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Physicochemical and Antimicrobial Properties of Soap Produced from Momordica Charantia Seed Oil and Palm Kernel Oil

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Abstract

Soap from Momordica charantia seed oil and palm kernel oil were produced and assayed to justify the utilization of M. charantia oil for soap production. The saponification and acid values of both oils were determined to know the number of KOH/g required to saponify and neutralize fatty acids. The M. charantia and palm kernel oils were blended in proportions of 70 g to produce different soap formulations. The saponification and acid values of the two oils were of 226.36 and 283.3 mgKOH/g and 18.5 and 7.35 mgKOH/g, respectively for M. charantia and palm kernel. Chemical analyses of the soaps showed a pH range of 9.07 – 9.56 with the foam abilities ranging between 2.32 – 6.75, total alkali content 1.57 – 3.10 and total fatty matter range of 76 – 88%. The soap with the least blend of M. charantia oil was next to that from palm kernel oil in cleansing capacity. Minimum inhibition value was observed in Staphylococcus aureus. Bacillus subtillis shows the highest antibacterial inhibitory value of 8.69±0.33 mm. Antibacterial sensitivity has the highest inhibition value compare to antifungal. Base on the finding, it shows that M. charantia oil incorporated with palm kernel oil can be utilized for soap production and other cosmetics preparation.

Keywords: Momordica Charantia, Oil, Palm Kernel, cleaning effectiveness, antimicrobial activity, foaming ability and stability

Citation

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1. Introduction

Soap is the result of the reaction of specific unsaturated fat and alkali via the aid of saponification (from oils or fats) or neutralization (from fatty acids) (Kuntom, Kifli and Lim, 1996); a cleanser molecule has prolonged hydrogen and carbon chain with a carboxylic group at one end, with an ionic bond besides a metal atom, mostly potassium or sodium. The hydrogen and carbon atom that is non-polar dissolves immensely in non-polar substances while the ionic bond at the end dissolves in water. (Abayeh, Aina and Okuonghae, 1998). The unsaturated fat is instrumental in the foaming as well as the washing properties of soaps (Kuntom et al., 1996). The features of soap are subject to various factors including the efficacy and pureness of the alkali, oil quality consumed, the completeness of saponification and soap lifespan. Such attribute of soap includes pH, total fatty acids (TFM), moisture content, and free alkali (Girgis, 2003).

Soap cleaners can break up or dislodge materials insoluble in water and retain them in the suspension of water. The capability of the cleaner is derived from the soap molecular structure. At a point where the soap is added to water which comprises of impurities materials and oil, the cleaner molecules encase the oil beads. Oil is broken down in the alkyl groups of the cleaner particle, while the ionic end permits it to break up in the water. Accordingly, the oil beads are to be scattered all through the water and can be washed away. (Abayeh *et al.*, 1998).

Momordica charantia Linn is a tropic and subtropic climbers of the family Cucurbitaceae normally alluded to as Bitter gourd or Bitter melon. It is broadly distributed in Malaysia, China, India and even some part in Africa. Different parts of M. charantia are regarded as a sexual tonic and are used to treat hepatic diseases, water bone disease, bronchitis, dysentery and gonorrhea.. Fruits of *M. charantia* are employed as conventional medication to alleviate different sicknesses like ailment, colic, hepatic disease. It is likewise discovered significant for treating malignant growth and diabetes. It is an incredible hypoglycemic specialist because of alkaloids and insulin, for example, peptides and a combination of steroidal sapogenins referred to as charantin (Omotoso and Iro-Idoro, 2015).

Alessandra et al (2007) reported that antifungal and antibacterial activities of M charantia seed tested in the oil are sensitive microorganism with antimicrobial activity value of 500 ug/ml. Saponification of bitter gourd oil indicates the measure of sodium hydroxide necessary to form a solid soap and palm oil has been greatly employed as fatty raw material in the production of cleanser. Due to the therapeutic properties of *M. charanti*a seed. this research aimed to determine the physicochemical and antimicrobial properties of soap produced from *M. charantia* seed oil and palm kernel oil.

