Physicochemical Analysis of Soap Produced from Tallow (Animal Fat) and *Sesamum Indicum* Seed Oil Blends

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Abstract

The objective of the present study is to understand the influence of sesame seed oil in soap production; This research presents the results of the physicochemical analysis of soaps produced from blends of tallow (animal fat) and Sesamum indicum seed oil. Nine (9) different blends of sesame seed oil and tallow were employed in soap production. The 50:50 blend gave the best soap judging by the TFM (74.5±0.71%), while 90:10 blend gave a better soap than the former in terms of foam ability (64.00±1.41cm^3). The saponification values of the oils 187.92 ± 2.01 mg KOH/g (sesame seed oil) and 196.50±3.50 mg KOH/g (tallow), acid values 42.07 ± 1.60 mg KOH/g (sesame seed oil) and 10.69±0.12 mg KOH/g (tallow), iodine value 102.99±5.66 g I_2/100g (sesame seed oil) and 42.20±1.35 gI_2/100g (tallow).

Keywords: soap, *sesamum indicum* seed oil, tallow (animal fat), saponification values, acid values and iodine values

Introduction

Tallow is a rendered form of beef or mutton fat, processed from suet. It is solid at room temperature. Tallow is used mainly in the production of soap and animal feeds (Alfred, 2002). Tallow is an ideal fat for soap making not because of its skin- nourishing qualities, but also because it is a homesteaders' fat. Also, tallow was used in the past by our parents to heal cracked skin, dry hands and as moisturizer. It contains vitamins A, D, K and E. Tallow also contains linoleic acid which has anti-cancer and anti-inflammatory properties as well as palmitoleic acid which has natural antimicrobial properties (Andrew, 2013).

Sesame seed is considered to be the oldest oil seed crop known to humanity (Raghav *et al.*, 1990). Sesame has one of the highest oil contents of any seed (Ray, 2011). Sesame oil is full of zinc, an essential mineral for producing skin collagen and giving skin more elasticity. Zinc also helps damaged tissue in the body to repair. Sesame oil is also known to sooths burns and prevents skin related disorders (Mike, 2013). Regular use of sesame oil can reduce skin cancer. It also contains antioxidants that help in detoxifying the skin. Also, it is a natural anti-inflammatory agent with antibacterial properties.

Materials and methods

Sample collection

The sesame seed oil and the animal fat were purchased from samara market in Zaria Metropolise, Kaduna state.

Sample preparation

The preparation of fats for soap making consist of cleaning the fats to be free from impurities contained in it. This is called rendering. To render the fat, all meat tissues was removed. The fat was then placed in a stainless-steel pot containing 500 cm^3 of distilled water. The mixture was boiled until the fat melted and the solution was allowed to cool overnight for further preparation as described by (Chalmers & Bathe, 1978; Shu'aibu et al., 2017).

Blend formulation

The Blend formulation of the fat and oil were carried out in accordance with the formulation described by Shu'aibu et al. (2017).

Blends (ST)	Sesame oil (%)	Tallow (%)
1	10	90
2	20	80
3	30	70
4	40	60
5	50	50
6	60	40
7	70	30
8	80	20
8	90	10

Physicochemical parameters of the oil blends

The following physicochemical parameters were determined for the various blend composition such as saponification value, acid value, iodine value and specific gravity as reported by Onyegbado (2002).

Preparation of the soap (saponification)

The amount of oil used for the saponification was 100 g and each oil blend required a different amount of base to react completely owing to the difference in their saponification value.

The amount of NaOH required with the different oil blends was calculated according to saponification values in Table 3.1. The calculated amount of NaOH was dissolved in 35 cm^3 of distilled water. The oil was warmed gently and poured into the beaker followed by the alkali solution to form an intimate mix and then stirred frequently for 1 minute using stirring rod until reaction reached equilibrium which was observed when trails of the mixture was seen on the surface upon lifting the stirrer and this stage is called „trace". The saponification mixture was then poured into mould and allowed to dry (cure) for 5 weeks. The cold process method was used for the saponification and the soap produced did not contain any additive (Eke et al., 2004).

