Investigating the Physical and Mechanical Properties of Broadleaf Cattail (*Typha Latifolia*) and Water Hyacinth (*Eichhornia Crassipes*) Paper Blend

*Alebiosu S. O., Akindiya I. O., Mohammed Raji A., Adefidipe O. A.
Department of Polymer & Textile Technology,
Yaba College of Technology.
Yaba. Lagos State

***Abstract:-* Water hyacinth (*Elchhornia Crassipes*) and broad leaf cattail (*Typha Latifolia*) plants are wastes in the environment; water hyacinth is a free float perennial aquatic plant which causes a lot of problems in the aquatic water ways by hindering the flow of water, boating and at times killing fishes. Broadleaf cattail is a wild grass grown in the guinea savanna; it is more or less of no use to both animal as feed and human being. Since higher percentage of paper production is gotten from trees, in which felling of these trees is causing a lot of problems to the eco- system by increasing global warming. This research work produced papers from the blend of water hyacinth and broadleaf cattail in the proportion of 100%, 60/40%, 50/50% and 40/60% ratio. Water hyacinth and broadleaf cattail pulps were obtained by soda pulping of their dried leafs and handmade papers were produced from the pulps. Physical and mechanical properties of the paper sheets produced were investigated. 40/60 water hyacinth /broad leaf cattail has the highest tensile strength of 14.99Mpa and tear strength of 2.51MPa , 100% bleached water hyacinth has the highest elongation at break of 5.9mm, 60/40 water hyacinth / broad leaf cattail has the highest resistance to abrasion of 1.08% weight loss. The behaviour of 40/60 water hyacinth/broad leaf cattail having the highest tensile and tear strength may be due to the high percentage of long fibre of broad leaf cattail. The blend of these wastes leaves gives them a better economic value and they can be a good substitute for pulp making which will in turn reduce the deforestation cause by pulp making from felling of trees.**

Keywords: Paper, Water Hyacinth, Pulp, Broadleaf cattail and Waste

INTRODUCTION

Pulp and paper making has been an age long activity, even with the increase knowledge and usage of ICT; paper production and pulp making is still on the increase all over the world [1]. Papers have vast usage in packaging, writing and etc [2]. Papers are been used for community currency [3]. There are a lot of problems associated with paper making and pulp production from wood, which include deforestation, high energy consumption, increase global warming [4, 5]. It also account for huge pollution of air and water [6]. To reduce the menaces caused by wood pulping , alternative sources of raw materials for paper production is necessary. In view of this, a lot of research works are being carried out [7]. Egypt has an ancient history in paper production [8]. Principles of paper making, was first established in china [9]. Researchers has been working on numerous non- wood materials for paper production so as to reduce if not totally solve these problems; materials like hemp, flax, and rags [10]. Kenaf tree bark and corn husk [11]. bagasse and banana stem [12], commercial paper making with kenaf [13], Canaabis sativa for paper making [14] , water hyacinth for parchment like paper [15], among others. Water hyacinth (*Eichhornia crassipes)* is an aquatic plant, which float freely on water. It causes a lot of problems in the aquatic region like hindering of marine transportation, fishing and irrigation and hydro power generation etc. water hyacinth is found in almost all the region of the world, and been put to many usages like pollution control. The plant has buoyancy ability and it is asexual in nature which makes it multiply easily and rapidly [16]. In the aquatic area water hyacinth harbours disease carrying insects [17]. Broadleaf cattail (*Typha catifolia*) is a common plant in most part of the world , though grow better in the wetland area [18]. It was tagged, 'world worst weed', it reduces rice production [19]. In some part of the world it is named unwanted organism [20]. Based on the attributes of these two plants, as seen as almost a menace to their environment. This research work aimed at producing pulp for paper production from the blend of these two plants (i.e water hyacinth (*Eichhornia crassipes)* and Broadleaf cattail (*Typha latifolia*) and investigates the physical and mechanical properties of the products.

MATERIALS AND METHODOLOGY MATERIALS

Water hyacinth (*Eichhornia crassipes*) and Broadleaf Cattail (*Tappi latifolia)* collected from Majidun Awori, Ikorodu, Lagos. Nigeria. Beaker, Caustic Soda (NaOH) from Loba cheime PVT Ltd. India, Hydrogen Peroxide (H_2O_2) from BOH chemical Ltd. Poole. England. Rosin, Water (H_2O), Mesh (A4 and round), Beaker. Conical flask, Measuring cylinder, Petri-dish, Weighing balance, Spatula, Stirrer, Soxhlet extractor, Thimble, Retort stand. Ovens: SVAC4 SHEL LAB Vacuum Oven, 4.5 Cu.Ft. (127 L) United States. Digester: PL1-00Model, Manufacturer : Xianyang Taist Test Equipment Co., LTD.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

