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PRODUCTION OF FLOOR TILES FROM RECYCLED LOW-DENSITY POLYETHYLENE (WATER SACHETS) /SAWDUST COMPOSITES

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ABSTRACT

This research investigates the effect of sawdust loading on the physical and mechanical properties of floor tiles produced using recycled Low-Density Polyethylene (rLDPE) as a matrix. Sieved sawdust particles with a mesh size of 450μm was incorporated into shredded rLDPE using a two-roll mill at different loadings of 20wt%, 30wt%, 40wt%, and 50wt%. The composition was molded into floor tile composite using a hydraulic press machine. The tiles produced were tested for hardness, impact strength, and compression test. The result obtained showed that hardness increased with an increase in filler loading while the impact strength and compression set decreased with an increase in the filler loading. The floor tiles produced at optimal conditions had desirable physical and mechanical properties.

KEYWORDS

Floor tiles, sawdust, hardness, compression test

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INTRODUCTION

In recent years, it is quite common to find in newspapers and publications that plastics are turning out to be a menace. Days are not so far when the entire earth will be completely covered with plastics and humans will be living over it. All the reasoning and arguments for and against plastics finally land upon the fact that plastics are non-biodegradable. The disposal and decomposition of plastics have been an issue, which has caused several research works to be carried out (Kerni *et* *al*., 2020). As far as plastics are concerned, polyolefin accounts for 35% of the total consumption. Out of these, one-third of the global consumption of plastic is polyethylene. Global demand growth is estimated to be around 4.4% annually up to 2020. Also, the proliferation of waste low-density polyethylene from waste grocery bags and packaging materials cannot be overemphasized.

Plastic and wood wastes have been a main environmental concern. Plastic is the biggest problem due to its high amount of waste generated, non-biodegradability, and the fast depletion of natural resources due to its short life cycles, leading to the increasing amount of materials utilized in its production, and waste generated. The same applies to wood to a lesser degree where it is depleting trees and forests and the waste mainly is either burnt or disposed of, resulting in extra consumption, depletion, and pollution of nature. Several worldwide attempts have been adopted, even in developed countries, to take advantage of these types of waste, especially with the rising need for alternative virgin materials (Winnandy *et al*., 2004). With the current high interest in recycling, it is intended to make a wood-plastic composite, which can be utilized for the production of innovative products such as floor tiles and at the same time protect the environment. This is the reason behind the selection of waste low-density polyethylene (water sachet) as a source of waste plastic in this study.

MATERIALS AND METHODS

Materials

The redwood sawdust obtained from pine trees was collected from a local sawmill at Sabon Gari Market in Zaria. The rLDPE was obtained from waste water sachets (also known as pure water sachets) and were collected from a packaged water producer known as Shobos Table water located at No.32, Dogon Bauchi Sabon Gari Zaria Kaduna State, Nigeria.

Method

The collected sawdust was dried on a concrete slab for 3 days and with the help of a laboratory mill was ground into fine particulate powder and the resultant powder was sieved using a 450µm sieve. The waste water sachets were sorted out, washed, dried, and reduced to form irregular particles with sizes ranging from 1mm-3mm in a specially designed plastic film-shedding machine.

The sawdust powder and the recycled low density were weighed according to the formulation in Table 1. The mixture was homogenously compounded based on the formulation using a two-roll mill at a temperature of 140°C. Tile production was carried out on an electrically heated hydraulic press. The homogeneous mix was placed in a pre-heated metallic mold with dimensions of 350mm and was pressed to a thickness of 4mm. After each press cycle, the resultant material was removed from the press for cooling. The procedure was repeated fro various compositions.

The composite produced was tested for hardness, impact strength, compression set, abrasion, and water absorption.

Table 1: Composite formulation

Samples	Temperature (°C)	Time (min)	Pressure (N/m^2)	rLDPE (g)	Sawdust (wt%)
A	140.0	10.0	40.0	100.0	0.0
B	140.0	10.0	40.0	80.0	20.0
C	140.0	10.0	40.0	70.0	30.0
D	140.0	10.0	40.0	60.0	40.0
E	140.0	10.0	40.0	50.0	50.0

RESULT AND DISCUSSION

Figure 1 shows the graph illustrating the hardness of rLDPE composite containing sawdust. Hardness, a material property, denotes its resistance to indentation (Cowie, 1991). The findings reveal that the hardness of composites, whether modified or unmodified, increases with higher filler loading. Notably, the rate of increase in hardness is more pronounced in the unmodified filler composite compared to the modified counterpart. This escalation in hardness can be attributed to the rigid nature of the filler, which fills the matrix core and enhances resistance to surface indentation. This observation aligns with the findings of Mersi *et al*. (2021), where hardness results augmented with escalating filler loading.