2. Materials and Methods

Seed Collection and Preparation

Commercially available *M. charantia* seeds were purchased from Oja-Odan market, Yewa south Local government in Ogun State, washed thoroughly with distilled water to eliminate dirt, dust and extraneous materials. Seed purchased was identified at Federal University of Agriculture in Botany Department. The seeds were then dehulled, dried and subsequently ground using a laboratory blender (Waring Commercial MX1200XTX). The ground samples were reserved in containers that are air tight and labelled adequately. Palm kernel seeds were purchased in Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Oyo state, then washed with distilled water and stored in an airtight container.

Oil extraction procedure

Soxhlet extraction method was employed for the M. *charantia* seeds and the palm kernel seeds. Exactly 70 g powdered sample was packed in a Whatman filter paper then was placed in the thimble which was then oppressed to soxhlet extraction. 150 ml of n-hexane was used for 8 hours at 50^{o}C. The extract of the M. *charantia* seeds and the palm kernel seeds was concentrated using rotary evaporator RE-300. The recovered oil was stored in a bottle for subsequent analysis.

The % yield was determined using;

$$\% \text{ oil yield} = \frac{\text{weight of oil}}{\text{weight of the sample}} \; x\; 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Chemical Parameter of the Oils

The chemical parameters of the oils such as Saponification value, Acid value, Total fatty matter, Total alkali was determined using standard methods.

Saponification Value

One gramme of the samples was measured into a 100 ml conical flask. 25ml of the alcoholic KOH solution was pipetted into the conical flask. A blank result was conducted. The sample was connected to the air condensers (Reflux) and was kept boiling gently until the process of saponification is complete After cooling of the flask, 1ml of phenolphthalein indicator was added and was titrated against 0.5N hydrochloric acid

Saponification value was determined using:

$$\text{Saponification Value} = \frac{56.1\,(B-S)N}{W}$$

Where

W = Weight in gramme of the oil. B= blank result (ml); S = sample titre value (ml); N = Normality of the standard hydrochloric acid.

Acid Value

This was calculated using a method described by Omotoso and Iro-Idoro, (2015). One gramme of the oil was weighed into a conical flask and 20 ml of methanol was added. Two drops of phenolphthalein indicator were added. The sample mixture was placed in a water bath for 7 minutes and then titrated against 0.1 M KOH. The pink colour was observed.

The acid value was determined using

$$AV\left(\frac{\text{mgKOH}}{\text{g}}\right) = \frac{\text{mL OF KOH x M x}\frac{56.1\text{g}}{\text{mol}}}{weight\ of\ sample} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

Where AV= Acid value; M= Molarity of potassium hydroxide

Preparation of Soap

The soap was prepared to employ the method used by Asante, (1993) with slight modifications. Different blends of *M. charantia* and palm kernel oils were prepared using proportions in Table 1.0 below. *M. charantia* and palm kernel oils were rationed into a plastic container, which was heated to 100^{o}C and 0.2 M sodium hydroxide solution was added and was thorough mixing. Insulation of the plastic container was carried out to avert the oil/fat from becoming hardened before soap mixing suitably. 0.1M of sodium carbonate and sodium sulphate were added into the mixture and heated to 110^{o}C, this aids in the adhering of the soap chemicals and it gives rise to the foaming power of the cleaner.

Table 1.0: Blending ratios of *M. charantia* and palm kernel oils for soap production.

	Blend of *M. charantia* and palm kernel oils (g)	
Sample	*M. charantia*	Palm kernel
A	14	52
B	16	50
C	18	48
D	20	46
E	22	44
F	0	66

Sodium silicate was added as the anti-oxidant agent when the soap is cold. The soap mixture was filtered to remove glycerol and washed with hot distilled water to curtail sodium hydroxide and any contaminant in the soap. The procedure was repeated for the different proportions of *M. charantia* and palm kernel oils. The soap was moulded in filter paper and was oven dried at 60^{o}C. The prepared soaps were stored for further analysis.

