

Physical Properties of Wall Clads Produced From Mixture of Saw Dust and Pure Water Sachet

Akinfiresoye W. Ayo, Olarewaju O. Opeyemi, Adebayo S. Ayodeji

Abstract—(16.5 x 36.5 x 145.5) mm clads were produced from the mixture of sawdust (SD) of three indigenous wood species (*Milicia excelsa*, *Ceibapetandra* and *Cola gigantea*) and nylon sachet (NS) of “pure water”. From each of the wood species, clads were produced at three different SD/NS ratios of 40:60, 30:70 and 20:80. The effect of the wood species and mix ratio on the physical properties (water absorption, thickness swelling and linear expansion) of the clads were investigated by immersing them inside water of temperature 20°C for 24 hours. NS was washed, dried, weighed as appropriate and allowed to melt at 190°C in the melting chamber of an existing locally produced Wood Plastic Composite Extruder (WPCE) of 0.8 kg/h capacity before adding SD which had earlier been dried to a moisture content of 10 % and sieved to size 10mm. The mixture was then fed into the WPCE kneading chamber for a thorough kneading into slurry form before extruding into a (20x 40x 150) mm mould which was hot pressed at 120°C and 1.12N/mm² force to a thickness of 16.5 mm, breadth 36.5 mm and length 145.5 mm. Samples were thereafter cut into specific dimension in accordance with British Standard D373. Results show that clads produced from *Milicia excelsa* at SD/NS mix ratio 20:80 were relatively low in water absorption, thickness swelling and linear expansion making it suitable for buildings protection in waterlogged areas.

Index Terms— *Ceibapetandra*, *Cola gigantea*, *Milicia excelsa*, Nylon Sachet.

I. INTRODUCTION

Waste generation is an important aspect of living which cannot be banished but can only be managed. These waste degrade the urban environment, and reduce its aesthetic value. As observed by [1], waste produce offensive odours during the rain and pollute the air with smoke when burnt uncontrollably.

They also constitute health hazards in themselves if they are not timely or badly disposed, and they become breeding places for worms and insects as also observed by [2]. Wood and polymeric wastes whose pictures are shown in Plates 1 and 2 are two major wastes identified to be common and poses great threat to healthy living in Nigeria according to [3] and [4].



Plate 1. Nylon sachet pure water (NS)



Plate 2. Heap of sawdust (SD)

Nigeria is one of the countries with large number of polymeric wastes made from polyethylene water sachet popularly called “Pure Water” [5]. PWS is non-biodegradable, and as such belongs to single-use plastic group. They can however be recycled by crafting it to another useful products, but unfortunately it mostly ends up on landfills or littering the ground after use [6]. [7] discovered that sachet water was introduced to the Nigerian market around 1990 and started attracting nationwide attention from year 2000 when the country’s National Agency for Food and Drugs Administration Control (NAFDAC) registered 134 different 10 packaged water producers. This led to the emergence and proliferation of private water enterprises that operated side by side with the government-owned public water utilities resulting in increase in their waste. As reported by [5] in the work of [8], about 70% of Nigerian adults drink, at least, a sachet of water per day. Unfortunately, the nylon used to package the sachet water are poorly disposed leading to environmental pollution and outbreak of diseases [9]. As also observed by [10], sachet water is all over Nigeria these days; and after drinking the water, the containers (plastic materials) is simply dumped anywhere. The same goes for wood waste popularly called saw dust (SD) in Nigeria. Wood dust or waste is the product of wood shavings from machining wood; it refers to the tiny sized and powdery waste produced by sawing of wood [11]. Wood processing and improper disposal of its wastes oftentimes results in emission of toxic when burnt and non-toxic particulates, pollution of

