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RESEARCH ARTICLE

BINDER RATE AND GRANULOMETRY EFFECTON THE PHYSICALAND MECHANICALPROPERTIES OF MAHOGANYSAWDUST PARTICLEBOARDS MADE WITH PEARLS BONE GLUE

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Abstract

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This work armtovalorizethesawdustofmahogany wood and the pearlsbone glue for environmental purposes.First, sawdust was sifted with three sieves respectively 0.8; 1.6 and 2.5mm diameter. So, we have four granulometries (g) $g \leq 0.8$ (G_1), $0.8 < g \leq 1.6$ (G_2), $1.6 < g \leq 2.5$ (G_3), $2.5 < g \leq 5$ (G_4) and the raw sawdust. particleboards are manufactured from sawdust by varyingsuchthebinder rate (5; 6.5; 7; 7.5; 8; 10; 12.5 and 15) and the granulometry. Second,physical properties such asthe density, thickness swelling (TS) Water absorption (WA) were searched. The mechanical properties (Modulus of Elasticity (MOE), the Modulus of Rupture (MOR) in flexion, and Internal Bond (IB)) are determined according to the standard ANSI A208.1 – 2016[1]. The threshold fixed by the standard fortheMOE andtheMORarewidelyreached.Themanufactured particleboards are classified in the categoriesofmeandensity and can only be used in dry conditions.

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Introduction:-

Lately,ithasbeendifficulttomanufacturehardwoods,andthiscausessome issues to wood industry. To respond to required environmental standards for a highcategoryofresidentialhomes,alternativestohardwoodsuchasplywood, MediumDensityFiberboards,particleboards, …,includingnaturalmaterial andsteelorchemicalcomposites,arenecessaryinconstruction.Withtheincreasingconsumptionofwoodasbaserawmaterial s,theuseofreasonable alternativesisinterested.Industriallignocellulosicresiduessuchassawdustof Mahogany wood can be easily used as alternatives to wood-based raw materials. Besides, those systems contribute to the recycling of industrial waste. In order torecyclethenatural resources tosatisfythedemandcausedbythe diminution of the supply in hardwood, several researches have succeeded in developing alternatives of wood particles, by using lignocellulosic fibers to manufacture ceiling panels from agricultural waste such as rice husk, and test these panels and commercial

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samples. The amount of water absorption and the stress in traction are determined. The result of the test confirmed that the manufactured panels are similar to commercial panels [2]. (Han et al., 1998)[3]have investigated the effect of the sizes of the particles and the density on the properties of the boards made from residues of cane and wheat. They reported that the boards made from fine particleshavebetterpropertiesthanthosemadefromcoarseparticles.Anincrease of the density of the residues leads to the improvement of the properties of the boards. (Viswanathan and Gothandapani, 1999)[4] have confirmed the dimensionalstabilityandthemechanicalpropertiesofthechipboardsmadeformmarrow ofcoconutwithmeanparticlessizes(0.4,0.8,1.2and2.1mm)bondedwith resinsofphenol–formaldehyde(PF)andurea–formaldehyde(UF)asadhesives. The water absorption and the thickness swelling were lesser and the mechanical properties were better for boards with coarse particles bonded with resin of PF [4-6].In the present study, sawdust of Mahogany wood has been used. The particle- boards from sawdust of Mahogany wood are manufactured by thermic pressing and with the use pearl bone glue. The physical properties (density, water absorption and thickness swelling rate) and the mechanical properties (modulus of elasticity, modulus of ruptureand internal bond) of the composite are determined, in order tostudythepossibility,usethe sawdust ofMahoganywoodaspartialor completealternativeinwood–basedparticleboards.Thecompositecanbeusedas alternative to particleboards and absorbent boards due to its stress and proper- ties of immersion in water, as well as its cost. The implementation of the natural cellulosicfibersofplantsortheagriculturaloragricultural and industrialresiduesinthe maufacturationofcompositesstructuralmaterialsformanyaddedvalueapplications,includingtheindustriesofconstruction andautomobile,isnowadaysof interest in research in several regions in the World.The only issue to realize those composites structural materials is the choice oftheappropriatebinder.Mostofthestudiesproposeformulasofchipboards where the binders are synthetic adhesives of UF or PF type. But these bindersdo not guarantee the harmlessness for human and environmental health because of the toxicity of the emissions of their volatile particles.

