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Characterization Of Composite Panel Produced From Exotic White And Black And Indigenous Black Chicken Feathers

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ABSTRACT: *Turning waste to wealth through the use of chicken feather (CF) would alleviate some nowadays environmental challenges being faced by every communities as its profitable use will minimize challenges posed by CFM and make more readily available construction materials. Studies on this waste demonstrated that the waste can be a potential concrete reinforcement. The composite reinforcement application of the CFF offers solution to challenges posed by chicken feathers than the traditional disposal methods. Samples were prepared and processed to form different particles sizes. A developed composite mixing machine was used to mix the constituent before the production of the composite panels.*

The maximum value of hardness, compressive and flexural strength for the exotic white and black and indigenous black were 2.82 kN/mm^2 , 1373.75 N/mm^2,2.23 kN/mm^2 respectively, and 5.40 kN/mm^2,1286.12 N/mm^2, 5.27 kN/mm^2 respectivelyand 5.40 kN/mm^2, 1315 N/mm^2 and 17.40 kN/mm^2 respectively. Percentage moisture contents of samples from different location on dry basis were 21.40%, 18.10% and 15.40% respectively.

The agro wastes would make good composites panel; however, composite panel from ground indigenous chicken feather has higher flexural strength compared to exotic white and black while exotic white panel has highest compressive strength when compared with other two used.

KEYWORD: *Agro-waste, Composite panel, Exotic,Flexural strength*

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I. INTRODUCTION

Chicken Feather Fibre (CFF) has contributed to environmental pollution being presently of little demand for utilization. Its two main disposal methods that are in use are burning and burying. Both methods have negative impacts on the environment (that is: emission of dangerous gases and low level bio- degradation). Recent studies on chicken feathers waste demonstrated that the waste can be a potential concrete reinforcement to produce composite. The composite reinforcement application of the CFF offers effective solution to environmental challenges posed by chicken feathers than the traditional disposal methods [1][2][3][4]. [5] reported that almost four billion kilograms of poultry waste products, especially feathers, are produced per annum in the United States and are processed into cheap animal feeds, buried or incinerated. Commercial poultry processing plants worldwide generate over 6 billion kilograms of waste feathers worldwide annually, creating a serious solid waste problem in many countries [6].

Chicken feathers are one of the important poultry waste products that are produced in Nigeria through her poultry processing industries. The data given by the Global Livestock Production and Health Atlas as reported by [7] showed that Nigeria has enough poultry processing industries to make available chicken feathers based materials needed for use in building construction.Some of the advantages of the CFF as a raw material in producing composites are their being inexpensive, renewable, acceptable specific strength and bio-degradability. Because of its renewable feature, it has been appreciated as a new class of reinforcement for polymer-based bio-composites.Composites building materials containing Chicken Feather Material (CFM) have high level of suitability which could potentially absorb all of the chicken feathers being produced yearly which eventually raised the market value [8].

According to [9], found the CFF keratin bio-fibre to have even distribution within, and adherence to polymers, due to their hydro-phobic nature and low energy dissipation. The need to effectively contain the problems posed by the very large production of chicken feathers which are of low bio-degradability has given rise to assorted uses such as for automotive parts, packaging materials, filters, insulators, household products and soil control materials [10].

Composites produced from fibres are known to possess desirable properties. These include; high strength, low density, high resistance to water absorption, durability against chemical degradation, high electrical resistance, high thermal insulation, excellent acoustic, non-abrasive behaviour, corrosion resistance and excellent hydrophobic properties when used as composites reinforcements [1]. The properties, performances and cost effectiveness of composites from fibres make composite to be particularly useful as constructional materials [11][1][2][3][4]. The simple and practical approach to incorporate poultry feathers into composite panels is to bind them with Portland cement [12]. However, this could offer an affordable, new type of building materials with both economic and environmental advantages.

This work focused on the development of structural and functional composite using chicken feathers from Nigerian poultry industries and determining the binder-fibre ratio and processing technique for optimal composite panel strength.

II. MATERIALS AND METHOD

2.1Collection of sample

Feathers of exotic chicken were obtained from Obasanjo Farms, Nigeria, Limited in Igboora; Zartech in Ibadan, Oyo State and Tuns Poultry Farm in Osogbo, Osun State. Feathers of exotic chicken collected have been processed in the factories being subjected to hot water treatment and separated from the chicken, using mechanically driven rubber fingers .Indigenous chicken were purchased from local markets in Ibadan and Ogbomoso, Oyo State (Fig. 1). These were slaughtered manually and de-feathered after soaking in hot water and their feathers were also used as test materials. Samples of different chicken feathers were collected due to hereditary factor.