inland waters and may also contribute to health hazards [12] and [13]. The saw mill industry in Nigeria keep increasing and as such the waste from the processed wood are rising without adequate measure for their disposal [14]. The deleterious effects of wood wastes can be curtailed by incorporating these items in the production of value added composite products [15] and [16]. Many Researchers have used plastic, especially polyethylene (PET) extensively as binder in the production of Wood Plastic Composites [4], [16], [17], [18], [19]. Lesser attention have been paid to nylon obtained from sachet pure water which also is a major source of municipal waste according to the research carried out by [5]. SD can be mixed with nylon sachet under specific heat to produce clads. Clads provide a degree of thermal insulation and fire resistance to buildings, and also improve the aesthetic appearance of farm structures according to [20]. According to [21], cladding is a type of “skin” or extra layer on the outside of a building. It can be attached to a building’s framework or an intermediate layer of battens or spaces. It is mainly used to stop wind and rain from entering the building. It is also used to make a building exterior look more attractive. Clads are made from wood, metal, block, vinyl, and composite materials that can include aluminum, wood, blends of cement and recycled polystyrene, wheat/rice straw fibers. This prompted the research on how clads can be produced from waste materials using simple technology. *Miliciaexelsa*, *Ceibapetandra* and *Cola gigantia* are common indigenous trees in South Western part of Nigeria, hence its selection for the research. The physical properties of clads produced from the sawdust of these trees using water sachet nylon as the binder will enable us to know the type of tree and the mix ratio of SD and NS that is most suitable for farm structures against adverse weather condition.

II. MATERIALS AND METHODS

Sawdust (SD) from wood species (*Miliciaexelsa*, *Ceibapetandra* and *Cola gigantia*) were sourced from Olukayode Sawmill in Akure, Nigeria, while the Nylon Sachet (NS) were got from the male hostel refuse bin of the Federal University of Technology, Akure. The study was carried out at the Farm Power and Machinery Workshop of Agricultural and Bio-Environmental Engineering Department of the Federal University of Technology, Akure. The moisture content of SD was reduced to 10 % by exposing them to the sun using hygrometer to measure the reduction in moisture content. This was done in order to reduce the moisture content of the wood cell lumen and gives room for the liquid NS diffusion. The SD was then sieved to a particle size of 2.00 mm for thorough and homogeneous mixing of SD and melted NS. Three mix ratios of SD/NS were chosen as 40:60, 30:70 and 20:80 after the initial trial test in respect to the three types of wood species under investigation. For the first group, *Miliciaexelsa*, NS was weighed to 210 g using electronic digital weighing machine while the SD was weighed to 84 g, 63 g and 42 g representing 40 %, 30 % and 20 % of 210 g of NS. This procedure was repeated for *Ceibapetandra* and *Cola gigantia* respectively. For the first group, *Miliciaexelsa*, 210 g of NS was melt inside the melting and mixing chamber of an

existing WPC extruder at a constant temperature of 190°C through a 3.5 Kw heat band. Thereafter 84 g of SD was added, stirred and allowed to fall under gravity into the extruding chamber of the machine, still maintaining the temperature at 190°C. The extruder kneaded the mixture thoroughly at machine speed of 277 rpm for 5 minutes after which it was collected into a mould of size 16.5mm x 36.5mm x 145.5mm. This was hot pressed at 120°C and 1.12N/mm² force to a thickness of 16.5mm and left for 15 minutes to give room for solidification before removal. Infrared thermometer and calibrated hydraulic press locally fabricated were used to measure the temperature and the thickness of the clad inside the mould while pressing it. This procedure was repeated for the other species of wood, *Ceibapetandra* and *Cola gigantia* respectively. Three sets of cladding were produced (Figure 2.0) for each group and a total of nine products which were subjected to physical properties investigation.

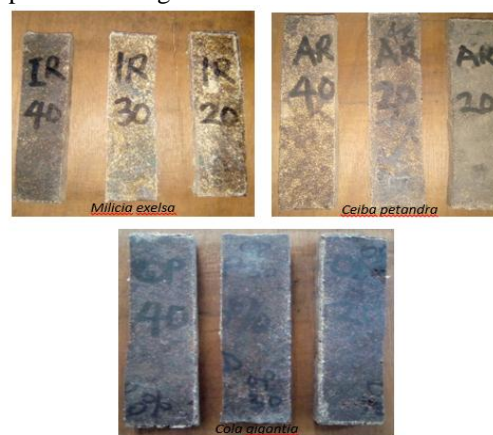


Fig. 2.0: Flat cladding produced from saw dust and nylon
A. Physical Properties Test

The physical properties tested include water absorption, thickness swelling, and linear expansion. The instruments used to carry out this test were electronic digital weighing balance, ruler, vernier calliper, micrometer screw gauge, stopwatch, hacksaw, plastic bowls and calculator. Required samples to be tested were still trimmed to conform to the dimensional size of 16.5 mm x 36.5 mm x 145.5 mm from each of the flat platen cladding in accordance to [22]. The initial weight, thickness and length of the clads were taken as W_0 , T_0 and L_0 respectively before immersing inside water of temperature 20°C. These parameters were measured at the end of the first 2 hours of water immersion, then the 12th hour and finally at the end of the 24 hours as W_1 , T_1 and L_1 representing the final weight, final thickness and final length of the clads respectively. According to [4], the Water Absorption (W.A.), Thickness Swelling (T.S.) and the Linear Expansion (L.E.) of the clads were thereafter calculated from the data obtained as in equations (1), (2) and (3).

