Characterization of Sawdust and Rice Husks Properties for Particleboard Production

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***Abstract*-Generation of wastes from wood pieces has resulted into underutilization in most timber markets, thereby creating environmental inconveniences. In this study, sawdust from Bauchi, Jos, and Rice husks was characterized. The results revealed that; Bauchi sawdust had pH 5.04 before and 5.14 after heating, Jos sawdust had 6.96 before and 6.91 after heating, Rice husks had 5.24 before and 5.34 after heating. Bulk densities are; 157kg/m^3 Bauchi, 132kg/m^3 Jos and 331kg/m^3 Rice husks. Equilibrium moisture content; 40min oven and 180min non-oven drying for Bauchi sawdust, 25min oven and 150min non-oven drying for Jos and 20min oven and 90min non-oven drying for Rice husks. Percentage moisture content; 4.95% Bauchi, 2.24% Jos and 1.01% rice husk atoven drying, 5.12%, 2.64% and 0.29% at environmental temperature. This implies that the underutilized bio-based wastes materials could be a good source for particleboard productionas the drying time required inachieving reasonable properties atboth ambient and oven based temperature is favourable within the standard values. Work on determination of functional groups is ongoing.**

Keywords: **Characterization, Particleboard, Properties, Rice-husks, Sawdust**

I. INTRODUCTION

The use of wood in building construction being an important engineering material is vital especially when it comes to the roofing. This material cannot be used directly on the site until the sizes of the long logs is reduced to the requirement of the engineer before usage. The logs are cut into different sizes and shapes known as 2 by 2"; 2 by 3" etc., as it is commonly used in construction of wooden structures and building [1]. However; during the resizing or cuttingprocesses, substantial amount of particles is generated and later discarded as wastes from the cut-offs. These particles are known as sawdust. While rice husks are generated from post-harvest during the rice milling.

The demand for lignocellulose in composite industry as a raw material is on the increase despite the fact that forest resources are diminishing due to over dependence on the wood chips or particles[2]. In recent time, research is intensified on this lignocellousic biomass utilization for composite materials which includes particleboard production.

Particleboard is a product of wood materials which are chipped to smaller sizes and bonded together with suitable binder at high temperature and pressure [3]. The global production of particleboard is more than 23 million cubic meters per annum as result of increase in its consumption [4]. Itis extensively used in furniture and house construction, which includes; flooring systems, stair trends and underlayment [5], interior and exterior applications in floor, wall, ceiling panels, office dividers, bulletin boards, cabinets, counter and desks [6].

Previous researches on this lignocellulose wastes were; sawdust, plastic waste and ureaformaldehyde [7]. Polystyrene and bamboo wastes [8].Straight raw grain oriental beech wood [1]. Sugarcane bagasse and castor oil [9].Bamboo waste and branches [10]. Maize cob particles and recycled low density polyethylene [2]. Rice husks [11],[12].Wood, bamboo and rice husks [13]. Wood particles and nano-reinforced composite [14]. Saline eucalyptus long logs [5].Wheat straw [15]. Low density sugarcane bagasse bonded with citric acid [16].Starch in oil pam trunk [17]. Water melon peels and recycled low density polyethylene [18].All these findings were aimed at how to utilize the biomass wastes to wealth. From previous research, it has been established that the primary sources of particleboard are from lignocellulose materials such as wood and agro-based residues.

Maximum conversion of biomass material could lead to successful utilization of these residuals and reduction in the over dependence on wood as raw materials and improved environmental challenges of wastes disposal from the sawdust. Although the residues are used as fuels or ashed for usage as fertilizer in the farm, in Nigeria, large quantities of this biomass residue are generated in various timber shades and has not been effectively utilized and subsequently ended being waste and menace to the environment. The underutilized waste when left on the land-fill could result into generation of toxic substance and unsaturated hydrocarbons when decomposed.

Therefore, the desired to determine the qualities of this biomass as raw materials in developing country becomes imperatives, due to the increase in population growth and conversion of waste to wealth and also to establish its environmental friendliness for sustainable green

ecosystem.Figure 1.0 present pile of sawdust wastes and logs of wood in Bauchi state North eastern Nigeria.

Fig. 1.0: Sawdust and wood Logs (Location: Bauchi Timber Market)

This researchis aimedat characterization ofsawdustand rice husks physical properties as a way of its conversion to engineering materials, with the objectives of determining the bulk density [19], [20], [21], pH[4], [5], [21], equilibrium moisture and moisture content [19], [20], [21].

In this paper, sawdust from Bauchi, Jos timber markets and Rice husks was sieved with mesh size 600µm to 3.35mm and conditioning at room temperature and pressure, was carried out at Nigerian Building and Road Research Institute (NBRRI) Jos, North central Nigeria. While determination of physical properties of the materials (Bauchi sawdust (BSD), Jos sawdust (JSD) and Rice husks (RHs)) was carried out at University of Jos postgraduate research Chemistry laboratory at various temperatures. The need to understandthe propertiesof the sawdust and rice husks as raw materials becomes a critical issue as some of the qualities required for particleboard manufacturing, hence the study.

