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Investigation into the Physicochemical Property of Lye Extracts suitability for Soap Production

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ABSTRACT

Research work was conducted to investigate the suitability of dye extracted from softwood sawdust ash for soap production. The physicochemical properties of the dye obtained as the final raw material for the production of liquid and solid bar soap was examined in terms of pH, density, viscosity and water content with value of 5.5, 1.00kg/m^3, 2.650 cst and 58.7%. The metal content from the alkaline/dye extracts obtained are lead (p^b) 0.31283mg/l, Iron (Fe), 4.6574 mg/l, manganese (mg) 0.53927 mg/l , calcium (Ca) 8.13065 mg/l, Sodium (Na) 6.52849 mg/l, Potassium (k) 493404 mg/l, phosphorus (p) 2.4278 mg/l and mercury (Hg) 0.00135. The result obtained revealed that the alkaline/dye extracts does not meet the required standard for soap production when compared with the Canadian limit of P^b (10-20 mg/l), Fe (19-60 $/l$), mg(0.7-2.2 mg/l), C_a (7.4-33.1 mg/l), Na (24.4 mg/l), K (126.1 mg/l) P(0.3-1.4 mg/l) and Hg (Nil). This investigation reveals that lye extracted from soft wood sawdust ash cannot be useful in the production of liquid and solid bar soap, since the physicochemical properties and the characteristics of the lye lack the required nutrient and constituent for soap production.

Key words: Investigation, physicochemical Property, lye, extracts, soft wood sawdust ash, soap production

1. INTRODUCTION

Woods are majorly divided into two types, the hard woods (*angiosperms*), the soft woods (*conifers* also known as *gymnosperms*) [1]. Soft woods are woods obtained from conifer trees, conifer trees are those trees with cones and needles some examples are pine, cedar, fir, redwood and spruce [2]. Hard wood trees produce seeds and leaves, some examples are oak, maple, cherry, mahogany, palm tree, bamboo, and walnut [2]. There is a special wood type known as Engineered wood, this wood type does not occur naturally but they are manufactured to meet up specification some examples are: plywood, composite board, oriented strand board and medium density fiber board. Semi-hard wood refers to the part of wood tree that is not fully mature [3-5].

Saw dust or wood shaving is a by-product of wood obtained from wood work such as: cutting, sanding, screwing, drilling, sawing and similar activities [6-7]. It could be used in our homes to achieve so many results. Sawdust can be used in the following areas such as: Saw dust as a food additive: Cellulose or wood pulp obtained from the sawdust could be found in some food such as grated cheese, parmesan (contains up to 8.8% cellulose), some packaged foods like cereals and granola bars, packaged cookies etc. Cellulose is an indigestible plant fiber obtained from shredded wood like saw dusts. It is used as a thickener to add fiber and texture to foods. Saw-dust derived cellulose is used as filler in bread [8]. Sawdust as fertilizers: The use of compost formed from sawdust with the addition of enough water and grass clippings (nitrogen rich material) can help balance out the high amount of carbon in the sawdust and when added to the soil helps to enrich the soil [9]. Sawdust can be added to soils like heavy sandy and clay soils to help improve their moisture retention and as well improve the soil texture [10]. Sawdust as a mulch: When sawdust is poured on the farmyard, it helps to suppress the growth of weeds by acting as a mulch [1]. The spread of sawdust around the base of garden plants can help the plant roots to retain moisture, keep the roots cooler [7]. (iv). Sawdust as beddings: Saw dust has its application in the floor of the cages of poultries like chickens and rabbits to act as beddings to help soak up the wastes they passed out and make the cage appear drier and also regulates the temperature of the cage [10-12].

