Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLVII
Broj 3, 2022.
Strane: 9 – 22

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLVII
No. 3, 2022.
pp: 9 – 22

UDK:636.84 :631.3

Original Scientific paper
Originalni naučni rad
DOI:10.5937/PoljTeh2203009O

EVALUATION OF THE PHYSICO-MECHANICAL PROPERTIES OF POLYESTER/CORN STALK COMPOSITE

Okoye Obuora Anozie*[1], Ntunde Dilibe Ifeanyi [1]

[1] *Michael Okpara University of Agriculture, Department of Mechanical Engineering, Umudike, Abia State, Nigeria*

Abstract: In this study, corn stalk/polyester composites were prepared using molding techniques at several percentage filler loadings per weight and the physio-mechanical properties were studied. The composite showed moderate improvement in tensile strength 13.582MPa for 3% corn stalk which was the highest. The composite also reported the highest values for impact strength 744.90(J/m^2) and flexural strength 23.947MPa, respectively for filler loading of 3% corn stalk and 93% polyester and 2% corn stalk and 98% polyester composite samples. The significant strengths recorded can be attributed to the good surface intermingling bonding between the corn stalk fillers and the polyester matrix. The study also revealed that, density of the composites decreased with increase in filler loading and the density dropped from 0.116 g/cm^3 to 0.108g/cm^3. The composites recorded increase in water uptake with increasing filler loading. The results showed that the highest water absorption rate was at 5% corn stalk loading which had maximum water absorption of 4.55% by the composite samples. The physio-mechanical properties of the composites indicate that it can be useful in applications which require moderate strengths. These composites could be considered as a potential way of utilizing agricultural waste materials and as sustainable resources for manufacturing of structural materials such as particle board, partitioning panels, ceiling boards thereby reducing the amount of agricultural wastes and eliminating the pollution caused by burning of corn stalk waste.

Key words*: Corn Stalk, Tensile Strength, Polyester, Impact Strength, Water Adsorption, Agricultural Wastes, Composites, Density*

*Corresponding Author. E-mail: okoye.obuora@mouau.edu.ng

INTRODUCTION

Composites are materials composed of two or more different materials with the properties of the newly formed materials become superior to the properties of individual material that make up the composites. Hence by this definition, a blend or mixture of any agricultural waste and plastic materials can be considered composites [1]. Agricultural wastes are by-products of agricultural produce especially after harvest. It can be husk, straw, cobs, stalk or fiber as for the maize plant [2]. The studies of agricultural wastes which are, in essence natural fibers, made into composites have attracted limitless consideration from academicians and industrialists for their excellent properties such as; improved mechanical strength, excellent water and oxygen barrier, dimensional stability, thermal, wear, chemical or corrosive resistance, etc., [3]. In practical applications, agricultural wastes fiber reinforced thermoplastic composites are gaining significant roles in building and automobile industries, and other consumer applications [4]. More so, the inherent quality outputs of waste plastic composites such as low cost, renewability, biodegradability, low specific gravity, availability, high strength and non-abrasiveness proffer the use of agricultural waste plastic composites in variety of practical applications [5]. Underutilized and discarded agricultural wastes are most importantly rich resources of lignocelluloses materials and some typical example are millet, rice, wheat, corn straw, corn stalk, cocoa husk, corncobs and fiber [6]. Though there are limited numbers of research studies on some of the agricultural wastes on millet husk, corn husk and rice husk reinforced plastic composites [7], more work has to be done on the other agricultural wastes which constitute the plant such as corn stalk, etc. Considering the generality of lignocelluloses fibers in the reinforced plastic composites, major setback in using these fibers is the relatively poor compatibility with hydrophobic thermoplastics, which often lead to poor mechanical properties [4]. However, agricultural waste as a filler and reinforcement in thermoplastics are popular [8]. The research in this area now competes with that in inorganic materials such as glass filler, carbon filler, clay etc. [9]. Thus, these inorganic filler materials most likely produce residues with toxic byproducts during manufacturing process. Generally, natural fiber polymer composites such as wood plastic composite seem to be incompatibile between hydrophilic and hydrophobic thermoplastic matrix [10]. Apart from the fact that agricultural wastes are low in cost, there is particular interest nowadays on its effects to the environment and especially, its biodegradability properties. To actualize the scale up production of agricultural waste plastic composites by the formation and synthesis of these filler fibers, various methods are required which involve mixing of filler husks at different filler loading per weight [4].