Experimental

PreparationofthePearlsbone glue

The pearlsbone glue is mixed with water at 60% of weight. from the LARASE (Laboratory of Research on The Agriculture resources and Environmental Health) at the University of Lomé.

The pearls born glue is mixed with water at 60% of weight. from the LARASE (Laboratory of Research on The Agriculture Resources and Environmental Health) at the University of Lomé. The photo 1 show ten process of preparation of pearls bone glue. The photo 1 below show the preparation of pearls bone glue.

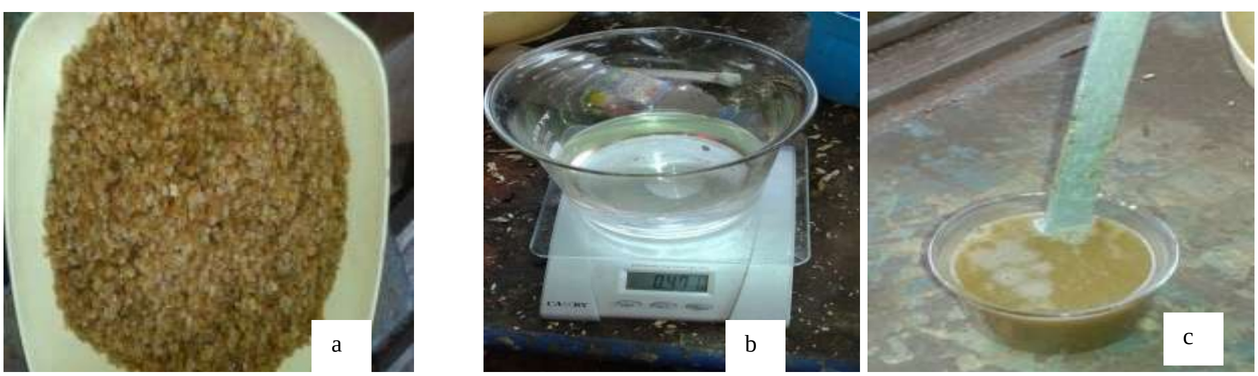


Photo 1:- Preparation of the pearls bone glue binder (a): the weight of pearls bone glue; (b) the weight of water (c): the binder.

Preparation of the particleboards of sawdust of Mahogany wood

The mixtureofbinderandparticles the total mass of the dry materials (particles + binder) are 700 grams. The weight of the binder and of the particles are then determined according to the rate of the binder. The results are presented in the following table (table1). Water at a rate of 20% (140 gr) is added to the mixture. The mixture is kneaded for five (5) minutes.

Table 1:- Mass of the binder and the particles according to the rate of the binder.

Binder rate (%)	Binder weight (gr)	Particle’s weight (gr)
5	35	665
6.5	45.5	654.5
7	49	651
7.5	52.5	647.5
8	56	644
10	70	630
12.5	87.5	612.5
15	105	595

Thermalpressingoftheparticleboards

Themixtureisputuniformlyin amold.Themoldhasbeenprimarilyheatedupto160◦C.Itisthenplaced betweentwoheatingplatesofthethermopresseofCARVERtype.Apressure of11barsisthenappliedandmaintainedduringtwenty(20)minutes.After the time out, the board is unmolded, immediately weighted, labeled, its thickness is measured, and then it is stored in plastic packaging to prevent it from moisture andotheralterations.Six (6) particleboards of each content of binder and for each type of binder have been manufactured.