Other area of applications includes: Sawdust as oil sorbent: Sawdust can be used to soak up spills of oil, gasoline and grease. The low buoyancy and high surface area of sawdust helps sawdust to adsorb oil content from an oil-water mixture effectively [13]. Sawdust is a low-cost, relatively abundant and a natural cellulosic material that could be beneficial compared to other conventional adsorbents in the removal of oil contaminate from water [14]. Sawdust ashes used for soap production: Sawdust ash is used as raw material for the production of lye used for the production of soap and it gave good quality hard bar soaps with creamy lather comparable to soaps produced commercially [15]. Sawdust as source of fuel: Large amount of sawdust is used in making briquettes which are burnt to produce heat as a form of energy and used for cooking and smoking [15]. Sawdust can also be used to create pathways in the garden, mixed with adhesives to fill up defects and wood holes and for creativity in arts and crafts [16].

The size of sawdust particles produced from the sawing of wood depends on the kind of wood from which the sawdust is obtained and also the size of the saw teeth [17-18]

Wood species and agricultural materials have been used as source of potash production, they are combusted and their lye is extracted and used in soap making [19]. The type of plant material used determines the potash yield and the process of production also determines the quality and quantity of potash produced [20]. The quality and quantity of potash recovered is determined by the temperature at which the woods components were combusted, the type of wood from which the potash is obtained and the type of soil on which the wood-tree grew on [15]. The temperature at which the plant materials or wood species are combusted also determines the quality and quantity of potash obtained because at low temperature, the wood species will not be fully combusted to ashes [13]. For the best result during combustion, the wood species should be combusted in a temperature-controlled furnace to help facilitate the rate of combustion and also ensure a complete combustion of the wood species into ashes [13].

The aim of this research work is to investigate the suitability of lye obtained from softwood sawdust can be used in the production of liquid and solid soap. However, the research demonstrates that the concentration of the lye obtained lack some percentage of nutrients required to produce high quality and health wise without health challenges experienced after utilization. Research illustrates detail characteristics and composition in terms of physicochemical properties of the lye produce as well as the liquid and solid bar soap after adding the necessary reagents.

2. MATERIALS AND METHODS

Materials

The major raw material used for this soap production is the saw dusts from soft wood. It was collected from a Saw Mill located at Sand fill in Ilabuchi Port Harcourt, Rivers State. Materials are further subdivided into Apparatus and Reagents.

Apparatus and their Uses: The various apparatus used in this research work are available in the Department of Chemical/Petrochemical Engineering Laboratory at Rivers State University, Port Harcourt.

Density Determination

The following procedures were adopted in the determination of density;

i. Empty weight of pyrometer (W_1) was measured
ii. The Pyrometer was filled to the brim and covered with the lye
iii. Weight of the Pyrometer and then the lye sample (W_3) was measured
iv. Volume of the Sample was ($50m$) W_4

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Density $(g/cl) = \frac{W_3 - W_1}{W_4}$

pH Determination

The following procedures were adopted in the determination of pH;

i. pH meter was standardized with buffer 7 solution
ii. $150ml$ of the Sample was measured into $250ml$ beaker
iii. pH electrode was inserted into the sample in the beaker
iv. pH reading was recorded.

Viscosity Determination

The following procedures were adopted in the determination of Viscosity;

i. Samples were subjected into a capillary viscosity 150 ASTM size.
ii. Samples in the apparatus were pumped into the upper mark of the viscosity
iii. Samples were allowed to drop to lower mark of the apparatus simultaneously and observe time changes on the stop clock.
iv. Flow time of samples from upper mark to the lower mark were recorded
v. Time were converted to second and multiply by the ASTM size No: (0.025)
vi. Viscosity in Centistokes was recorded

Moisture Content or Water Content

i. The weight of empty (W_1) crucible was measured
ii. 10gm of the sample was measured into the crucible (W_2)
iii. Weight of both Crucible and sample (W_3) was recorded.
iv. Samples were dried in the crucible at 105℃ until dryness.
v. Weight of the crucible and dry sample (W_4) was measured.
vi. The weight of the dryed sample (W_5) was then recorded.

However, % moisture = $\frac{W_4 - W_1}{W_2}$ x 100

Metal

i. All samples were allowed to undergo acid extraction processes and also digested
ii. Metal elements were analyzed through spectrophotometer using their individual wavelengths.