Physicochemical Properties of Soaps Produced from the Blends

The physicochemical properties analysed in the soaps are:

pH determination

A 5g of the soap shavings were weighed and dissolved with distilled water in a 100 cm^3 volumetric flask. The electrode of the pH meter was inserted into the soap solution and the pH reading was recorded (Warra et al., 2012)

Moisture content

For the determination of moisture content, 5 g of samples was accurately weighed using analytical balance of sensitivity 0.1 mg into dried tarred moisture dish in an oven for 2 hrs and temperature of 101˚C and repeated until a constant weight was reached. The % moisture was calculated using the following formula:

% moisture = $\frac{c_{s-}c_l}{c_{s-}c_W}\ x\ 100$

Where; C_W = Weight of crucible, C_S = Weight of crucible + sample, C_l = Weight of crucible + sample after floating (AOCS. 1997).

Free caustic alkali

Free caustic alkali was determined by the method described by (Milwidsky & Gabriel, 1994). According to this method, 5 g of finished soap was weighed and dissolved in 30 cm^3 of ethanol. Few drops of phenolphthalein indicator and 10 cm^3 of 20% $BaCl_2$ were added. The resulting solution was titrated against 0.05 M H_2SO_4 (aq).

Free Caustic Alkali was calculated using the formula:

$$FCA = \frac{0.31}{w} \times V_A$$

Where; V_A = Volume of acid, w = weight of soap.

Total alkali

The total alkali was determined by titillating excess acid contained in the aqueous phase with standard solution of NaOH. Ten grams of finished soap was weighed and 100 cm^3 of neutralized alcohol was added to it. About 5cm^3 of 0.5M H2SO4 solution was added to the mixture and heated till the soap sample dissolved. Test solution was titillated against 1 M NaOH using phenolphthalein as indicator (Mak-Mensah, 2011). The total alkali was obtained with the formula:

$$\text{Total alkali} = \frac{V_{A-}v_B}{W} \times 3.1$$

Where V_A = volume of acid (cm^3)

V_B = volume of base (cm^3)

W = weight of soap (g)

Determination of total fatty matter (TFM)

A modified method was used. The total fatty matter test is carried out by reacting soap with acid in the presence of hot water and measuring the fatty acids obtained. About 10 g of finished

soap was weighed and 150 cm^3 distilled water was added and heated. The soap was dissolved in

20 cm^3 of 15 % H2SO4 while heating until a clear solution was obtained. Fatty acids on surface of

the resulting solution was solidified by adding 7g of candle wax and reheated (Roila *et al.*, 2001) The set up was allowed to cool to form cake. Cake was removed and blotted to dry and weighed to obtain the total fatty matter using a formula:

$$\%TFM = \frac{A-X}{W}\ X\ 100$$

Where A= weight of wax + oil (g)

X = weight of wax (g)

W = weight of soap (g)

Foam ability test

The soap (2 g) was added to a 250 cm^3 measuring cylinder containing 50 cm^3 of distilled water. The mixture was shaken vigorously so as to generate foams. After shaking for 10 seconds, the cylinder was allowed to stand for 10 minutes. The height of the foam in the solution was measured and recorded (Warra et al., 2012).

Result and Discussion

Table 1: Physicochemical Properties of the Oil/Fat Blends

Oil blends (ST)	Saponification value (mgKOH/g)	Iodine value (gI_2/100g)	Acid value (mgKOH/g)	Specific gravity
1	195.00±1.20	40.00±1.10	11.00±3.13	0.913
2	180.32±1.41	49.17±2.30	13.33±2.00	0.932
3	181.98±1.49	50.23±1.11	17.12±2.23	0.911
4	187.11±2.08	63.77±3.10	31.3±2.77	0.921
5	172.50±3.23	73.11±2.11	35.00±2.33	0.917
6	190.00±1.50	77.11±1.17	37.23±2.11	0.907
7	191.00±1.70	85.73±2.90	37.97±2.70	0.943
8	185.00±2.01	86.32±3.30	39.27±3.10	0.927
9	192.00±1.41	97.37±3.90	40.03±2.70	0.930

Values are expressed as mean and ± standard deviation of double determinations
ST = Sesame – Tallow

