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REDUCED PLASTICITY AND REINFORCEMENT OF POLYVINYL CHLORIDE USING SAWDUST POWDER AS A NATURAL FILLER

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ABSTRACT

This study investigates the use of powdered sawdust from three wood types (Mitragyna ciliata, Aucoumea klaineana and Khaya anthotheca) as a natural filler in polyvinyl chloride composites (PVC) to enhance performance properties such as tensile strength, impact resistance, and hardness compared to non-reinforced PVC composites. The research aims to evaluate the physicochemical characteristics of wood sawdust and its impact on the mechanical properties of polyvinyl chloride (PVC) composites. Wood-plastic composites (WPC) were prepared by incorporating sawdust into the PVC polymer matrix using tetrahydrofuran (THF) as the dissolving solvent, with moulded samples created using silicone gel. The physicochemical properties of the wood sawdust, such as pH, moisture content, dry weight percentage, bulk density, porosity, grain volume, iodine number, and ash content, were analyzed and found to vary significantly across the wood types. Mechanical property assessments revealed no enhancements in the reinforced PVC composites. Tensile strength varied by wood type: Mitragyna ciliata (4.73 N/mm²), Aucoumea klaineana (5.69 N/mm²), and Khaya anthotheca (7.50 N/mm²). Similarly, impact resistance showed variations: Mitragyna ciliata (0.21 N-m/mm²), Aucoumea klaineana (0.26 N-m/mm²), and Khaya anthotheca (0.84 N-m/mm²), with an overall hardness of 13.00 N/mm². Statistical analysis consistently demonstrated that sawdust-reinforced PVC composites exhibited superior mechanical properties compared to unreinforced PVC. It can be concluded that Khaya anthotheca wood sawdust powder has outstanding overall performance in mechanical properties when compared to the other wood sawdust powders investigated. Therefore, Khaya anthotheca sawdust is recommended for further study in terms of durability, weathering properties, and other environmental conditions to evaluate its suitability as a filler in PVC plastic product manufacturing.

Keywords: Polyvinyl chloride, Powdered-sawdust, PVC composite, Physicochemical properties.

INTRODUCTION

Polyvinyl chloride (PVC) is a widely used thermoplastic polymer produced by polymerizing vinyl chloride monomers, which are typically synthesized via the chlorination of ethylene (Enayati*et al.*, 2021). Due to its favorable propertiessuch as chemical resistance, flame retardancy, mechanical strength, and ease of processing PVC finds extensive applications across various industries, including construction, automotive,

electronics, and healthcare (Morgan & Mukhopadhyay, 2022; Mazhar *et al.,* 2020). It is especially valued for its electrical insulation capabilities and versatility, as it can be manufactured into rigid or flexible forms through the incorporation of additives and plasticizers (Mazhar *et al.,* 2020). Rigid PVC is commonly used in pipes, window profiles, and roofing due to its structural integrity and weather resistance (Rimdusit*et al.,* 2014), whereas flexible PVC is preferred for medical tubing, cable insulation, and flooring because of its pliability and biocompatibility (Gimeno *et al.,* 2014)

However, concerns have emerged regarding the environmental and health impacts of PVC, particularly related to the use of certain plasticizers and the release of toxic byproducts during disposal or incineration (Hahladakis*et al.,* 2018; Man *et al.,* 2014). These challenges have intensified the search for more sustainable formulations. One promising approach involves the development of wood–plastic composites (WPCs), which incorporate natural fillers such as sawdust to reduce the environmental footprint of PVC products while enhancing their structural performance (Medved *et al.,* 2020; Gardener *et al.,* 2015).

WPCs combine lignocellulosic fibers with thermoplastics to produce hybrid materials that offer improved mechanical properties and reduced reliance on synthetic polymers. Despite their advantages, challenges persist, particularly regarding the poor compatibility between hydrophilic sawdust and hydrophobic PVC. This mismatch can lead to inadequate filler–matrix adhesion, reduced mechanical integrity, and poor dispersion of the natural filler (Hammiche *et al.,* 2021). Additionally, the influence of sawdust on thermal stability, flame resistance, and weatherability must be thoroughly understood to ensure performance in real-world applications (Asim *et al.,* 2020).

