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ORIGINAL RESEARCH ARTICLE

Production of floor tiles using buffing dust and sachet water bags

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ABSTRACT

This study focused on the production of floor tiles from recycled pure water sachets and buffing dust as an alternative means of reducing environmental pollution and promoting sustainable waste management. Samples of used pure water sachets and buffing dust were randomly collected from the Federal University Dutse and an abattoir, respectively. The collected materials were processed into three floor tile samples designated A, B, and C and subjected to laboratory tests to evaluate their mechanical and physical properties. Tensile strength and compressive strength were assessed using a Universal Testing Machine. The tensile test was conducted at a crosshead speed of 10.000 mm/min, while the compression test was performed at a crosshead speed of 5.000 mm/min, with a specimen height of 100 mm. Chemical resistance was evaluated using different chemical media, while water absorption was determined by immersing the tile samples in water for 24 hours and recording the change in weight. The quantitative findings showed that Sample A recorded the highest overall performance value of 95%, followed by Sample B at 90% and Sample C at 85%. The difference between Samples A and B was 5 percentage points, while Sample A exceeded Sample C by 10 percentage points. These results indicate that Sample A demonstrated the most favorable overall performance among the three samples based on the reported percentages. The findings suggest that recycled pure water sachets and buffing dust have potential for use in floor tile production. The study recommends further assessment of the tiles' durability, safety, and suitability for practical flooring applications. Encouraging the production of tiles from these waste materials could also create employment opportunities for young people, reduce plastic waste, and contribute to improved environmental sanitation and sustainable waste management.

Key words: Production, Floor, Tiles, Buffing Dust, Sachet water Bags

Introduction

Plastics are organic polymers with high molecular mass and often contain additives that improve their strength, flexibility, durability, and other properties. Most plastics are produced from petrochemical resources, although some are manufactured from renewable materials, such as polylactic acid derived from corn and cellulose obtained from plant-based sources (Wiley,2020). Despite their wide range of applications, the increasing use of plastic products, particularly single-use pure water sachets, has contributed to the growing problem of solid waste disposal and environmental pollution. When improperly discarded, these materials can accumulate in the environment and create challenges for effective waste management.

One practical way to address this problem is to convert plastic waste into useful construction materials, such as floor tiles. The production of floor tiles from discarded pure water sachets

offers an opportunity to transform waste into a valuable resource while reducing the amount of plastic entering the environment. In this study, recycled pure water sachets were combined with buffing dust to produce floor tiles for laboratory evaluation. The inclusion of buffing dust was intended to explore its potential contribution to the properties of the finished tiles. By assessing the tensile strength, compressive strength, chemical resistance, and water absorption of the produced samples, the study seeks to determine their potential suitability for flooring applications. This approach could provide an alternative use for locally available waste materials, promote environmental sanitation, and create opportunities for small-scale enterprises and youth employment. However, the practical application of the tiles will depend on their measured performance, durability, and safety.

Most plastics are made up of organic polymers consisting of long chains of carbon atoms, sometimes combined with oxygen, nitrogen, or sulfur. These chains are formed by joining many small molecules called monomers, which create repeating units along the polymer chain. The main part of the chain, known as the backbone, connects these repeating units and gives the plastic its basic structure (Swanson et al., 2021).

The productive use of waste materials is an effective way of reducing the challenges associated with solid waste management. Recycling and reusing waste help conserve natural resources, reduce environmental pollution, and minimize energy consumption during the production of new materials (Davis & Cornwell, 2018). In recent years, attention has increasingly focused on converting plastic waste into useful products rather than allowing it to accumulate in the environment. According to Mong et al. (2024), plastic waste can be transformed into valuable materials through different recycling and recovery techniques, creating opportunities for more sustainable waste management. This approach is relevant to the present study, which explores the production of floor tiles using discarded pure water sachets and buffing dust. By converting these waste materials into a potentially useful construction product, the study aims to reduce environmental waste while investigating an alternative source of materials for floor tile production. If the resulting tiles demonstrate satisfactory strength, durability, and safety, this approach could contribute to resource conservation, improved environmental sanitation, and local economic opportunities.

Waste materials and industrial by-products can be valuable resources when properly processed and reused. Plastic waste and buffing dust, for example, can remain in the environment for long periods if improperly disposed of. Their accumulation can contribute to land pollution, block drainage channels, and increase the burden on waste management systems. One effective way to reduce these problems is to recycle these materials into useful products, such as composite floor tiles. According to Sivakumar (2020), reusing solid waste in other industries can help transform discarded materials into value-added products. Therefore, incorporating waste plastics and buffing dust into floor tile production could reduce the amount of waste sent to dumpsites, conserve raw materials, and promote a more sustainable approach to construction material production.