The samples of chicken feathers were stored separately in sacks according to species and of the source of the samples. Three different types of chicken were thus selected and their feathers were used; two from exotic breed (white broiler and black spent layer chicken) and one from indigenous chicken. This is done so as to identify the effects of species on the physical and mechanical properties of the feathers and therefore on the panels made from the feathers.

2.2 Preparation of chicken feathers

Chicken feathers (CF) collected from each of the chicken processing plants contained various foreign materials, such as skin, blood, faeces and flesh. The feathers are also known to harbour aerobic and anaerobic bacteria. When these grow on feathers, they use feather keratin thereby degrading the feathers [5]. It is therefore necessary to clean chicken feathers to inhibit bacteria growth. For this work, the feathers were washed with detergent soap and ethanol. The feathers were then spread on galvanized iron sheets and sun-dried for three days.

2.3 Processing of the chicken feathers for the production of panels

Chicken feathers were subjected to size reduction using Disc Attrition Mill. Particle size selection was carried out on the ground CF in order to obtain different degrees of fineness of the samples to be used in panel fabrication. The ground feathers were sieved into different particle sizes of 0.05 mm, 1.50 mm and 3.00 mm based on levels generated by Box-Behnken Design of Response Surface Methods (RSM). The three different levels of particle sizes selected for data analysis are lower, middle and higher levels (that is 0.05 mm, 1.00 mm and 3.00 mm respectively). Samples of different ground chicken feathers are shown inFig. 2.

Figure 1: Pictorial views of different chicken feathers: (a) exotic white; (b) exotic black; and (c) indigenous black

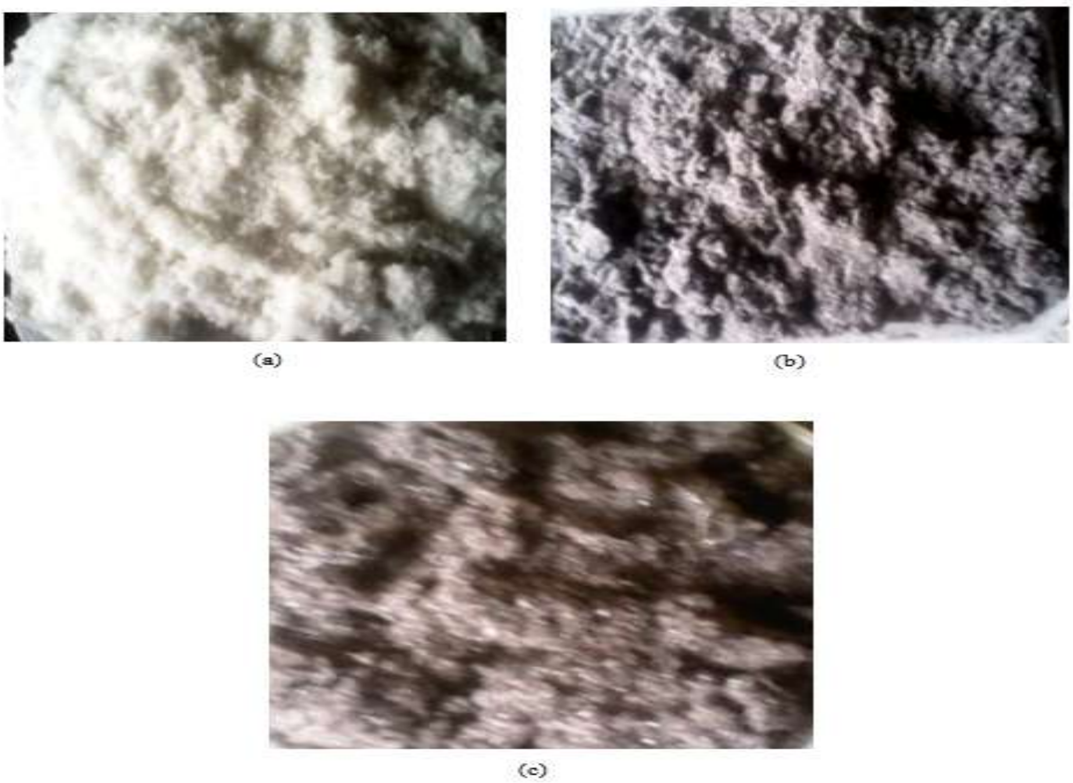


Figure 2: Different ground chicken feathers: (a) exotic white; (b) exotic black;and (c) indigenous black

2.4 Production of concrete mixing machine
For the experimental aspect of the work, a concrete mixing machine was produced Fig. 3.