This study investigates the reinforcement of rigid PVC using sawdust derived from three hardwood species native to West and Central Africa.*Mitragyna ciliata* (commonly known as Abura), *Aucoumea klaineana* (Okoumé or Oleku)and *Khayaivorensis* (African mahogany). These species were selected due to their availability as byproducts of the wood-processing industry, as well as their favourable mechanical and physical properties. *Mitragynaciliata* is a medium-density hardwood with a straight to slightly interlocked grain and fine texture. It is commonly used in furniture, flooring, and plywood applications and is appreciated for its good workability and moderate durability (Kelechi-Asumba *et al.,* 2019). *Aucoumea klaineana*, a lightweight hardwood with a pale pinkish to light brown hue, is known for its fine, even texture and high dimensional stability. It is widely used in marine plywood and indoor joinery due to its excellent bonding characteristics, although it has low resistance to biological degradation (Anris *et al.,* 20202). *Khaya ivorensis*, or African Mahogany, produces a moderately dense, aesthetically valued timber with a reddish-brown colour and interlocked grain. It is extensively used in high-end furniture, cabinetry, and architectural applications, offering good machining and finishing properties.

The use of sawdust as a reinforcing filler in rigid PVC aligns with circular economy principles by encouraging the reuse of wood-processing waste and reducing reliance on virgin polymer materials. Beyond lowering production costs and material input, the addition of these natural fillers improves the stiffness and dimensional stability of the composite, making it more suitable for structural applications.

MATERIALS AND METHODS

Preparation of Materials

PVC, THF solvent, and silicone gel were sourced from a chemical shop in Warri, Delta State, while wood sawdust from three different species (*Aucoumea klaineana*, *Mitragyna ciliata* and *Khaya anthotheca*) was obtained from a sawmill in Udu, Warri, Delta State.A solution was prepared by thoroughly mixing 70 mL of THF with 20 g of PVC until complete dissolution occurred. Then, 30 g of sawdust from each wood species was

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separately added to individual batches of the PVC solution and stirred until uniform pastes were formed, resulting in three distinct wood-reinforced mixtures. Each mixture was poured into a metallic mold pre-treated with silicone gel as a release agent. The composites were left to solidify in the molds for 10 hours before removal for testing.A control sample was also prepared using only 70 mL of THF and 20 g of PVC, without any sawdust reinforcement. Both the sawdust-reinforced PVC composites and the non-reinforced control underwent mechanical testing to assess tensile strength, impact resistance, and hardness. Additionally, the physicochemical properties of the sawdust fillers were analysed.

Physiochemical Characteristics of Sawdust: pH Value

The pH of the sawdust samples was determined using a microprocessor pH meter. A 20 g portion of the sample was sieved through a 2mm mesh, placed in a 100 ml beaker, and mixed with 20 ml of distilled water while stirring. The pH of the resulting mixture was then measured using the microprocessor pH meter, and the readings were recorded.

Moisture Content

The moisture content of the sample was determined using the weight reduction method.Initially, thesample along with its container was weighed to obtain the combined wet weight (ww). The sample was then dried at an environmental temperature between 15 ^{0}C and 37 ^{0}C until a constant weight was achieved. After drying, the container with the dry sample was weighed again to record the dry weight (Wd). The weight of the empty container (Wc) was also measured separately. The weight of the wet sample was calculated as (Ww - Wc) and the weight of the dry sample as (Wd - Wc).

The moisture content on a dry basis was then calculated using the formula:

$$\frac{\text{Moisture content initial weight} - \text{dry weight}}{\text{dry weight}} \text{ x } 100$$

$$= \frac{w_w - w_d}{w_w - w_c} \text{ x } 100$$

Weight of container Wc

Weight of container plus wet samples (g) = Ww

Weight of container plus sample after drying (g) = Wd

Iodine Number

The iodine number was determined using Wig's reagent in accordance with the ASTM D4607-14 method. A measured amount of sawdust sample, typically between 0.1 and 0.5 g, was placed in a beaker, followed by the addition of 10–20 mL of carbon tetrachloride and Wig's reagent, which comprised approximately 0.5–1.0 g of iodine dissolved in 10.0 mL of glacial acetic acid. The mixture was allowed to stand for about 30 minutes to enable adequate adsorption. Thereafter, 2.0 g of potassium iodide and 100.0 mL of distilled water were added to the solution. The resulting mixture was titrated against 0.1 N sodium thiosulphate, using a few drops of the starch solution near the endpoint to indicate the completion of the reaction. A blank titration was also conducted using only distilled water to ensure accuracy.