$$W.A. (%) = \frac{W_1 - W_0}{W_0} \times 100 \quad \text{eqn (1)}$$

$$T.S. (%) = \frac{T_1 - T_0}{T_0} \times 100 \quad \text{eqn (2)}$$

$$L.E. (%) = \frac{L_1 - L_0}{L_0} \times 100 \quad \text{eqn (3)}$$

Data collected were statistically analyzed using experimental model design of 2³ factorial in Complete Randomized Design (CRD) using SPSS software of version 13.0. Analysis of variance (ANOVA) was used to establish the significance of the independent variables (W.A., T.S. and L.E) on the dependent variables (wood type and mix).

III. RESULTS AND DISCUSSION

A. Physical properties

The physical properties investigated were the water absorption, the thickness swelling and the linear expansion.

1. Water absorption

As shown in Figure 3.0, at the end of the first 2 hours of moisture immersion test, the water absorbed by clads produced by the three types of tree samples ranged from 1.69 % to 2.80 %. Samples obtained from *Miliciaexelsa* absorbed the least water of 1.47 %, 0.85 % and 0.88 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. This is followed by that of *Ceibapetandra* of 2.80 %, 2.29 % and 1.60% and *Cola gigantia* having the greatest percentage of water absorbed as 4.49 %, 2.88 % and 1.69 % for same mix ratio respectively. This trend was observed at the end of the 10 hours of the immersion test as shown in the bar chart of Figure 3.1. While each of the samples absorbed more water when compared to the end of the first 2 hours; *Miliciaexelsa* still absorbed the least as it moved from 1.47 %, 0.85 %, 0.88 % to 3.68 %, 2.56 % and 1.75 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. However, SD/NS 30:70 mix ratio of *Miliciaexelsa* which absorbed lesser water of 0.85 % as against the 0.88 % of 20:80 mix ratio now rose to 2.56 % and 1.75 % for the 30:70 and 20:80 mix ratio respectively at the end of the 10 hours of immersion test. *Ceibapetandra* followed in this order as they moved from 2.80 %, 2.29 %, 1.60% to 4.9 %, 5.34 % and 4.00 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. *Cola gigantia* rose from 4.49 %, 2.88 %, 1.69 % to 6.41 %, 5.77 % and 5.08 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. At the end of 24 hours of water immersion test as shown in Figure 3.2, Clads produced from *Miliciaexelsa* has the least water absorption of 4.41 %, 2.56 % and 1.75 % of SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. The ones produced from *Ceibapetandra* followed with 5.59 %, 5.34 % and 4.80 % values of water absorption for SD:NS mix ratio of 40:60, 30:70 and 20:80 respectively. Clads produced from *Cola gigantia* has the highest water absorption of 8.33 %, 7.69% and 6.78 % of SD:NS mix ratio of 40:60, 30:70 and 20:80 respectively.

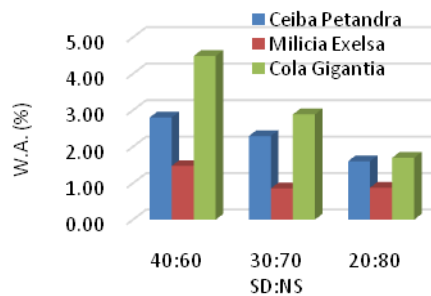


Fig.3.0. Effect of wood specie and nylon mix ratio on water absorption of clad after 2 hours of water immersion.

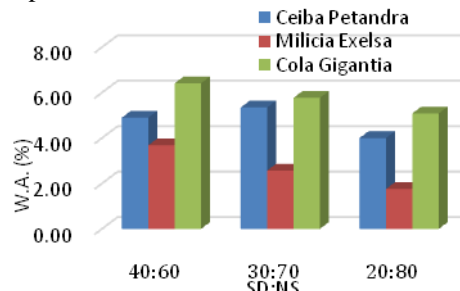


Fig.3.1. Effect of wood specie and nylon mix ratio on water absorption of clad after 12 hours of water immersion.

