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Production of Local Soap Using Alkali Derived from Mango and Plantain Peel

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Abstract

Local soap was produced using mango and plantain peels as an active ingredient. The mango and plantain peels are agricultural-wastes matter that litter the environment. This study made use of mango and plantain peel ashes as a cheap alternative source of alkali that is much needed in soap making. The agricultural waste materials were burnt and the ashes were used to prepare a solution of potassium hydroxide (KOH), which was heated alongside palm kernel oil (PKO) until soap was formed. The quality of the soap was assessed thus: The colour:dark-brown, the texture: soft, the foamability: good, the foam size: small, and Foam stability: stable. The physicochemical parameters of the soap were also assessed thus; Total Fatty Matter: 62.42%, Total Free Alkali: 6.40%, Free Caustic Alkali: 2.97%, Wash Active Substance: 34.98%, and pH: 10.02. These assessments revealed that the alkali derived from mango and plantain peels is a good and cheap active ingredient for soap production. The exploitation of alkali derived from agricultural waste materials for the making of soap is worthwhile. This would also prevent environmental pollution by these waste materials that might potentially cause harm to the populace, and also reduce over dependence on synthetic alkali for soap production and also provide an alternative source of income.

1. Introduction

Soap is an essential daily household commodity that is used for cleaning. It is produced in different forms, such as bars, flakes, granules, and liquid, made from fatty acids of organic fats and oils mixed with the salts of sodium or potassium [1,2]. The use of soap in cleaning is paramount because it removes stains that ordinary water alone cannot entirely eliminate. Soap exerts its cleansing potential by allowing the contaminants of dirt, oil, or grease to be dissolved in water and then washed away [3]. Soaps are basically created when oils are hydrolysed with caustic soda, turning palmitic, stearic, and oleic acid glycerides into salts of sodium and glycerol [4,5].

In recent years, agricultural waste materials such as plantain peels, mango peels, cassava peels, maize cobs, cocoa pods etc. have become a matter of concern as they are found littered in the environment, thereby posing an environmental health risk to society. They may also have some useful purposes which include being used as raw materials for energy production and soap preparation, among others [6]. Discarding these agricultural waste materials is a waste of beneficial resources that could be used as raw materials needed in the production of soap [7]. Hence, such agricultural waste materials could be recycled to alkali used for the production of soap [8].

Alkalis derived from agricultural waste materials such as plantain peels, maize cob, palm bunches, banana peels, sugar-beet chaff, cocoa pods, wood, and several others contain a significant amount of potassium on combustion, which offers an economical substitute for the imported alkali [9].

The production of soap from alkalis derived from agricultural waste materials has been an ancient skill in African countries, especially Ghana and Nigeria. This locally made soap has different names and has been called across Nigeria. In the northern region of Nigeria, the soap is called *chahul-mtse* among the Tiv-speaking people and *sabulun-solo* among the Hausa-speaking people. In the eastern part of Nigeria, local soap is known as *Ncha-nkota in the* Igbo language. In the western region among the Yoruba people, local soap is popularly known as *ose-dudu,* while in the south-south region of Nigeria, particularly Edo State, local soap is called *evbakhue-edo* among the Bini ethnicity.

The appearance of the local soap ranges from pale brown to black, which is dependent on the alkali source used in the soap preparation or the methodology used [10].

African local soap is highly recommended for showering due to its natural vitamin source (A& E). Because of its phenolic compound composition, it is effective for the treatment of skin problems and can also improve uneven skin tone [11].

The addition of natural additives such as honey, coconut oil, and shea butter to the locally made soap has been reported to aid the soap's antimicrobial activity [12]. The use of local soap extract against the micro-organisms associated with skin problems has been scientifically proven to exert antibacterial activity [13]. Olajuyigbe *et al.* [14] reported that local soap has therapeutic properties that could be employed for commercial purposes.