2.5 Production of panels

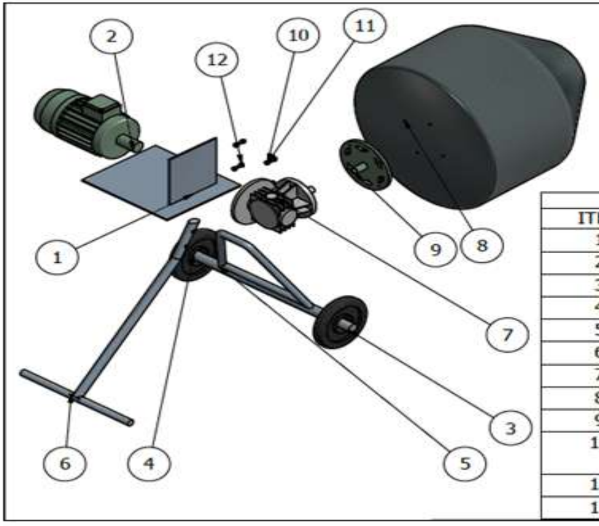
Samples of ground chicken feathers were measured into different particle sizes of 0.05 mm, 1.50 mm and 3.00 mm and wooden formwork of 150 mm x 100 mm x 20 mm in dimension was used for the fabrication of panels as shown in Fig. 4. The composites panel was fabricated with different fibre loadings based on the method used by [13] with slight modifications. The mixing ratios of sand, cement and ground feather were conducted in line with [13]with slight modifications. [13]in his work, used ratio 2:1 for sand and cement respectively but ratios of ground feather used was not stated.

In this study, three different particle sizes of ground chicken feathers were selected to ascertain best combination of mixing ratios of sand, cement, water, calcium chloride, complex 340 silane and formaldehyde. 100 ml each of the following chemicals (Calcium Chloride, Formaldehyde and Complax 340 Silane) were used for panel fabrication. An aqueous lingo-sulfonate-based super-plasticizer (Formaldehyde) was used as water reducer to improve workability and cement hydration. An alkoxysilane coupling agent (Complax 340 Silane) with both organic and inorganic reactivity was used to improve the bonding and stabilization of feather fibres to the cement matrix. $CaCl_2$ was preferred to other accelerators because it is cheaper and more effective [14].Water, between 135 and 195 ml (based on the cement/ sand ratio) was added when the mixture was judged too dry and would not be able to form a paste that could uniformly coat all feather particles.

2.6 Curing of panels

After removal of each panel from the wooden formwork, samples of panels for each chicken feathers used were subjected to curing for 28 days. This was done to determine how curing affects strength of the panel with time. The chicken feather fibre (CFF) reinforced composite panels were evaluated in accordance with [15] D3039/ D3039M (Tensile Properties of Polymer Matrix Composite Materials), EN ISO 14125 (Fibre-reinforced Plastic Composite-Determination of Flexural Properties) and EN ISO 179-1 (Determination of Charpy Impact Properties).

2.7 Testing of panels for physical and mechanical properties
The fabricated and cured panels were subjected to tests for various physical and mechanical properties. Relevant properties that were tested for from the fabricated panels produced were the density, water absorption, compressive strength, flexural strength and hardness. Other relevant tests that were investigated include sound proofing and fire resistance.
The equipment used are:
(i) Universal testing machine (Instron type, Model 1195, Carton, MA)
(ii) Leitz micro-hardness tester
(iii) Semi-automatic 25 kg capacity weighing machine (Model: EL22-500)
(iv) D600 Data-logging Sound Level Metre (ExtechInc.USA)
(v) Air Quality Metre (Model: AQ9901SD, Lutron, Taiwan)



PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Motor Seat	Mild Steel
2	1	Electric Motor	Finished Product
3	1	Wheel Rod	Mild Steel
4	2	Wheel	Finished Product
5	1	Wheel Frame	Mild Steel
6	1	Handle	Mild Steel
7	1	Gear	Fiinished Product
8	1	Mixer	Mild Steel
9	1	Flange	Finished Product
10	8	ISO 7092 - ST 6 - 140 HV	Plain washers
11	4	ISO 4015 - M6 x 30	Hexagon head bolts
12	4	ISO 4032 - M6	Hexagon nuts

