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Characterization of the Physicochemical Property of Lye Extract from Wood Saw Dust Ash and Its Alternative Use as a Raw Material in Soap Making

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Abstract

This research work was conducted to Characterize the Physicochemical property of lye-extract from wood sawdust and its alternative use in soap-making. The lye extracted from the ashes of the Hard-wood sawdust served as a raw material for the production of liquid and bar soap and its physicochemical property when examined gave Density (*D*) as 1.00kg/m^3, pH is 7.5, Water content is 53.6% and Viscosity (*V*) is 2.672 cSt. The metal composition was analysed and compared to the Canadian standard and the elements present were lead (Pb) 1.00183mg/l, Iron (Fe) 3.59624mg/l, Magnesium (mg) 1.43475mg/l, Calcium (Ca) 19.50093mg/l, Sodium (Na) 4.74821mg/l, Potassium (K) 7.31976mg/l, Phosphorus (P) 5.17342mg/l and Mercury (Hg) 0.00135mg/l but their various amounts were not in accordance to the permitted Canadian limit required for soap production. The soaps produced were analysed for parameters like foam height, pH, dissolved-solids, suspended-solids, sediments, foam-dispersal, toxicity, lather texture, solubility in water and foam capacity, hardness in 50g, penetration, moisture content, reactivity in hard water and total alkali content, the characteristics and physicochemical property of the lye-extract revealed that it could serve as an alternative raw material but lacks the sufficient minerals required for the production of the best quality of soaps unless more reagents were added.

Keywords: Characterization, Physicochemical Property, Lye-extract, Hard-wood, sawdust-ash, soap-making.

1.0 INTRODUCTION

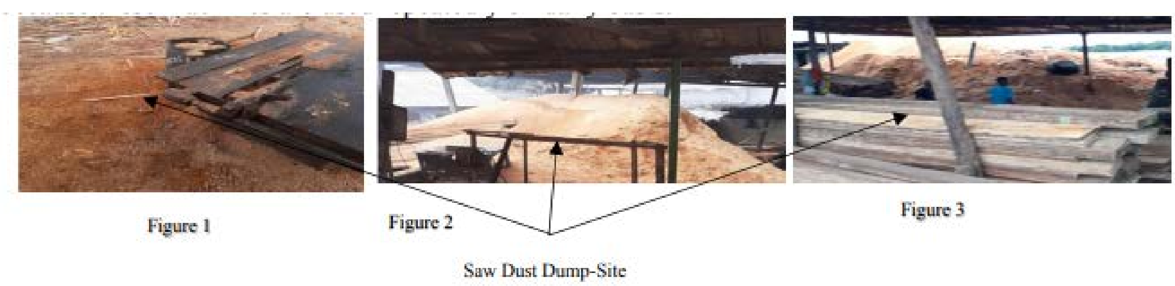
Wood is a hard-fibrous material that makes up most of a tree substance and it forms the trunks and branches of trees. The main types of woods are the soft woods (Gymnosperms), some examples are redwood, cedar, spruce, and fir (Ramange *et al.*, 2017; Okonkwo *et al.*, 2016). The hard woods (angiosperms), examples are maple, walnut, mahogany, oak, cherry, (Awe *et al*., 2019; Beetseh and Godwin, 2015). Another special wood type called the Engineered wood is specially designed to meet up specifications, examples are medium density fibre board, plywood and composite board. The term “Semi-hard wood” refers to partially mature wood (Sotannde and Riki, 2019).