Lye Extraction

i. 1kg of ash were measured and then soaked in warm distilled water of different volume labeled A, B, C, D, E and F.
ii. Each of solution was allowed to settle for the period of 48 hours.
iii. It was then filtered and the residual products were collected as extracts.
iv. The solution of the extract indicates alkalinity (alkaline extract)
v. This alkaline extract is known as the Lye

3. RESULTS AND DISCUSSION

The results obtained from the research work are presented in Tables and Figures below:

Table 1: Parameters showing the Physicochemical Properties of the Lye Extracts

Parameter	Unit	Soft Wood Saw dust
pH		5.5
Density	kg/m^3	1.00
Viscosity	cSt	2.650
Water Content	%	58.7

The lye extracted from the various varieties of sawdust components were analyzed for some parameters like pH, Density, Viscosity and Water content and the result obtained are shown in Table 1.

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Table 2: Metal Content from the Alkaline /Lye Extracted from the Various Saw Dust Components Compared to the Canadian Standard.

Sample (mg/l)	Soft Wood Ash (mg/l)	Canadian Limit (mg/l)
Pb	0.31283	10-20
Fe	4.65741	19-60
Mg	0.53927	0.7-2.2
Ca	8.13065	7.4-33.1
Na	6.52849	24.4
K	4.93404	126.1
P	2.42784	0.3-1.4
Hg	0.00135	Nil

The results obtained after analyzing the lye extracted from the various sawdust ash components for their metal composition are recorded as shown in Table 2. The results obtained were compared with the Canadian acceptable limit and great derivation in concentration was experienced. This revealed that the lye state is not suitable but requires addition of more ingredients to improve the constituent concentration of the lye for soap production.

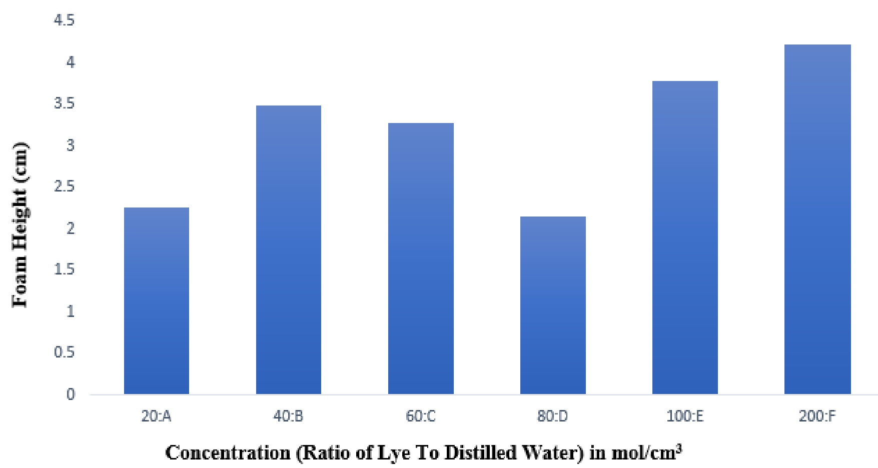

Figure 1: Plot of Foam Height against Concentration of Ratio Lye to Distilled Water Mixture