Plastics generally have low chemical reactivity because of their stable molecular structure and relatively high molecular weight. However, their potential effects on human health and the environment depend on the type of polymer, the additives used during manufacturing,

and the presence of contaminants. Some plastic additives, such as certain plasticizers, flame retardants, and stabilizers, may be released during use, ageing, or degradation and can pose environmental or health risks under particular conditions. Furthermore, the chemical structure of a polymer can be modified to improve specific properties, such as strength, flexibility, and durability. Therefore, when using recycled plastics to produce floor tiles, it is important to consider not only their mechanical performance but also the potential effects of additives and contaminants on the safety and environmental suitability of the finished products.

Floor tiles were produced using recycled low-density polyethylene (LDPE) obtained from discarded pure water sachets and buffing dust collected from an abattoir. The materials were selected to investigate the potential of converting locally available waste into useful construction products and to reduce the environmental problems associated with improper waste disposal.

The collected plastic sachets were sorted, cleaned to remove dirt and other contaminants, and dried before processing. The dried sachets were cut into smaller pieces to facilitate melting and mixing. The buffing dust was prepared by removing unwanted materials and ensuring that it was sufficiently dry before use.

The prepared LDPE and buffing dust were combined according to the mixture proportions used for each formulation. The mixture was heated at 160-170 °C for 20 minutes to soften or melt the plastic and allow it to bind with the buffing dust. The mixture was stirred for 20 minutes to promote uniform distribution of the constituent materials. [State whether a separate binder was added or whether the softened LDPE served as the binding material.]

The resulting mixture was transferred into a mould measuring 200mm × 200mm × 10-15 mm and subjected to a pressure of 1-3 Mpa for 3-5 minutes. The molded tiles were before being removed from the mould. The produced tiles were labeled Samples A, B, and C according to their respective mixture proportions and were prepared for laboratory testing.

The finished samples were evaluated for tensile strength, compressive strength, chemical resistance, and water absorption. Tensile and compressive strength were measured using a Universal Testing Machine. Chemical resistance was assessed using the selected chemical media, while water absorption was determined by immersing each sample in water for 24 hours and recording the change in mass. The results obtained were used to compare the performance of the three tile formulations.

Materials and Methods

Standard method was used for the recycling and production of floor tiles from Recycled Low Density Polyethylene and Buffing Dust.

Materials, Apparatus and Reagents

The recycled low-density polyethylene (LDPE) sachets used in this study were thoroughly washed with clean water to remove dirt and other visible impurities. The sachets were then sun-dried for 24 hours to remove moisture before processing. After drying, the sachets were manually cut into small pieces using scissors and transferred into a clean, dry bowl in preparation for the floor tile production process. The sachet material was identified as LDPE,

subject to confirmation from the material supplier or packaging specifications. The sachets were considered ready for processing after drying; however, complete dryness was not independently verified using a moisture measurement method. The collected buffing dust was milled to reduce the particle size and then sieved to obtain particles passing through a 150 µm sieve aperture. The 150 µm particle size was selected to obtain relatively fine particles that could be distributed more uniformly within the recycled low-density polyethylene (LDPE) matrix. A finer particle size improve the contact between the buffing dust and the plastic matrix, promote a more uniform composite structure, and reduce the presence of large particles that could affect the surface finish and mechanical properties of the produced floor tiles. The sieve aperture was specified as 150 µm (0.150 mm). 150 µm as the size selected for this study.

Table 1: Materials and apparatus used for floor tile production and testing

Material/apparatus	Manufacturer	Model number	Source
Recycled LDPE (pure water sachets)	Not applicable	Not applicable	Federal University Dutse
Buffing dust	Not applicable	Not applicable	Dutse Abattoir
Mould	Not recorded	Not recorded	Gida Dubu, Dutse
Test tubes	Not recorded	Not recorded	Jigawa Poly Lab
Weighing balance	A&D Instruments	HR-200-BC	Jigawa Poly Lab
Universal Testing Machine	Vickers	MV1-PC	Jigawa Poly Lab
Scissors	Not recorded	Not applicable	Jigawa Poly Lab

Source : Field Survey, 2024.

Sample and sampling techniques

A total of 210 discarded pure water sachets and approximately 40 g of buffing dust were collected for the production of floor tiles. The sachets were randomly collected from Federal University Dutse, while the buffing dust was collected from Dutse Abattoir. The collected materials were prepared for production by washing and sun-drying the sachets, cutting them into smaller pieces, and milling and sieving the buffing dust to obtain the required particle size.