Preparationofthesamplesforthetests

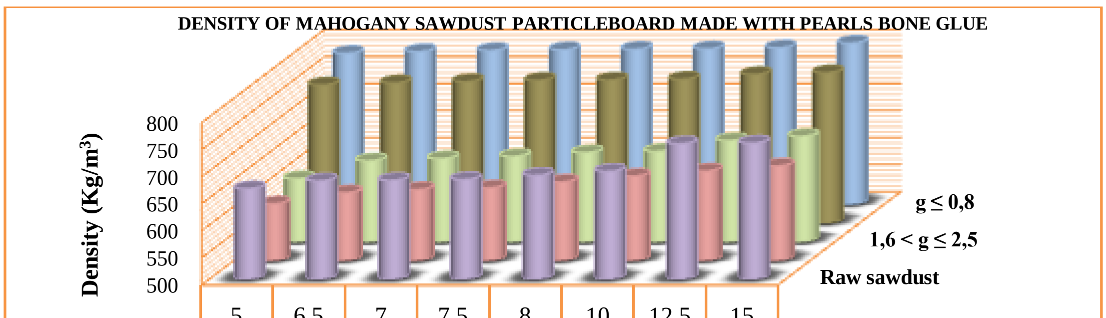
Once manufactured, the particleboards are store in dry conditions (air–conditioned room at 20◦C) for forty –eight (48) hours. Then, they are cut into specimens at the required dimensions for the different tests to be conducted. The specimens are the replaced in dry conditions.AccordingtothestandardANSIA208.1–2016,six(6)specimensofdimensions 150 × 50 mm for the bending test, ten (10) specimens of dimensions50×50mmforthedeterminationofthedensity, twelve(12) specimens of the same dimensions for the test of thickness swelling, and six (6) specimens of dimensions 150 × 20 mm for the test of traction, are needed.Threetypesofspecimensarecutfromeachparticleboardspecimensfor the three–points–bending test, specimens for the test of traction and thickness swelling.

Results And Discussion:-

Physical properties

Density

The density of the particleboard from sawdust of mahogany increases with thebinder rate. The following histogram (Figure 1)representthevariationofthedensityaccordingtothe binder rate and the size of particles. The lower densities are those of the granulometry (g) is between 2.5 and 5 mm ($2.5 < g \leq 5$). The heavy densityis those of the granulometryg≤ 0.8. The boards are mean density (MD) according to American standard ANSI A208.1, 2016 [1]



	5	6.5	7	7.5	8	10	12.5	15
Raw sawdust	667.78	682.36	683.25	684.85	692.56	700	751.12	752.22
2,5 < g ≤ 5	605.15	625.56	631.45	634.75	645.55	656.24	665.83	675.35
1,6 < g ≤ 2,5	617.2	650.2	654.25	658.33	665.21	667.78	687.78	695.56
0,8 < g ≤ 1,6	756.11	759.81	762.26	764.56	765.15	766.67	775.56	778.89
g ≤ 0,8	780	783.22	785.25	786.67	787.56	788.15	790.33	798.89

Figure 1:- Histogram of the density according to the particle size and the binder rate.

The density increases slightly with the rate of binder. The rate of binder is a parameter which significantly influences the physical properties of the particleboards. The increase in the binder content of the boards leads to an improvement in the physical behaviors of the particleboards [7–9].The ANOVA analysis on R gives results which are in Table 2.

Table 2:- Effect of factors on the density.

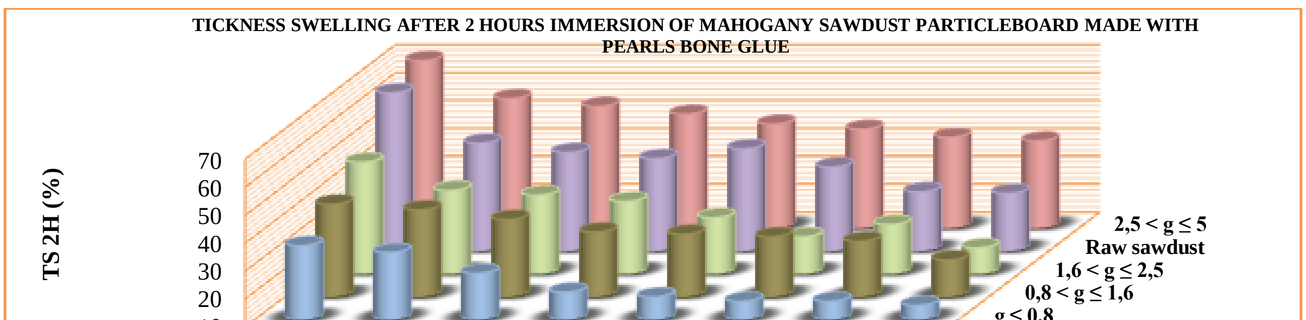
Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	258853	86284	706.7059	< 2.2 e-16 ***
Binder rate	7	20802	2972	11.060	< 2.2 e-16 ***
Granular x Binder rate	28	4076	194	1.596	0.0594.
Residuals	239	27959	122		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

