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INVESTIGATION OF QUALITATIVE PARAMETERS IN SOAP PRODUCED FROM BLEND OF NEEM AND CASTOR OIL

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ABSTRACT
Soap is a chemical compound formed by interaction of fatty acids and metal radicals. Different types of vegetable oils have been found to be good candidates for soap production due to their saponifiable nature. However, edible oils are often expensive to use for soap production due to competing demand between commercial and domestic buyers. So, in this work, blend of nonedible neem and castor oils were used at different proportions to produce various soap samples. The foregoing was achieved via the two well-known processes of soap production, that is; the hot and cold processes. The work investigated the parameters that influence the quality of soap and determined their optimum values using various blends of the oils. Six samples were produced, and their properties analyzed and compared with two commercial samples to determine a blend with the most desirable qualities. The yield, foamability, pH, hardness and cleansing power of the produced soap samples were determined. It was found that the blend of 60 ml neem oil and 40 ml castor oil was the best with a yield of 70.4%, foamability of 11.8 cm, pH of 10.42 and a high cleansing power. The results were found to be consistent with those of the two commercial samples used as controls.
Keywords: *Castor, cleansing power, foamability, hardness, neem, oil, soap samples*

1.0 INTRODUCTION

There are several ways of describing what a soap is; it can be regarded as any cleansing agent that is produced in different forms such as bars, granules, and liquid (Warra, 2013). However, in simple chemistry terms, soap is a chemical compound formed from saponification reaction of fatty acid components of vegetable oils and/or animal fats with alkalis. The reaction involves splitting of esters into alcohol and sodium or potassium salts of fatty acids (Hassan *et al.*, 2015). Although the sodium and/or potassium-based soaps are the commonly used cleaning agents and formed the basis of this work, it is worth mentioning that there are other forms which are exclusively used for other purposes. These include aluminum, calcium, chromium and magnesium-based soaps. They are insoluble soaps that are utilizable as lubricants, thickeners of oils and paper sizing (Warra, 2013).

Mak-Mensah and Firempong (2011) studied the chemical properties of neem oil-based toilet soap. They found that the produced soap showed good medicinal characteristics that makes neem oil an ideal substitute to the edible palm oil for soap production. Ameh *et al.* (2013) produced and characterized antiseptic soap using the blend of neem and shea butter oils at various proportions. They analyzed such properties as foamability, hardness, pH as well as the antibacterial properties of the produced soaps and reported that the properties agree closely with commercial samples from other sources. The consistency of their results indicates that the neem oil can act as a raw material for soap manufacturing. Similarly, Hassan *et al.* (2015) utilized a blend of neem and *Acacia nilotica* seed oils to produce soap. The researchers extracted the oils from the seeds by Soxhlet extraction method before producing their samples. Based on the oil yields and chemical analysis reported, they contended that the neem and *Acacia nilotica* seed oils are good sources of fatty acids for commercial purposes especially in soaps production. Moreover, other studies revealed medicinal benefits of employing neem oil for antiseptic soap production. It has been reported that neem oil-based soaps are capable of healing diseases like eczema (Schimutterer and Ascher, 1986). The neem extracts also find applications in other areas such as insect antifeedants, growth disruption, (Alfred and Patrick, 1985; Warra, 2009), anti-inflammatory uses (Schimutterer and Ascher, 1986,

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Ameh *et al*., 2013), and highly bactericidal in nature (Upadhyay *et al.,* 2010).

Castor oil on the other hand is a naturally occurring and environmentally friendly oil obtained from a plant seed called *Ricinus communis*. It is usually extracted by mechanical pressing or solvent extraction techniques. Although the castor seed oil is believed to have a wide range of applications which includes biodiesel production (Ndana, *et al.*, 2011), its main use is in soap production, lubricants and coatings manufacturing (Patel *et al.,* 2016). Despite being found to be a promising raw material for production of soap, castor oil may not necessarily give requisite physicochemical properties when singly used. The foregoing could be because castor oil contains various carboxylic acid groups (Mishra, 2009) which may in turn give varying physicochemical characteristics. Some researchers have demonstrated the applicability of the castor oil as a raw material in soap and detergents synthesis. One of such studies was conducted by Mishra (2009). The researcher carried out a study that involves the use of the castor oil as a blending stock with other types of oils to produce different soap samples. The work focused on the analysis of the properties of soap produced by both single and blends of various oils at varying ratios. The results showed that castor oil is a good source of fatty acid for saponification reaction, and it produced a soap with a high cleansing power and lathering ability. However, because of its varying chemical composition, castor oil-based soaps are usually soft in nature. Therefore, to achieve desirable physicochemical properties, it should be used as a blend with other oils.

Even though the study by Mishra (2009) and a host of other works available in published literature have been able to utilize different blends of other oils to produce soaps and detergents, there has been little attention on the use of the blend of castor and neem oil. Most of the published literature focused on other uses of these oils such as biodiesel production. Hence, this work was aimed at using the blends of the castor and neem oils to produce and determine a soap sample with best quality parameters. The choice of the aforementioned oils was informed by the fact that they are nonedible, available, less expensive, and have favorable medicinal properties for soap synthesis.