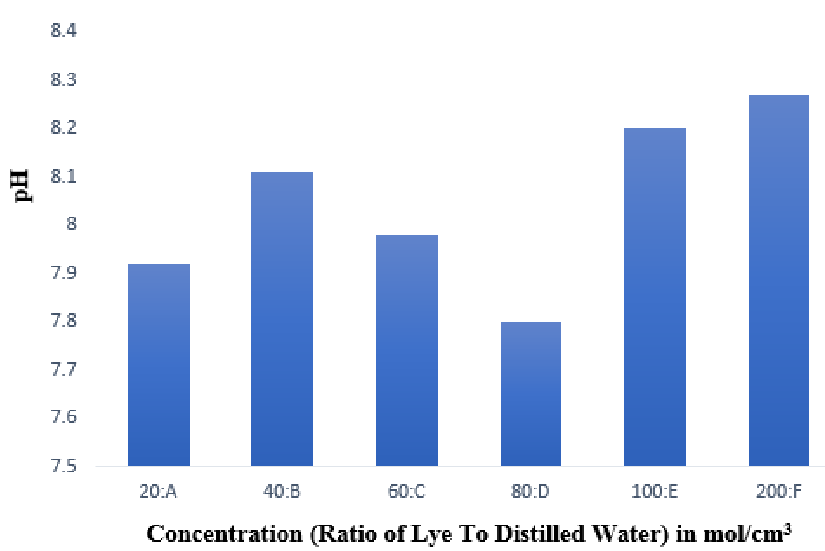

Figure 2: Plot of pH against Concentration of Ratio Lye to Distilled Water Mixture

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Figure 1 shows the relationship between the effects of lye concentration on the foamability height of liquid soaps produced from soft wood saw dust. Increase in foam height was observed in the magnitude order of: 200:F > 40:B > 60: C > 80:D > 100:E >20:A. The variation in the foamability heights of the liquid soaps was observed with variation in the concentration of the lye. This variation could be attributed to the change in concentration of the lye (ratio mixture of the lye to distilled water).

Figure 2 demonstrates the effects of concentration of lye on the pH value of the liquid soaps produced from soft wood. The variation in the pH value of the liquid soaps increased in the magnitude order of: 200:F > 100:E > 40: B > 60:C > 20: A >80:D. The variation in the pH values of the liquid soaps produced using the soft wood saw dust could be attributed to variation in the concentration of the lye.

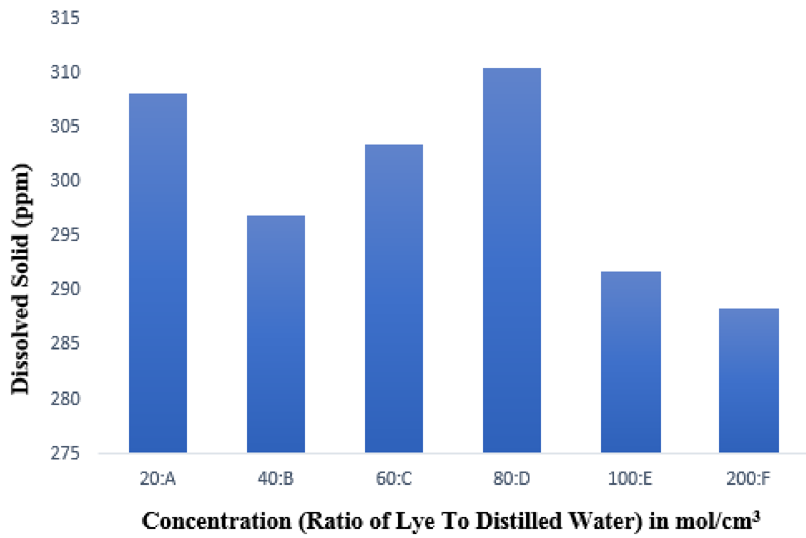

Figure 3: Plot of Dissolved Solid against Concentration of Ratio Lye to Distilled Water Mixture

Figure 3 demonstrates the effects of concentration on the dissolved solids of the liquid soaps from the soft wood saw dust. The variation in the dissolved solids increased in the magnitude order of 80:D > 20:A > 60:C > 40:B > 100:E >200:F. The difference in the dissolved solids in the liquid soaps could be linked to change in the concentration of lye used in their production.