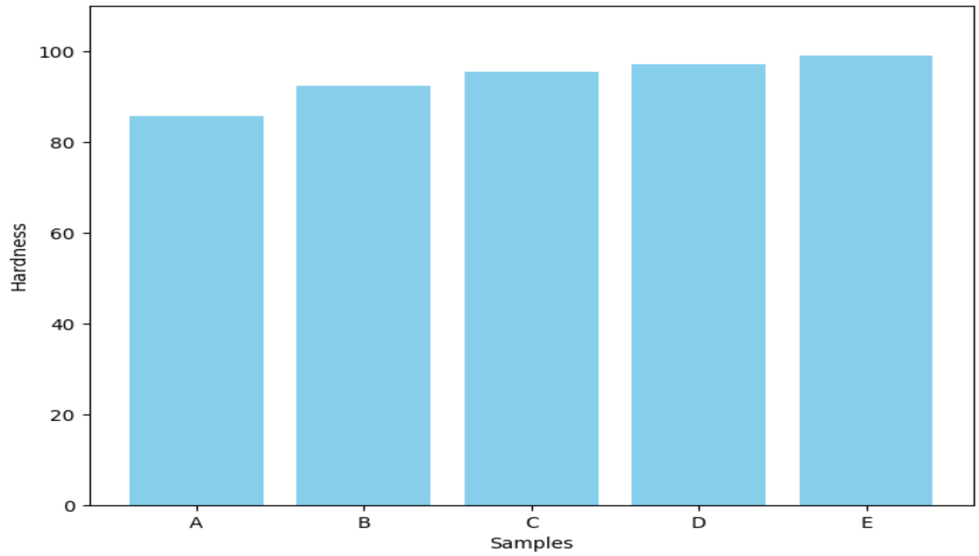

Figure 1: Hardness of Sawdust/ rLDPE composite

Figure 2 illustrates the impact strength graph for the composites. Impact strength denotes a material's ability to absorb energy before fracturing (Ikhlef *et al*., 2012). The findings indicate a decrease in impact strength with higher filler loading for the composites produced. A significant drop occurs at 50 wt% (Sample E) loading, possibly due to a higher weight fraction of filler. This decline in impact strength may stem from inadequate molecular interaction between the filler and matrix.

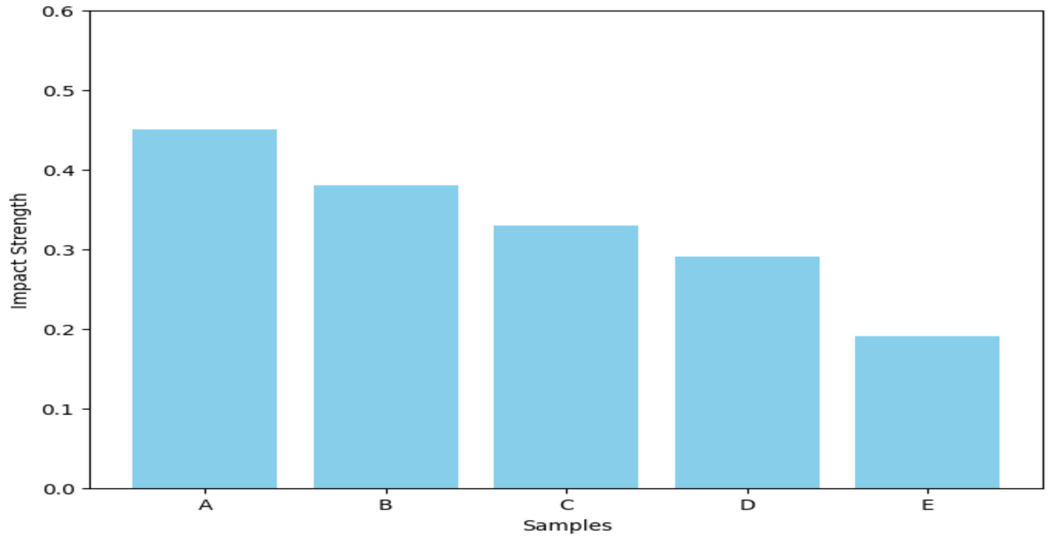

Figure 2: Impact strength of Sawdust/ rLDPE composite

Analyzing the compression set results, depicted in Figure 3, requires consideration of compressibility, particularly due to the distinct characteristics of thermoplastics compared to rubbers. Thermoplastics exhibit rigidity and minimal resilience in contrast to rubbers, resulting in varied responses under load. The trend observed indicates that as sawdust content rises, the material displays greater compressibility. This suggests reduced resistance to compression load with increased sawdust content in the composite.