The formula used to calculate iodine number is as follows;

$$\text{Iodine Number (\%)} = \frac{\text{Blank} - \text{sample}}{\text{weight of sample}} \text{ x } 12.69$$

Ash Content

The ash content of biomass materials such as sawdust was determined using the dry oxidation method in accordance with ASTM E1755. Initially, the sawdust sample was oven-dried at 105 °C to eliminate moisture and ensure accurate mass measurement. Approximately 1 to 2 grams of the dried sample were weighed into a pre-weighed crucible made of platinum, silica, or porcelain. The crucible was then placed in a muffle furnace and heated to 24 ± 6 hours at 575 ± 25 °C. The sample was maintained at this temperature until complete combustion of organic matter occurred, leaving behind only

inorganic mineral residue (ash). After combustion, the crucible was removed from the furnace, cooled in a desiccator to prevent moisture uptake, and reweighed. The ash content was expressed as the percentage of the residual mass relative to the original oven-dried sample weight. This procedure offers a reliable estimate of the total inorganic fraction present in the biomass.

Calculationof Ash Content

$$\text{Ash Content (\%)} = \frac{W_1 - W_2}{W_1} \text{ x } 100$$

W_1 = initial weight of Dry sample

W_2 = weight of Ash (after burning)

Bulk Density

5 grams each of the sawdust samples were sieved using a 0.5 mm sieve. The bulk density was then determined using the "core" sampler method. The finest sawdust samples of 0.40mm particle size were weighed and kept in a core. The core was prepared with a nickel foil and stainless mesh made in a cylindrical shape. Alternatively, the core sample was taken by driving the metal core (that is, the cylindrical material) into the sawdust sample at the desired depth and horizon. The bulk density (pb) was then calculated by the mass of the sample divided by the total volume of the sample

$$\text{pb} = \frac{\text{M}_\text{s}}{\text{V}_\text{t}}$$

M_s = mass of over dried sawdust (g)

V_t = total volume of sawdust (cm^3)

Which is equal to core sample's volume (v)

$$\text{V} = \pi \text{ x } \left(\frac{\text{d}}{2}\right)^2 \text{ x h}$$

h = core sample height

d = core sample diameter, all measured using a Venier Caliper

Porosity

The porosity was determined using the gravimetric method by first measuring the bulk volume, pore volume, and grain volume of the three sawdust samples. Initially, 5 grams of each oven-dried sawdust sample were weighed (W_1) and their bulk volumes were measured using a graduated cylinder or displacement method (V_bulk). To ensure complete water saturation, the samples were placed in a vacuum chamber and distilled water was gradually added while applying vacuum to displace all trapped air from the pores. The vacuum saturation process continued until no more air bubbles emerged, with samples maintained under vacuum for 30-60 minutes to guarantee complete saturation. The water-saturated samples were then removed, gently blotted with filter paper to remove excess surface water, and immediately weighed (W_2). The pore volume was calculated as (W_2 - W_1) divided by the density of water (1 g/cm^3), representing the volume of water absorbed into the pore spaces. The grain volume was subsequently determined by subtracting the pore volume from the bulk volume (V_grain = V_bulk - V_pore). Finally, the porosity percentage was calculated using the formula: Porosity (%) = (V_pore / V_bulk) × 100, providing a quantitative measure of the void space within each sawdust sample relative to its total bulk volume.All physicochemical data were subjected to one-way analysis of variance (ANOVA), and statistical analyses were conducted using IBM SPSS Statistics version 27.

Determinationof Mechanical Properties

All the mechanical tests were carried out at the Mechanical Engineering Laboratory at Petroleum Training Institute (PTI), Warri, Delta State.