II. MATERIALS AND METHODS

A. *Materials*

The materials used in this research is sawdust waste from Bauchi state North eastern Nigeria and Jos, plateau state North central Nigeria metropolitan timber markets and rice husks from corn miller in Bauchi Muda Lawal market. The following equipment were used; sieve mesh sizes less than 3.35 mm El79-2300 model, made in England; digital weighing balance; laboratory drying oven DHG-9101 model; crucibles, water bath Gallenkamp registered in U.K made in England; digital pH meter Labtech model; 25ml graduated measuring cylinder BS604 N 20^{o}C made in England, beakers borosilicate Techmel made in U. S. A. and distilled water.

B. *Methods*

Sawdust was obtained from Bauchi and Jos timber markets and sieved with 3.35 mm size to removed logs and sharp objects without further treatment. Rice Husks was sourced from Bauchi milling center. This was followed by weighing into various quantities for experimentations to determine; bulk density, pH, equilibrium moisture and moisture content.

1. *pH Determination*

The pH of Bauchi sawdust (BSD), Jos sawdust (JSD) and RHs was determined using [4], [5], [21] procedures. 2.5g of the samples was soaked in 50ml distilled water each. This was followed by shaking for 30 minutes. The pH of the mixture was taken as before heating and moved to water bath and allowed to heat for 10 minutes at elevated temperature of 100^{o}C. Thereafter the solution was removed and allowed to cool to take the pH after heating.

2. *Determination of Bulk Density*

The bulk density was determined using the procedure for dry samples [19], [20], [21]. A graduated empty cylinder 25ml capacity was weighed (wt_1) and filled with dried BSD, JSD and RHs samples separately and reweighed (wt_2), and the volume of the graduated cylinder occupied by the dried BSD, JSD and RHs was recorded (Vc). Thus the bulk density;

$$\rho_b = wt_2 - wt_1/V_c \quad \ldots (1)$$

Where;

ρ_b = bulk density (g/ml)

wt_1= weight of empty graduated cylinder (g)

wt_2 = weight of cylinder and BSD/JSD/RHs sample

V_c= volume of graduated cylinder occupied by the sample (BSD or JSD or RHs) ml.

3. *Equilibrium Moisture Content (EMC)*

The moisture content of the BSD, JSD and RHs was determined according to ASTM D 1307 (1991) [19]. The weight of crucible was weighed and 5g of samples each was added and reweighed as initial weight (w_1) and final weight (w_f). Followed by setting the oven temperature at 80 ± 2◦C [5], [7], [21] and allowed to dry at intervals of 5 min and reading was taken until equilibrium moisture was attained. This was also carried out on the environmental conditions without oven drying at the intervals of 30 min drying time at room temperature.

$$M.C_{Tn} = w_1 - w_{n-1} \quad \ldots (2)$$

Where;

$M.C_{Tn}$= moisture content at time (T) min

w_1 = initial weight of sample (g),

w_{n-1}= weight of sample after each runs (g) until equilibrium moisture content (EMC) is attained.

4. *Moisture Content (M. C)*

The moisture content (M. C) of BSD, JSD and RHs samples was carried out using [19], [20], [21] procedures. The

processed BSD, JSD and RHs was conditioned and weighed, oven temperature was set at 105◦C and stabilizes. The weight of empty crucible was weighed as Wc_1(g) and 3g of sample was added to crucible and reweighed as Wc_2 (g). This becomes the weight before drying (Wb) and placed in an oven to dry for 2hrs. After 2 hrs drying period, the sample was cooled and reweighed as weight after (Wa). M.C was also carried out at environmental temperature for both samples. Thus;

$$M.C = W_b - W_a/W_b \times 100\% \quad \ldots (3)$$

Where;

M. C = moisture

W_b = weight before drying (g)

W_a = weight after drying (g)

III. RESULTS AND DISCUSSIONS

The results obtained from the investigations for; pH, bulk density was calculated using Eqn.1, equilibrium moisture content was calculated using Eqn.2 and percentage moisture content was calculated using Eqn.3.

pH Determination

Sawdust from Bauchi and Jos, rice husks were characterized for acidity.The pH of the samples before transfer to water bath was JSD 6.96, BSD 5.04 and RHs 5.24. After heating the solution, the pH for JSD decreased from 6.96 to 6.91, this implies that heating increase the concentration of the wood properties. BSD increased from 5.04 to 5.14 and RHs increased from 5.24 to 5.34, this also implies that heating decreases the concentration of the wood properties.