Polyester was used as the composite matrix and are naturally occurring chemicals, such as in the cut in of plant cuticles, as well as synthetics such as polybutyrate. Natural polyesters and a few synthetic ones are biodegradable, but most synthetic polyesters are not. The material is used extensively in clothing [11]. According to the polyester's chemical structure, it can have the properties and behave as a thermoplastic or thermoset [12]. Hardeners are a beneficial way to cure polyester resins. The most popular and one of the earliest uses of polyester were to make polyester suits which were in vogue in the 70s. Polyester clothes were very popular due to its strength and tenacity and also used to make ropes in industries [13].

This study seeks to add value to agricultural waste of maize plant, increase the economic strength of the maize plant and hope to increase the exploitation of maize plant for composite production instead of allowing them to decay or decompose. Corn waste is more than 50% of the entire maize plant which consists of the stalk, leaf, cob, husk with the husk accounting for 10% of the dry corn waste [14]. Thus, this study presents agricultural wastes (corn stalk) as a reinforcement resource in composite production with a view to create cheaper composite materials that can be viable for a wide variety of products such as paper, textiles, fibre-based materials and wood-based panels (fibreboards and particleboards).

MATERIAL AND METHODS

Materials

Polyester Resin is a liquid which will cure to a solid when the hardener is added. It has been specially formulated to cure at room temperature. The hardener, Methyl Ethyl Ketone Peroxide (MEKP) is added to cure, or harden the resin. MEKP hardeners for polyester resin often referred to as catalyst and available in small plastic tubes or bottles with graduated measurements marked on them. Hardeners are measured in drops or fractions of teaspoons for most lay-up or repair jobs.

Corn-stalk is most at times used as animal feed, artificial sugar, paper and fuel. Corn stalk is composed of cellulose (42%), lignin (13%), ash (4.2%) and other materials (41%). In this work, modalities have been developed to extract fibres from stalk of the maize plant by mechanical and chemical processes. The extracted fibres are rough and harsh, chopped and used for forage or left on the field for animal bedding [15]. Research shows that corn stalks can be used in many applications including human consumption and as a source of industrial raw material for the production of oil, alcohol and starch [16, 17]. It can also be used to make reasonably good particleboard and fiberboard [18, 19].

Methods

The raw materials used in this research were collected from farms in Umudike, Abia State, Nigeria which are freshly harvested. They were gathered and pruned to leave only the corn stalk. The corn stalk was sorted, cleaned and sun dried for days at approximately 30°C – 35°C. Crushing of the corn stalk was done using a medium two flywheel plastic crushing machine to reduce them to smaller sizes. Polyester was purchased from Onitsha, Anambra State, Nigeria. The whiskers were extracted into strands by hand manually and were cut to average length of about 2-3 inches; the whiskers were treated with sodium hydroxide (NaOH) and saline solution for one hour respectively.

They were later washed with water in which acetic acid was added and also washed severally with clean tap water which was dried in an oven at 100°C for two hours. A mould measuring 30cmx 20cm x8mm was made available, and the polyvinyl acetate was used as mould release agent. The polyester resin was cured with cobalt naphthenate as the accelerator and methyl ethyl ketone peroxide as the catalyst. The gel time was between them was 10 – 15 minutes.

Each sample was mixed with appropriate mass fraction of polyester resin and appropriate mass fraction of corn stalk before casting inside the mould. They are kept at room temperature to cure effectively and demoulded after 2 days.

Table 1. Sample Mixture of Corn Stalk/Polyester Composites

Sample Specimen (SS)	Percentage Mass of Polyester (%)	Percentage Mass Of Corn Stalk (%)	Actual Mass of Polyester (g)	Actual Mass of Corn Stalk (g)
Control Sample	100	0	552	0
Sample A	95	5	546.48	5.52
Sample B	90	10	540.96	11.04
Sample C	85	15	535.44	16.56
Sample D	80	20	529.92	22.08
Sample E	75	25	524.40	27.60

After demoulding, a rip saw was used to cut the samples according to the appropriate test sample geometry and were smoothened with sandpaper. For tensile tests, specimen geometry (l x b x h) was 25cm x 2cm x 8cm and flexural test specimen geometry was 10cm x 2cm x 8cm.

(a) (b) (c)

Plate 1. Picture of (a) cured composite, (b) Cutting of composite into test sample geometry and (c) Corn Stalk/Polyester Composite Test Samples ready for testing.