Physicochemical Analysis of the Soap.

pH determination

Exactly 10g of the soap samples were weighed into a beaker and 50 ml of distilled water was then added and were stirred for two minutes. The solution was poured into the sensor hole of the already calibrated D-6 Dialysate meter and the pH was determined using the D-6 Dialysate meter.

Foam Ability Test

Two grammes of soap samples were added to a 1000 cm^3 measuring cylinder with 100 cm^3 of deionized water, the mixture was then shaken for 2 minutes to generate foams, and the mixture was allowed to stand for about 10 minutes. The foaming height was measured and recorded (Isah, 2006).

Tests for Cleansing Effectiveness

To determine the cleansing of prepared soap, a drop of the oil samples was put on four different filter paper and the filter paper was then immersed in a test tube containing the soap solutions (1 g of cleaner sample in deionized water). Each test tube was shaken for 60 seconds and the filter papers were removed, then rinsed with deionized water. The cleanliness effectiveness in each paper was determined.

Determination of Total Fatty Matter

The total fatty matter was calculated using Mak-Mensah and Firempong, (2011) method. Ten grammes of soap sample was dispersed into 15 ml of deionized water and was heated; 20 ml of 15% hydrogen tetraoxosulphate (VI) was added until a clear solution was observed. Eight grammes of bee wax was added and was reheated. The mixture was allowed to cool for five minutes to form a cake. The cake was then removed and the weight was determined.

The total fatty matter was determined:

$$\%\text{TFM} = \frac{(A - Z)}{W} x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (iv)$$

Where A = weight of the cake observed, Z = wax weight and W = Weight of the soap.

Total Alkali Determination

Total alkali is determined using Betsy, Jilu, Reshma and Varkey, (2013) methods. 10 ml of neutralized alcohol was added to 10 g of the soap sample with 5 cm^3 of 1 M of hydrogen tetraoxosulphate (VI)) solution and the sample were heated for five minutes until the soap gets dissolved; then the soap solution was then titrated against 1 M sodium hydroxide using phenolphthalein.

The total alkali was calculated using:

$$\%\ \text{Total alkali} = \frac{(V_A - V_B)}{W} x100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (v)$$

Where V_A = titre value of blank titration using only acid, V_B = titre value of acid with soap and W = weight of the soap.

All chemical analyses were done in triplicate and the mean values were calculated using SPSS.

Soap antimicrobial sensitivity test

The test for antimicrobial sensitivity was carried out using some selected bacteria: *Staphylococcus aureus*, *Bacillus subtilis* and fungi: *Aspergillus niger*. Agar diffusion method was used as described by Ameh (2013). Nutrient agar and potato dextrose agar were prepared for the sensitivity test and was poured into a sterile petri dish. The microorganism was inoculated at 37°C for 48h and 37°C for 96 hours for bacteria and fungi respectively. Following serial dilution method of 1×10^{6} cfu/ml, 1g/ml of the soap samples was prepared from which various serial dilutions of (1×10^{-1}, 1×10^{-2}, 1×10^{-3}, 1×10^{-4}, and 1×10^{-5}) was prepared. 1ml of the serial dilution of each solution prepared was pipetted into the sterile petri dishes. The zones of inhibition were determined and recorded.

Inhibition Concentration

Exactly 22 g of *M. charantia* seed oil and 44 g of palm kernel oil were added to sample A1 and A2 at serial dilution 1×10^{-1} and 1×10^{-3}, respectively. 20 g of *M. charantia* seed oil and 46 g of palm kernel oil was added to sample B1 at serial dilution 1×10^{-1} and 1×10^{-3}, respectively. Also, 18 g of *M. charantia* seed oil and 48 g of palm kernel oil were added to sample C1 and C2 at serial dilution 1×10^{-1} and 1×10^{-3}, respectively.
Sixteen grammes of *M. charantia* seed oil and 50 g of palm kernel oil were added to sample D1 and D2 at serial dilution 1×10^{-1} and 1×10^{-3},respectively. Fourteen grammes of *M. charantia* seed oil and 52 g of palm kernel oil was added to sample E1 and E2 at serial dilution 1×10^{-1} and 1×10^{-3} respectively. 66 g of palm kernel oil was added to F1 and F2 at serial dilution 1×10^{-1} and 1×10^{-3}, respectively.