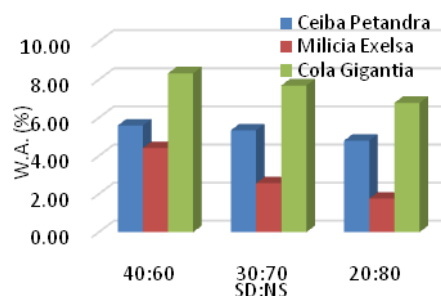


Fig.3.2. Effect of wood specie and nylon mix ratio on water absorption of clad after 24 hours of water immersion.

2. Thickness swelling

The thickness swelling (T.S.) results is as represented in Figures 3.3, 3.4 and 3.5. At the end of 2 hours of water immersion, claddings produced from *Miliciaexelsa* swells the least by 11.5 %, 9.2 % and 7.7 % for 40:60, 30:70 and 20:80 SD/NS mix ratio respectively. At the same ratio, *Ceibapetandra* followed after *Miliciaexelsa* by 14.6 %, 13.8 % and 10.8 % respectively. The highest TS at the end of 2 hours immersion test was clad produced from *Cola gigantia* with 15.4 %, 14.6 % and 13.8 % for the 40:60, 30:70 and 20:80 SD/NS mix ratio respectively. At the end of the 10 hours of immersion test, there was a steady increase in the T.S. as clad produced from *Miliciaexelsa* have T.S. of 13.8 %, 11.5 % and 10.8 %; that of *Ceibapetandra* increased to 16.9 %, 15.4 % and 11.5 %; and specimen from *Cola gigantia* increased to 19.2 %, 16.9 %, and 12.3 % for SD/NS mix ratio of 40:60, 30:70 and 20:80. This movement was maintained at the end of 24 hours of immersion test whereby cladding produced from *Miliciaexelsa* swells the least at 14.6 %, 13.8 % and 12.3 % for 40:60, 30:70 and 20:80 SD/NS mix ratio respectively. This was followed by claddings produced from the trees of *Ceibapetandra* and *Cola gigantia* in that order with TS values of 17.7 %, 16.2 %, 13.1 % and 20.0 %, 18.5% 15 % for SD/NS mix ratio 40:60, 30:70 and 20:80

respectively.

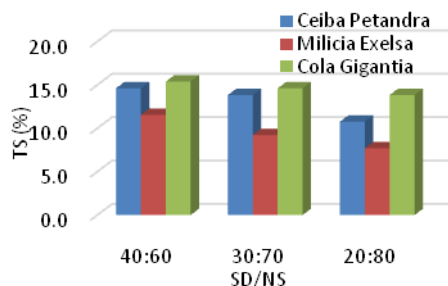


Fig.3.3. Effect of wood specie and nylon mix ratio on thickness swelling of clad after 2 hours of water immersion.

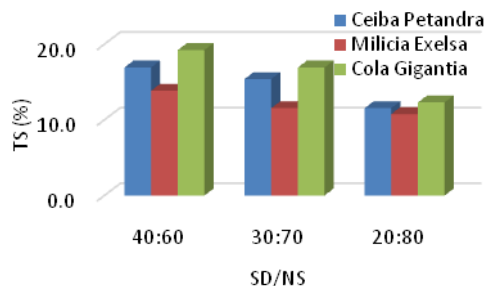


Fig.3.4. Effect of wood specie and nylon mix ratio on thickness swelling of clad after 12 hours of water immersion.

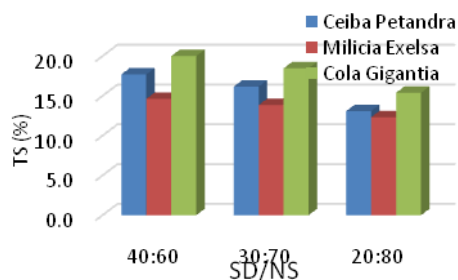


Fig.3.5. Effect of wood specie and nylon mix ratio on thickness swelling of clad after 24 hours of water immersion.

