Assessment of the flexural strength and dimensional stability of cement-bonded board manufactured from *Gmelina arborea* sawdust and maize cobs.

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Introduction

- Cement bonded wood composites are strands, particles or fibers of wood mixed together with Portland cement and manufactured into panels, bricks, tiles and other products used in the construction industry.

- Cement-bonded composites helps to overcome the problem associated with the importation of resin adhesives in developing countries like Nigeria by providing a good substitute for resin-bonded particleboards, which contains 65% resin adhesives.

Introduction conts.

- Cement-bonded composites has excellent weathering qualities, which make it suitable for many external building purposes.

  Typical exterior applications are:

  - flat roofing
  - tunnel linings
  - prefabricated structures
  - balcony parapets and floors
  - cladding for industrial and warehouse buildings
  - sound barrier walls on highways
  - fire barriers
  - pavilions
  - soffits, agricultural buildings
  - swimming pool surroundings and paving

Research Objectives

The research work was carried out to

- Explore an economic use to which maize cobs can be adapted.
- Assess the measure of suitability of maize cobs for the production of cement-bonded composite boards.
- Evaluate the flexural strength and dimensional stability of cement-bonded composites manufactured from maize-cobs blended with *Gmelina arborea* sawdust.
- Recommend the level of blending proportion of *Gmelina arborea* sawdust:maize-cob flakes, and mixing ratio with inorganic binder that will produce the board of the best quality.

Research Methodology

Technical data

- **Board type - Homogeneous (One layered composite)**
- **Board dimension - 350mm×350mm×6mm**
- **Pre-treatment- Hot water (80c)**
- **Moisture Content - 12%**
- **Inorganic binder - Ordinary Portland Cement (OPC)**
- **Chemical Reagent - Calcium chloride (CaCl2)**
- **Pressing pressure - 1.23 Nmm-2**
- **Board Density - 1200kg-3**

Material preparation

- **Center pith removal**
- **Hammer mill conversion**
- **Sieving and exposure to air**
- **Pre-treatment at 80c for 60mins**
- **Drying under laboratory condition**
- **Weighing of materials**

Research Methodology Conts

Production

- Mixing of materials
- Mat laying on Caul plates
- Pressing at 1.23Nmm-2
- Demoulding after 24h
- Curing for 14days
- Conditioning at 30c& 65%R.H for 2 weeks

Testing

- Edge Trimming& Dimensioning
- Flexural Strength (MOR)

  $$MOR = \frac{3\rho L}{2bh2}$$

- Water Absorption

  $$WA (\%) = \frac{W2 - W1}{W1} \times 100$$

- Thickness swelling

  $$TS (\%) = \frac{T2 - T1}{T1} \times 100$$

- Linear expansion

  $$LE (\%) = \frac{L2 - L1}{L1} \times 100$$

Research Methodology Conts

Statistical Analysis

- Experimental Layout

	BP1	BP2	BP3	BP4	BP5
MR1	×	×	×	×	×
MR2	×	×	×	×	×

- Experimental Design: 2×3×3 factorial experiment in completely randomized design

- Statistical Model: Yijk= N+ Ai + Bj + (AB)ij + eijk

- Statistical Tools: MS Excel analysis tool pack

  SPSS analysis software

Outcome of the Study

Table showing the mean values of water absorption (WA), thickness swelling (TS), linear expansion (LE) and modulus of rupture (MOR).

Board No	Treatment Combinations	MOR(Nmm^{-2})	TS(%)	WA(%)	LE(%)
1	BP1MR1	-	-	-	-
2	BP2MR1	0.00±0.00	11.43±0.06	44.39±5.95	1.35±1.00
3	BP3MR1	0.06±0.02	9.73±0.20	37.65±1.78	1.14±1.00
4	BP4MR1	0.15±0.04	6.34±0.25	29.45±1.76	1.01±0.50
5	BP5MR1	0.52±0.11	4.53±0.05	27.58±0.59	0.63±1.00
6	BP1MR2	-	-	-	-
7	BP2MR2	0.26±0.05	8.43±0.05	27.29±0.92	1.18±1.50
8	BP3MR2	0.43±0.03	7.20±0.15	23.26±3.42	0.84±0.50
9	BP4MR2	0.52±0.02	3.06±0.05	22.45±0.85	0.61±0.50
10	BP5MR2	0.65±0.02	0.60±0.05	20.14±0.45	0.47±0.50

*The mean values of 2 replicates ± standard error (SE).