3. Results and Discussion

The saponification values of *M. charantia* oil and palm kernel oil were determined to be 226.36mg/KOH/g and 283.31mg/KOH/g respectively which means that the oils could be utilized in cleanser making on the grounds that the higher the saponification value, the below unsaturated fats normal length, the lighter the mean atomic weight of the fatty oils and conversely. Oils with high saponification values are more suitable for soap making (Warra, Hassan and Gunu, 2009). The saponification value of *M. charantia* seed oil observed in this study is below 190.70 measured by Prashantha and Premachandra (2009) though this could be attributed to geographical factors or the land in which it was cultivated on.
Acid value estimates the degree where hydrolysis frees unsaturated fats from their ester linkage to the parent glyceride atom. (Omotoso and Iro-Idoro, 2015). Therefore, the higher the corrosive estimations of oil, the lower its stockpiling quality. (ISO 3960 Bulletin, 1988). The acid value of *M. charantia* oil is 18.5 as compared to palm kernel oil of 7.35 indicating lower storage quality compared to palm kernel oil which could be improved on and the acid value of palm kernel oil indicates it is more suitable for soap production compared to *M. charantia* oil.

The soaps produced from from *M. charantia* seed oil and palm kernel oil were assayed for physical and chemical parameters, which include pH, foam ability, effectiveness in cleansing, total alkali and total fat content. The results were presented in Table 2 below.

Table 2: Physiochemical characteristic of the prepared soaps.

Soap Characteristics	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
PH	9.07±0.06	9.20±0.05	9.28±0.03	9.41±0.01	9.56±0.02	9.36±0.01
Foam ability	2.32±0.03	2.71±0.01	3.31±0.01	4.35±0.01	4.75±0.01	6.75±0.03
Effectiveness in cleaning	6th	5th	4th	3rd	2nd	1st
Total alkali content	1.57±0.01%	1.93±0.01%	2.01±0.03%	2.13±0.01%	2.24±0.01%	3.10±0.01%
Total fatty matter	76%	77%	78%	79%	80%	88%

The pH value for the soap samples are in the range of 9.01 – 9.56, this is similar to previous studies by Antonic, Dordevic, Jancˇíková, Tremlova and Kushkevych (2020) with pH range of 9.53 to 9.96 and below are the obtained pH of household bath soap; such as lux soap (10.23), joy soap (10.10), imperial leather soap (10.12), premier soap (10.40), Eva Classique soap (10.25), Dettol soap (10.17), safeguard soap (9.64), tetmosol soap (10.12), septol soap (9.96) and premier cool soap (9.93) (Idoko, Emmanuel, Salau and Obigwa, 2018). The prepared soaps are beyond the limit of 6.5–8.5 of WHO guidelines (Goncharuk 2013) although this could be attributed to incomplete alkali hydrolysis during the saponification determination and soap with pH range of 9-11 or higher (which are basic) are consider to be harsh to the skin (Taiwo, Oluwadare, Shobo and Amologe, 2008) but this could be overwhelmed by expansion of abundance fat or oil to diminish the harshness of the soap. Healthy skin has a pH of 5.4 to 5.9, hence high pH in the prepared soaps could be considered as not destructive to the skin, as the salt of a weak acid (unsaturated fat) and strong base (Sodium hydroxide) cleanser is alkaline in aqueous solution and given that some household bar soaps have been found to have slightly higher pH than those produced in this study. Alkaline substances kill the body's defensive corrosive mantle that goes about as a boundary against microbes and infections, however this high alkalinity favours detergency (Mak-Mensah and Firempong, 2011).