Saw dusts are obtained as waste products from wood work operations like screwing, sanding, sawing, etc. (Risse, 2010). The particle sizes of the saw dust depend on the wood type and the saw- teeth size used during wood work operation (Bello, 2017; Bariska *et al*., 2016; Rizki *et al*., 2010). It finds its application in the following areas such as: Saw dust is used as fertilizer (Onochie *et al*., 2018; Risse *et al*., 2010). Sawdust can act as an oil sorbent (Kelle, 2018; Deli *et al*., 2015), it could be used as source of fuel for cooking, as a food additive in some packaged foods, for making Poultry beddings and as an alternative raw material for soap production (Beetseh and Godwin, 2015). Saw dusts is a rich source of potash production. The quality and quantity of Potash yield depends on the type of tree and the part of tree combusted (Onochie *et al*., 2018). The potash composition could also be determined by the temperature of combustion, the part of wood tree burnt and the process of combustion. To obtain more potash during combustion, the wood specie should be allowed to burn completely to white ash (Ilesanmi *et al*., 2014; Betsy *et al*., 2013; Babayemi *et al*., 2010). Most research scholars have attempted producing soaps from agro-waste like Kolanut pods and Almond leaves (Osagie *et al*., 2015), Plantain and Cassava Peels (Umeh *et al*., 2013), Millet Stalk and Palm Oil (Atiku *et al*., 2014), Maize Cob, Plantain peel and Cocoa Pods (Azeez *et al*., 2016), Cashew nut shell (Ogundiran *et al*., 2011), Plantain and Banana Peels (Olabanji *et al*., 2012), Palm bunch (Ogunsuyi *et al.*, 2012; Akunna *et al*., 2013) as well as Palm Bunch wastes like *Elaeis Odora*, *Elaeis Oleifera and Elaeis Guineensis* (Undiandeye *et al.*, 2015). Also, the research work of Beetseh and Godwin, 2015 showed that sawdust could be used as an alternative raw material for soap making because it subsidizes the cost of producing soaps and when used gave rich creamy lather just like other commercial soaps.

The aim of this research work is to Characterize the Physicochemical property of the lye extract obtained from the hard wood saw dust ash and use it as a raw material for bar soap making. This research demonstrates that the concentration of lye obtained from the potash of Hard wood origin lacks the percentage composition required to produce high quality soaps that would be tolerant to the skin without adverse health effect experienced after use. Details of the characteristics and composition of the liquid and bar soaps produced from the lye -extract from the Hard wood ash after adding the necessary reagents are demonstrated in this research.

2.0 METHODS, TECHNIQUES, STUDIED MATERIAL AND AREA DESCRIPTIONS

2.1 Studied Material: The major raw material used for this research study is the sawdust from Hard wood. It was collected from a Saw Mill located at Sandfill in illabuchi, Mile 2, Diobu, Port Harcourt, Rivers State, Nigeria and used for the production of liquid and bar soaps. Engineering measures were put in place to control the volume of hard wood sawdust discharged from the electric circular sawing machine and sawmill planing machine at a particular time. The hard wood sawdust generated were packed in large sacks and kept away safely for use at one corner of the Sawmill to avoid contamination with other wood types because these machines are used repeatedly on daily basis.



Figs. 1, 2 and 3 shows the Sectional View of the Sawdust Dump-Site in a Sawmill at Sandfill in illabuchi, Mile2 Diobu, Port Harcourt, River State, Nigeria.

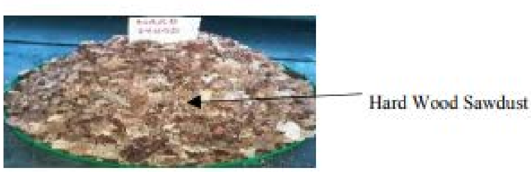


Figure 4 Showing a Sample of Hardwood Saw Dust Collected from the Sawmill

The materials used in this research work were further subdivided into apparatus and reagents and they are available in the Department of Chemical/Petrochemical Engineering Laboratory at Rivers State University, Port Harcourt, Nigeria

2.2 Area of the Study: The area of study is Rivers State University, Nkpolu – Oroworokwo, Port Harcourt, Nigeria.

2.3 Technique of the Study: The method adopted in this study was the experimental approach and this include: sample collection (sawdust from hard wood), combustion to ashes, leaching, extraction of lye, evaporation, saponification, separation (of liquid soap from foam and sediment) and moulding of soap cake to form bar soap.

2.4 Procedure for Extracting Lye from Sawdust

- 10kg of hard wood saw dust was combusted in a muffle furnace at a temperature of 450ºC for 12 hours till became powdered white-ash.
- 1kg of the ash was soaked in 2-Litres of warm distilled water and allowed to leach for 48hours and the solution obtained was extracted by filtering severally using a white cotton material and filter to get a clearer solution that showed alkalinity indicating that it is an alkaline extract, this is known as the Lye extract.
- Six (6) portions of the lye extract was obtained diluted with different volumes of distilled water and labelled A, B, C, D, E and F.