Table 2: Physicochemical Properties of Soap Produced from the Blends

Blends (ST)	TFM (%)	MC (%)	PH	Total alkali	Free caustic alkali	Foam height	Texture
1	73.60±0.14	I.87±0.031	10.80±0.14	0.47±0.22	0.21±0.031	50.00±1.41	VERY FIRM
2	70.60±0.35	3.39±0.014	10.90±0.14	0.47±0.22	0.137±0.02	55.00±2.83	VERY FIRM
3	70.40±0.28	3.97±0.073	10.95±0.07	0.47±0.22	0.087±0.01	55.00±2.83	VERY FIRM
4	69.30±0.40	4.31±0.021	10.90±0.14	0.64±0.44	NIL	50.00±1.41	VERY FIRM
5	74.50±0.71	4.95±0.07	10.90±0.14	0.47±0.22	NIL	55.00±2.83	FIRM
6	71.80±0.14	5.13±0.07	10.90±0.14	0.62±0.44	NIL	40.00±2.83	FIRM
7	47.37±0.14	7.35±0.06	11.00±0.14	0.62±0.44	NIL	50.00±1.41	FIRM
8	45.00±0.14	8.13±0.056	11.15±0.07	0.62±0.44	NIL	40.00±2.83	FIRM
9	46.31±0.35	10.19±0.07	11.15±0.07	0.62±0.44	NIL	64.00±1.41	FIRM

Values are expressed as mean and ± standard deviation of double determinations
TFM = Total Fatty Matter
MC = Moisture Content

Sample ST1 has a saponification value of 195.00±1.200 mgKOH/g which is greater than 148.3±1.13 crude oil of canerium fruits (Ayoade et al., 2015) but less than that of citrullus lanatus seed oil 222.19±0.4 mgKOH/g (Edidiong et al., 2013) making it a possible good oil for soap production. Sample ST2 has a saponification value of 190.32±1.00 mgKOH/g which is less than that of canary melon seed oil 233.62±0.01 mgKOH/g (Warra *et al.*, 2015) but greater than that of african pear oil 142.76 (Ikhuoria and maliki, 2007). Blend ST3 has a saponification value of 181.98±1.49 mgKOH/g lower than that of neem and low acid value of 17.12±2.77 mgKOH/g coupled with its saponification value that falls within those of neem seed oil and crude canarium fruits oil, it is therefore recommended that this blend of oil be used for soap making.

Sample ST3 has a saponification value of 181.98±1.49 mg KOH/g lower than that of neem and low acid value of 17.12±2.77 mg KOH/g coupled with its saponification value that falls within those of neem seed oil and crude canarium fruits oil, it is therefore recommended that this blend of oil be used for soap making. Sample ST4 has a saponification value of 187.11±2.00 mg KOH/g greater than 148.3±1.13 mg KOH/g crude oil of canerium fruits (Ayoade *et al.*, 2015) but less than that of citrullus lanathus seed oil 220.19±0.4 mg KOH/g (Edidiong *et al.*, 2013) making it a possible good oil for soap making.

ST5 has a saponification value of 172.5±3.00 mg KOH/g lower than that of coconut oil (Oshinowo, 1987) but greater than that of beeswax 93 mg KOH/g which are commonly used in soap making (Mabrouk, 2005). This indicates that the oil could be used in soap making since its saponification value falls between the ranges of values of these oils.

ST6 has a saponification value of 190±1.50 mg KOH/g less than melon 233.62 (Warra et al., 2015) but greater than that of African pear oil 143.76 mg KOH/g (Ikhuoria and maliki, 2002) and is recommended for soap making.

ST7 has a saponification value of 191.10±1.70 mg KOH/g which is lower than that of *Chrysophyllum Albidum* seed oil with value 199.50 mg KOH/g (Adebayo *et al.*, 2012) but greater than that of crude castor seed oil 185.82 mg KOH/g (Akpan *et al.*, 2006).

ST8 has a saponification value of 185±2.01 mg KOH/g which is in close agreement with that of crude castor seed oil 185.85 mg KOH/g (Akpan, *et al.*, 2006) and since this oil is used in soap making, it means this blend can be used as well.

ST9 has a saponification value of 192.00±1.00 mg KOH/g, iodine value of 97.37±3.20 which is greater than that of palm kernel oil 18.54 mg KOH/g (Eke *et al.*, 2004).

Sample ST1 has a very low iodine value of 11.00±3.31 I_2/100g which is greater than *canery* melon seed oil 6.35±0.01 mg KOH/g (Warra et al., 2015) and also 3.83 mg KOH/g for groundnut oil (Warra et al., 2010). ST2 has acid value of 13.33 mg KOH/g. Also, sample ST3 has a low acid value of 17.12±2.77 mg KOH/g coupled with its saponification value that falls within those of neem seed oil and crude. Sample ST4 has acid value of 31.3±2.77 mg KOH/g. Sample ST5 has an acid value of 35.00±2.33 mg KOH/g is greater than that of canary melon seed oil 0.35±0.01 mg KOH/g (Warra et al., 2015).