METHOD

Materials- water hyacinth and broadleaf cattail, were left to dry so as to reduce their moisture content. Dried stem of the plants were chopped into smaller bits, their moisture content analysed by moisture content analyser, the value gotten for the moisture content helped in determining the amount of water to be used for the proceessing, then the bath containing caustic soda was prepared using TAPPI (Technical Association of the Pulp and Paper Industry standard). The chopped stems were weighed indiviually and put into conical flasks that contains the caustic soda bath after which they were placed into the digester at temperature of 120° C for 45 mins and pressure of 0.1 MPa (this process is known as pulping). The digester was stopped, allowed to cool, the conical flasks brought out, and the content emptied into a mesh, washed under running water then placed in the oven to dry.

After drying in the oven with temperature of 90° C, the samples were weighed to determine the yield of the plants, then a quantity of each sample was taken for the extraction process- where all extracts were checked with ethanol.

What was left of the pulps were then weighed and then bleached using hydrogen peroxide (H_2O_2) to get bleached samples, while for the unbleached samples the process of adding hydrogen peroxide was skipped.

The above process was followed in producing 100% water hyacinth as well as 100% Broadleaf Cattail, while for 50% Broadleaf Cattail and water hyacinth the weight of the pulp was same, while that of 40% broadleaf cattailand 60% water hyacinth was done in ratio of 40:60 respectively in terms of weight, and the same was repeated for 60% Broadleaf Cattail and 40% water hyacinth.

The pulp gotten was then placed in the valley beater which further breaks down the pulp, rosin was also added to the pulp while in the valley beater and then further valley beaten to allow the proper distribution of the rosin, after which the pulp was poured into the rectangular / circular mesh and allowed to dry.

TESTING TENSILE TEST

Tensile test: The samples were prepared in rectangular shape and mounted on the machine (instron model 5980 series of universal testing system) the values of the parameters were gotten on the monitor, Parameters such as tensile strength, elongation and the likes were evaluated.

TEAR TEST

For the tear strength tests the samples were prepared in trouser shape The test was carried out on instron model 5980 series universal testing system.,The tear strengths of the samples were determined.

ABRASION/ WEIGHT LOSS TEST

Martindale Abrasion Tester Halifax England with of weight 9kg and 500cycles revolutions, was used to determine abrasion/weight loss of the samples. The samples were cut in circular shapes of four specimens per samples, and they were weighted, before and after the test to determine the actual weight loss,

RESULTS AND DISCUSSIONS TENSILE STRENGTH

KEY

A= 100% Unbleached Water Hyacinth
B= 100% Unbleached Broadleaf Cattail
C=100% Bleached Water Hyacinth
D=100% bleached Broadleaf Cattail
E= bleached water hyacinth 60%: bleached Broadleaf Cattail 40%
F= bleached water hyacinth 40%: bleached Broadleaf Cattail 60%

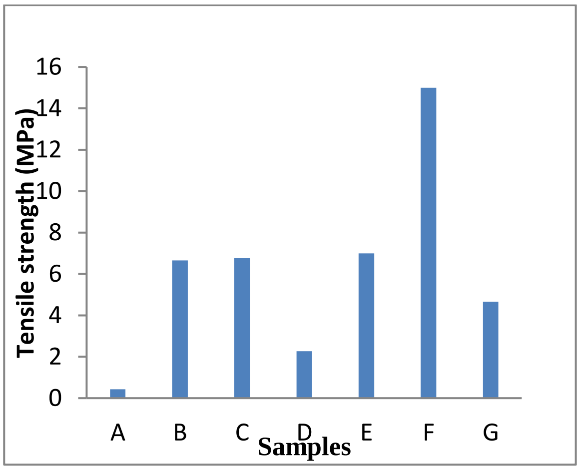

Figure 4.1: Tensile strength of samples A, B, C, D, E, F and G

From Figure 4.1, it can be seen that sample F (40% bleached water hyacinth and 60% bleached Broadleaf Cattail) has the highest values of tensile strength with wide gap when compared with the values for other samples. This high distinct value might be due to the presence of higher percentage of long fibres of bleached Broadleaf Cattail in the composition; the fibres were also free of impurities, which allows better interfacial bonding interaction among the fibres. Broadleaf cattail fibre length is about 25mm (1 inch) and round in shape [21], while water hyacinth fibre length is about 1.53mm [22]. Followed by sample E (60% bleached water hyacinth and 40% bleached Broadleaf Cattail) with samples C and B having close values, followed by sample G and then sample D and sample A (100% unbleached water hyacinth) having the least value for tensile strength test. The drastic drop in tensile strength was because of the short fibre length of the water hyacinth and the presence of impurities. A similar trend was observed by Alebiosu *et al* (2014)

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

ELONGATION AT BREAK

From Figure 4.2, it can be seen that sample C (100% bleached water hyacinth) has the highest value of elongation at break, it shows that the fibre of the water hyacinth is more elastic than that of broadleaf cattail, though of lesser strength, followed by sample D, then samples G, with sample B, E and F having close values and sample A (100% unbleached water hyacinth) having the least value for elongation at break, which shows that impurities has great negative effect on the interfacial bonding of the fibre which in turn affect the elasticity.