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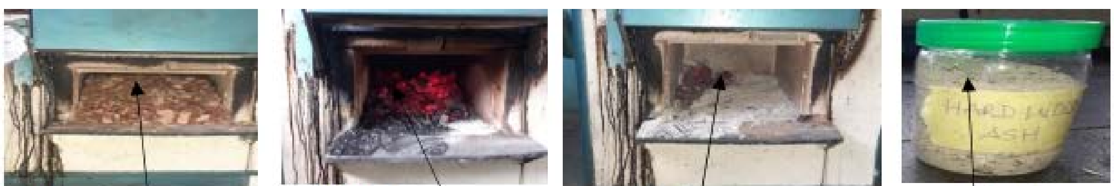

Figure 5 — Dry Sawdust in The Furnace; Figure 6 — Combustion of Sawdust; Figure 7 — White-ash formed; Figure 8 — Ash in air-tight container

Figs. 5, 6, 7 and 8 showing the Various Stages undergone to Combust Sawdust to Ash.

Figure 9: Soaked Ash; Figure 10: Filtration; Figure 11: Residue From; Figure 12: Lye; Figure 13: Evaporation

Figures 9, 10, 11, 12 and 13 Explaining the Extraction of Lye from Hardwood Sawdust and Evaporation of the Lye Extract for better Concentration.

2.5 Physicochemical Analysis of Lye Extract

2.5.1 Determination pH Value

- pH meter was standardized with buffer 7 solution and then 150ml of the lye extract sample was measured into a 250ml beaker.
- pH meter was inserted into the lye extract sample in the beaker and pH value of the sample was recorded.

2.5.2 Determination of Density

- Weight of the empty Pycnometer was measured (W_x).
- A volume of 50ml of the lye extract sample was poured into the Pyrometer (W_y).
- The weight of the lye extract and the Pyrometer were (W_z).

- Density (g/ml) = $\frac{Wz-Wx}{Wy}$.

2.5.3 Determination of Viscosity

- Lye extract sample was poured into a Cannon-Fenske Viscometer of 150 ASTM size.
- The lye sample was pumped till it reaches the highest calibrated mark of the viscometer before it was allowed to drop to the lowest calibrated mark of the apparatus and the flow time recorded with a stop watch, then the value obtained was multiplied by the ASTM constant 0.025
- The viscosity of the sample was measured and recorded in centistoke (cSt).

2.5.4 Determination of Water content of Sawdust

- The weight of empty crucible was measured (W_{a}).
- 10g of the sample (W_b) was added to the crucible.
- The weight became weight of the sample and crucible were measured to be (W_c).
- The sample was dried at a constant temperature of 105ºC till its fully dry.
- The weight of the crucible and the dry sample were measured (W_d) but the weight of the dry sawdust sample when measured alone was obtained as ($W_e = W_d – W_a$).

However, % Water content (W) = $\frac{Wd-Wa}{Wb}$ x 100.

2.5.5 Determination of Metal Composition

- Sample was passed through acid extraction and also digested.
- The metal elements were analysed using their individual wavelengths through a spectrophotometer.

3.0 RESULTS

The results obtained in this research work are presented using Figures and Tables as shown below:

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

Parameter	Unit	Sample (Hard Wood sawdust)
pH		7.5
Density	kg/m^3	1.00
Viscosity	cSt	2.672
Water Content	%	53.6

Table 2: Metal Content of Lye Extract from the Hard Saw Dust Compared to the Canadian Limit.

Metal content	Sample (mg/l)	Canadian Limit (mg/l)
Pb	1.00183	10-20
Fe	3.59624	19-60
Mg	1.43475	0.7-2.2
Ca	19.50093	7.4-33.1
Na	4.74821	24.4
K	7.31976	126.1
P	5.17342	0.3-1.4
Hg	0.00473	Nil