Figure 3: Parts list of the concrete mixer

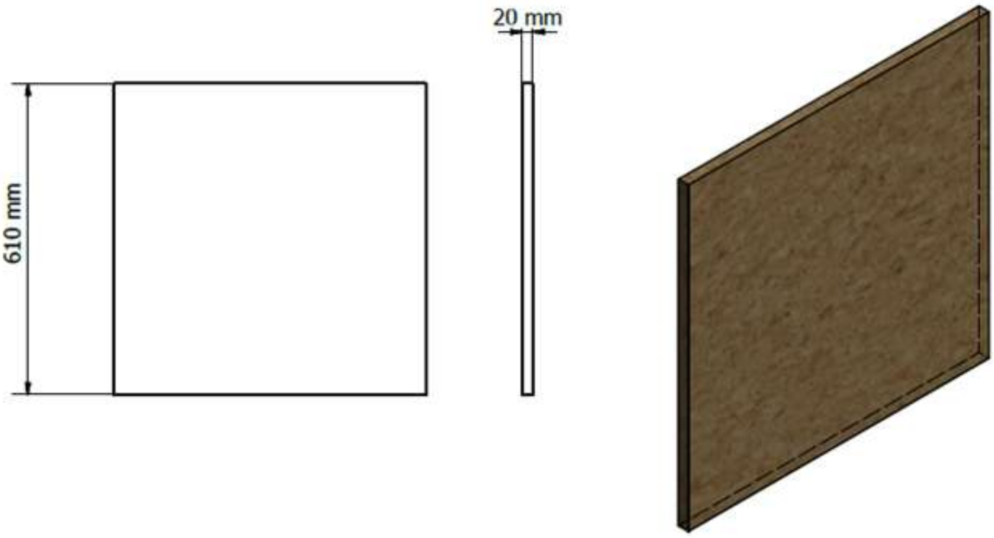


Figure 4: Pictorial view of panel

2.8Determination of compressive strength of panels

Panel with dimension 610 mm x 610 mm x 20 mm of each sample used was subjected to strength test using a compression testing machine. The compressive strength was determined using the procedure of ASTM D1037-93 [15]. The flat surface of the sample was placed on the base plate of the machine. With another plate placed parallel to the first one, the distance between the two parallel plates was slowly reduced using motorized screw of the machine. The reduction of the distance was continued until crack occurred on the panel. The compressive strength was computed using the panel cross-sectional area and load at the fraction point..

$$Compressivestrength = \frac{\text{Maximum Load in Compression}}{\text{Cross -sectional area}} \quad (1)$$

2.9 Determination of hardness of panels

This was done using a Leitz micro-hardness tester. A diamond indenter, in form of a right pyramid with a square base and an angle 136^o between opposite faces, was forced into the flat surface of the material under a load F. The diagonals X and Y of the indentation left on the surface of the material after removal of the load was measured and their arithmetic mean L was determined. Vickers hardness number was calculated using

$$H_v = 0.1889\frac{F}{L^2} \quad (2)$$

$$L = \frac{X+Y}{2} \quad (3)$$

where, F is the applied load (N), L is the diagonal of square impression (mm), X is the horizontal length (mm) and Y is the vertical length (mm).

2.10Determination of flexural strength

The effects of different combinations of parameters (ground feathers, feather particle size, sand and cement) on panel flexural strength were evaluated using a three point bending test following ASTM D790 [16] at room temperature with a universal mechanical testing machine (Instron, model Z010; Germany) with a load capacity of 10 kN with some modifications. Cured panel sample measuring 610 mm x 610 mm x 20 mm was used for flexural strength test. Modulus of Rupture (MOR), maximum load and deflection were determined for each panel by applying the load at the rate of 1.30 mm/min on 140 mm span using an Instron universal testing machine [17].

III. RESULT AND DISCUSSIONS

The results of moisture contents and mechanical properties of composite panel produced from exotic white and black and indigenous black are presented in Table 1 and Fig. 5a to Fig. 7c respectively. The hardness for the three samples were found to be better with panel fabricated from chicken feathers from exotic and indigenous black having the highest range value of 5.42 kN/mm^2 . The implication is that panel from exotic and indigenous black chicken feathers would be better in use in terms of hardness than that of exotic white.

The compressive strength for the three samples were found to better with panel produced from chicken feathers from exotic white having highest compressive strength ranging from 1.190 kN/mm^2 to 1.383 kN/mm^2 and panel from exotic black chicken feathers having lowest compressive strength ranging from 1.181 kN/mm^2 to 1.286 kN/mm^2.