Analysis of the mean with the Tukey test in the R software, shows that the first five identical binder rates (5; 6.5; 7; 7.5 and 8) and the last three identical (10; 12.5 and 15) are different. This means that on the side of quality and price, only two rates (5 and 10) instead of the eight have to consider to characterize all the panels.

Thethicknessswelling(TS)

The standard ANSI A208.1 – 2016[1]has set the thickness swelling threshold for particleboards at 20 % for floor panels, 8% for roof panels and 50% after 24 hours for all types of particleboards.Theseresults(Figures. Figure 2 and Figure 3)confirmthoseofKadja, 2012[10]whocharacterizedthe kenaf and cotton panels with pearls bone glue and found that the rate of thickness swelling decreases with the rate of binder.



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	36.67	34.2	26.75	20	18.23	16.67	16.67	15.2
0,8 < g ≤ 1,6	43.33	41.3	37.83	33.33	32.56	31.67	30	23.33
1,6 < g ≤ 2,5	50	40	38.35	36.11	30.25	23.33	27.78	19.44
Raw sawdust	66.66	48.61	45.25	43.05	46.56	40	31.25	30.75
2,5 < g ≤ 5	70.14	56.35	53.56	50.75	47.21	45.33	42.45	41.15

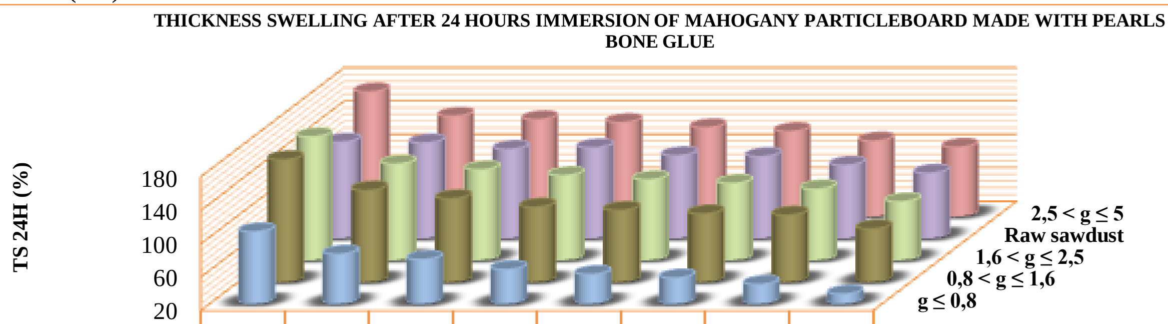
Figure 2:- Histogram of the TS after 2 hours according to the particle size and the binder rate.

The result presented in Table 2and Table **2** reveals that the factors have a significant effect on the thickness swelling after 2 hours and 24 hours of immersion.