3. Linear expansion

The linear expansion (L.E.) of clads produced from the saw dust of *Miliciaexelsa*, *Ceibapetandra* and *Cola gigantia* at the end of the 2 h, 10 h and 24 h of water immersion test ranged from 0.03 % to 1.40 % as expressed in the bar charts of Figures 3.6, 3.7 and 3.8 respectively. At the end of the 2 hours water immersion test, clads produced from *Miliciaexelsa* had the least linear expansion (L.E.) for SD/NS mix ratio of 40:60, 30:70, and 20:80 as 0.14 %, 0.10 % and 0.03 % respectively. This was followed by the ones produced from *Ceibapetandra* with values 0.28 %, 0.21 % and 0.10 % at the same mix ratio of SD/NS respectively. Clads produced from *Cola gigantia* had the highest L.E. of 0.70 %, 0.56 %, and 0.35 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. This trend continued at the end of the 10 hours of water immersion test. L.E. of clads from *Miliciaexelsa* increased to 0.21 %, 0.15 % and 0.14 %, that of *Ceibapetandra* increased to 0.42%, 0.28% and 0.17 %, and that of *Cola gigantia* increased to 1.26 %, 0.77 % and 0.56 % for SD/NS mix ratio of 40:60, 30:70 and 20:80 respectively. At the end of the 24 hours of water immersion test, there was a minimal increase in the L.E. of clads

produced from *Miliciaexelsa* by 0.22 %, 0.17 % and 0.16 %; *Ceibapetandra*, 0.49 %, 0.35 % and 0.21 %; *Cola gigantia*, 1.40 %, 1.19 % and 0.70 % for SD/NS mix ratio of 40:60, 30:70, and 20:80 respectively.

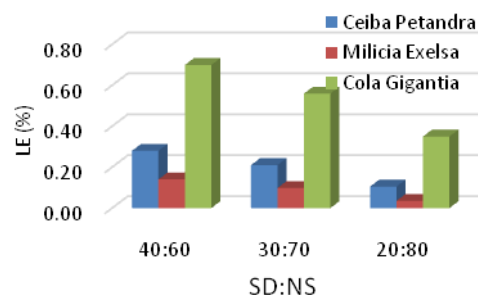


Fig.3.6. Effect of wood specie and nylon mix ratio on linear expansion of clad after 2 hours of water immersion.

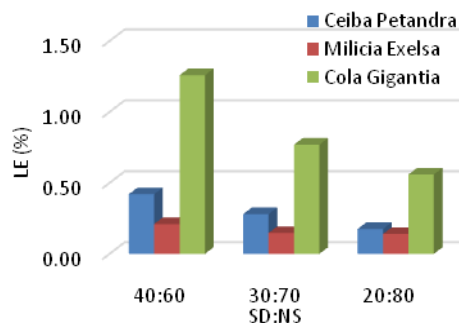


Fig.3.7. Effect of wood specie and nylon mix ratio on linear expansion of clad after 12 hours of water immersion.

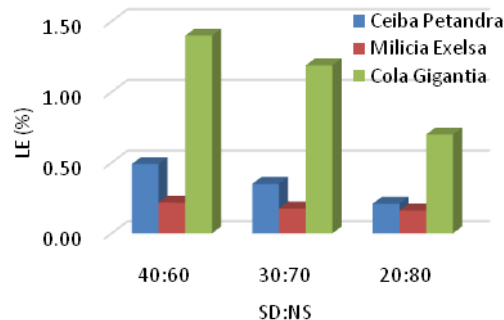


Fig.3.8. Effect of wood specie and nylon mix ratio on linear expansion of clad after 24 hours of water immersion.

It was generally observed for all the three species of wood that the higher the NS content, the lower the water absorbed, thickness swelling, linear expansion while the higher the SD content, the higher the water absorbed, thickness swelling and linear expansion. This agrees with the related work of [19] and [4] as reported by [24] on the properties of wood plastic composites. Specifically, it was discovered that clads produced from *Miliciaexelsa* of SD/NS mix ratio of 30:70 and 20:80 no longer absorb water after 10 hours of their immersion up till the 24th hour. The same observation goes for the thickness swelling and the linear expansion at same ratio and time. This may be as a result of the type of tree and

the hydrophobic nature of thermoplastic generally of which nylon is a family as observed in the work of [16] and [6] on the properties of wood plastic composites.