Testing for Physical Properties

Water absorption and density of composite samples were used to characterize the physical properties. The expressions for testing for water adsorption and density are given below.

$$\left[\frac{(w_2 - w_1)}{w_1} x100\right] \quad (1)$$

where

w_1 = dry weight of composite;

w_2 = wet weight of composite

$$\rho = \frac{m}{V} \quad (2)$$

where
ρ = density;
m = mass of test sample;
V = volume of test sample

Testing for Mechanical Properties

Universal Test Machine at the Materials Strength Laboratory in University of Nigeria Nsukka was used to perform tensile test (according to ASTM standard D638) and flexural test (according to ASTM D790) while the impact strength was computed. The machine was operated at a uniform cross head speed of 50.00mm/min. The applied load that caused the material to fail under tensile and flexural testing was recorded and used to compute the tensile and flexural strengths from established relationships. These relationships can be found in [20–22] and impact strength was computed from the expression below.

$$G_c = \frac{U}{A}(J/m^2) \tag{3}$$

where is:
G_c = Impact Strength;
U = Energy of Fracture (Joules);
A = Area of test sample (m^2).

RESULTS AND DISCUSSION

Results of Physical Properties Tests

The results of the tests conducted to characterize the physical properties are outlined in Tables 2 and 3 whereby plots are generated in order to discuss the findings.

Table 2. Results of water absorption test of corn stalk/polyester composite samples

Sample Specimen (SS)	Hours	Corn Stalk %	Polyester %	Initial Weight (g)	Final Weight (g)	Water Absorption, w_a (%)
Control Sample	4	0	100	219.2	219.2	------
Sample A	4	1	99	109.1	110.7	1.47
Sample B	4	2	98	121.3	123.9	2.14
Sample C	4	3	97	122.1	125.1	2.46
Sample D	4	4	96	132.7	135.8	2.34
Sample E	4	5	95	63.8	66.7	4.55

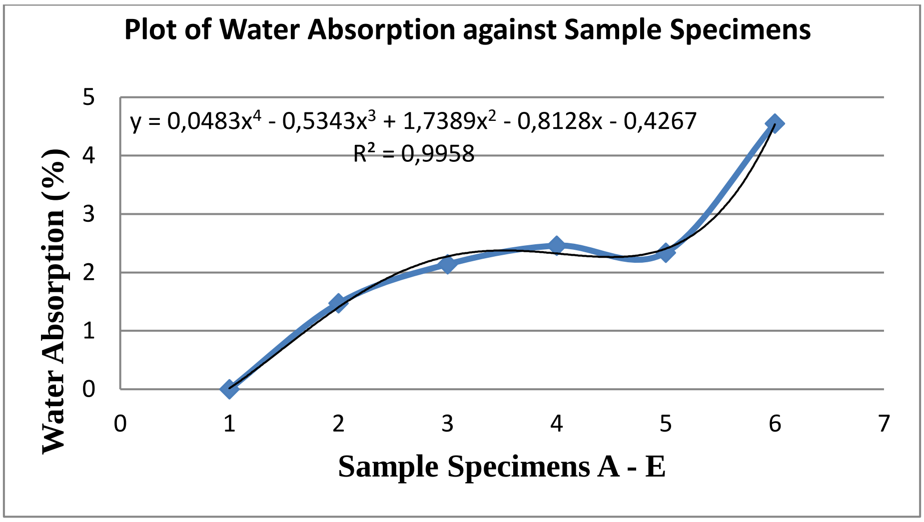

Figure 1. Plot of water absorption (%) against Sample Specimens

Table 2 and Fig. 1 presents the percentage water intake by corn stalk /polyester composite at different mass filler fractions after immersion in water for 4 hours. The Control Sample has zero percent water intake because it has no corn stalk whiskers and the polymer molecules are hydrophobic in character i.e. they do not contain any polar group as such, the polymer does not easily bond to water molecules explaining its ability to stay dry [23]. The plot shows a steady rise from 1% corn stalk filler mass fraction in polyester matrix with 5% mass fraction having the highest water being absorbed. This confirms that water absorption rate increases as corn stalk filler mass fraction increases though there was a little reduction between 4% cornstalk filler mass fraction (Sample D) and 5% cornstalk filler mass fraction (Sample E). The water absorption profile in the different compositions of cornstalk/polyester has a very good correlation and given as

$$Wa = 0.048\ SS^4 - 0.5343\ SS^3 + 1.7389\ SS^2 - 0.812 \quad (4)$$
$$(R2) = 0.9958$$

Water absorption affects the mechanical behavior of the composites and has already been established that the water absorption degenerates the tensile behavior of the polymer matrix composites [24]. Due to the established water absorption by the cornstalk/polyester composites of different percentage mass fractions, the composite becomes suitable for applications, such as particle boards, devoid of moisture.