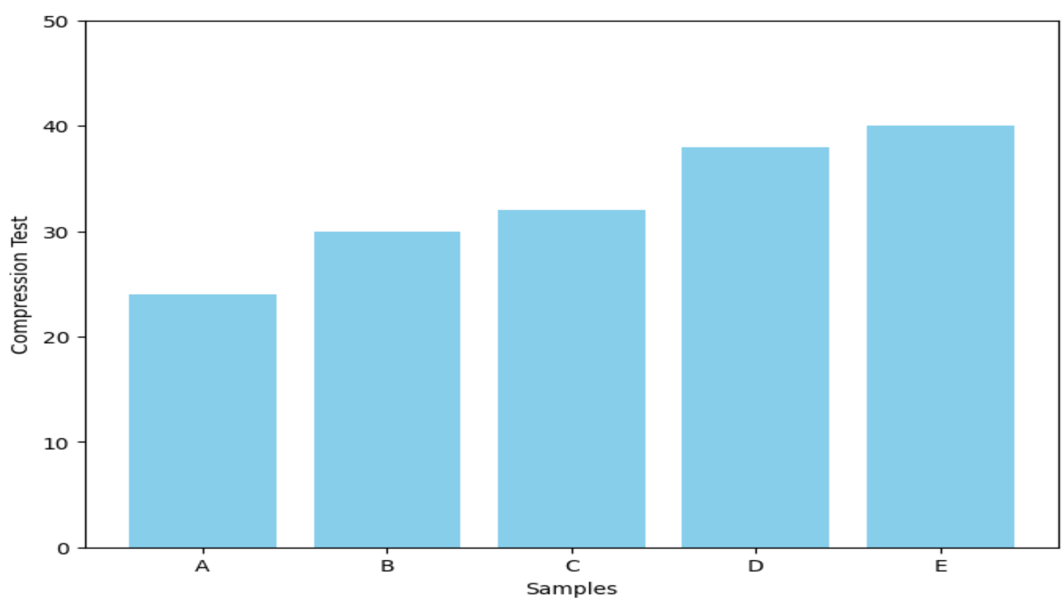

Figure 3: Compression test of Sawdust/ rLDPE composite

Additionally, the abrasion resistance shown in Figure 4 suggests an increase in resistance at 20% to 30% sawdust loading but declined with further increases in sawdust content. This can be attributed to reduced interfacial adhesion between the filler and the matrix (Chitan & Candioto, 2020).