Impact Strength

The Izod impact test was conducted in accordance with ASTM D256 to determine the impact strength of both reinforced and unreinforced PVC samples. The PVC

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specimens were machined with a notch to a depth of 2.54 mm, cut perpendicular to the direction of molding with a radius of 0.25 mm. The samples were clamped vertically in the pendulum impact test fixture with the notched side facing the striking edge of the pendulum. The distance between the top of the specimen and the bottom of the notch was maintained at 22 mm. The pendulum was released from a fixed height and allowed to strike the specimen, and the energy absorbed by the specimen during fracture was recorded as the difference between the initial and final pendulum energies. The impact strength was calculated using the formula: Impact Strength (J/m) = Energy Absorbed (J) / Cross-sectional Area at Notch (m^2).

$$\text{Toughness} = \frac{\text{Energy Absorbed}}{\text{Area}}$$

Hardness Test

A hardened steer spherical indenter with a diameter of 5mm was cleaned and placed on a flat and rigid support. The specimen was then placed parallel to the indenter. A force of 500kgf was then applied on the indenter and pressed on both the reinforced and non-reinforced PVC for 20 seconds. The force of the indenter was then removed and then the diameter of the indentation on both the reinforced and non-reinforced PVC was then measured and recorded.

The following relation was then used to calculate the hardness

$$\text{Brinel Hardness} = \frac{2F}{\pi D\ (D - VCD^2 - d^2}$$

F = applied force (in kgf)

D = diameter of the indenter (in mm)

d = diameter of the indentation (in mm)

brinel hardness is typically expressed in units of HB (Brinel hardness number) which is a dimensionless quantity.

Tensile Strength

A universal tensile strength machine was used to conduct the tensile strength on both the reinforced and non -reinforced PVC. Each PVC samples were placed horizontally between the grips of the tensile machine. An extensometer was also added to the specimen to measure the strain. The initial distance between the grips was adjusted to match the gauge length of the PVC samples at a constant rate of cross – head movement until the PVC sample broke or fail. The load and displacement data were then recorded from the machine, and the strain from the machine, and the strain from the extensometer. The stress was calculated by dividing the load by the cross – sectional area of the specimen, while the strain was calculated by dividing the change in length by the original length of the PVC samples. A graph was plotted for the stress-strain curves and was used to determine the tensile strength.

RESULTS AND DISCUSSION

The Physicochemical Properties of Sawdust

Table 1 depicts the physicochemical properties of the sawdust samples (*Aucoumea klaineana*, *Mitragyna ciliata* and *Khaya anthotheca*), including pH, moisture content, dry weight, bulk density, porosity, gram volume, iodine number. An increase in pH values was observed in the following order: *Mitragyna ciliata* > *Khaya anthotheca* > *Aucoumea klaineana*. This trend can be attributed to thedifferences among the wood species. The recorded pH value of 5.23 for *Aucoumea klaineana* and the highest value of 5.94 for*Khaya anthotheca*are consistent with the findings reported by Mallackpour *et.al*. (2021). The acidic nature of sawdust is primarily due to the presence of organic acids, such as acetic acid, which are produced during the decomposition of wood. Acetic acid formation acts as a depolymerization catalyst, accelerating the breakdown of polysaccharides in the wood structure. These organic acids can influence the compatibility of sawdust with polyvinyl chloride (PVC), potentially affecting the mechanical and thermal properties of resulting composites. Porosity measurements revealed a distinct hierarchy: *Khaya anthotheca* demonstrated the highest

porosity, followed by *Mitragyna ciliata*, then *Aucoumea klaineana*. As reported by Duruaku*et al*. (2023), porosity and bulk density critically influence a material's absorption capacity. This positions *Khaya anthotheca* as the most effective for applications requiring strong absorbent properties within composite matrices. Moisture content followed an inverse pattern: *Aucoumea klaineana* exhibited the highest moisture levels, trailed by *Mitragyna ciliata*, then *Khaya anthotheca*. Elevated moisture content can compromise composite stability and processing efficiency, as water acts as a plasticizer. This plasticizing effect often reduces mechanical performance by weakening intermolecular bonds during material fabrication. *Khaya anthotheca* sawdust demonstrated 87.46 - 91.89% dry weight, representing the proportion of residual solids after moisture extraction. These values align with foundational work by Sombatsompop and Chaochanchaiku (2004), whoidentified high solid-content sawdust as effective reinforcement agent in polymer composites.