The prepared materials were used to produce three tile samples designated A, B, and C. Equal quantities of the prepared materials were used in producing the three samples to maintain consistency in the material composition and production procedure. The samples were subsequently subjected to laboratory tests to evaluate their tensile strength, compressive strength, chemical resistance, and water absorption. The resulting measurements were compared to assess the performance of the produced tiles.

Laboratory/Analysis Procedure

Mechanical property Test

a. Tensile strength test

b. Compression test

Chemical absorption test

Water absorption test

Mechanical Property Test

a. Tensile Test

The tensile strength test of the produced floor-tile samples was conducted at the Chemistry Laboratory of Jigawa State Polytechnic, Dutse, Jigawa State, Nigeria, using a Universal Testing Machine. Each specimen was prepared and mounted securely in the machine before testing. The test was performed at a crosshead speed of 10 mm/min, with each specimen measuring 100 mm in height, as specified in the experimental procedure.

Three replicate specimens were tested for each sample formulation, and the average values obtained were reported. Testing the replicate specimens helped to improve the reliability of the results and allowed for comparison of the tensile performance of Samples A, B, and C.

The tensile test results were used to assess and compare the mechanical performance of the produced floor tiles. The specimen width and thickness, together with the testing standard or method followed, should be reported where these details are available. If no formal testing standard was followed, the procedure should be identified as the experimental method adopted for this study.

b. Compression Test

The compression test of the produced floor-tile samples was conducted at the Chemistry Laboratory of Jigawa State Polytechnic, Dutse, Jigawa State, Nigeria, using a Universal Testing Machine. Each specimen was positioned centrally between the compression platens of the machine to ensure that the applied load was distributed as uniformly as possible. The test was conducted at a crosshead speed of 5 mm/min, with a reported specimen height of 100 mm.

Three replicate specimens were tested for each sample formulation, and the average values obtained were calculated and reported. The test was performed to evaluate and compare the resistance of Samples A, B, and C to compressive loading.

c. Chemical resistance/ Chemical absorption testing

The chemical resistance of Samples A, B, and C was evaluated using petrol as the test medium. Before the test, the three sample formulations were dried at room temperature for one week. Three replicate specimens were prepared from each sample formulation by cutting the materials into small portions. The initial weight of each specimen ((W_1)) was measured and recorded before exposure to petrol.

Each specimen was placed in a test tube containing petrol and completely immersed throughout the 24-hour exposure period at room temperature. After 24 hours, the specimens were removed from the petrol, gently wiped with a clean cloth to remove surface liquid, and reweighed to determine their final weight ((W_2)). The initial and final weights were used to calculate the percentage change in weight as an indication of the specimens' response to petrol exposure.

The percentage change in weight was calculated using the following formula:

$$[\text{Percentage weight change}= \frac{W_2-W_1}{W_1}\times100]$$

Where (W_1) is the initial weight before exposure and (W_2) is the final weight after exposure and surface wiping. A positive value indicates weight gain, while a negative value indicates weight loss.

The specimens were tested in triplicate, and the results were used to compare the chemical resistance of Samples A, B, and C. The individual initial weights were recorded; however, the specimen dimensions and exact volume of petrol used were not measured or recorded. These limitations should be acknowledged when interpreting the results and describing the reproducibility of the experiment.

d. Water Absorption Test

The water absorption test was conducted to assess the ability of the produced floor-tile samples to absorb water over a 24-hour period. Before immersion, each specimen was weighed, and its initial weight ((W_1)) was recorded. The specimens were then completely immersed in water for 24 hours. After the immersion period, each specimen was removed from the water, and excess surface water was removed before its final weight ((W_2)) was measured.

The percentage water absorption was calculated using the following formula: (\text{Water absorption (%)}= (\frac{W_2-W_1}{W_1}\times100 where (W_1) is the initial weight before immersion and (W_2) is the final weight after 24 hours of immersion and removal of excess surface water.

Three replicate specimens were tested for each sample formulation. Where the results are presented as mean values, the percentage water absorption was calculated for each replicate, and the arithmetic mean of the three results was reported for each sample. The individual initial and final weights should be provided in the raw data or an appendix where available to support verification of the reported mean values.

3.2 Sample Collection

Recycled low-density polyethylene (RLDPE) sachets were collected from Federal University Dutse, Jigawa State, Nigeria, while buffing dust was collected from Dutse Abattoir, Jigawa State, Nigeria. The collected materials were used as the primary raw materials for producing the composite floor-tile samples. The materials were prepared and combined in different proportions to investigate how varying the buffing dust content affected the properties of the produced tiles.