Ikezu *et al.* [6] performed a comparative investigation of the alkali, moisture, and ash levels of several agricultural by-products, such as palm bundles, plantain peelings, banana leaves, and corn cobs. He reported that some of these wastes can be used to make soap, which would reduce the environmental dangers they may cause. The use of agricultural waste materials like plantain peeling as a source of alkali for soap making has been reported to produce good quality soap [15].

A study by Ajongbolo [4] showed that soap produced from agricultural waste of palm oil and cocoa pods can compete favourably with other soaps. Alkali derived from millet stalks was proven to be a good ingredient for the production of traditional soap [16].

Soap produced from alkali derived from mango peel has been reported to be good and also have a milky white appearance, which is the same colour as the synthetic or imported alkali [17]. The alkali derived from mango peel has been reported for its pleasant fragrance, flavour and also high nutritional content [18]. Umeh-Idika and Maduakor [19] reported that the ashes derived from cassava and plantain peels are good active ingredients in the production of soap.

The aim of this work presents an organic local soap with a blend of alkali derived from agricultural waste materials of both plantain peels and mango peels. The utilization of mango peel would add a good fragrance to the soap, thereby reducing the use of artificial scent additives in soap. The use of agricultural waste materials would reduce environmental pollution and provide a less cost-effective soap that is safe and beneficial to the skin.

2. Methodology

2.1 Collection and Pre-treatment of Plantain and Mango Peelings

Plantain peelings were obtained from a roasted plantain trader, around the Ugbowo axis in Benin City, Edo State, Nigeria. Mango fruits were obtained from a fruit vendor at the new Benin market, Benin-City, Edo State. The peels of the mango were carefully removed with the aid of a sharp knife. The plantain and mango peelings were properly cleaned and oven dried at 100^0 C for 24 hours, until the peelings were bone-dried.

2.2 Preparation of the Alkalis

The dried plantain and mango peelings were combusted separately in a muffle furnace; the ashes were stored in a clean air tight container.

2.3 Extraction and Determination of the Alkali Content of the Ashes

The concentration of the potassium hydroxide (KOH) of the ashes gotten from plantain and mango peelings was assessed using the titrimetric method as described by Umeh-Idika and Maduakor [19].

2.3.1 Procedure for Titrations

100ml of distilled water was measured and placed in two separate beakers. 5g of the ash (plantain and mango) was placed in each beaker containing 100ml of distilled water and stirred properly. The solutions were boiled and allowed to cool and were filtered using a filter paper. 25cl of hydrochloric acid (Hcl) was placed in the burette, and 2 ml of the ash solution was measured and placed in a cornel flask. A drop of methyl orange indicator was added into the solution and titrated. The appearance of a pink coloration showed that the concentration of the KOH was high. The base content of the ashes of both plantain and mango peel was determined using the method described by Okunola *et al.* [17].

2.4 Determination of alkali pH

The pH of the alkalis was measured using a pH meter. $100cm^3$ of the alkali was measured and placed in a volumetric flask. The pH meter electrode was placed into the volumetric flask containing the alkali and the readings were taken [7].

2.5 Test for the Alkalinity of the Ash Extract

An alkalinity test was done by the use of a red litmus paper.

2.6 Soap Production Procedures

Two litres of water were added to the stainless steel bowl. A weight of two hundred grams (200g) of the ashes (plantain and mango peels), in the ratio of 1:1, was placed into the bowl. The solution was strained using baffled cloth and filtered using cotton wool. The solution was heated to get a concentrated solution of the alkali. 500ml of palm kernel oil (PKO) was gradually added to the boiling solution and was stirred continuously until it was adequately saponified [7]. The prepared local soap was left for about three days in the mold to solidify [20].

2.7 Tests for the Quality of the Local Soap

The local soap quality was assessed by determining the following properties: colour, texture, foamability, stability, and foam size.

2.7.1 Test for Soap Foamability and Stability

The test for soap foamability and stability was carried out by utilizing the techniques outlined by Okunola *et al*.[17].

2.8 Local Soap: Physico-Chemical Characteristics

The physicochemical characteristics of the local soap produced were assessed utilizing techniques described by Ajongbolo [4].