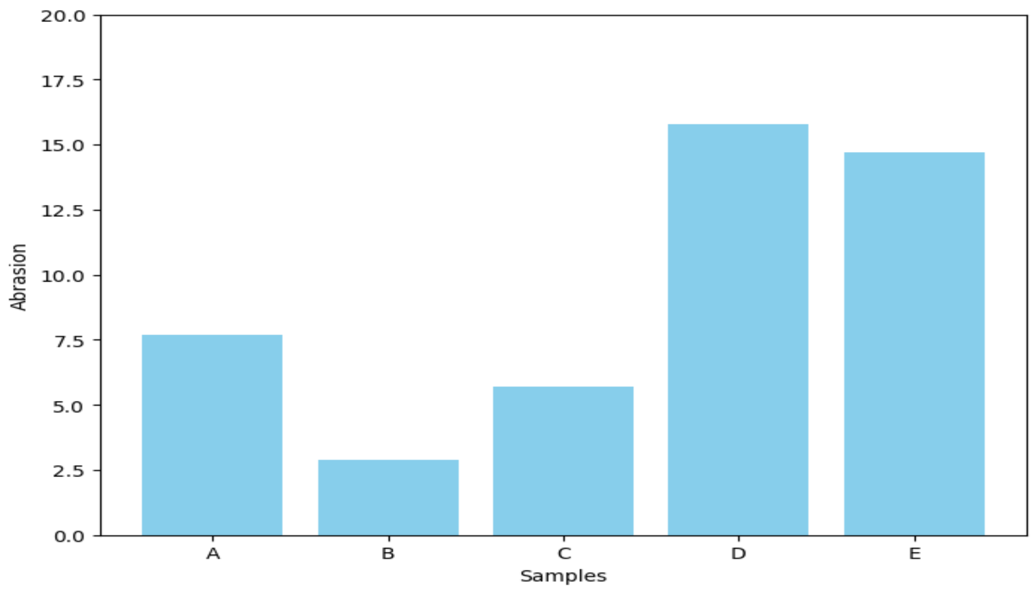

Figure 4: Abrasion of Sawdust/ rLDPE composite

Figure 5 illustrates the percentage water absorption of the composite. Percentage water absorption refers to the increase in weight experienced by a polymer after being submerged in water over 24 hours. The results obtained indicate a rise in water absorption with filler loading for all composite samples. This trend is attributed to the hydrophilic nature of the filler, which readily absorbs water. The control sample (A) exhibits 0% water absorption, while the sawdust-loaded composite (samples B, C, D, and E) absorbs a higher percentage of water at 7%, 11%, 13%, and 20% respectively. The overall progressive increase in water absorption is linked to the agro-filler nature of sawdust, which inherently possesses moisture absorption properties (hydrophilic) (Daniel *et al*., 2019).

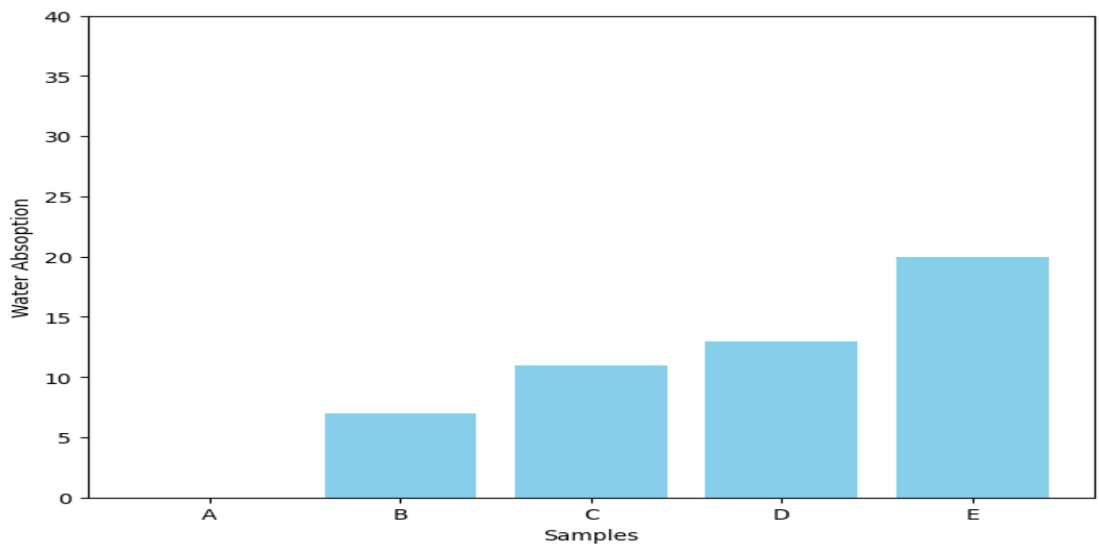

Figure 5: Water absorption of Sawdust/ rLDPE composite

CONCLUSION

The production and characterization of floor tile from recycled Low Density Polyehylene (Water sahets)/ sawdust composites was successfully achieved. All process variables were kept constant except varaiations in loading ratio between the matrix and filler. Sample E with the highest filler loading gave the best hardness property due to the inherent nature of the filler. A similar trend was observed with the compression test. An inverse of the hardness behaviour on the other hand was observed in the impact strength property. Higher weight fractions and poor interfacial bonding may be the reason for such a behaviour on the impact strength of the composites. Evident of a reduction in the interfacial bonding could as well be seen in the behaviour of the abrasion resistance test. A 7%, 11%, 13% and 20% increase in water absorption as filler loading increases as compared to the control sample was observed, this is not unconnected to the inherent nature of sawdust as an agro-filler. Agro-Fillers are characteristically hydrophilic in nature.

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