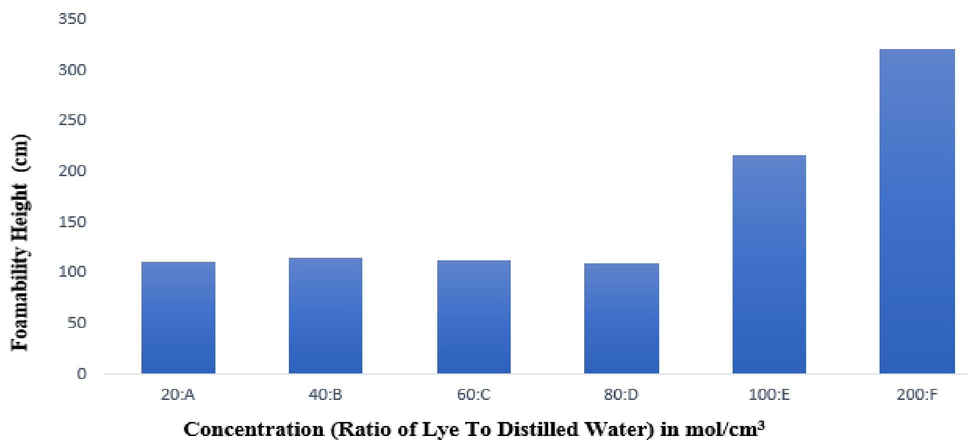

Figure 17: Plot of Foamability Height against the Concentration of Lye to Distilled Water Mixture.

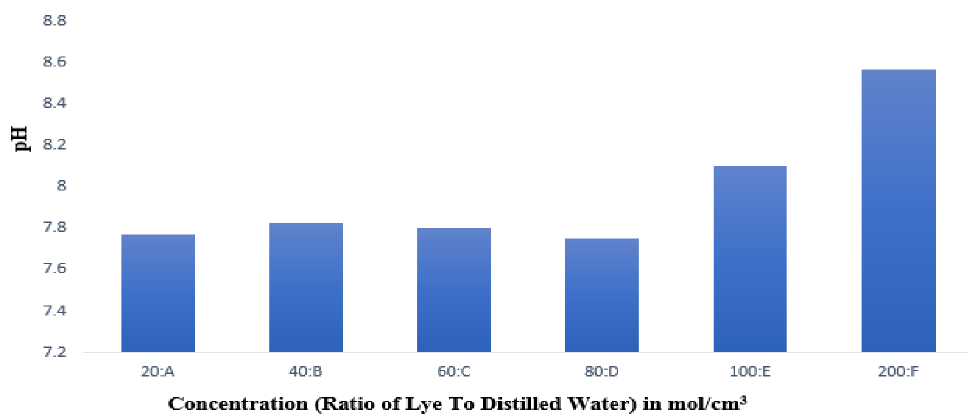

Figure 18: Plot of pH against the Concentration of Lye to Distilled Water Mixture.

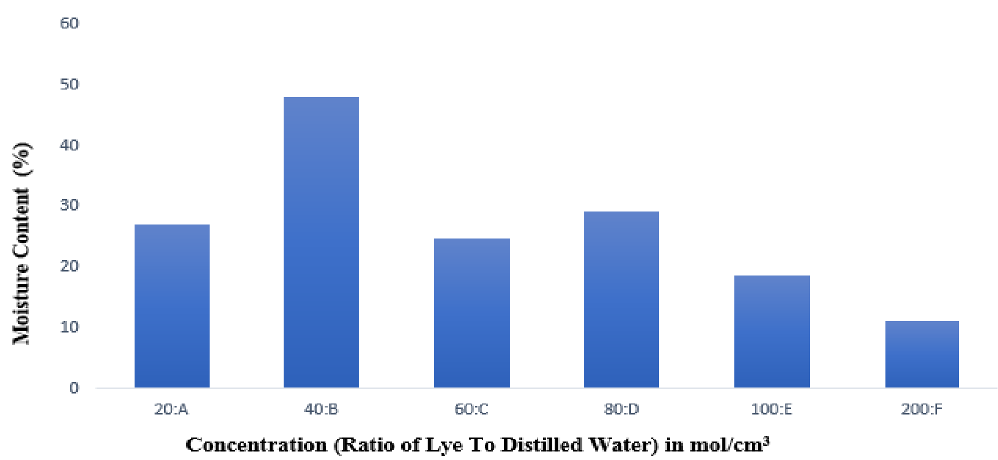

Figure 19: Plot of Moisture Content against the Concentration of Lye to Distilled Water Mixture.