2.0 MATERIALS AND METHODOLOGY

The materials and equipment used in this work are shown in Table 1.

Table 1: Materials and equipment

Materials	Equipment
Neem oil	Liquid-in-glass thermometer
Castor oil	pH meter (Kent EIL 7055)
Sodium hydroxide	Round bottom flask
Distilled water	Weighing balance (MT-501)
Perfume	Stirring rod
Phenolphthalein	Beaker

2.1 Preparation of the soap samples

To prepare the soap samples, a blend of oil containing 60 ml of neem oil and 40 ml of castor oil was measured and transferred into a container. The content was then heated to 50 ^oC to increase the saponification rate between the alkali and the oil (hot process). A calculated amount of NaOH was weighed and added to a fixed amount of distilled water to form a solution (Mak-Mensah and Firempong, 2011). The prepared solution was then poured gently to the heated oil blend and stirred gently in one direction to ensure thorough mixing of the solution. The soap was then poured into a soap mold and allowed to cool for 24 hours. The produced soap was then weighed. The procedure was used to prepare different soap samples with varying blending ratios. Also, for the cold process, a similar procedure was adopted except that the process was allowed to take place at room temperature.

Amount of sodium hydroxide pellets required was determined as follows (Mishra, (2009)):

Amount of NaOH = Amount of oil x saponification value of oil.

Amount of distilled water = Amount of oil x 0.3

Calculation of Yield:

For all the soap samples prepared using different blends of the oils, the weight was measured for the dried samples. Yield was calculated by dividing the weight of the soap by the weight of the raw materials used. The soap samples produced were analyzed and compared with the commercial samples by determining their properties.

2.2 Determination of foamability and pH

One (1) g of the soap sample was dissolved into a 50 ml of water in a 250 ml measuring cylinder and was shaken vigorously for 2 minutes. Then the height of the foam was monitored and recorded after 4 minutes. This procedure was repeated for the various soap samples. It was also done for the two commercial samples obtained from the market (Hassan *et al. 2015*).

In order to measure the pH, one 1 g of the produced soap was dissolved in 10 ml distilled water and the pH of the solution was determined using a pH meter. This procedure was repeated for the soap samples produced at various blends and also for the commercial samples (Ameh *et al*. 2013).

2.3 Determination of cleansing power and hardness

To determine the cleaning property of the prepared soaps, a drop of oil was placed on four separate strips of filter paper. The filter papers with the oil spot were immersed in separate test tubes containing soap solutions. Each was shaken vigorously for 1 minute after which the filter papers were removed and rinsed with distilled water and the degree of cleanliness in each filter paper was visually observed. The procedure was repeated for commercial samples to compare the cleanliness of the prepared soap and that of the commercial sample.

For the hardness test, a method reported by (Ameh *et al*. 2013) was adopted. In the method, a soap sample was placed on top of a flat table and a hardness needle with a load attached to the top was placed gently on top of the soap vertically (with the pointed end on top of the soap). The depth by which the needle goes into the soap was marked and measured with a transparent ruler. It was then recorded. The procedure was repeated for all the samples produced and the commercial samples.

3.0 RESULTS AND DISCUSSION

Table 2 gives the properties of the commercial soap samples (Control 1 and Control 2) used as standards for comparison with the results obtained in this work.

Table 2: Properties of the commercial samples

Samples	pH	Foamability(cm)	Cleansing power	Hardness
Control 1	9.48	12.3	Very good	Very Hard
Control 2	10.7	12.0	Good	Very Hard

3.1 Foamability test results of the produced soap samples

Table 3 presents the result of the foamability test carried out on the produced soap samples using both the cold and hot process methods.

Table 3: Foamabilities of the produced soap samples

	Hot process	Cold process
Samples	Foamability(cm)	Foamability(cm)
50ml Neem+50ml Castor	10.7	10.8
60ml Neem+40ml Castor	11.8	11.6

70ml Neem+30ml Castor	11.0	11.9

From Table 3, it can be seen for the hot process the soap sample containing 60 ml neem oil and 40 ml castor oil had the highest foamability followed by a sample containing 70 ml neem and 30 ml castor oil, with the sample containing equal proportion of neem and castor having lowest foamability. However, for the samples produced via cold process, a proportion of 70 ml neem and 30 ml castor oil gave soap with the highest foamability followed by sample containing 60 ml neem and 40 ml castor oil with the sample of equal proportions having the lowest value.