Outcome of the Study Conts

Table showing the ANOVA for WA, TS, LE and MOR properties

Source of variation	Degree of freedom	F-Values (ά=0.05)			
		WA	TS	LE	MOR
Blending proportion	3	8.13*	2.46^{ns}	53.29*	34.26*
Mixing ratio	1	38.03*	2.18^{ns}	38.04*	72.35*
Interaction	3	1.84^{ns}	0.01^{ns}	1.76^{ns}	3.14^{ns}
Error	8				
Total	15				

* denotes significant at $P < 0.05$; ns denotes not significant at $P \geq 0.05$

Outcome of the Study Conts.

Summary of the Student-t test performed on the Mixing ratios (MR)

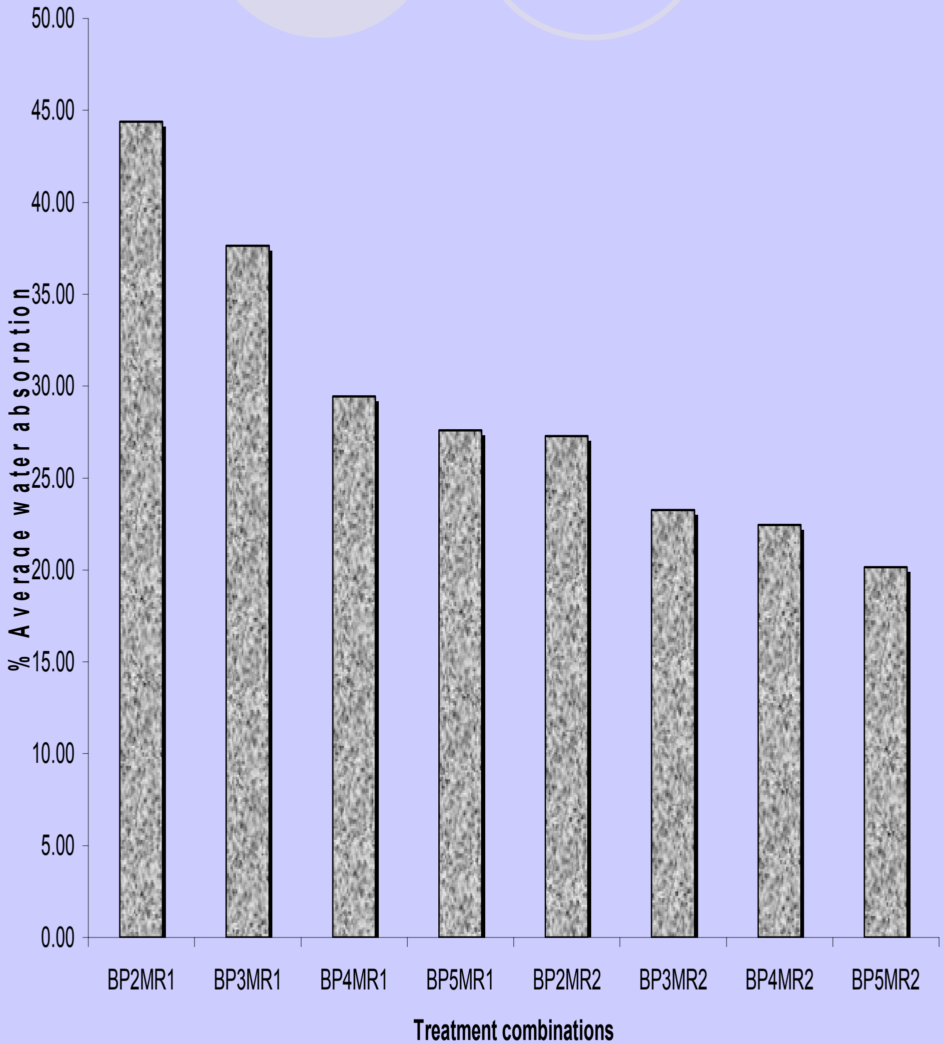
	WA	TS	LE	MOR
Mean MR1 (2:1)	34.765	8.006	1.034	0.183
Mean MR2 (3:1)	23.285	4.822	0.779	0.465
t-stat	5.894^{ns}	2.500^{ns}	5.025^{ns}	0.000*
t-critical(ά=0.05)	2.364	2.364	2.365	2.365