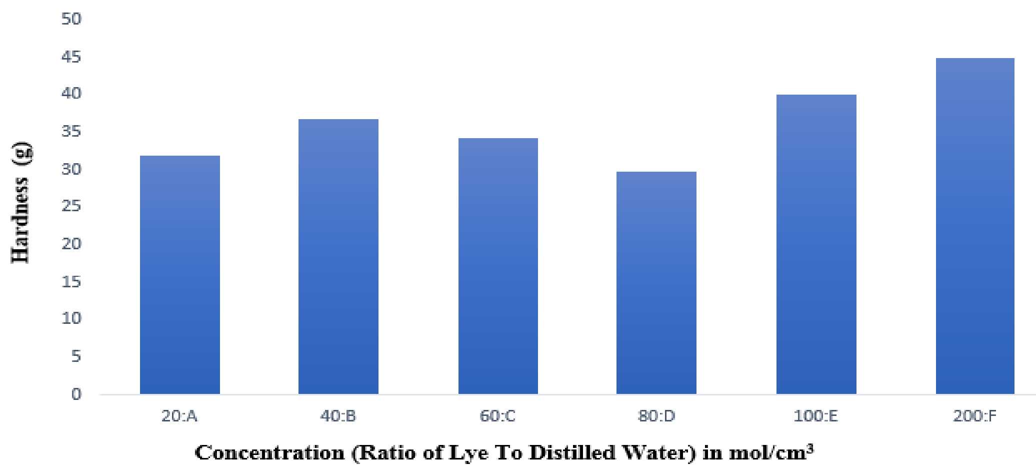

Figure 20: Plot of Hardness against the Concentration of Lye to Distilled Water Mixture.

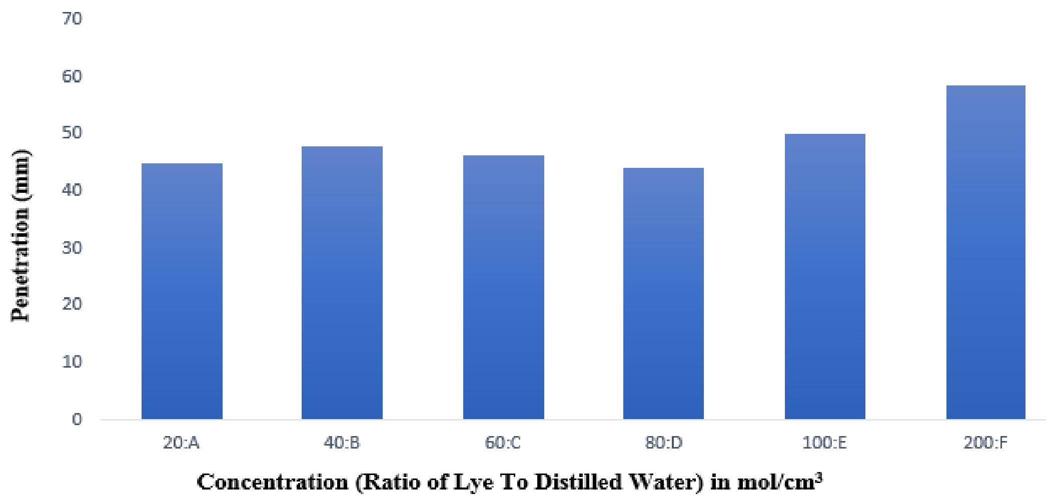

Figure 21: Plot of Penetration against the Concentration of Lye to Distilled Water Mixture.

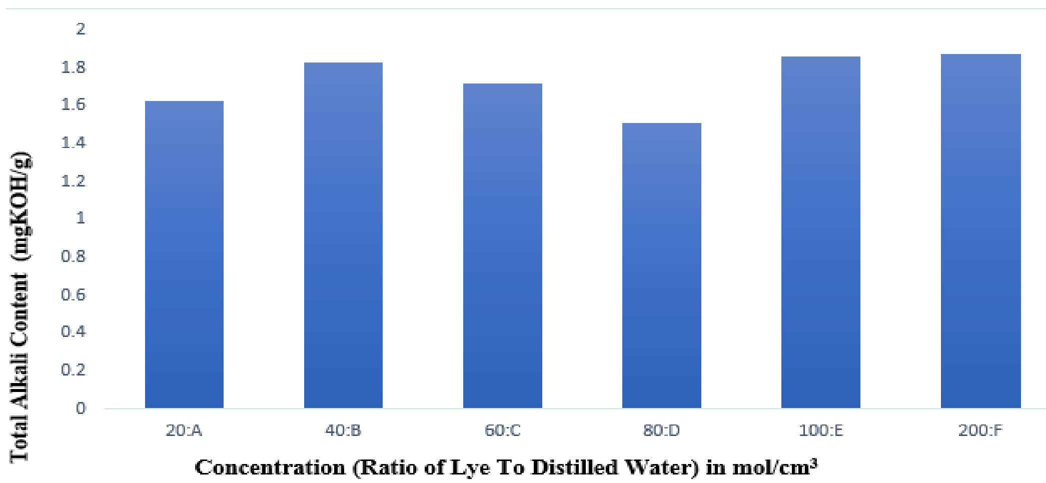

Figure 22: Plot of Total Alkali Content against the Concentration of Lye to Distilled Water Mixture.