Table 3. Computed results of density of corn stalk/polyester composite samples

Sample Specimen (SS)	Corn Stalk (%)	Polyester (%)	Mass (g)	Volume (cm^3)	Density, *D* (g/cm^3)
Control Sample	0	100	22.34	151.3	0.148
Sample A	2	98	11.12	103.4	0.108
Sample B	4	96	12.36	113.9	0.109
Sample C	6	94	12.45	110.2	0.113
Sample D	8	92	13.53	117.4	0.115
Sample E	10	90	13.02	112.2	0.116

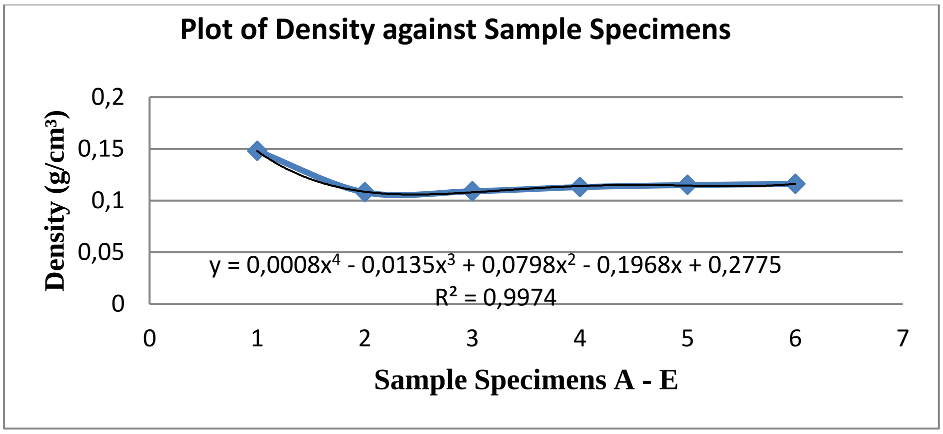

Figure 2. Plot of density against Sample Specimens

The plot on Fig. 2 is obtained from Table 3 and it shows the variation of the cornstalk/polyester composite densities as a result of the increasing cornstalk filler mass fractions. The decrease in the densities of the cornstalk/polyester composite as the cornstalk filler mass fraction increases can be caused by air trapped within the cornstalk filler reinforcement material. After curing, micro voids may be formed in the composites along cornstalk whiskers due to the fibres orientation which has adverse effect on the general properties of composites and this reduces the density of the composite. However, natural fibres are known to be light weight which explains when the filler content increases, density of the composites decreases. This is in line with the result obtained by [25]. The density profile has a good correlation and represented by the equation

$$D = 0.0008\ SS^4 - 0.0135\ SS^3 + 0.0798S^2 - 0.1968\ SS - 0.27758 \quad (5)$$
(R2 = 0.9974)

The density of the composites also show a steep decrease with varying ratio of the fillers though there was a reversal from Sample B to Sample E but the density is less than Sample A. These results of density imply that these composites can replace non-natural filler composites because of their light weight [26].

Results of Mechanical Tests

The results of the tests conducted to characterize the mechanical properties are outlined in Table 4 and plots are generated in order to discuss the findings.

Table 4. Results of tensile strength of corn stalk/polyester composites samples

Sample Specimen (SS)	Corn Stalk (%)	Polyester (%)	Tensile Strength, (*TS*) (N/mm^2)	Flexural Strength, (*FS*) (MPa)	Impact Strength, (*IS*) (J/m^2)
Control Sample	0	100	22.204	63.167	882.00
Sample A	1	99	10.560	23.699	526.80
Sample B	2	98	12.267	23.947	708.10
Sample C	3	97	13.582	20.590	744.90
Sample D	4	96	7.622	20.113	416.10
Sample E	5	95	8.337	21.933	664.50