ST6 has acid value of 37.23±2.11 mg KOH/g which is greater than 16.1 mg KOH/g for tallow (Warra et al., 2010). Sample ST7 has an acid value of 37.97±2.11 mg KOH/g also greater than that of tallow (Warra et al., 2010). Since these oils are used in making soap, the saponification value suggests that the blends are suitable for soap making.

Also, sample ST8 with acid value of 39.27±3.10 mg KOH/g is greater than that of canary melon seed oil (Warra et al., 2015). ST9 has acid value of 40.03±2.7 mg KOH/g is greater than that of canary melon seed oil (Warra et al., 2015) as well as that of the palm oil standard used whose acid value is 9.40±0.13.

ST1 has iodine value of 40.00±1.10 I_2/100g which is lower than that of canary melon seed oil 135.6±0.07 I_2/100g (Warra et al., 2015) and 50.50±8.023 I_2/100g reported for *jatropha curcas* seed oil (Warra et al., 2012) recommended for cosmetics and medicinal purposes which implies that sample ST1 can similarly be recommended for cosmetics. ST2 has an iodine value of 49.17±2.30 I_2/100g lower than canary melon seed oil 135.6±0.07 I_2/100g (Warra et al., 2015) and this blend of oil is recommended for soap making since its saponification value falls within that of canary melon seed oil and African pear oil which are both used in soap making seed oil 213.00 mgKOH/g (Akpan, 1999) but greater than that of crude canerium fruits

148.3±1.13 mgKOH/g (Ayoade *et al.*, 2015). Sample ST3 has an iodine value of 50.23±1.11 I_2/100g. ST4 with iodine value of 63.77±3.10 I_2/100g and ST5 with iodine value of 73.11±2.11 I_2/100g are all less than that of Apricot kernel oil 88.2 I_2/100g but greater than that of palm kernel oil 17.00 I_2/100g (Adel et al., 1998). ST6 has a high iodine value of 77.11±1.17 I_2/100g and ST7 has an iodine value of 85.73±2.90 I_2/100g less than that of canary melon seed oil 135.6±0.007 I_2/100g (Warra et al., 2015) but greater than that obtained for *chryosophyllum albidum* seed oil 35.00 I_2/100g (Adebayo et al., 2012). ST8 also has an iodine value of 86.32±3.30 I_2/100g less than that of canary melon seed oil 135.6± 0.07 I_2/100g (Warra et al., 2015). ST9 has an iodine value of 97.37±3.20 which is less than that of castor oil 87.72I_2/100g (Akpan, 2013). From table 3.3, ST6 and ST7, had a Total alkali value of 0.62±0.44 is less than that of Jatropha oil soap with value 0.76 (Ladan et al., 2010) but greater than that of neem oil soap with value 0.24±0.01 (Mak – Mensah *et al.,* 2011). Samples, ST1, ST2, ST3 and ST5 all have Total Alkali value of 0.47±0.22 which is less that of onion seed oil soap with value of 0.92±0.02 (Warra & Fatima, 2015) but greater than 0.76 reported for *jatropha* oil soap (Rangwala & Sarasan 2014). Soap Sample ST9 have a total alkali value of 0.78±0.22 is greater than 0.24±0.01 for neem oil soap (Mak-Mensah et al., 2011) but less than that obtained for onion seed oil soap 0.92±0.02 (Warra and Fatima, 2015) and also 0.92±0.02 for canary melon seed oil soap (Warra et al., 2015) samples ST2 and ST3, with %TFM values of 70.6±0.35and 70.40±0.28 respectively are in close agreement with each other. These values are greater than 36.66±0.02 for canary melon seed oil soap (Warra et al; 2015), but less than that of palm – kernel oil (PKO) which has a value of 83.6% (Eke *et al.,* 2004). These high value of the samples shows that they would be suitable for toilet soap. According to Warra et al. (2015) soaps with 70% - 80% fatty matters are considered best one in quality. If the TFM lowers, then it would not give the softness that is expected of a soap. Samples ST1 with %TFM values 73.6±0.14 is greater than 58±2.30 for Shea nut fat (Warra& Komo, 2014). Samples ST4 with %TFM values 69.3±0.40 is greater than that of neem seed oil soap 63.75±0.007 (Mak-Mensah et al., 2011). Sample ST5 with %TFM values of 74.50±0.71 is greater than 36.66±0.02 onion seed oil (Warra & Fatima, 2015). This value is within the %TFM range 70 – 80% (Warra et al., 2015). Sample ST6, with %TFM values 71.8±0.14 is less than that of neem seed oil soap with %TFM value of 63.75±0.07 (Mak-Mensah et al., 2011) and also greater than that of 36.66±0.02 for canary melon seed oil soap (Warra et al., 2015). Samples ST8, ST9 and ST7 with %TFM values of 45±0.14, 46.31±0.35 and 47.37±0.14 respectively are very low when compared with the other soaps made from other blends but are greater than 36.66±0.02 for onion seed oil soap (Warra & Fatima, 2015). These low values of %TFM suggests that the soaps from these blends are good for laundry purposes instead of bathing (Toilet) soap.