During the process of soaking, it was observed that the JSD sank to the bottom which resulted into high concentration of the solution and likewise RHs. The BSD had substantial amount of the dust suspended with little quantity falling down resulting to low concentration of solution. This change in pH revealed the effect of heating on the property of the material.

Although the pH value is acidic, it is a weak acid, showing the characteristic property of inorganic acid and has less effect in application. High acid concentration in wood material for particleboardcan have negative effect on the dimensional stability and internal bond strength [4].

Bulk Density (ρ_b)

The bulk density which is the density of the wood was determined and calculated using Eqn. 2. The following result was obtained, BSD had density of 157kg/m^3, JSD had 132 kg/m^3 and rice husks had331 kg/m^3. These values for sawdust revealed that both materials have low density which has met the requirement for wood particle density in composite material except the rice husks which is relatively high but still within the range. A wood particle with low density is preferred to wood with high density for ease formulation and penetration of binder into the particles during compression processes [9], [19], [20], [21].

Equilibrium Moisture Content

The equilibrium moisture content study was carried out to determine the duration at which the desired moisture could be achieved at 80^{o}Cby oven drying and the result is presented in Figure 2.

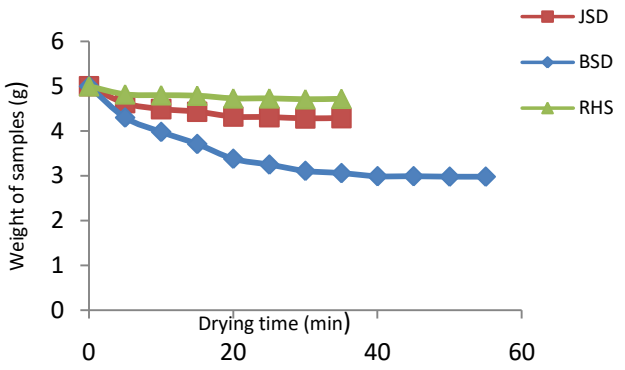

Fig.2. Equilibrium Moisture Content at 80^{o}C Oven Drying

After several runs, JSD attains equilibrium moisture at 25min; BSD attains equilibrium moisture content at 40min and RHs at 20min.This revealed that BSD requires 40 minutes to remove reasonable amount of moisture which is 15 min longer than JSD and RHs requires 20min which is 5min less than JSD by oven drying.

Figure 3. present the equilibrium moisture content of the Bauchi sawdust (BSD), Jos sawdust (JSD) and Rice Husks (RHs) at ambient conditions.

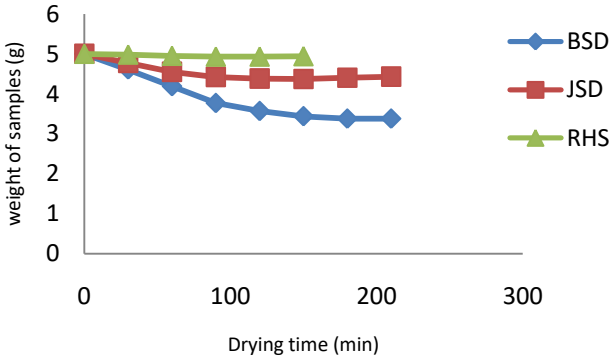

Fig.3. Equilibrium moisture content Non-oven Drying

The same amount for oven dried sample was used for the ambient conditions. In this process, the drying time was at

the interval of 30 min since it is an open system. BSD attains equilibrium at 180min, JSD at 150min and RHs at 90min drying time. However, the moisture removal was less than the oven drying since no heating was involved coupled with fluctuation in the day temperature.

Percentage Moisture Content (% M. C.)

The percentage moisture content of the sieved sample was determined. The overall moisture content of the two samples obtained were, BSD 4.95%, JSD 2.24%and RHs 1.01% oven drying and 5.12%, 2.24% and 0.24% at environmental temperature, this results is in the range of M.C of biomass material widely used in composite and particleboard manufacturing in the literature [9], [11], [22], [23].

IV. CONCLUSION

Sawdust and rice husks, bio-based agricultural waste generated abundantly in Nigeria are promising raw material for particleboard production. In this study, bulk density, pH, moisture content and equilibrium moisture content of this biomass was investigated at both oven and non-oven drying process, for its suitability and future utilization.

Based on the tests performed in this study, the results showed that the densities of Bauchi sawdust and Jos sawdust fall within the required density for raw materials in particleboard manufacturing. Rice husks had density twice that of the sawdust. Moisture contents at equilibrium for the materials were carried out and the results were adequate for the required moisture content in lignocellousic materials for particleboard manufacturing. The pH which determines the curing of composite materials is within the standard range for wood chips used in panels.

The Bauchi sawdust is from soft wood species and Jos sawdust is from hard wood species based on their availability and location usage, this forms the basis for variations obtained in tested results. Both materials could be adequately utilized in particleboard production without further pretreatment of the wood chips.

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