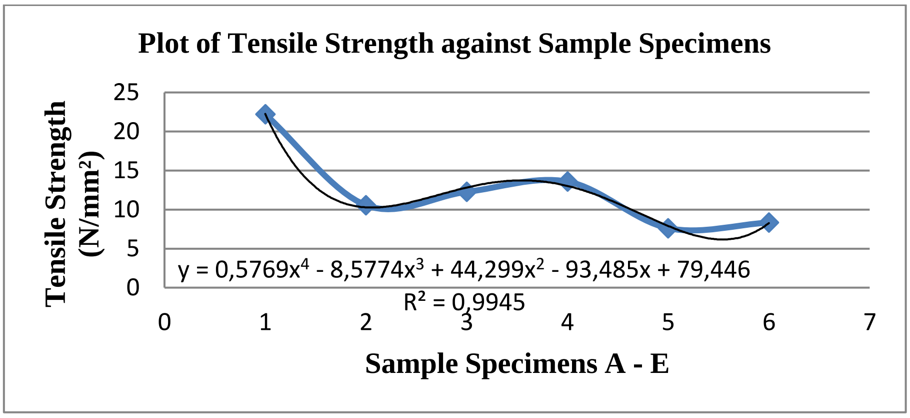

Figure 3. Plot of Tensile Strength against Sample Specimens

Table 4 gives the values of the tensile and flexural tests conducted and impact strength computed. Figure 4 is the plot characterizing the tensile strength of the different filler compositions. The pristine polyester had a higher tensile strength than all composite samples. The inculcation of corn stalk filler loadings greatly reduces the tensile strength. The increase in mass fractions of cornstalk filler reinforcement in polyester matrix further decreases the tensile strength of the composites. There was a steep decrease from 0% mass fraction to 1% mass fraction and next, a steady increase in tensile strength through 2% mass fraction to 3% mass fraction. Tensile strength decreased from here to 4% mass fraction and tipped up a little to 5% mass fraction. The decrease in tensile strength observed in these composites could be attributed to agglomerate formation and stress centers in the composites which originate and initiate cracks on application of stress. The tensile strength alternating (increase and decrease) behavior can also be attributed to the extent of fibre-matrix interfacial adhesion. Tensile strength profile is presented by this equation and correlation value

$$TS = 0.5769\ SS^4 - 8.5774\ SS^3 + 44.299\ SS^2 - 93.1485SS - 79.446 \quad (6)$$
$(R^2) = 0.9945$

Its strength is satisfactory for useful applications such as pharmaceutical shelves, particle board and partition wall.

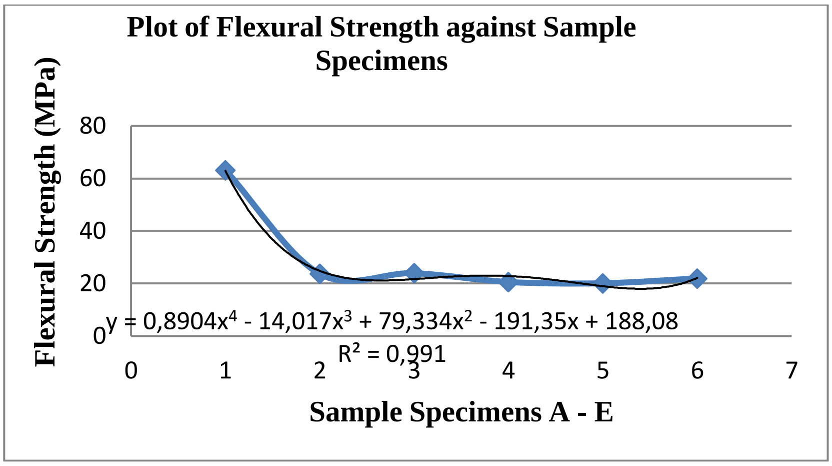

Figure 5. Plot of Flexural Strength against Sample Specimens

From the plot of the flexural strength of cornstalk/polyester composite as seen in Figure 5, the cornstalk/polyester composite again decreases below the pristine polyester which had higher flexural strength than all composite samples. It was observed that the flexural strength of the composites decreases with increasing filler mass fractions which were also similar to the tensile behavior. This could be due to poor intermolecular interaction and adhesion between the polyester matrix and the cornstalk whiskers. Similar results were obtained by [27] in his study on some mechanical properties of polyester filled with the seed shell of sunflower and water melon.

The flexural strength profile for the different mass fractions of cornstalk/polyester composite is present by equation and correlation value

$$FS = 0.8904\ SS^4 - 14.017\ SS^3 + 79.334\ SS^2 - 191.35SS - 188.08 \quad (7)$$
$(R^2) = 0.991$

The decline in flexural strength can be due to formation of agglomerates which created stress centres in the composites contributing to in mechanical failure properties of the composites [28].