Summary of the Duncan Multiple Range Test (DMRT)

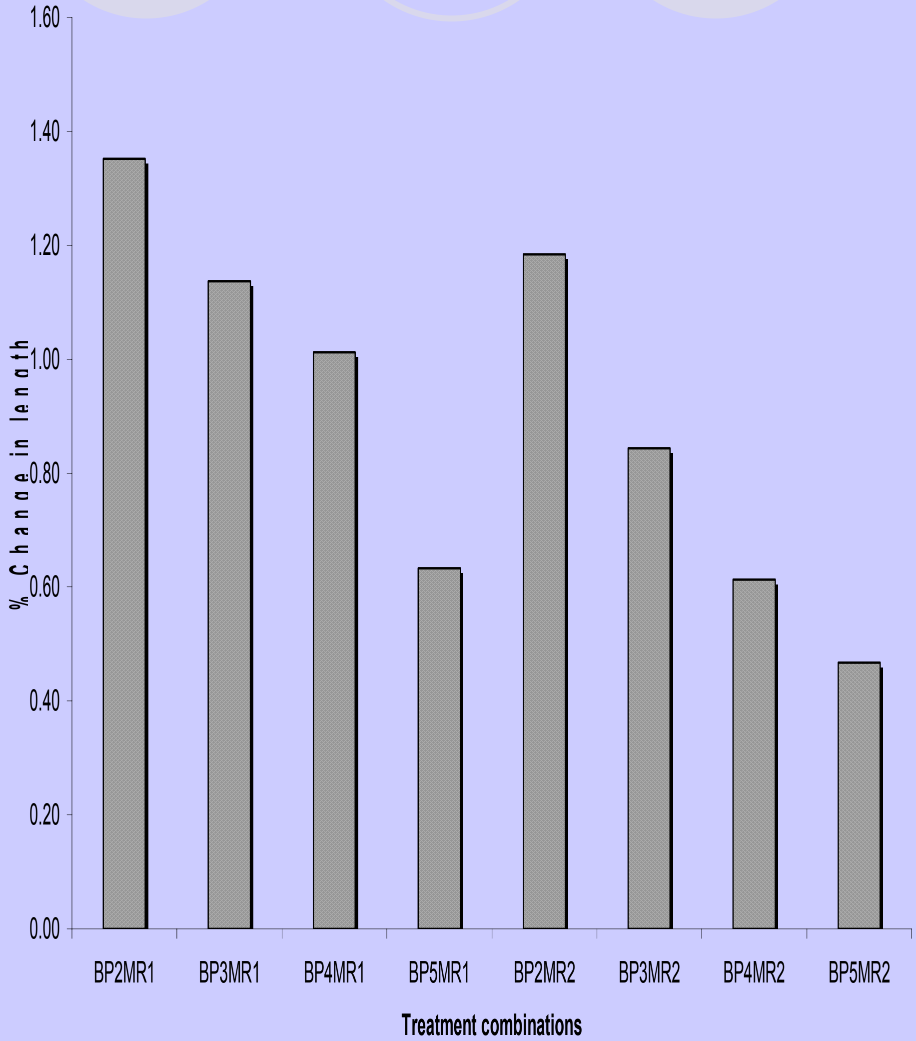
Notation	Blending Ratio	WA	TS	LE	MOR
BP5	100:0	23.86^{a}	2.56^{a}	O.55a	0.59^{a}
BP4	75:25	25.95^{ab}	4.70^{a}	0.81^{b}	0.33^{b}
BP3	50:50	30.46^{bc}	8.47^{a}	0.99^{c}	0.25^{b}
BP2	25:75	35.84^{cd}	9.93^{a}	1.27^{d}	0.13^{c}
BP1	0:100	-	-	-	-