The minimum and maximum values of flexural strength obtained from different panels produced for the three chicken feathers were found to be 0.13 to 2.46 kN/ mm^2 , 0.56 to 6.50 kN/ mm^2 and 0.98 to 17.14 kN/mm^2 for exotic white and black and indigenous chicken feathers respectively. These values while comparing it with the results obtained by [18][19] on recycled paper/chicken feathers of composite sandwich beams and waste chicken feathers as reinforcement in cement-bonded composites respectively, where values obtained are 12.4 kN/m^2 and 3.12 to 9.22 MPa, respectively, it shows that the panel produced in this study could be utilized in building construction.

Table 1: Result of Moisture contents of Un-ground Chicken Feathers

Feather Type	Moisture content on Wet Basis (%)	Moisture content on Dry Basis (%)
Exotic White Chicken Feather from Ibadan	17.5	21.2
Exotic White Chicken Feather from Osogbo	17.0	20.4
Exotic White Chicken Feathers from Igboora	18.5	22.6
Exotic Black Chicken Feathers from Ibadan	15.5	18.3
Exotic Black Chicken Feathers from Osogbo	15.5	18.3
Exotic Black Chicken Feathers from Igboora	15.0	17.6
Indigenous Black Chicken Feathers from Ibadan	13.5	15.6
Indigenous Black Chicken Feathers from Ogbomoso	13.2	15.2

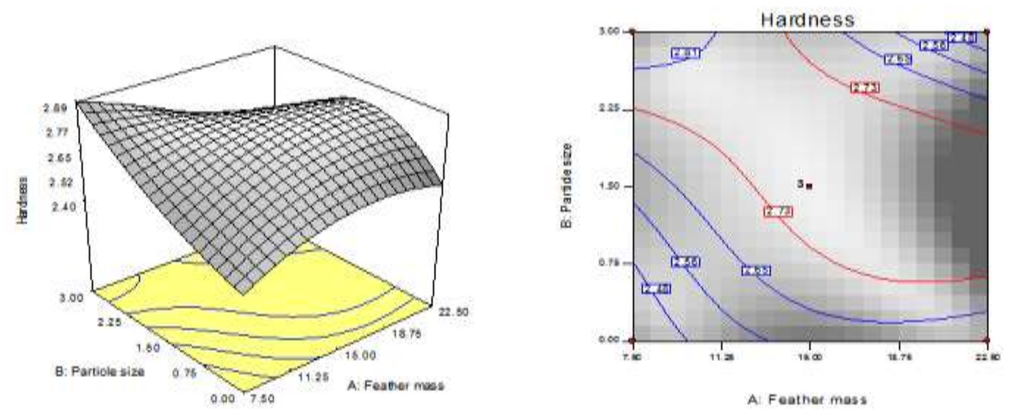


Figure 5a: Surface plot of interaction of panels with ground exotic white chicken feathers between feather mass and particle size on hardness

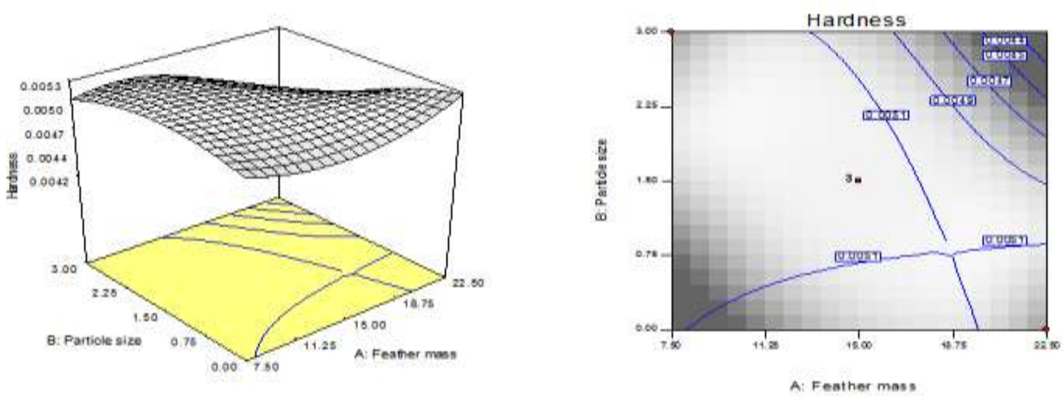


Figure 5b: Surface plot of interaction of panels with ground exotic black chicken feathers between feather mass and particle size on hardness