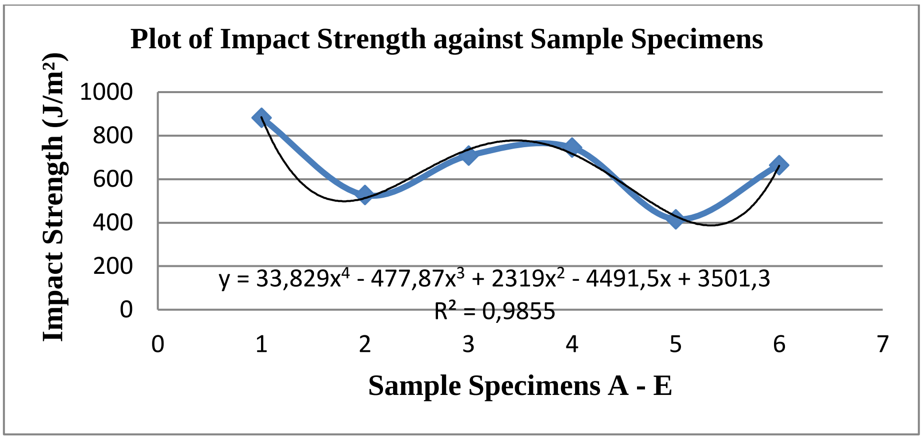

Figure 6. Plot of Impact Strength against Sample Specimens

The computed impact strength of the cornstalk/polyester composite depicts a different behavior compared to the tensile and flexural strengths. Pristine polyester also had higher impact strength than all composite samples. The tests proved that the cornstalk/polyester composites have ability to withstand shock loading or absorb mechanical energy under impact loading and stresses. The impact strength value decreases with increasing filler mass fractions from 0% to 1% mass fractions and increases from 1% to 3% mass fractions. However, another reduction was observed from 3% to 4% mass fractions and increment from 4% to 5% mass fractions of cornstalk filler reinforcement. The impact strength profile and correlation value are

$$FS = 0.8904\ SS^4 - 14.017\ SS^3 + 79.334\ SS^2 - 191.35SS - 188.08 \qquad (8)$$
$$(R^2) = 0.991$$

It has been reported that high fibre content increase the probability of fibre agglomeration which results in regions of stress concentration requiring less energy for crack propagation [29, 30]. The decrease in impact strength can be attributed to saturation of the polyester resin by the fillers, thus, preventing proper bonding of the fillers to form strong adhesion forces. The results reveal that the cornstalk/polyester composites can withstand medium energy impact without fracturing. Improvements in absorbing energy by the composites could be enhanced with better interaction of the filler and matrix. A deviation was reported in similar work on production and properties of sweet potato flour/HDPE composites which shows decrease in impact strength with increase sweet potato powder as reported by [25].

CONCLUSION

This study investigated the successful preparation and investigation of the physico-mechanical properties of corn stalk/ polyester composites. Also, a means of discarding agricultural waste (corn stalk) as a resource for new material by adding value to them was proferred.

The water absorption behavior of the cornstalk/polyester composites at different filler mass fractions followed similar trend in other reported research. Water absorption revealed huge influence on the physico-mechanical properties of cornstalk/polyester composites. A four hour immersion in water revealed that the water absorption by the cornstalk/polyester composites increased as the cornstalk filler mass fractions were also increasing and similar results were observed by [31]. The cornstalk/polyester composite densities decreased with increasing cornstalk filler mass fractions.

The mechanical properties of the cornstalk composites revealed, essentially, that the introduction of cornstalk fillers in a polyester matrix reduced the tensile strength, flexural strength and impact strength of the cornstalk/polyester composites below the tensile strength, flexural strength and impact strength of pristine polyester matrix (i.e. 100% polyester resin). This is in contrary to the description of composites stated in the introduction of this paper. The results reported makes cornstalk filler unlikely suitable for polyester resins or maybe unsuitable for all polymer matrices or resins. Poor cornstalk fillers and polyester matrix interfacial adhesion can be the reason for the decline in tensile, flexural and impact strengths of the cornstalk/polyester composites.

Furthermore, the results also show that density of the cornstalk/polyester composites decrease considerably with varying percentage of cornstalk filler mass fractions and provide moderate interaction and interfacial bonding between the cornstalk fillers and the polyester matrix.

BIBLIOGRAPHY

[1] Bavan, D. S.; Kumar, G. C. M. (2010). Potential Use of Fibre Composites in India, *Journal of Reinforced Plastics and Composites*, Vol. 29, No. 24, pp. 3600–3613.

[2] Abubakar, M. S.; Ahmad, D. (2010). Pattern of Energy Consumption in Millet Production for Selected Farms in Jigawa, Nigeria, Vol. 4, No. 4, pp. 665–672.

[3] Ates, S.; Ni, Y.; Akgul, M.; Tozluoglu, A. (2008). Characterisation and Evaluation of Paulownia Elongata as a Raw Material for Paper Production, *African Journal of Biotechnology*, Vol. 7, No. 22, pp. 4153–4158.

[4] Panthapulakkal, S.; Sain, M.; Law, S. (2005). Enhancement of Processability of Rice Husk Filled High Density Polyethylene Composites Profiles, *Journal of Thermoplastic Composite Material*, Vol. 18, No. 5, pp. 445–459.

[5] Dominique, M. R.; Georget, D. M. R.; Abd Elmoneim, O.; Elkhalifa, E. O.; Beltom, P. S. (2012). Structural Changes in Kafirin Extracted from a White Type II Tannin Sorghum, *Journal of Cereal Science*, Vol. 57, No. 48, pp.106–111.