The iodine number results revealed the following order: *Khaya anthotheca*> *Aucoumea klaineana*>*Mitragyna ciliata*, with *Khaya anthotheca* exhibiting the highest value (11.5 %/100g) and *Mitragyna ciliata* the lowest (7.9 %/100g), indicating that higher iodine numbers are associated with a larger surface area and, consequently, a greater potential for interaction between sawdust and PVC; additionally, grain volume measurements showed 1.7630 cm^3 for *Khaya anthotheca* and 2.500 cm^3 for *Aucoumea klaineana*, suggesting that the sawdust samples studied possess properties that can enhance compatibility, adhesion, and dispersion within the PVC matrix, as supported by Torres-Gineve*t al.* (2016).

Ash content analysis revealed *Mitragyna ciliata* (6.3%) >*Khaya anthotheca* (5.5%) >*Aucoumea klaineana* (3.9%). According to Silver *et al.* (2017), ash contents>5% (seen in *Mitragyna ciliata*/ *Khaya anthotheca*) may enhance flame retardancy but risk mechanical degradation, while *Aucoumea klaineana*'s lower ash content favors performance; grain volume measurements followed *Aucoumea klaineana* > *Mitragyna ciliata* > *Khaya anthotheca*, aligning with Gwon *et al.* (2012) on how optimal dispersion (facilitated by higher grain volumes like *Aucoumea klaineana*'s 2.500 cm^3) improves mechanical properties in PVC composites. Bulk density analysis showed that *Aucoumea klaineana* (0.92 g/cm^3) >*Khaya anthotheca* (0.80 g/cm^3) >*Mitragyna ciliata* (0.79 g/cm^3), consistent with Pokhrel *et al.* (2021), who reported that higher bulk density—as observed in *Aucoumea klaineana* promotes better particle packing. This, in turn, enhances mechanical properties in PVC–sawdust composites by minimizing voids and strengthening interfacial bonding. The porosity values, which indicate the percentage of void space volume, are presented in Table 1 and show that *Khaya anthotheca* has the highest porosity (0.49%), followed by *Mitragyna ciliata* (0.39%) and *Aucoumea klaineana* (0.20%); according to Ndiaye *et al.* (2013), higher porosity can reduce mechanical strength due to decreased interfacial adhesion between the sawdust filler and the PVC matrix, so a lower porosity such as that observed in *Aucoumea klaineana*, suggesting better dispersion and interaction between sawdust and PVC, which is likely to enhance the composite's mechanical properties, making *Aucoumea klaineana* sawdust the most favorable among the samples tested for producing stronger PVC-sawdust composites.

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Table1: Physicochemical Properties of Wood-Sawdust

Sawdust Sample	pH Value	Moisture Content (%)	Dry Weight (mass)%	Bulk Density (g/cm^3)	Porosity %	Grain Volume (cm^3)	Iodine Number %	Ash Content %
Aucoumeaklaineana	5.23	12.54	87.46	0.9167	0.2011	2.5200	9.3	3.9
Mitragynaciliata	5.94	10.23	89.77	0.7991	0.3901	1.9820	7.9	6.3
Khayaanthotheca	5.62	8.11	91.89	0.8002	0.4871	1.7630	11.5	5.5

Table 2: Analysis of Variance (ANOVA) for the Physiochemical Properties of Wood-Sawdust Composites

Parameter	Source of Variation	SS	Df	Mean Square	F-value	P-value	Remarks
pH	Sawdust samples	0.4101	2	0.20505	339.42	<0.0001	Significant difference
	Residual Error	0.00363	6	0.000605			
	Cor Total	0.41373					
Moisture (%)	Sawdust samples	36.64	2	18.32	91.6	<0.0001	Significant difference
	Residual Error	1.2	6	0.20			
	Cor Total	37.84					
Bulk Density	Sawdust samples	0.01788	2	0.00894	89.4	<0.0001	Significant difference
	Residual Error	0.0006	6	0.0001			
	Cor Total	0.01848					
Porosity	Sawdust samples	0.04557	2	0.02278	151.87	<0.0001	Significant difference
	Residual Error	0.0009	6	0.00015			
	Cor Total	0.04557					

Key: SS-Sum of Squares, df- Degrees of Freedom, MS- Mean Square (SS/df), F- MS between/MS within