The foam ability test in table above indicates that the control soap has the highest ability to foam due to its highest height of foam, as the proportion of *M. charantia* oil increases, the foam ability also increases. This showed that soap made from *M. charantia* and palm kernel oils are suitable for soap production.

The total fatty matter of samples A, B, C, D, E and F are 76, 77, 78, 79, 80 and 88% respectively. The difference in the total fatty matter is not much but could be due to the high moisture contents and quantities of the used fatty materials. Dry skin needs soap which is high in the total fatty matter (80%) which is exactly the result obtained for the control soap (sample F), though the other samples were close by. This rehydrates the skin making it smooth, and additionally the high oil content within the soap acts as a lubricant throughout the day (Ara, Sidiqui and Faizi, 1990).

The total alkali content of the soaps ranged between 1.57 – 3.10. According to ISO 644, total alkali content for soap is maximum 2%, therefore Samples A – E are soaps with good quality and good for health and the environment.

The antimicrobial sensitivity of the *M. charantia* seed oil is presented in table 2. Base on the result, it shows that *B.s subtillis* had the highest sensitivity of microbe of 8.67 ± 0.33mm at serial dilition (1×10^{-1}). *A. niger* had the lowest zone inhibition of 0.57 ± 0.07 at serial dilition (1×10^{-3}). The oil samples show a high antibacterial inhibitory value of 8.69±0.33mm against *B. subtillis* and 7.83±0.17 mm against *S. aureus*. The highest antifungal inhibitory value was observed in *A. niger* at serial dilution 1×10^{-1}. The zone inhibition indicate that the oil had a highest antibacterial sensitivity when compared with antifungal sensitivity. It was observed that sample E1 and E2 have no inhibition against *A. niger*. Also, F1 and F2 did not have inhibition and these are because no *M. charantia* seed oil was added. This study agreed with Marili et al (2018) that oil has a higher antibacterial activity with value of 21.0 ± 1.41mm against *Salmonella typhi* than antifungal inhibition value of *Candida albicans* (17.0 ± 1.41 mm).

Table 3: Sensitivity of microorganisms to the prepared soaps (with mean and standard error).

Sample code	Diameter of Zone of Inhibition (mm)

	Staphylococcus aureus	*Bacillus subtillis*	*Aspergillus niger*
A1	7.83 ± 0.17	8.67 ± 0.33	5.90 ± 0.06
A2	6.67 ± 0.33	7.67 ± 0.33	5.00 ± 0.00
B1	5.87 ± 0.09	7.60 ± 0.31	4.83 ± 0.17
B2	4.83 ± 0.17	6.67 ± 0.33	3.93 ± 0.07
C1	4.57 ± 0.33	5.60 ± 0.31	2.83 ± 0.17
C2	3.73 ± 0.15	4.80 ± 0.15	1.87 ± 0.09
D1	3.50 ± 0.06	4.00 ± 0.00	0.93 ± 0.07
D2	2.83 ± 0.17	2.93 ± 0.09	0.57 ± 0.07
E1	2.00 ± 0.00	2.87 ± 0.07	NI
E2	1.07 ± 0.07	2.00 ± 0.00	NI
F1	NI	NI	NI
F2	NI	NI	NI

Where ZI: Zone of Inhibition; NI: No Inhibition

4. Conclusion

The result obtained from this study after the synthetic and antimicrobial examination of the oils showed that *M. charantia* oil incorporated with palm kernel oil is utilizable for soap making. The analysis and properties displayed by the soap produced indicated it is suitable for commercial processing.

The soaps prepared kept away from the incorporation of auxiliary raw materials such as synthetic antimicrobial agents and preservations. It is therefore recommended that bitter melon seed oil should find application in the industry especially in the manufacture of soap. Further research should be made on its use for the production of skincare products.

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