Table 3:-Effect of factors on the TS after 2 hours immersion.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	50080	16693	241.8263	$< 2.2\ e^{-16}$ ***
Binder rate	7	13006	1858	26.9153	$< 2.2\ e^{-16}$ ***
Granular x Binder rate	28	707	34	0.4879	0.9727
Residuals	239	15808	69		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of event. Confidence level: 0.05 (5%)



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	106.92	80	73.52	61.55	55.62	51.33	43.61	32
0,8 < g ≤ 1,6	166.64	130.22	120.35	110.22	106.36	102.14	100.56	84.12
1,6 < g ≤ 2,5	167.93	135.11	128.175	121.39	116.305	111.905	105.41	90.425
Raw sawdust	135.11	134.25	126.46	128.39	119.01	117.88	107.44	97.93
2,5 < g ≤ 5	169.22	140	136	132.56	126.25	121.67	110.26	102.73

Figure 3:- Histogram of the TS after 24 hours according to the particle size and the binder rate.

As for the binder rates, the first six rates (5; 6.5; 7; 7.5; 8 and 10) and the last two (12.5 and 15) are different. This means that, in terms of quality and price, only the two rates of binder (5 and 12.5) instead of the eight are to be considered to characterize all the particleboards from mahogany sawdust.

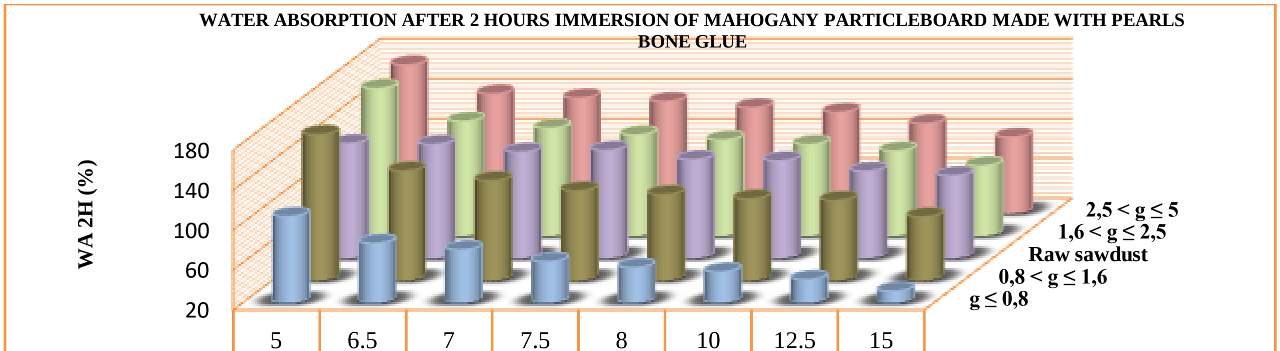
Table 4:- Effect of factors on the TS after 24 hours immersion.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	60158	20053	357.4066	$< 2\ e^{-16}$ ***
Binder rate	7	18235	2605	46.4308	$< 2\ e^{-16}$ ***
Granular x Binder rate	28	631	30	0.5357	0.9537
Residuals	239	12848	56		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

The thickness swelling observed in the present study is far from that reportedby[11, 12]).Forthelatter,thethicknessswellingsobtainedforbarkpanels made with 12% of UF resin binder are 14.1% and 14.2%, after 2 and 24 hours,respectively.Thethicknessswellingsobtainedinthisstudyaresignificantlyhigherthanthosereportedby Maloney, 1973[13]wherethethicknessswellingsvary between 3.3 and 4.5% for a UF resin binder content of 10%.

The Water absorption (WA)
particleboards from sawdust of mahogany manufacturedhavewaterabsorptionrateshigherthan120%after2hoursand168% after 24 hours of water immersion for the pearls bone glue. ThestandardANSIA208.1–2016hasno requirements for water absorption rate.