Table 3.2 contains the pH values for the soap samples, Samples ST8, ST9 and ST7, with values 11.10±0.07, 11.15±0.07, 11.00±0.14 and 11.20±0.14, respectively are all very high compared to 10.4±0.04 for neem oil soap (Mak-Mensah et al., 2011). The value is also greater than that of Jatropha oil soap (Rangwala & Sarasam, 2014). This high value is due to incomplete alkali hydrolysis resulting from the saponification process. This indicates that, the prepared soap would be corrosive to the skin, so therefore, these samples would be best used as laundry soaps and especially for white clothes. Samples ST1with pH value of 10.80±0.14 is less than that of 11.03±0.02 for onion seed oil (Warra & Fatima, 2015) but greater than 9.0 for palm oil (Beetseh & Anza, 2013). Samples ST2, ST4, ST5 and ST6 with same pH value of 10.9±0.14 is greater than 9.0 for black soap (Beetseh & Anza, 2013) but less than 11.03±0.02 for canary melon seed oil soap (Warra et al., 2015). Higher PH values would neutralize the body's protective acid mantle that acts as a barrier against bacteria and viruses. Samples ST2 and ST3 with % moisture content of 3.39±0.014, 3.99±0.073respectively are all in close agreement with each other. sample ST3 has a %MC value less than 12.63±0.04 for neem oil soap (Mak-Mensah, 2011) as well as that of palm-kernel oil soap (8.20) as reported by (Eke et al., 2004). These low values might be due to the high percent of tallow oil in the oil samples used for the production of the soap. Samples ST4 and ST5 with %MC values 4.31±0.021 and 4.95±0.07 respectively. Samples ST1 with %MC values 1.87±0.031 and Sample ST6 with %MC values of 5.13±0.07. Samples ST8, with %MC values 8.13±0.056 is less than that of neem seed oil soap with value 12.63±0.04 (Mak-Mensah et al., 2011). These values are higher than those samples with high proportion of Tallow in the oil sample. Sample ST9 with %MC values of 10.19±0.07. Moisture content shows how hard a soap is.

The higher the percent moisture content, the less hard the soap would be. Also, the lower the percent moisture content, the harder the soap. Soap samples with high percent of tallow were observed to have low percent moisture content thereby resulting in a very hard bar.

Also, table 3.2 contains values for the free caustic alkali present in all the soap samples. Just few of the soap samples have free caustic alkali. This free caustic alkali is the amount of alkali free to prevent soap from becoming oily (Mak-Mensah et al., 2011). Excess free caustic alkali causes skin itching and clothes wear – out (Mak-Mensah et al., 2011). Samples, ST4, ST5, ST6, ST7, ST8 and ST9 all shows absent of free caustic alkaline in them which implies these soap samples are not corrosive to the skin. But samples ST1, ST2 and ST3 all have free caustic alkali values of 0.210±0.03, 0.137±0.02 and 0.087±0.01 respectively. All these values are greater than those of neem oil soap with value 0.06±0.002 (Mak-Mensah et al., 2011).

From the Table; samples ST1, ST2, ST4 and ST7 all have the same foam height as measured to be 50.00±1.42cm^3. This value is less than that obtained for canary melon oil soap with value 75.13±0.15cm^3 (Warra et al., 2015). ST6 has foam height to be 40±2.83 cm^3 which is less than 75.13±0.15 cm^3 for onion oil soap reported (Warra & Fatima, 2015). ST9 with foam height 64±1.41cm^3 is also less than that of canary melon seed oil soap 75.13±0.15 (Warra et al., 2015). While samples ST3 and ST5 both have foam ability of 55±2.83 cm^3.

Conclusion

From the result of the physicochemical properties of the oil as well as the physicochemical properties of the soap produced, it can be concluded that blends of sesame seed oil and Tallow has the potential in the production of soap.

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