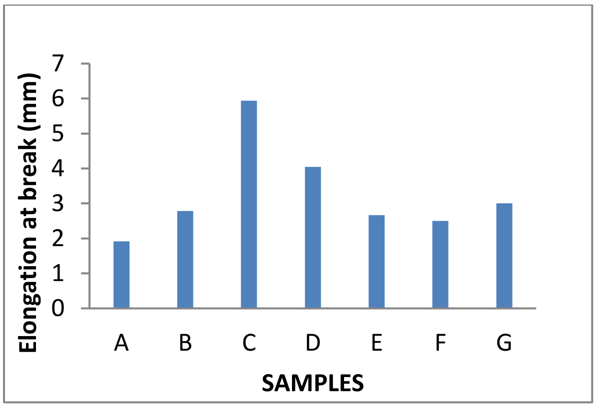

Fig. 4.2: Elongation at break of samples A, B, C, D, E, F and G

TEAR STRENGTH

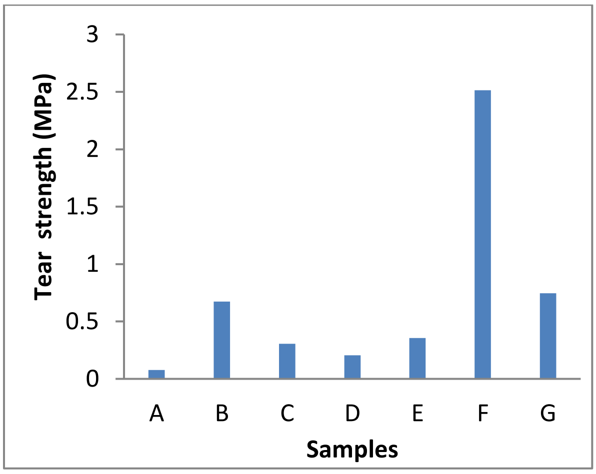

Figure 4.3: Tear strength of samples A, B, C, D, E, F and G

From figure 4.3, it can be seen that sample F (40% water hyacinth and 60% broadleaf cattail) has the highest value of tear strength, also followed the same trend like the plot of tensile strength. This has further confirmed that the long fibre length of broadleaf cattail has great effect on the strength of the sample. Followed by sample G (50%water hyacinth and 50% broadleaf cattail), then sample B, Sample C and sample E is seen to be of almost same value, then followed by sample D and finally sample A (100% unbleached water hyacinth) having the least value for tear test, which also confirmed the effect of short fibres of the water hyacinth.

PERCENTAGE WEIGHT LOSS.

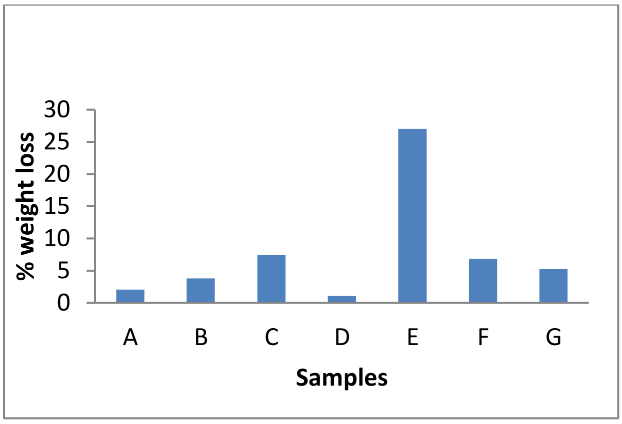

Fig. 4.4: Percentage weight loss of samples A, B, C, D, E, F and G

From figure 4.4, it can be seen that sample E has the highest weight loss value and least abrasive resistance, this might be due to high percentage of water hyacinth short fibres in the composition which might lead to poor interfacial bonding among the fibres also the dominance of short fibres, cause easy pull out of fibres during abrasion. Followed by sample C, then sample F, sample G, sample B, then sample A and sample D; having the least value for weight loss and highest abrasive resistance. This might be due to the homogenous nature of the fibres in the composition which allowed better interaction among the fibres and does not allowed easy pull out of fibres during abrasion.