3. Results and Discussion

Table 1: Alkali concentration, pH and Basicity of the plantain and mango peel ash extracts.

Samples	Concentration of KOH(g/dm^3)	pH	Basicity
Plantain peel ash	63.75	11.5	Turns red litmus paper blue
Mango peel ash	11.98	10.7	Turns red litmus paper blue

As shown in Table1, the alkali concentration of the plantain and mango peel ashes was calculated as 63.75g/dm^3 and 11.98g/dm^3 respectively. This is in close range with the alkali concentration of plantain peel ash, 64.57g/dm^3 recorded by Umeh-Idika and Maduakor,[19] and 12.13g/dm^3 of mango peel ash reported by Okunola *et al*., [19]. It was observed that the alkali content of the mango peel ash was lower than that of the plantain peel ash but much higher than that of the ash of palm kernel bunch as reported by Akunna *et al.* [5]. The pH meter readings of the 10% solutions of both plantain and mango peel ashes at 200 °C indicated that the solutions were alkaline.

Table 2: Physical Assessment of Local Soap Quality

Parameters	Local soap	Lux soap
Colour	Dark-brown	White
Texture	Soft	Soft
Foamability	Good	Very Good
Foam size	Small	Small
Foam stability	Stable	Very stable

The physical assessment of the quality of the produced local soap compared favourably with a synthetic soap (lux soap) as shown in Table 2. The colour difference in both soaps is as a result of the alkali source used in the soap preparation.

Table 3: Physico-Chemical Assessment of the Local Soap Produced

Parameters	Values
Total Fatty Matter (TFM)	62.42%
Total Free Alkaline (TFA)	6.40%
Free Caustic Alkali (FCA)	2.97%
Wash Active Substance (WAS)	34.98%
pH	10.02

The physicochemical characteristics of soaps determine their quality. Knowing the physicochemical properties of soaps helps in assessing the soap’s efficacy and cleansing abilities.

Total fatty matter (TFM) is a measurement used to determine how much fatty matter is contained in soap. As shown in Table 3, the TFM was calculated as 62.42%. This percentage value showed that the local soap produced falls in the category of grade 2 soap. This agrees with literature as reported by Betsy *et al*. [21]. Apparently, the soap quality is good. The total free alkaline (TFA) value was 6.40%. This value falls within the range (3–8%) reported by Tarun *et al*. [22]. This implies that saponification can be carried out with PKO without refinement. The TFM and TFA properties are crucial for assessing a soap's effectiveness and suitability for cleansing purposes.

The free caustic alkali (FCA) value was 2.97%, which falls within the standard literature value and compares with the work done by Beetseh and Anza [23] and Ajongbolo [4]. FCA is the amount of lye that is free to prevent the soap from turning greasy. The wash active substance was calculated as 34.98%, which falls within the values obtained by earlier researchers [4, 20, 23]. During the extraction process, the W.A.S. property makes it easier to collect the agricultural waste products on the surface of the water. The average pH reading taken for the local soap produced was 10.02, which falls within the normal pH range (9–11) for soaps [24].

4. Conclusion

The production of an organic soap using alkali derived from mango and plantain peel ashes was successful. The data obtained from the analysis of the local soap agrees with the data reported in the literature, and this shows that the local soap produced can successfully compete with other soaps in the market. The slight difference could be as a result of the agricultural waste materials used in producing the soap. The exploitation of alkali derived from agricultural waste materials for soap making is worthwhile. This would not only free the environment from the agricultural waste materials that pose potential harm to the populace but would also reduce the over-dependence on synthetic alkali for soap production and also provide a residual source of income.

The use of agricultural waste materials for soap production is highly recommended to provide a good and cheap alternative to the much needed alkali for soap preparation. The dark-brown color of the soap may be improved by the addition of colorant and bleaching of the oils used in soap making. The antimicrobial analysis of the local soap produced using alkali derived from plantain and mango peel should be carried out for further study.

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