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Some properties of composite corn cob and sawdust particle boards

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HIGHLIGHTS

- Particle boards from corncob and sawdust with urea formaldehyde as binder showed good prospect.
- Selected physical and mechanical properties were determined.
- Indoor application is recommended.

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ABSTRACT

This research examined the possibility of developing a composite corncob (CC) and sawdust (SD) particle board using urea formaldehyde as binder. The panels were produced using 0%, 25%, 50%, 75% and 100% variations for both agricultural wastes with a constant volume of adhesive to evaluate their effect on the physical and mechanical properties. The results showed that 25% and 50% replacement of SD with CC had favourable physical properties recommendable for indoor uses in buildings. In contrast, the particleboards cannot be recommended for load bearing purposes based on poor mechanical properties which improved as the composition of CC increased from 25% to 75% and also because it failed to satisfy European Standard requirements. 75% CC replacement had the highest value for both MOR and MOE but possessed poor physical properties. Within the experimental investigation and possible limitations the panels with 50% CC replacement were the most preferred since they had preferable performances for both physical and mechanical properties.

1. Introduction

A lot of housing challenges are faced by most developing countries which have created a lot of housing shortages as a result of high interest rates, increased taxes, high labour costs and government policy bottlenecks. Most banks are not interested in financing housing construction through provision of loans and where it is available the interest and collateral requested are ridiculous, as a result of these challenges, a larger percentage of the populace live in sub-standard and ramshackle buildings. As a way of finding a lasting solution to these problems, lots of researches are being conducted on the use of non-conventional building materials which has the same properties as those popularly used for development of structures [1]. Most of the developing countries are very rich in agricultural and natural fibre since majority are peasant farmers who produce rice, palm trees, sugarcane and a lot of other crops accompanied with a large portion of agricultural wastes which are used as fuel or burnt off in disposal sites thereby constituting health hazards. It has been observed through various researches that these natural fibres have very good physical and mechanical properties and have the potential of being used in the development of different materials for various building applications [2–4]. Particleboard (PB) is a panel product made of wood products or other materials having lignocellulose properties bonded together by urea formaldehyde or other synthetic resin under high temperature and pressure to produce sheets [5–8]. Particleboards are light weight boards that can be used as thermal insulators, ceiling boards, wall partitions, doors and some other household furnitures [9]. Agro-wastes are being incorporated into green buildings because they are usually more economical at the long run. This led to the development of new environmentally friendly technologies for turning agricultural residues like maize cob, rice husk, groundnut shell [10,11] coconut coirs, durian peel [12,13] bamboo [14], bagasse, wheat straw, chir pine needles, chilli pepper stalks [15] woven cotton fabrics, rubber wood [16] cotton stalks, red cedar [17] and

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banana stem among others into quality value-added composite particle board products using conventional formaldehyde-based resins [2]. Some works have been done on development of composite particle and ceiling boards from both industrial and agricultural products in Nigeria. Sawdust, waste paper and starch were varied by weight to produce a ceiling board with good physical, mechanical and thermal conductivity properties [18]. Olorunmaiye and Ohijeagbon [19] also developed a composite particle board from wood waste and *jatropha curcas* seed cake with an observed improvement in the mechanical properties. In another study, general purpose particle boards which satisfied ANSI/A208.1-1999 specification were produced from cassava stalks and corn cobs [20]. Cengiz et al. [21] developed a composite particleboard panel by varying the sunflower stalks and calabrian pine percentage compositions using 100, 75, 50, 25 and 0% roportions. In a similar research, particles of empty fruit bunch of *Elaeis guineensis*, pineapple leaves, and Tetra Pak packages were mixed with 3 kinds of wood from *Gmelina arborea*, *Tectona grandis* and *Cupressus lusitanica in* 50:50, 70:30, and 90:10 variations [22]. The objectives of this research were to determine some physical and mechanical properties of composite corn cob and sawdust particles in a pre-determined proportions.

2. Materials

The materials used for the production of composite particleboard from corn cob and saw dust were sourced locally from the Landmark University community. These include 30 kg of corn cob (CC), 30 kg of saw dust (SD) which was from saw milled Mahogany specie of timber, Urea Formaldehyde resin (Top Bond) and plywood for the construction of moulds.

3. Methodology

3.1. Preparation of Corn Cob

The CC was collected at an average moisture content of 6.44%, room dried for 7 days to an average of 6.18% moisture content and manually crushed using a wooden mortar and pestle (Plate 1). The CC was hammer milled and sieved (Plate 2) so as to obtain particles passing through a B.S. sieve of aperture 3 mm and retained in a sieve of aperture 1.18 mm. The particles retained were re-milled and re-sieved while the particles that pass through the 1.18 mm sieve were discarded.

The volume of CC particles required for the production of 20 panels for the experimental design shown in Table 1 was 70,000 cm^3. The processed CC particles were weighed and the weight recorded as initial weight. Thereafter, these particles were conditioned in the oven at 60 °C for 24 h to achieve a new equilibrium moisture content of 3% of the initial.

Plate 1. Mortar crushed CC.

Plate 2. Milled and sieved.

Table 1
Experimental mix.

Composition code	Composition of SD (%)	Composition of CC (%)	Replicates
C1	100	0	4
C2	75	25	4
C3	50	50	4
C4	25	75	4
C5	0	100	4

3.2. Preparation of saw dust

The SD was sourced from the dumpsite within the University at a moisture content of 12.54% when analyzed with the aid of AND MX-50 moisture analyzer, room dried for 7 days, oven dried at 60 °C for 24 h till the moisture content reduced to 9.41% and sieved (Plate 3) using B.S. sieves of 3 mm and 1.18 mm apertures to remove oversized and undersized particles, enhance uniformity and improve homogeneous mixing. The volume of CC particles required for the production 20 panels for the experimental mix in Table 1 was 70,000 cm^3.

3.3. Production of composite particle board

To produce the composite, the calculated volumes of particles required as shown in Table 2 were measured using a graduated bucket. The different compositions were then batched into black

Plate 3. Sieved saw dust CC particles.