As shown in Tables 1, 2 and 3, Statistical analysis of variance conducted on the independent factors (type of woods and mix ratio) and dependent factors (W.A., T.S. and L.E.) at 5% level of probability revealed that the wood specie and the time specimen spent in water have significant effects on its water absorption, thickness swelling and linear expansion all through the 2 hours, 10 hours and up to 24 hours. Whereas, the mix ratio does not have significant effect on the

specimens' water absorption after the first 2 hours spent in water until the 10th and 24th hour. This was different for T.S., though very little, the mix ratio has effect on the specimen T.S. at the end of the 2 hours, 10 hours and 24 hours of water immersion test. This also was different for L.E., the mix ratio of SD/NS have a significant effect only after the 2 h of water immersion test, but were no longer significant for the 10th and 24th hour under investigation. This implies that the type of wood and SD/NS mix ratio have significant effect on the physical properties of clads when exposed to rainfall.

TABLE 1. ANOVA FOR 2 H WATER IMMERSION

Source of Variation	df	2 h P-value		
		WA	TS	LE
Wood Specie	2	0.036*	0.004*	0.002*
Mix Ratio	2	0.076 ^{ns}	0.024*	0.038*
Error	4			
Total	8			

*significant at (P<0.05) probability level; ns not significant at (P<0.05) probability level

TABLE 2. ANOVA FOR 12 H WATER IMMERSION

Source of Variation	df	12 h P-value		
		WA	TS	LE
Wood Specie	2	0.002*	0.030*	0.014*
Mix Ratio	2	0.035*	0.014*	0.148 ^{ns}
Error	4			
Total	8			

*significant at (P<0.05) probability level; ns not significant at (P<0.05) probability level

TABLE 3. ANOVA FOR 24 H WATER IMMERSION

Source of Variation	df	24 h P-value		
		WA	TS	LE
Wood Specie	2	0.001*	0.004*	0.006*
Mix Ratio	2	0.041*	0.005*	0.152 ^{ns}
Error	4			
Total	8			

*significant at (P<0.05) probability level; ns not significant at (P<0.05) probability level

IV. CONCLUSION

The investigation on the effect of three indigenous wood species at three SD/NS mix ratios for clad production was successfully carried out. Clads produced from *Miliciaexelsa* and *Ceibapetandra* in that order were both outstanding after exposure to moisture content for 24 hours. They were dimensionally stable than clads produced from *Cola gigantia*. However, the SD/NS mix ratio of 20:80 of *Miliciaexelsa* was more resistance to water uptake, thickness swelling and linear expansion than the other mix ratios of 30:70 and 40:60. From this study, it is important to consider the type of wood and its mix ratio with the binder before embarking on the production of clads. It is seen from this research also that clads produced from the saw dust of

Miliciaexelsa are more suitable for farm building in areas prone to water logging and for aesthetic structural designs. More research should still be conducted on indigenous wood species from different region to different continent, and other polymeric binder in order to ascertain the suitability of the wood species for clad production.

REFERENCES

- [1] O.O. Dosunmu, and A.B. Ajayi, "Problems and management of sawmill waste in Lagos". Proceedings of International Symposium on Environmental Pollution Control and Waste Management 7-10 January 2002, Tunis (EPCOWM'2002), p.271-278.
- [2] O. Kehinde, M. Godswill, P. Anita, and R. Tobias, "Nigerian Wood Waste": A Dependable and Renewable Fuel Option for Power Production World Journal of Engineering and Technology, 2014, 2, 234-248
- [3] E.B. Ogunbode, F.O. Fabunmi, S.M. Ibrahim, I.O. Jimoh, and O.O. Idowu, "Management of Sawmill Wastes in Nigeria": Case Study of Minna, Niger State. Greener Journal of Science, Engineering and