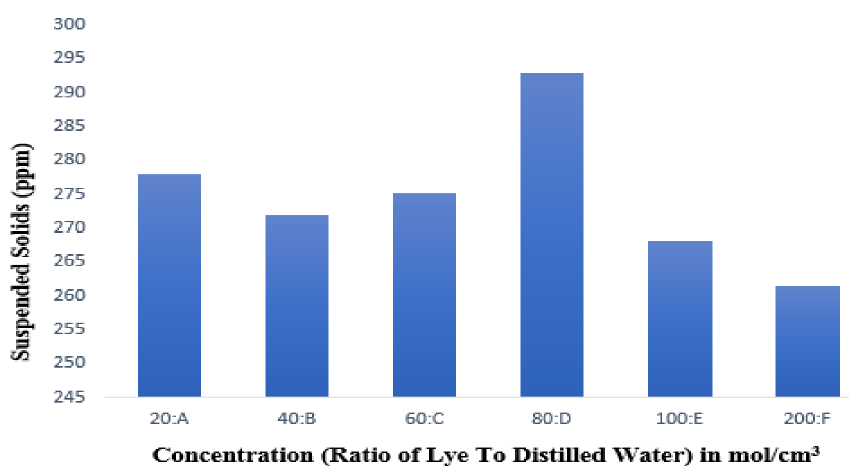

Figure 4: Plot of Suspended Solid against Concentration of Ratio Lye to Distilled Water Mixture

Figure 4 shows that concentration of lye could have impact on the suspended solids in the liquid soaps from the soft wood saw dust. The variation in the suspended solids in the liquid soaps increased in the magnitude order of: 80:D > 20:A > 60:C > 40:B > 100:E > 200:F. The change in the suspended solids in the liquid soaps could be attributed to change in concentrations of lye.

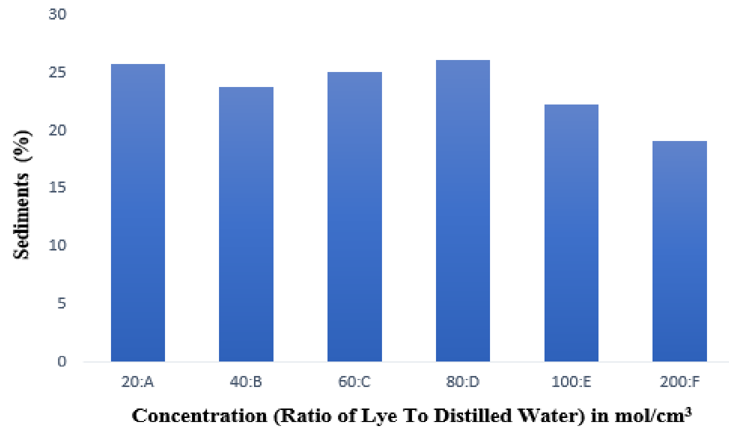

Figure 5: Plot of Sediment against Concentration of Ratio Lye to Distilled Water Mixture

From Figure 5 it could be seen that the concentration of lye has impact on the sediments formed in the liquid soaps produced from the soft wood saw dust. The variation in the sediments in the liquid soap from the soft wood saw dust increased in the magnitude order of: 200:F > 100:E > 40:B > 60:C > 20:A > 80:D. This variation could be linked to difference in the concentration of the lye (ratio mixture of lye to distilled water) used for the liquid soap production.

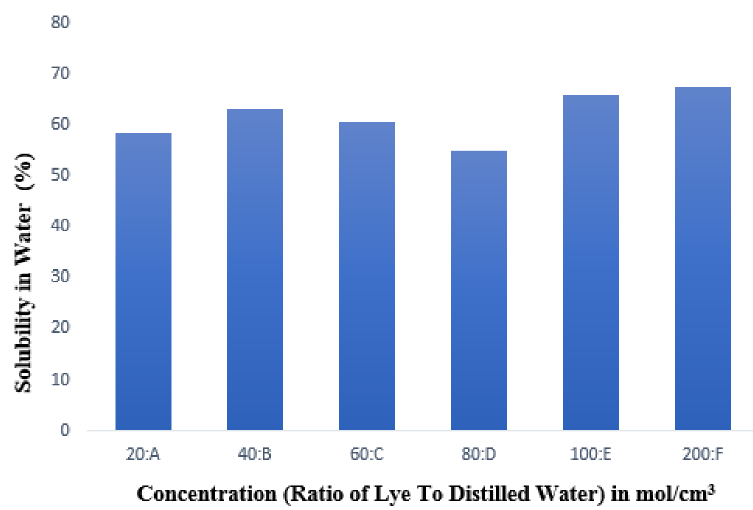

Figure 6: Plot of Solubility in Water against Concentration of Ratio Lye to Distilled Water Mixture.