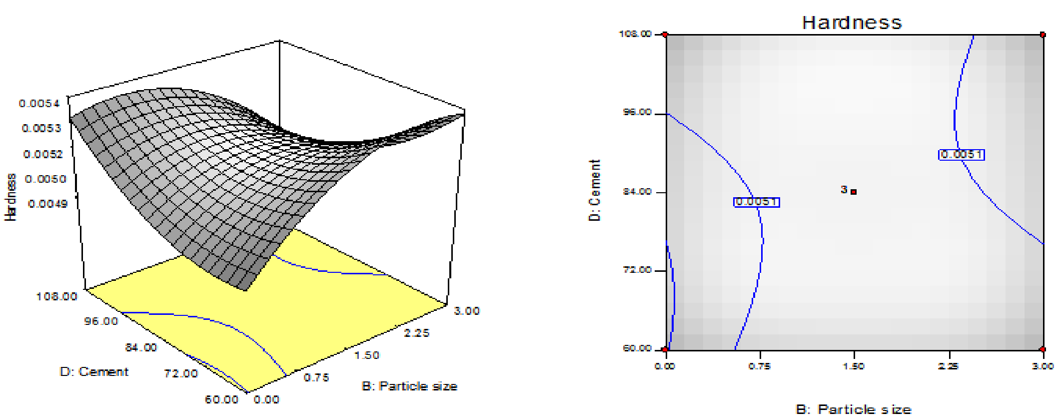


Figure 5c: Surface plot of interaction of panels with ground indigenousblack chicken feathers between particle size and cement on hardness

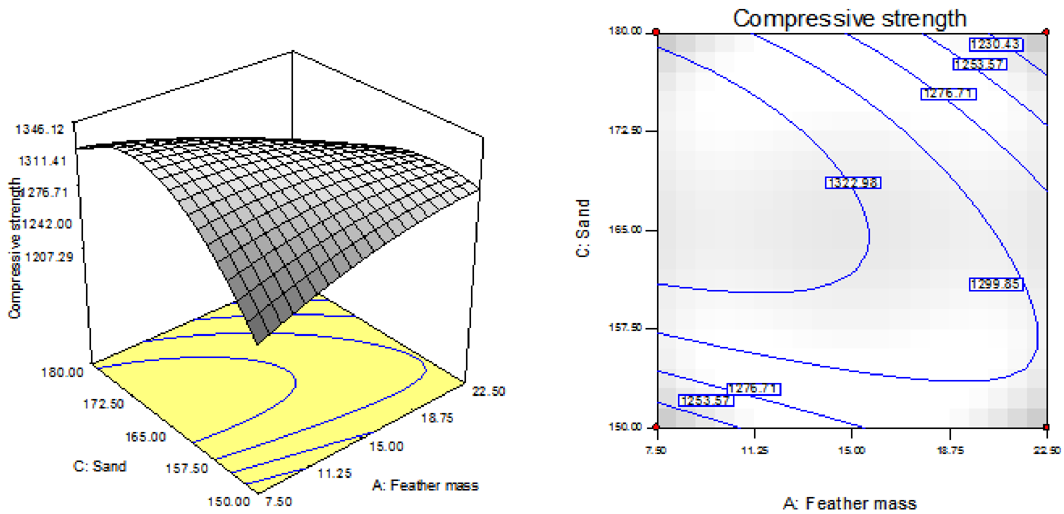


Figure 6a: Surface plot of interaction of panels with ground exotic white chicken feathers between feather mass and sandoncompressive strength