The one-way ANOVA was employed to assess the influence of sawdust type-namely *Aucoumea klaineana*, *Mitragyna ciliata* and *Khaya anthotheca* on selected physicochemical properties including pH, moisture content, bulk density, and porosity (Table 2). The results demonstrated statistically significant differences across all parameters, as evidenced by the extremely high F-values and p-values less than 0.0001 in each case.For the pH values, a highly significant effect of sawdust type was observed, with an F-value of 339.42 and a p-value below 0.0001. This strong difference, coupled with a low within-group mean square (MS = 0.000605), suggests that the variation in pH is directly associated with the inherent characteristics of the different wood species. These variations may be due to differences in organic acid content, lignin concentration, or overall chemical composition of the sawdust. Consequently, pH can be considered a reliable distinguishing factor among the tested sawdust types.

Moisture content also differed significantly among the sawdust samples, with an F-value of 91.6 and a p-value less than 0.0001. *Aucoumea klaineana* displayed the highest moisture content, potentially indicating a greater hygroscopic nature or a lower lignin content, which tends to retain water more effectively. The sharp contrast in between-group variance (SS = 36.64) relative to the

within-group variance (SS = 1.2) highlights the consistency of moisture retention within each sawdust type and affirms the effect of wood species on moisture behaviour.

Similarly, bulk density was found to vary significantly, yielding an F-value of 89.4 with a corresponding p-value below 0.0001. *Aucoumea klaineana* again exhibited the highest bulk density, likely due to a denser anatomical structure or smaller particle size. This implies that denser sawdust types may offer advantages in applications such as fuel briquette or pellet production, where higher density contributes to greater energy output and improved compaction properties. The within-group (residual error) variability for bulk density was minimal (MS = 0.0001), reinforcing the reliability of the observed differences.

The most pronounced variation was observed in porosity, which produced the highest F-value of 151.87. *Khaya anthotheca* had the highest porosity, whereas *Aucoumea klaineana* was the least porous among the samples. These findings suggest an inverse relationship between porosity and bulk density, which is expected given the nature of wood fiber packing. Porosity plays a key role in determining water absorption capacity and the potential for microbial colonization, thus influencing the suitability of a particular sawdust type for applications such as composting, filtration media, or substrate formulation in biotechnological processes.

Mechanical Properties of Reinforced and Unreinforced PVC

Tensile Strength

Table 3 and Figure 1 show that PVC reinforced with sawdust from *Mitragyna ciliata*, *Aucoumea klaineana*, or *Khaya anthotheca* wood has significantly higher tensile strength than unreinforced PVC (1 N/mm²), with *Khaya anthotheca*-reinforced PVC achieving the highest value (7.50 N/mm²), followed by *Aucoumea klaineana* (5.69 N/mm²) and *Mitragyna ciliata* (4.73 N/mm²); this improvement is consistent with previous findings (Perez *et al.*, 2012) that attribute enhanced tensile strength in wood dust-reinforced polymer composites to effective stress transfer between the PVC matrix and sawdust filler, which helps distribute stress more evenly, prevents crack propagation, and improves structural integrity, while variations in tensile strength among the different sawdust types may be due to differences in wood species, particle size, and compatibility with the polymer matrix (Bauafif *et al.*, 2009).

Impact Strength

The impact strength is a crucial mechanical property that assesses the ability of a material to absorb energy under loading conditions, such as impact or collision. The results obtained from the test of impact strength are shown in Table3and figure 1. The magnitude of the impact strength is in the order *Khaya anthotheca* > *Aucoumea klaineana*> *Mitragyna ciliata* with values of 0.84 N-^{m}/mm^{2}, 0.26 N-^{m}/mm^{2} and 0.21 N-^{m}/mm^{2} respectively. In contrast, the unreinforced PVC exhibited significantly lower impact strength measuring only 0.0017 N-^{m}/mm^{2}. The substantial improvement in impact strength from the reinforced PVC/sawdust filler echoes the outcomes of the investigation by Ashori, *et. al.* (2011), where wood flour reinforcement enhanced impact properties in polymer composite. This can be further explained that the increase in impact strength is attributed to the presence of sawdust particles within the polymer (PVC) matrix, which when subjected to impact loading, these particles help disperse and absorb. The energy associated with the impact event, this energy absorption occurs through mechanisms such as particle deformation, crack deflection and friction between the particle and polymer matrix (Ashori, *et. al.*, 2011).