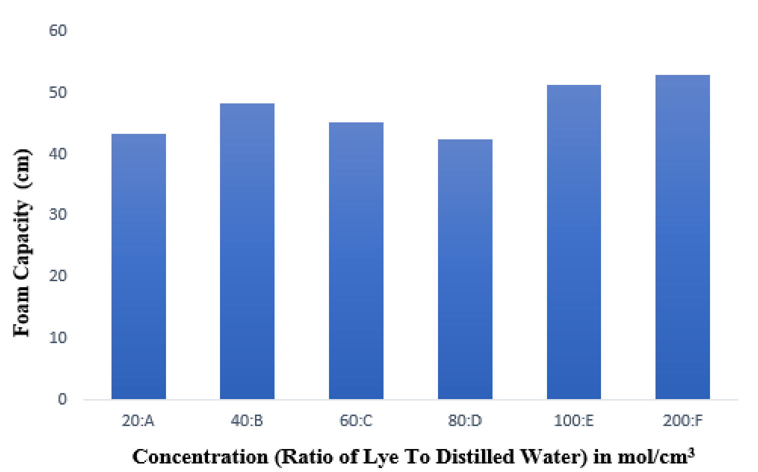

Figure 7: Plot of Foam Capacity against Concentration of Ratio Lye to Distilled Water Mixture

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Increase in the variation of solubility of the liquid soaps in water was in the magnitude order of 200:F **>** 100:E > 40:B > 60:C >20:A > 80:D as shown in Figure 6. The change inthe solubility of the liquid soaps in water could be as a result of change in the concentration of lye (i.e ratio of lye to distilled water) used in their production.

Figure 7 illustrates the impact of lye concentration on the foam capacity of liquid soaps produced from the soft wood saw dust. The change in the foam capacity of the liquid soaps increased in the magnitude order of 200:F > 100:E > 40:B > 60:C > 20:A > 80:D as shown in Figure 7. The variance in foam capacity could be attributed to the change in the concentration of the lye (ratio of lye to distilled water).

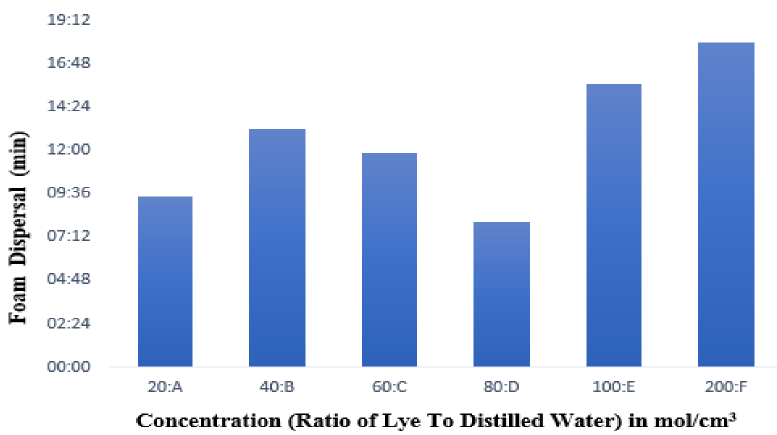

Figure 8: Demonstrates the Relationship between Concentration of Lye and Foam Dispersal of Liquid Soaps Produced from the Soft Wood Saw Dust

Figure 8 demonstrates the relationship between the concentration of lye and foam dispersal of the liquid soaps produced from the soft wood saw dust. The change in foam dispersal in the liquid soaps increased in the magnitude of: 200:F > 100:E > 40:B > 60:C > 20:A > 80:D as shown in Figure 8**.** The variation in the foam dispersal of the liquid soaps could be linked to the difference in the concentration of lye used for their production.