3.3 Formulation of the composite samples

Three formulations were prepared using different proportions of recycled low-density polyethylene and buffing dust. The total mass of ingredients was maintained at 100 g for each formulation. Sample A contained 95 g of RLDPE and 5 g of buffing dust; Sample B contained 90 g of RLDPE and 10 g of buffing dust; and Sample C contained 85 g of RLDPE and 15 g of buffing dust. These formulations provided a systematic increase in the proportion of buffing dust from Sample A to Sample C while maintaining a constant total ingredient mass.

Table 3.2: Formulation of the Composite Floor-Tile Samples

Ingredient	Sample A (g)	Sample B (g)	Sample C (g)
Recycled LDPE (RLDPE)	95	90	85
Buffing dust	5	10	15
Total mass	100	100	100
RLDPE (%)	95	90	85
Buffing dust (%)	5	10	15

Result and Discussion

Table 4: RESULTS OF TENSILE STRENGTH FOR PRODUCED FLOOR TILES

SAMPLES	FORCE AT PEAK (KN)	ELONGATION AT BREAK (mm)
SAMPLE A	0.262	22.025
SAMPLE B	0.158	14.497
SAMPLE C	0.185	17.960

SOURCE: Field Survey, 2024

The mechanical behavior of the newly developed floor tiles was evaluated to understand their structural reliability under stress. Table 4 details the core findings, breaking down performance by Force at Peak (kN)—which measures the maximum load the tiles can handle—and Elongation at Break (mm), which tracks how much they deform before fracturing.

When analyzing the metrics, distinct variations emerge among the formulations. Sample A exhibited the highest overall performance, recording a peak force of 0.262 kN alongside a maximum elongation at break of 22.025 mm. Conversely, Sample B recorded the lowest resilience with a peak force of 0.158 kN and an elongation of 14.497 mm, while Sample C positioned itself moderately at 0.185 kN and 17.960 mm.

The present finding is also consistent with recent work on recycled-plastic-based construction materials, which demonstrates that the mechanical properties of polymer composites can vary considerably with material formulation. For example, Amena and Hossain (2024) reported that changes in the proportions of recycled PET and other constituents significantly influenced the mechanical performance of composite boards. Their findings further demonstrated that appropriate material combinations can improve the structural performance of recycled-polymer products.

Table 5: RESULTS OF COMPRESSION STRENGTH FOR PRODUCED FLOOR TILES

SAMPLES	FORCE AT PEAK (KN)	DEFORMATION AT BREAK (mm)
SAMPLE A	1.072	61.794
SAMPLE B	0.649	51.230
SAMPLE C	0.408	47.701

SOURCE: Field Survey, 2024

Table 5 outlines the core findings, tracking two critical metrics: Force at Peak (kN), which measures the maximum load the tiles can endure before failing, and Deformation at Break (mm), which records how much the material compressed or shortened vertically right up until structural collapse.

When analyzing the compressive metrics, Sample A demonstrated superior load-bearing capacity and resilience, recording a peak force of 1.072 kN and a maximum deformation at break of 61.794 mm. In contrast, Sample B and Sample C exhibited lower performance, with peak forces of 0.649 kN and 0.408 kN, and corresponding deformations of 51.230 mm and 47.701 mm, respectively.

The reduction in peak force from Sample A to Samples B and C is related to differences in the composition and internal structure of the tiles. In polymer-based composites, mechanical performance is influenced by the interaction between the matrix and reinforcement or filler. Good interfacial bonding promotes efficient transfer of stress through the composite, whereas poor dispersion, voids or weak interfaces can become points of stress concentration and initiate failure. Recent studies by Shifa (2026) have similarly reported that the mechanical performance of recycled polymer composites depends strongly on composition and the quality of matrix–filler interaction.

The findings are particularly relevant to floor-tile applications because compressive resistance is an important property for materials expected to withstand loads during service. Recent research on recycled polymer floor-tile materials found that appropriately designed polymer composites can achieve useful compressive performance while also maintaining low water absorption. This result is in agreement with the works of (Shifa, 2026, Micheal and Muneer, 2012). Similarly, recent research on recycled polypropylene floor tiles showed that optimized compositions produced substantial compressive strength, while excessive reinforcement could reduce performance because of agglomeration and weaker interfacial bonding.

Table 6: RESULTS OF PETROL ABSORPTION TEST FOR PRODUCED FLOOR TILES TILES

SAMPLES	Initial weight (W_1) (g)	Final weight (W_2) (g)	(W_2-W_1)	% Weight gain/loss
Sample A	0.20g	0.20g	0g	0%
Sample B	0.30g	0.30g	0g	0%
Sample C	0.30g	0.30g	0g	0%

SOURCE: Field Survey, 2024

The table above tracks the weight changes of the tile samples before (W_1) and after (W_2) exposure to petrol over the specified testing period.