Hardness

The results of the hardness tests are shown in Table 3 and Figure 1. Hardness measures a material's resistance to indentation or scratching. The results obtained show a consistent increase in hardness for all the reinforced samples in the order of *Khaya*

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anthotheca > *Aucoumea klaineana* > *Mitragyna ciliata*. The values obtained are *Khayaanthotheca* 59.72 HB, *Aucoumea klaineana* 40.80 HB, and *Mitragyna ciliata* 39.50 HB, respectively. In contrast, the unreinforced PVC exhibited a significantly lower hardness value, measuring only 13.0 HB. This lower hardness is typical of pure PVC, which lacks the additional reinforcing elements necessary to resist deformation and indentation effectively. The observed increase in the hardness of the PVC/sawdust matrix aligns with findings from studies such as those conducted by Jeamtrakull, *et. al.* (2012), which indicate that incorporating sawdust as reinforcement introduces microstructural changes that affect the overall hardness of the composite material. Additionally, the improved hardness can be attributed to the rigid nature of the sawdust particles, which reinforce the PVC matrix and resist deformation under load, thus enhancing the material's resistance to indentation.

Table 3: Mechanical Properties of Reinforced and Unreinforced PVC

	ReinforcedPVC			UnreinforcedPVC
Mechanical Property	***Mitragyna ciliata***	***Aucoumea klaineana***	***Khaya anthotheca***	
Tensile(N/mm^2)	4.73	5.69	7.50	1.0
Impact(N^{-m}/mm^2)	0.21	0.26	0.84	0.0017
Hardness(HB)	39.50	40.80	59.72	13.0

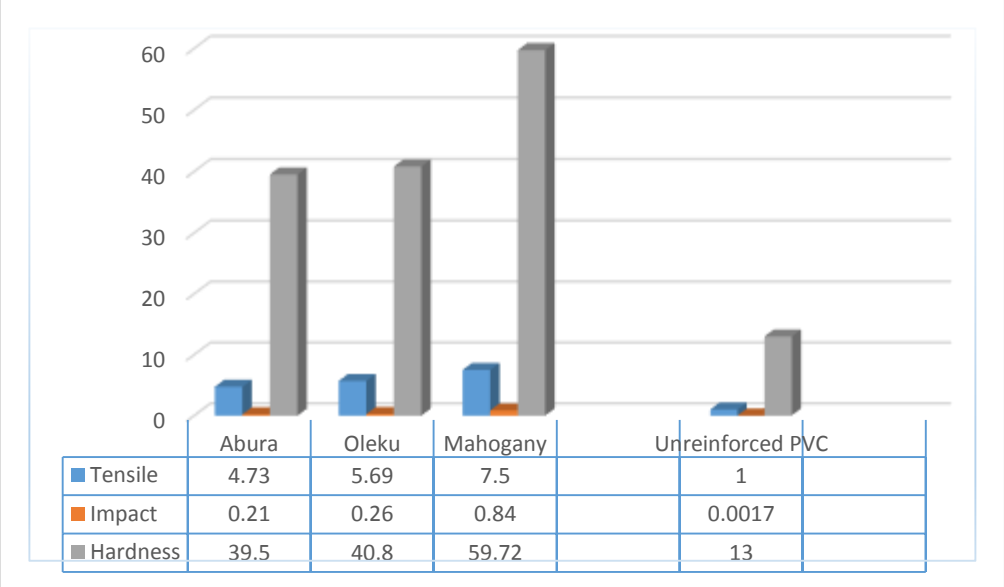

Figure 1: Graphical Representation of Reinforced and Unreinforced PVC

CONCLUSION

The study demonstrated that reinforcing polyvinyl chloride (PVC) with sawdust from different wood species enhances its mechanical properties. Physicochemical analysis revealed variations in pH, moisture content, bulk density, porosity, and ash content among the samples, all of which influenced the composite behaviour. Among the species tested, *Khaya anthotheca*-based composites exhibited the highest tensile strength, impact resistance, and hardness, making them the most effective reinforcing filler. These findings highlight the potential use of wood sawdust, particularly *Khaya anthotheca*, in developing sustainable, high-performance PVC composites for various industrial applications.

Conflict of Interest

The contributors to this study confirm the absence of any competing interests related to the published findings.

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