4. CONCLUSION

The following conclusion was outlined based on the findings.

i. The result obtained in terms of the physicochemical properties of the lye revealed that the concentration of the lye is not within the acceptable standard for soap production.
ii. The pH value obtained is acidic which means that if used for soap production, it will cause health challenges.
iii. Soap production using softwood sawdust ash can only be achieved if the lye concentration is improved to meet up the world standard.
iv. Although the lye extracted was process to obtain liquid and solid bar soap and when analyzed the characteristics obtained reveals the usefulness of the liquid and solid bar soap produced. In this condition the liquid and solid bar soap produced can only be used for industrial purposes with carefulness to prevent health effect on the users.
v. We recommend further research work on the way forward to ensure that the waste saw dusts are converted into useful raw materials for soap product and other in areas of applications.
vi. The result obtained reveals that the concentration of moisture content (distillated water concentration) influences the quality of the soap produced.

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Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Atiku, F. A., Fakai, I. M., Warra, A. A., Birnin-Yauri, A. U., & Musa, M. A. (2014). A Production of Soap Using Locally Available Alkaline Extract from Millet Stalk: A Study on Physical and Chemical Properties of Soap. *International Journal of Advanced Research in Chemical Science (IJARCS).1*(7), 1-7.
2. Azeez, O. S., & Abegude, G. S. (2016). Production and Characterization of Liquid Detergents from Some Agricultural Waste Products. *Nigerian Journal of Technology*. *5*(1), 60-65.
3. Babayemi, J. O., &Adewuyi, G.O. (2010). Assessment of Combustion and Potash Production as Options for Management of Woods Waste. *Journal of Applied Sciences and Environmental Management*. *14*(1), 73-75.
4. Chandrasekar, V., Sampath, C., Prasanna, D. B., & Regupathi, I. (2015). Refining of Edible Oils: A Critical Appraisal of Current and Potential Technologies. *Intersection of Academic Research and Industrial Applications*. 50(1), 13-23.
5. David, D. B; Roberto, B., & Allan, S. H. (2021). Optimization of Bleaching Process. *The American Oil Chemists' Society,* 1-3.
6. Deli, Z., Feng, L., Ming, Z., Zhengxin, G., & Chengyu, W. (2015). Novel Superhydrophobic and Superoleophilic Sawdust as Selective Oil Sorbent for Oil Spill Cleanup. *Chemical Engineering Research and Design*, *102*, 34-41.
7. Do-Dinh, N., Tan, T. D., Quang, T. L., Tri, D. L., Long, G. B., Duy, C. N., & Tran, Q. T. (2019). Extraction of Saponin from Gledtsia Peel and Applications on Natural Dishwashing Liquid Detergent. *Materials Today Proceeding*. *18*(638-645), 5219 – 5230.
8. Garba, S., & Ahmad, H.Z. (2018). Assessment of Alkaline Content and Heavy Metals in some Agro-Waste obtained from Pauta Farmlands, Kaduna State, Nigeria. *Research Journal of Chemical Sciences*. *8*(3), 16-21.
9. Garba, S. (2018). Determination of Alkaline Content and Heavy Metals in Agro-Waste Obtained from Pauta Farmlands Kaduna State. *Research Journal of Chemical Sciences. 8*(3), 16-21.
10. Idoko, O., Emmanuel, S. A., Salau, A. A., &Obigwa, P. A. (2018). Quality Assessment on Some Soaps Sold in Nigeria. *Nigerian Journal of Technology (NIJOTECH), 37*(4), 1137 -1140.
11. Ikezu, U. J. M., Ugariogu, S. N., Ikpa, C. B. C., Ibe, F. C., & Iwu, V. C. (2020). Coparative Analysis of Alkali, Ash and Moisture Content of Some Agricultural Wastes. *Open Access Journal of Waste Management and Xenobiotics*, *3*(2), 32-36.
12. Ilesanmi, A. D., Adefemi, A., & Funmilayo, A. (2014). Design of a Processor for the Production of 30,000 Tons of Caustic Potash per Annum from Cocoa Pod Husk. International Journal of Science and Research (USR).*3*(3), 691-700.
13. Israel, A. U., & Akpan, I. A. (2016). Mineral Composition of Ashed and Charred Palm Bunch and Plantain Peels. *British J. of Applied Sci. and Techno.16* (5), 1-9.