[6] Tsai, W.T.; Chang, C.Y.; Lee, S.L. (1998). A Low Cost Absorbent from Agricultural Wastes Corn Cob by Zinc Chloride Activation, *J. of Biotechnology*, Vol.64, No.34, pp. 211–217.

[7] Premlal, H. G. B.; Ismail, H.; Baharin, A. (2002). Comparison of Mechanical Properties of Rice Husk Filled Polypropylene with Talc Polypropylene Composites, *Journal of Polymer Testing*, Vol. 21, No. 7, pp. 833–839.

[8] Adhikiry, K. B.; Pang, S.; Staiger, M. P. (2008). Dimensional Stability and Mechanical Behaviour of Wood-Plastic Composite Based on Recycling and Virgin High-Density Polypropylene (HDPE), *Compos Part B—Engineering*, Vol. 39, No. 5, pp. 807–815.

[9] Li, T. N.; Yan, N. (2006). Mechanical Properties of Wood Floor/HDPE/Ionomer Composites, *Compos Part A-Journal of Applied Science*, Vol. 38, No. 1, pp. 1–12. doi:10.1016/j.compositesa.2006.02.003

[10] Zurina, M.; Ismail, H.; Bakar, A. A. (2004). Rice Husk Powder – Filled Polystyrene / Styrene Butadiene Rubber Blends. Journal of Applied Polimer Science 92(5):3320-3332. https://doi.org/10.1002/app.20321.

[11] Wagner, H. D.; Vaia, R. A. (2002). Nanocomposites: issues at interface, *Materials Today*, Vol. 7, No. 11, pp. 38–42.

[12] Sharifah, H. A.; Martin, P. .; Simon, T. .; Simon, R. . (2005). Modified Polyester Resins for Natural Fibre Composites, *Compos. Sci. Technology*, Vol. 65, 521–535

[13] Winey, K. I.; Vaia, R. A. 2011. Polymer Nanocomposites, *MRS Bulletin*, Vol.32, No.4, pp. 314–322.

[14] Macatangay, P. M.; Magundayao, E. C.; Rosales, C. A. M. (2010). Utilization of Agricultural Wastes in the Manufacture of Composite Boards, Vol. 29, No. 2, 129–140

[15] Youngquist, J. A.; English, B. E.; Spelter, H.; Chow, P. (1993). Agricultural Fibers in Composition Panels, *In: Maloney, T.M. (Ed), Proceedings of the 27th International Particleboard/Composite Materials Symposium*, Washington State University, Pullman, WA, pp. 133–152

[16] Muoneke, C. O.; Ogwuche, M. A. O.; Kalu, B. A. (2007). Effect of Maize Planting Density on the Performance of Maize/Soybean Intercropping System in a Guinea Savannah Agroecosystem, *Afr. J. Agric. Res*, Vol. 2, No. 12, pp. 667–677.

[17] Yang, H. S.; Kim, H. G.; Son, J.; Lee, B. J.; Twang, S. T. (2006). Rice Husk Flour Filled with Polypropylene Composites, Mechanical and Morphological Studies, *Journal of Composite Structure*, Vol. 63, Nos. 3–4, pp.305–312. doi: 10.1016/S0263-8223(03)00179-X

[18] Chow, P. (1974). *Dry formed composite board from select agricultural residues. World Consultation on Wood Based Panels,* New Delhi, India.

[19] Wu, J.; Zhang, X.; Wan, J.; Ma, F.; Tang, Y.; Zhang, X. (2011). Production of fiberboard using corn stalk pretreated with white-rot fungus Trametes hirsute by hot pressing without adhesive, *Bioresource Technology*, Vol. 102, No. 24, pp.11258–11261

[20] Okoye, O. A. (2011). *Fracture Mechanical Behavior of Polypropylene/Talc Composites 2011.*Department of Mechanical Engineering, Nnamdi Azikiwe University, Awka

[21] Mgbemena, C. O.; Okoye, O. A. (2012). Computational Approach to Modelling Fracture Behaviour of Polypropylene / Talc Composites, Vol. 2012, No. August, 841–847. doi:10.4236/jmmce.2012.118077

[22] Okoye, O. A.; Ntunde, D. I. (2016). Mathematical modelling of mechanical properties Polypropylene / Talc composites : Power equation approach, Vol. 2, No. 4, pp. 15–19.