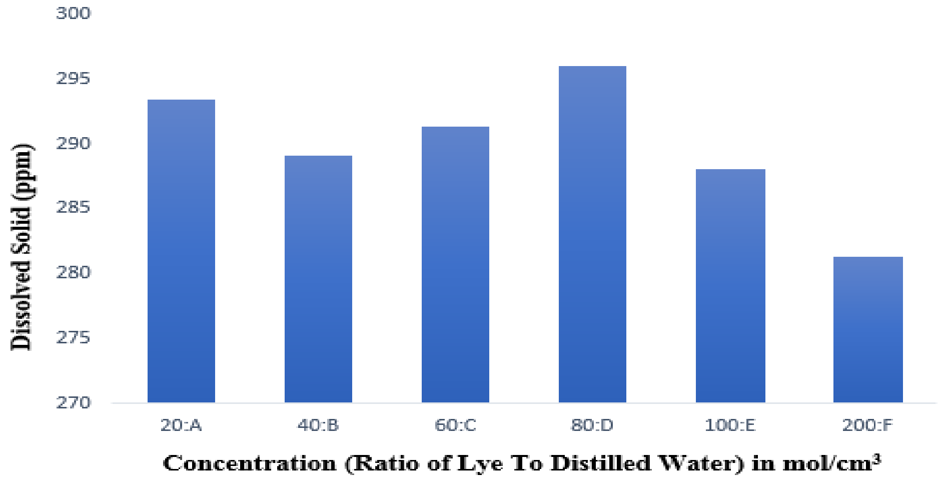

Figure 23: Plot of Dissolved Solids against the Concentration of Lye to Distilled Water Mixture.

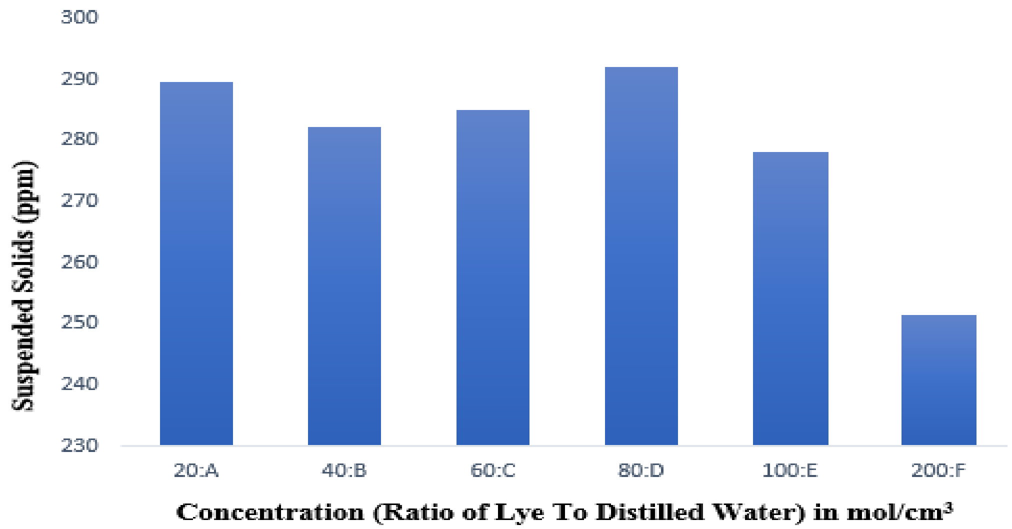

Figure 24: Plot of Suspended Solids against the Concentration of Lye to Distilled Water Mixture