Looking at the numbers in Table 6, a uniform trend emerges across all tested compositions. Samples A, B, and C all recorded a net weight difference of 0 g, resulting in a 0% mass change following their exposure to petrol.

The finding is consistent with recent studies by (Vila, 2020) showing that polymer-based construction composites can exhibit low liquid absorption when their structures are sufficiently dense and resistant to fluid penetration. For example, recent work on recycled-polymer floor tiles reported water absorption values below 1% for the investigated composites, demonstrating the potential of polymer-based materials to provide relatively low permeability. (Amena and Hossain, 2024)

The high resistance observed here suggests that the tile materials do not readily react with or dissolve in refined hydrocarbons like petrol. This aligns well with findings by Obasi et al.

(2014) regarding the chemical inertness of composite materials in specific solvent environment.

Table 7: RESULTS OF WATER ABSORPTION TEST FOR PRODUCED FLOOR TILES

SAMPLES	Initial weight (W_1) (g)	Final weight (W_2) (g)	(W_2-W_1)	% Weight gain/loss
Sample A	0.20g	0.20g	0g	0%
Sample B	0.30g	0.30g	0g	0%
Sample C	0.60g	0.60g	0g	0%

SOURCE: Field Survey, 2024

Table 7 outlines the findings by tracking the initial dry weight (W_1) and the final weight (W_2) after exposure to water under the testing conditions.

In Table 7, all three samples—Sample A, Sample B, and Sample C—recorded a net weight difference of 0 g, translating to a 0% weight change across the board.

The data strictly demonstrates that the samples showed no measurable mass change after 24-hour immersion under the stated conditions, indicating reliable short-term resistance to moisture and hydrocarbon exposure. Obasi , et al, (2014). The result agrees with recent research on recycled polymer composites by Amena and Hossain (2024) who reported that increasing recycled PET content in a waste-based composite reduced water absorption and thickness swelling, demonstrating the contribution of polymer content to moisture resistance. Recent research on polymeric floor-tile composites has likewise reported very low water absorption values, with some formulations showing values below 1%.

The present finding is also supported by research on waste-plastic tiles, where zero water absorption was observed for some plastic-rich formulations (Kiruthika, 2024). Such behaviour was associated with the relatively impermeable nature of the polymer-based structure.

The 0% water absorption obtained in the present study therefore suggests that the produced tiles have good resistance to moisture penetration under the test conditions. This characteristic could be advantageous in areas where floor materials are exposed to water, washing or occasional moisture. (Central pollution Board, 2022.). This shows that the tiles cannot be absorbed by petroleum or water because the tiles are of high durability.

Conclusion

Based on the research and analysis conducted on the floor tiles produced from recycled low-density polyethylene (such as pure water sachets) and buffing dust, several key conclusions can be drawn. Among the formulations tested, Sample A demonstrated the superior overall mechanical performance, recording the highest values in peak force and deformation metrics during both tensile and compression evaluations and outperforming Samples B and C. However, in terms of chemical and moisture resistance, Samples A, B, and C all exhibited a uniform 0% mass change after 24-hour immersion in both petrol and water. Because all three samples performed identically in these tests, the fluid absorption metrics do not distinguish Sample A from the rest; rather, they collectively demonstrate that all formulated tile types possess reliable short-term resistance to water and hydrocarbon exposure under the stated conditions. Finally, the successful fabrication of tiles using waste polymers and

buffing dust highlights a highly viable pathway for resource recovery, proving that diverting materials like pure water sachets from the waste stream into structural products can effectively mitigate environmental pollution and plastic contamination.

Recommendations

Based on the findings of this research regarding the properties of floor tiles produced from recycled low-density polyethylene (pure water sachets) and buffing dust, the following recommendations are proposed for future research and practical application:

1. Thermal Property and Stability Analysis: Future studies should investigate the thermal properties, softening behavior, and thermal stability of the tile samples to better assess their performance and safety in practical, real-world flooring environments.
2. Exploration of Alternative Applications: Further research should explore alternative areas of application for composites formulated from pure water sachets and buffing dust to expand their commercial viability.
3. Laboratory Equipment and Accessibility: Institutional and educational laboratories should be adequately equipped with standard testing machinery to facilitate comprehensive material analysis and experimental accuracy.
4. Small-Scale Production and Quality Control: The production of these eco-friendly floor tiles should be promoted as a youth empowerment initiative. However, future efforts must incorporate formal standardization, strict quality control measures, and small-scale feasibility assessments to ensure consistent product reliable.

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