[23] Kabir, M. M.; Wang, H.; Aravintha, T.; Cardona, F.; Lau, K. T. (2011). Effect of Natural Fibre Surface on Composites Properties, *Eddbe 2011 Book of Proceedings*, 94–99

[24] Agarwal, A.; Garg, S.; Rakesh, P. K.; Singh, I.; Mishra, B. K. (2010). Tensile Behavior of Glass Fibre Reinforced Plastics subjected to different Environmental Conditions, *Journal of Engineering and Materials Sciences*, Vol. 17, No. 6, pp. 471–476

[25] Danladi, A.; Shuaib, J. (2014). Fabrication and Properties of Pineapple Fibre/High Density Polyethylene Composites, *American Journal of Material Science*, Vol. 4., No.3, 139–143. doi:DOI:10.5923/j.materials.20140403.04.

[26] Sudipt, K.; Ananda, T. J. (2008). Metal matrix composites Production and characterization of aluminum-fly ash composite using stir casting method, pp.15–25.

[27] Mohammad, R. M. (2013). Study of Some Mechanical Properties of Unsaturated Polyester Filled with the Seed Shells of Sunflower and Water, *Journal of Babylon University/Engineering Sciences*, Vol. 21, No. 4, pp. 1270–1227

[28] Shenoy, M. A.; Melo, D. J. D. (2007). Evaluation of mechanical properties of unsaturated polyester-guar gum/hydroxypropyl guar gum composites, *Express Polymer Letter*, Vol. 1, No. 9, pp. 622–628

[29] Karmakar, A.; Chauhan, S. S.; Modak, J. M.; Chanda, M. (2007). Mechanical properties of wood–fiber reinforced polypropylene composites, *Compos. A*, Vol. 38, pp.227–233

[30] Haque, M.; Hasan, M.; Islam, S.; Ali, E. (2009). Bioresource Technology Physico-mechanical properties of chemically treated palm and coir fiber reinforced polypropylene composites, *Bioresource Technology*, Vol. 100, No. 20, pp. 4903–4906. doi:10.1016/j.biortech.2009.04.072

[31] Silva, D. W.; Mendes, R. F.; Mendes, L. (2013). Use of maize cob for production of particleboard production, No. September 2015. doi:10.1590/S1413-70542013000400006

PROCENA FIZIČKO-MEHANIČKIH OSOBINA KOMPOZITA POLIESTER-KUKURUZ

Obuora Okoye[1] , Dilibe Ntunde[1]

[1] Michael Okpara University of Agriculture,
Department of Mechanical Engineering,
Umudike, Abia State, Nigeria

Apstrakt: U ovom radu, kompozit u sastavu stabljika kukuruza-poliester su pripremljeni tehnikom oblikovanja sa nekoliko procenata opterećenja materijala za ispunu prema masi . Proučavana su fizičko-mehaničke osobine ovog materijala .
Kompozit je pokazao umereno poboljšanje zatezne čvrstoće od 13,582 MPa za 3% stabljike kukuruza, što je bilo najviše.
Kompozit je takođe imao najveće vrednosti čvrstoću na udar od 744,90 (J/m^2) i na savijanje od 23,947 MPa, respektivno za punjenje od 3% stabljike kukuruza i 93% poliestera i 2% stabljike kukuruza i 98% poliester materijala.
Značajno zabeležena vrednost otporosti materijala može se pripisati dobrom površinskom međusobnom vezivanju između materijala stabljike kukuruza i poliestera kao osnove.
Studija je takođe pokazala da se gustina kompozita smanjivala sa povećanjem količine materijala za punjenje, i vrednost gustine novog materijala je smanjena sa 0,116 g/cm^3 na 0,108 g/cm^3.
Kompoziti su zabeležili povećanje vrednosti upijanja vode sa povećanjem opterećenja materijala punioca. Rezultati su pokazali da je najveća stopa apsorpcije vode bila pri opterećenju stabljike kukuruza od 5%, što je imalo maksimalnu apsorpciju vode od 4,55% kod kompozitnih uzoraka.
Fizičko-mehaničke osobine materijala kompozita ukazuju da on može biti koristan u aplikacijama koje zahtevaju umerene vrednosti na čvrstoću.

Ovi kompozitni materijali mogu se smatrati potencijalnim načinom iskorišćavanja poljoprivrednog otpadnog materijala i održivim resursima za proizvodnju konstrukcijskih materijala kao: iverice, pregradne ploče, plafonske ploče čime se smanjuje količina poljoprivrednog otpada i eliminiše zagađenje izazvano sagorevanjem stabljike kukuruza.

Ključne reči: *Stabljika kukuruza, zatezna čvrstoća, poliester, udarna čvrstoća, adsorpcija vode, poljoprivredni otpad, kompoziti, gustoća*

Prijavljen:
Submitted: **16.01.2022.**
Ispravljen:
Revised: **11.07.2022.**
Prihvaćen:
Accepted: **20.07.2022.**