoleic	0.61	3.37	2.90	14.74	10.70	15.50	3.00
8	Oleic	9.02	36.58	42.40	28.98	44.20	47.03	8.10
9	Linolenic	-	-	0.90	27.87	0.40	1.39	25.00
10	Arashidic	-	-	-	-	-	-	7.00

1 – This study
2 – Mata et al., 2010
3 – Ma and Hanna, 1999
4 – Ma and Hanna, 1999
5 – Mata et al 2010
6 – Mata et al 2010
7 - Abdoli et al 2014

Therefore, having the above parameter within the limits indicates that the application of Nigeria beef tallow would strike a positive balance in the chemical reaction process of saponification and transesterification.

Chalmers and Bathe (1978) has reported that oil with high Iodine value gives shorter foaming duration soap and this is likely going to be the trend of the quality of Nigerian tallow in agreement with the findings in this research. Meyer (1960) has reported higher Iodine values (49.2 to 58.9) in palm oil against 35.4 to 42.3 in beef tallow while Ali et al (2008) has reported 48.65 to 49.15 for Pakistan beef tallow. The Saponification value of tallow is observed to be lower than that reported for of palm oil because of its larger molecular weight (Meyer 1960). Meyer (1960) reported 196-200 and 200-205 for beef tallow and palm oil respectively while Ali et al (2008) got 195-197 for Pakistan beef tallow. These results agree with the findings in this research (199.50 for Nigerian beef Tallow). The tallow fat quality in terms of colour could be improved by refining (bleaching) and its useful incorporation into food products investigated. Equally, the yield (15% of fat) shows that the process of extraction would equally make a good business.

The tallow fat obtained in this study compared well with other animal fats in fatty acid composition as contained in Table 2. It has 46.65% Stearic acid followed by 41.33% Palmitic acid and 9.0% oleic acid as the major fatty acids while other fatty acids appear in negligible qualities (Figure 4 and Table 2).

4. CONCLUSION

Tallow fat is the most extensively used and important fat in the food and cosmetics industry. In this research work. it has been proven that Nigeria has large volumes of slaughter/abattoir wastes from which the beef tallow could be extracted but these are neglected and the country is left at the mercy of the high priced imported tallow fat for its industrial; activities especially in the cosmetics and food industry. Nigerian beef Tallow has been proven to be of high quality compared with other sources while the 15% yield of tallow fat obtained is encouraging. The remaining 85% post-rendering waste could be exploited for biogas generation. However, more researches are expected on how to optimize its extraction and other viable areas of application especially in cosmetics and food production since it can compete favourably with beef Tallow sources from other parts of the world.

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