CONCLUSION

From the research work, it has been established that pulp gotten from water hyacinth is of low yield when compared with the yield of Broadleaf Cattail and also the short fibre property of water hyacinth has made the pulp gotten from the plant to be prone to low tensile strength and tear strength, compared with broadleaf cattail, the tensile strength, elongation at break and tear properties improves significantly as against that of water hyacinth alone. Also, any amount of soft- fibred hyacinth pulp combined with Broadleaf Cattail helps reduce the tear index, understandably because this property is more dependent on fibre length. From this research work, paper produced from Broadleaf Cattail (*Typha Latifolia*) is of good quality in terms of mechanical properties.

REFRENCES

1. Sridash, W. (2010). The environmentally benign pulping process of non wood fibres. *Suranaree Journal of science and Technology*. 17 (2):105-123.
2. Ogunwusi, A. A. and Ibrahim, N. D. (2014). Advances in Pulp and Paper Technology and the Implication for the Paper Industry in Nigeria. *Industrial Engineering Letters*, 3-4.
3. Tobin, T. J. (2001). The construction of the codex in classic and postclassic period of maya civilization . *Westmoreland country college* , 56.
4. Casey, P. (1980). Pulp and Paper Chemistry and Chemical Technology. Third Edition, Vol 1. . chicago: Wiley Interscience Publication.
5. Gielen, D. and Tam, C. (2006). Energy Use, Technologies and CO Emissions in the Pulp and Paper Industry .Energy Efficient Technologies and CO2 Reduction Potentials in the Pulp and Paper Industry in collaboration with WBCSD, IEA, Paris, 9th October, 2006.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

6. Anslem, E.O. and Oluighbo, S.N. (2012). Mitigating the impact of climate change through waste Recycling. *Jornal of Environmental and Earth Science* , 776 -781
7. McClosekey, J. T. (1995). "What about Non wood?" . *Tappi Global fibre supply symposium proceedings* Atlanta Georgia: Tappi Press. P95.
8. Jones, M. (1983). Papyrus a new fuel for the third world. *New Scientists* , 71.
9. Zhen, H. H. (1981). The invention of paper. Taipei Taiwan: Yuanliu Publishing Co.
10. Hoernle, A. (2011). Who was the investor of Rag paper? *The Journal of the Royal Asiatic society of Great Britain and Ireland, revised by Cambridge Journals online* , 63-684.
11. Fagbemi. O.D., Taiwo Fagbemigu, K., Otitoju, O., Mgbachiuzor, E. and Igwe, C. C. (2014). Strength Properties of Paper from Pulp Blend. *British Journal of Applied Science & Technology*, 4 (28) 4125.
12. Alebiosu, S. O., Adeakin, O. A. S., Akindiya, I. O. & Oyebode, A. A (2014). Investigation into the Mechanical Properties of Banana/Sugar Cane Fibre Paper Blend. *International Journal of Engineering Research & Technology (IJERT)* , 1365.
13. Rymsza T. A, (2006) Commercial paper making with Kenaf. KP product Inc. dba Vision paper.Albuquerque, New Mexico.
14. Johnson, P. (1999). Industrial hemp: a critical review of claimed potentials for Cannabis. New York: Tappi Publisher.
15. Erlinda, L. Mari (2012). Parchment-Like Paper Using Water Hyacinth Pulp. *Philippine Journal of Science, 141* (2); 179-185.
16. Herford, T. A., Osthagen, H., Saelthun, N. R. (1994). The water hyacinth. Norwegian Agencyfor development cooperation. Water resources and energy Administratiom. Oslo ISBN, 82 - 410
17. Bennett, F.D. and (.Woodford E. J. (1978).Aquatic weed control in the Tropics. in: Weeds and their control in the humid and sub—humid tropics. Proceedings of a conference held at the international Institute of Tropical Agriculture, Ibadan, Nigeria. 5I -60
18. Wikipedia. (2017, July 26). *Wikipedia*. Retrieved November 03, 2017, from Wikipedia: https://en.wikipedia.org/wiki/Typha_latifolia
19. Holm, L, Doll, J., Holm, Pancho, J., Herberger, J.(1997). World weeds natural histories and distribution. Willey – Blackwell. p1129
20. Champion, P. D., Hosfstra, D. E, Clayton, J. S. (2007) Science for conservation (271) 41
21. CAMEO (2016) Semantic media wiki. www.cameo.mfa.org./wik/cattail.fiber. 12/02/2019
22. Zerrudo, J. V., Tadena, O. B., Exconde, A. M. (1978)Utilization of water hyacinth for pulp and paper manufacture 1, Dipithing, morphological and chemical properties of fibres NSDB Technology Journal 3 (4); 51-57.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)