Outcome of the Study Conts.

Water Absorption

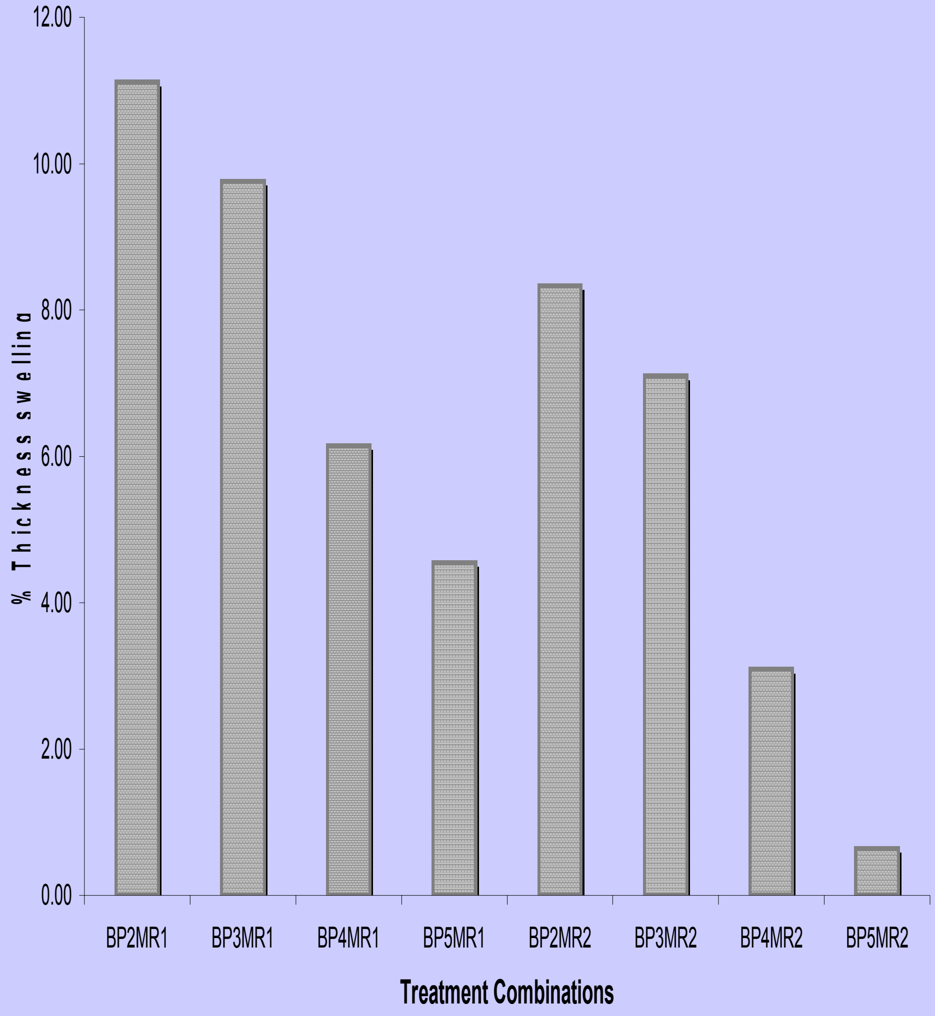


Linear Expansion

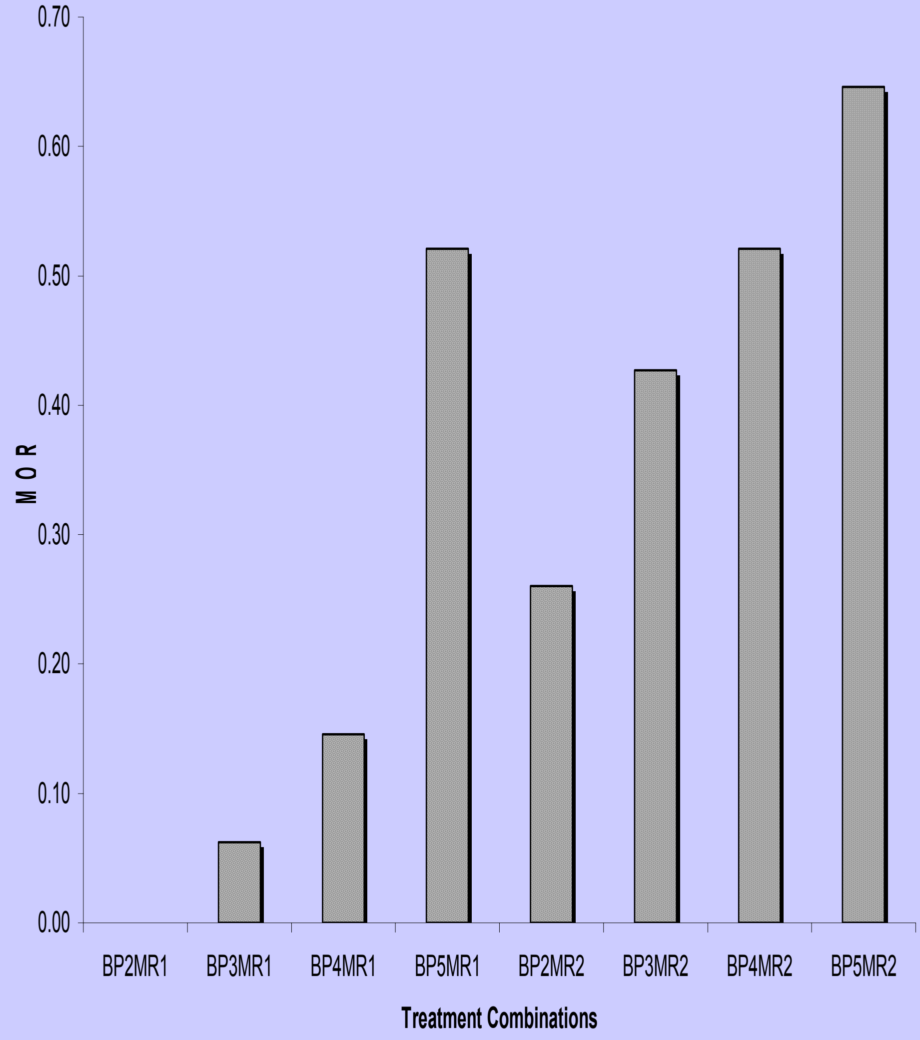


Outcome of the Study Conts.

Thickness swelling



Modulus of rupture



Conclusions

- The research work shows that viable boards can be produced using a blend of maize cobs and *Gmelina arborea* sawdust.

- Boards manufactured at 75:25 blending proportion and 3:1 mixing ratio proved satisfactory as assessed by the four parameters.

- The dimensional strength properties of the boards are absolute proof of their durability even under harsh environmental conditions.

Recommendations

- Maize-cobs should be incorporated into the raw material base of cement-bonded composites.
- In developing countries, better value-orientation should be made available so as to stimulate the taste of the public towards the adoption of the panel product as a suitable alternative to round log consumption.
- More research endeavour so as to deliver a technology that is adoptable to the composite boards industry.

Thank you.