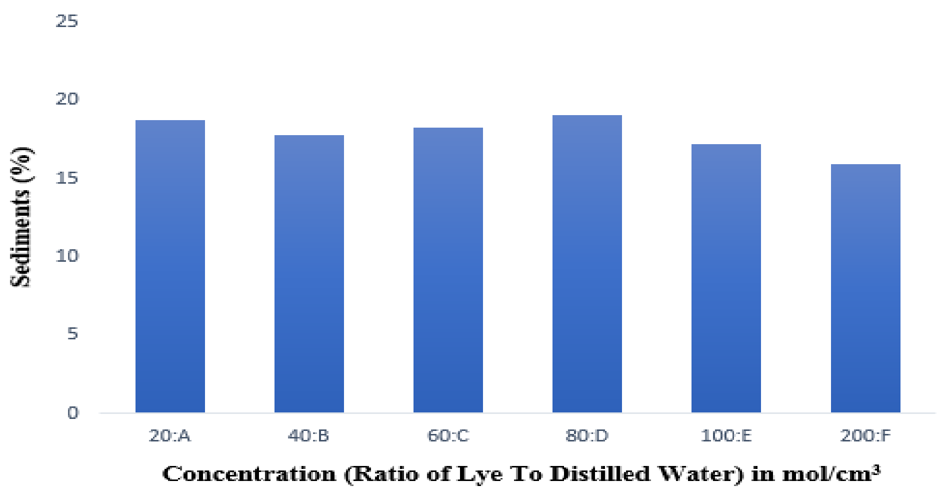

Figure 25: Plot of Sediments against the Concentration of Ratio of Lye to Distilled Water Mixture

4.0 DISCUSSION

Table 1 shows the results obtained from analysing lye extracts from the Hardwood sawdust for parameters like pH, Density, Viscosity and Water content. Whereas, Table 2 showed the result obtained from analysing the lye extract from the Hardwood sawdust for its metal composition are recorded as shown in Table 2 and compared to the Canadian acceptable limit. The results showed great deviation in the concentration of the metals present indicating that the lye extract is not suitable alone as an alternative raw material for soap production but requires the addition of more reagents to improve its concentration and suitability for soap production.

After the characterization of the Physicochemical Properties of the Soap, it was observed that the concentration of lye from the hardwood saw dust had effect on the foamability heights of the bar soaps produced from the hard wood saw dust as indicated in Figure 17 and also on the pH values of the bar soaps as shown in Figure 18 and this effect increased in the magnitude order of 200:F > 100: E > 40: B > 60: C >20: A > 80: D. The change in the foamability height and pH values of the bar soaps could be as a result of change in the concentration of lye (ratio mixture of lye to distilled water) used for the bar soap production.

Also, Figure 19 demonstrated the impact of concentration of lye on the moisture content of the bar soaps in an increasing magnitude order of 80: D > 20: A > 60: C 40: B 100: E > 200: F but the impact of concentration on the Hardness of the bar soaps as shown in Figure 20 increased in the magnitude order of 200:F > 100:E > 40:B > 60:C > 20:A > 80:D. This variation could be attributed to change in the concentration of lye used in the soap production.

In Figure 21, the impact of the concentration of lye in the penetration of bar soaps and the effect of lye on the Total Alkali content of soap as shown in Figure 22 were observed to increase in the magnitude order of: 200:F >100:E > 40:B >60:C >20:A > 80:D, their differences could be linked to the different concentration of lye used.

Figures 23, 24 and 25 showed the relationships beween concentration of lye on the dissolved solids, Suspended solids and the Sediments found in the produced soaps. Their variation occurred in an increasing order of 80:D >20: A > 60:C >40: B >100: E >200: F. The variation of Dissolved solids, Suspended solids and Sediments found in the soaps could be attributed to the change in the concentration of lye used for the soap production.

5.0 CONCLUSION

Based on the findings from the characterization of the physicochemical properties of the lye extract and the soaps produced, the following conclusions could be drawn:

1. The lye extracted from the hard wood sawdust did not meet up the acceptable limit in terms of its metal constituents required for the production of best quality soaps.
2. The lye extract does not give the best result when used alone for the production of soap unless more reagents were added to boost its constituents though it could be used as an alternative raw material for soap production as a way to help convert wastes to wealth in the absence of synthetic chemicals.
3. The water content in the lye was high and this could have affected the concentration of the lye which in turn affected the quality of soaps produced.
4. Also, the low pH value tested in the lye extract revealed that the lye obtained was acidic and soaps produced from it may pose health challenges when used.

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