- Technology Research ISSN: 2276-7835 Vol. 3 (2), pp. 034-041, February 2013.
- [4] K.S.Aina, E.O. Osuntuyi, and A.S. Aruwajoye, "Comparative Studies on Physico-Mechanical Properties of Wood Plastic Composites Produced from three Indigenous Wood Species". *International Journal of Science and Research*. 2(8): 226 -230 – 2013
 - [5] I.O. Bamidele, O.S. Dahunsi, M.A. Awogboro, S.O. Oladipupo, "Investigation of the Properties of "Pure Water" Sachet Modified Bitumen". *Civil and Environmental Research*, Vol.3, No.2, 2013 47-2013.
 - [6] G.J. Roland, R.J. Jenna, and L.L. Kara, "Production, use, and fate of all plastics ever made" *Science Advances* 3(7), 2017. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5517107/>
 - [7] J.I. Onemano, and J.A. Otun, "Problems on water quality standards and monitoring in Nigeria". Paper presented at the 29th Water, Engineering and Development Centre International Conference, in Abuja, Nigeria. 2003
 - [8] M.O. Edoga, L.I. Onyeji, and O.O. Oguntosin, "Achieving Vision 20:2020 through Waste Produce Candle". *Journal of Engineering and Applied Sciences*, 3(8): 642-646. 2008
 - [9] K.N. Aroh, E.M. Eze, D. Ukaji, C. Wachuku, A.E. Gobo, S.D. Abbe, S.C. Teme, and A.H. Igoni, "Health and environmental components of sachet water consumption and trade in Aba and Port Harcourt, Nigeria". *Journal of Chemical Engineering and Materials Science* Vol. 4(2), pp. 13-22, 2013.
 - [10] D.J. Idiata, N.R. Agbale, and K. Iguisi, "Menace of Sachet Water Waste in Benin City, Nigeria". *Oriental Journal of Scientific research* Vol.2 (1) 2013.
 - [11] R.T. Maharani, T.Y. Yutaka, and T. Minoru, "Scrutiny on Physical Properties of Sawdust from Tropical Commercial Wood Species - Effects of Different Mills and Sawdust's Particle Size" *Journal of Forestry Research*, Vol.7, No.1 pp20-32, (2010).
 - [12] W.A. Akinfiresoye, O.J. Olukunle, and A.A. Akintade, Development of Wood Plastic Extruder. *International Journal of Waste Resources*. Vol. 7 – Iss. 3 – 1000251. ISSN: 2252 – 5211. 2017
 - [13] K. Oluoti, G. Megwai, A. Petterson, and T. Richards, "Nigerian Wood Waste: A Dependable and Renewable Fuel Option for Power Production". *World Journal of Engineering and Technology* (ISSN: 2331-4222 (P) 2331-4249 (O)). 2, 234-248. 2014
 - [14] S.O. Ojo, and B.M. Obalokun, "Analyses of Productivity and Technical Efficiency of Sawmill Industries in Nigeria". *Journal of Tropical Forest Science* 7(3):428-437 (2005).
 - [15] O.A. Olufemi, and G.M. Armando, "Evaluation of Wood Plastic Composites from Mahogany and Teak". *International Journal of Advanced Engineering Research and Sciences*. (4): 27-32. 2017
 - [16] W.A. Akinfiresoye, O.J. Olukunle, A.S. Oyerinde, A.A. Akintade, and A.S. Olutayo, Physico-Mechanical Characterisation of Wood Plastic Composites Produced from Indigenous Trees in Nigeria. *International Journal of Research*. Vol.6. Iss.2. ISSN. 2394-3629. 2018.
 - [17] K.O. Oladejo, and T.E. Omoniyi, "Dimensional Stability and Mechanical Properties of Wood Plastic Composites Produced from Sawdust of *Anogeissus leiocarpus* (Ayin) with Recycled Polyethylene Terephthalate (PET) Chips". *European Journal of Applied Engineering and Scientific Research*, 2017, 5 (1): 28-33. 2017.
 - [18] J. I. Fabiyi, A.G. McDonald, "Effect of wood species on property and weathering performance of wood plastic composites". Part A 41: 1434 -1440. 2009.
 - [19] K.S. Aina, E.O. Osuntuyi, and J.A. Fuwape, "Effect of weathering on strength properties of wood plastic composites produced from *Gmelina arborea*". *Nigerian Journal of Forestry*, 38(1):62 -73. 2008
 - [20] B. Adam, "What is Cladding, and Why can it be a Fire Risk? 2017 The Daily Telegraph Retrieved online on 29/03/2021 at <https://www.telegraph.co.uk/news/0/cladding-fire-risk-grenfell-tower/>.
 - [21] Sydney Morning Herald, What is Cladding and why is it used on Building? Australia Building Codes Board. NSW Government Online. Retrieved on 29/03/2021. [https://en.m.wikipedia.org/wiki/Cladding_\(construction\)](https://en.m.wikipedia.org/wiki/Cladding_(construction)) 2017
 - [22] BS D373, British Standard Institutions. Specifications for wood chipboard and methods of test for particleboard. BS 5669: 1989.
 - [23] D. N. Izekor, and M.E. Mordi, "Dimensional Stability and Strength Properties of Wood Plastic Composites Produced from Sawdust of *Cordia alliodora* (Ruiz and Pav)." *Journal of Applied and Natural Science* 2014. 6(2):338-343.