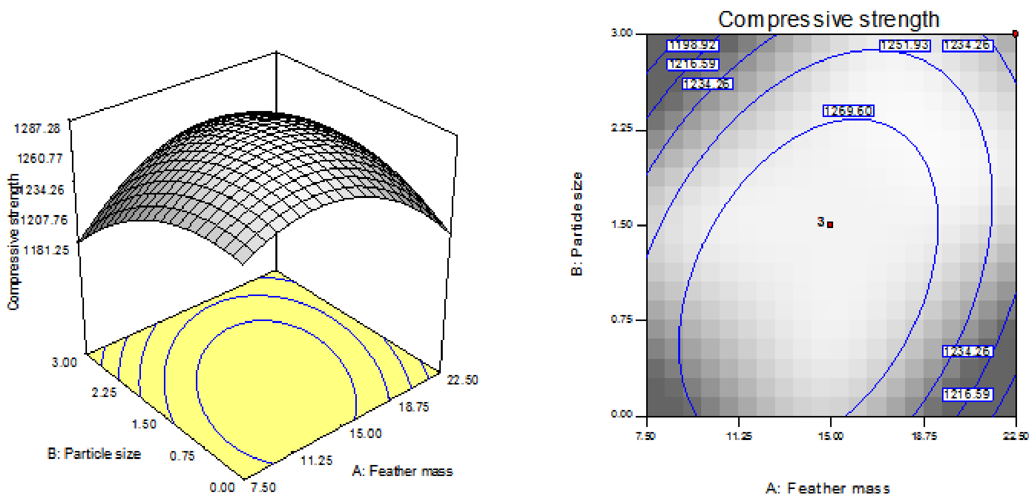


Figure 6b: Surface plot of interaction of panels with ground exotic black chicken feathers betweenfeather mass and particle sizeon compressive strength

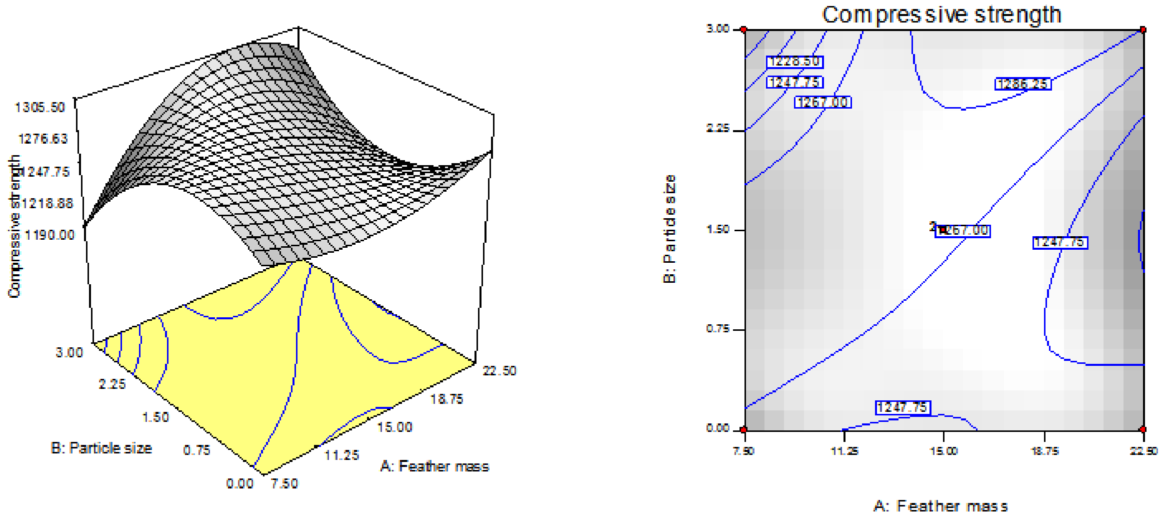


Figure 6c: Surface plot of interaction of panels with ground indigenousblack chicken feathers between feather mass and particle sizeoncompressive strength

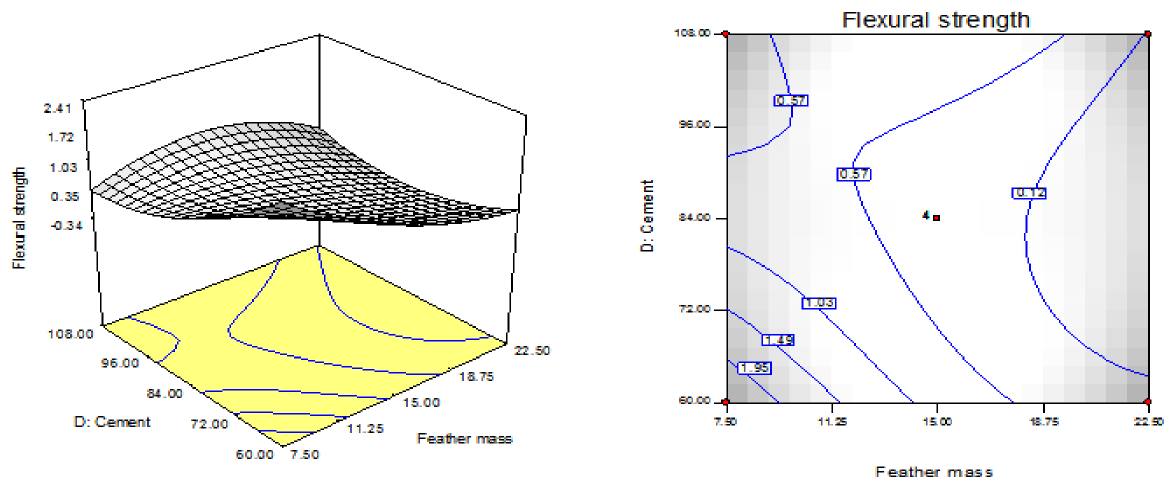


Figure 7a: Surface plot of interaction of panels with ground exotic white chicken feathers betweenfeather mass and cement on flexural strength