The foamabilities of the soaps can considerably be compared with those of the two commercial samples: control 1 and control 2. It can be observed that though the foamability of the blend containing 70 ml neem and 30 ml castor oil produced via cold process exceeded that of control 2, however, its foam stability (time duration of the foam) was observed to be lesser than that of the commercial sample. Usually, the efficiency of a soap is assessed through the amount and stability of its foam. Thus: the soap obtained from a blend of 70 ml neem and 30 ml castor produced via cold process can ideally be considered to have a higher efficiency. However, the foam produced by this sample was seen to persist for a shorter period compared to that of 60 ml neem and 40 ml castor produced via the hot process, thereby making it less desirable. Also, even though the foamabilities of the soaps produced via the different methods appeared to be similar, the foams from the samples produced via the hot process showed higher stability.

The observed variability in the foamabilities of the soaps could also be ascribed to the difference in the fatty acids content of the utilized oils in the formulation. Phanseil, 1998 reported that, saturated fatty acids such as lauric and myristic acids produce soaps with fluffy lather and high cleansing power. Therefore, the difference in fatty acid composition in the castor and neem oils could be the factor that contributed to the observed contrast in the lathering ability.

3.2 pH value

Table 4 shows the pH values of the various soap samples produced from both the hot and cold processes.

Table 4: pH values of the produced soap samples

	Hot process	**Cold process**
Samples	**pH**	**pH**
50ml Neem+50ml Castor	10.20	10.58
60ml Neem+40ml Castor	10.42	11.00
70ml Neem+30ml Castor	10.62	11.54

Based on the results in Table 4, it can be noted that the sample containing 70 ml neem and 30 ml castor oil produced via cold process have the highest pH value of 11.54 while that with equal proportions of the oils showed a lowest pH of 10.58. The blend of 60 ml neem and 40 ml castor oil showed an intermediate value of 11.0. For the hot process, the sample with 50 ml neem and 50 ml castor oils had the lowest pH and that of 70 ml neem and 30 ml castor had the highest value. The variation in the pH values was likely due to the improper or incomplete saponification process which could possibly be overcome either by super fatting or using less amount of caustic soda solution. It is however, necessary to control the pH since a high pH value can be detrimental to the skin especially for toilet soap. A pH value within the range of 9-11 is usually acceptable for laundry soap (Mak-Mensah and Firempong, 2011; Onyango *et al*, 2014). Thus, except for the sample with 70 ml neem and 30 ml castor oils produced via cold process, the pH values of the other samples analyzed fall within the permissible range.

3.3 Yield

Table 5 gives the yield of the produced soap samples.

Table 5: Yield of the produced soap samples

	Hot process	Cold process
Samples	Yield (%)	Yield (%)
50ml Neem+50ml Castor	66.0	63.8
60ml Neem+40ml Castor	70.4	69.5
70ml Neem+30ml Castor	67.5	70.9

From Table 5 it can be seen that for the hot process, the soap sample containing 60 ml neem and 40 ml castor had the highest yield while the sample with equal proportion of the oils had the lowest yield. The cold process on the other hand, gave near-equal yields for both the samples with 60 ml neem, 40 ml castor and that of 70 ml neem and 30 ml castor oil. The difference in the yields among the various samples may be attributed to the type of oil used. This is perhaps because the yield of soap depends on the type of oil used and on the carboxylic acid and base that make up the soap. Evaluating the yield is pertinent because the higher the yield the more economical is the process (Mishra, 2009).

3.4 Hardness and cleansing power

Table 6 gives the hardness and cleansing power of the various soap samples produced from the different blends of the neem and castor oils.

Table 6: Hardness and cleansing power of the soap samples produced

	Hot process	
Samples	Hardness	Cleansing power
50ml Neem+50ml Castor	Relatively hard	Good
60ml Neem+40ml Castor	Hard	Very good
70ml Neem+30ml Castor	Very hard	Good
	Cold process	
50ml Neem+50ml Castor	Soft	Good
60ml Neem+40ml Castor	Hard	Good
70ml Neem+30ml Castor	Hard	Good

Castor oil when used alone to produce soap usually gives a soft soap. However, when blended with a neem oil which is usually hard gives a soap with good hardness feel. It can be observed from Table 6 that for both hot and cold processes, the hardness of the soap samples increased with increase in the amount of the neem oil and became softer with increase in the fraction of castor oil. This shows the benefit of blending different oils in soap production which bring in the properties of both oils together to enhance the quality of the soap. It can also be seen that the soap with 60 ml neem and 40 ml castor oil produced via hot process has higher cleansing power and that of 70 ml neem and 30 ml castor in the cold process had demonstrated a poor cleansing ability.

4.0 CONCLUSION

Blends of neem and castor oils were used to produce various soap samples at varying proportions using the two well-known processes of soap production, that is; the hot and cold processes. The produced soaps were analyzed using several properties such as foamability, yield, cleansing power, hardness and pH and compared with two commercial samples. The sample containing 60 ml neem and 40 ml castor oil produced via hot process was found to be the best as its properties agreed closely with the two commercial samples. It had a pH of 10.42, yield of 70.4% and foamability of 11.8 cm. The sample was also hard and showed a higher cleansing ability than the other samples. Therefore, it can be concluded that within the limit of this work, the best blend that gave good quality soap was that of 60 ml neem and 40 ml castor oil.

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