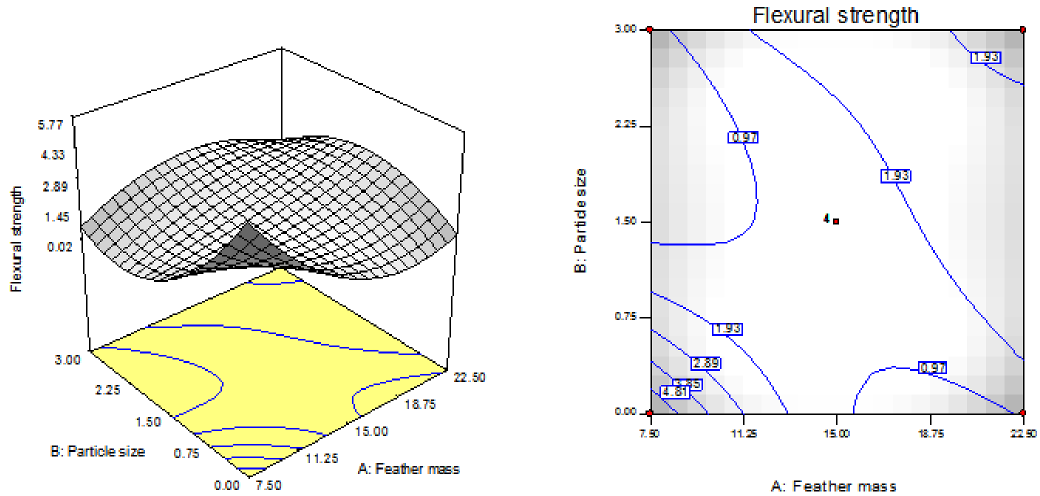
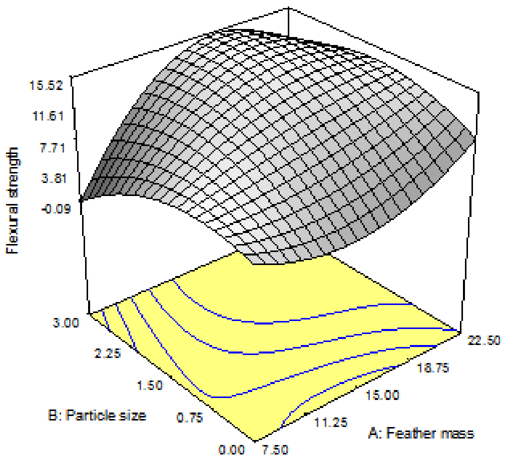


Figure 7b: Surface plot of interaction of panels with ground exotic black chicken feathers betweenfeather mass and particle size on flexural strength



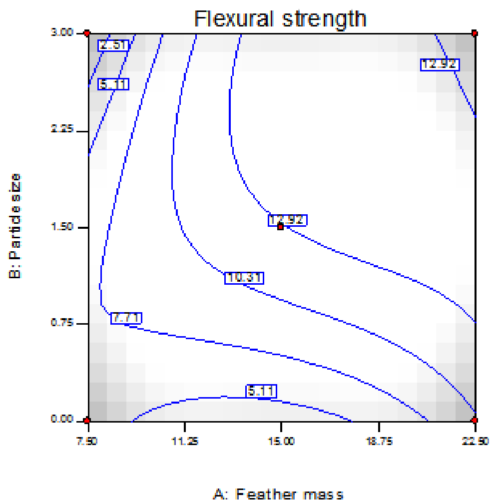


Figure 7c: Surface plot of interaction of panels with ground indigenous black chicken feathers between feather mass and particle sizeon flexural strength

IV. CONCLUSION

From the results and findings of this study, the following conclusions were drawn:

Composites panels from the three samples examined in this study would be good for utilization in building construction.

Composites panels produced from the three agro-wastes would be stable and durable panels.

Panels from exotic white are better than those from exotic and indigenous black going by the values of maximum compressive strength, while those from exotic and indigenous black are better than those from exotic white going by the values of their hardness. Also, panels from indigenous black are better than those from exotic white and black going by the value of flexural strength.

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