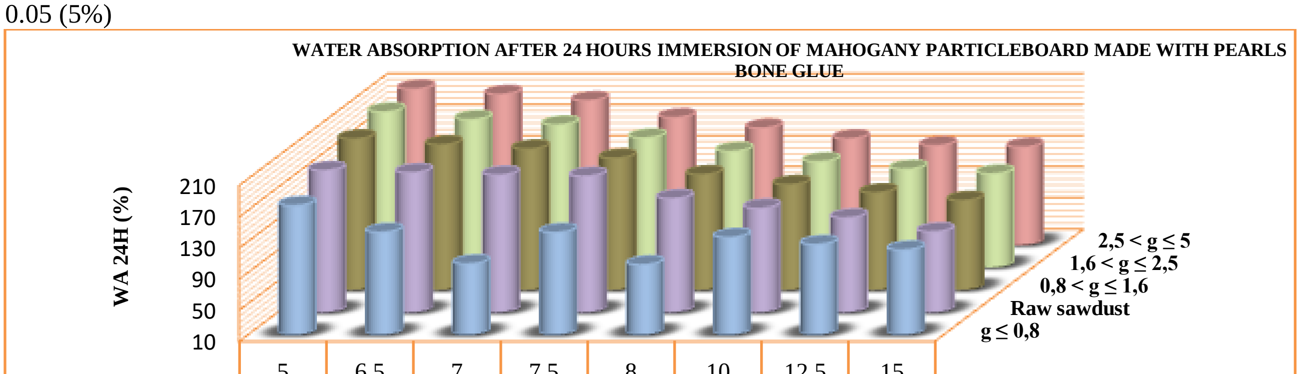
	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	106.92	80	73.52	61.55	55.62	51.33	43.61	32
0,8 < g ≤ 1,6	166.64	130.22	120.35	110.22	106.36	102.14	100.56	84.12
Raw sawdust	135.11	134.25	126.46	128.39	119.01	117.88	107.44	102.93
1,6 < g ≤ 2,5	167.93	135.11	128.175	121.39	116.305	111.905	105.41	90.425
2,5 < g ≤ 5	169.22	140	136	132.56	126.25	121.67	110.26	96.73

Figure 4:- Histogram of the WA after 2 hoursaccording to the particle size and the binder rate.

Table 5:- Effect of factors on the WA after 2 hours immersion.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	92807	30935.6	294.8076	< 2.2 e^{-16} ***
Binder rate	7	48990	6998.6	66.6945	< 2.2 e^{-16} ***
Granular x Binder rate	28	665	31.7	0.3019	0.998922
Residuals	237	24030	104.9		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	175.89	142	101.35	141.78	100.17	135.38	126.33	119.22
Raw sawdust	192.07	189.25	186.12	184.61	155.87	143.61	131.59	113.7
0,8 < g ≤ 1,6	203.76	196.24	190.67	178.945	157.815	144.82	134.35	124.46
1,6 < g ≤ 2,5	209.605	199.735	192.945	176.112	158.787	145.425	135.73	129.84
2,5 < g ≤ 5	215.45	203.23	195.22	173.28	159.76	146.03	137.11	135.22

Figure 5:- Histogram of the WA after 24 hours according to the particle size and the binder rate.

The rate of water absorption (Figures. Figure 4 and Figure 5) has followed the shape of the rate of thickness swelling as a function of the rate of binder thus confirming those of Kadja, 2012[10] whichcharacterizedthepanelsofkenafandcottonwithpearlsboneglueand (Drovou et al., 2015)[14].The analysis of the variance of water absorption generated by the R software is grouped in

Table 5 for 2 hours and

Table 5for 24 hours of immersion.

Table 6:- Effect of factors on the WA after 24 hours immersion.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	74679	24892.9	160.7588	< 2.2 e^{-16} ***
Binder rate	7	52989	7569.9	48.8862	< 2.2 e^{-16} ***
Granular x Binder rate	21	804	38.3	0.2473	0.9997715
Residuals	229	35460	154.8		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

The water absorption rate of particleboards from sawdust of mahogany varies considerably with the binder rate. The analysis of the mean with the Tukey test in the R software shows that for the binder rates, the first five rates (5; 6.5; 7; 7.5 and 8) and the last three (10;12,5and15)aredifferent.Thisleadstosaythatintermsofqualityand price,onehadbtoconsiderthatthetwobinderrates(5and10)insteadofthe eight to characterize all the panels from sawdust of mahogany.The water absorption rate of particleboards with the pearls bone glue is high.

Mechanical properties

Modulus of elasticity (MOE)

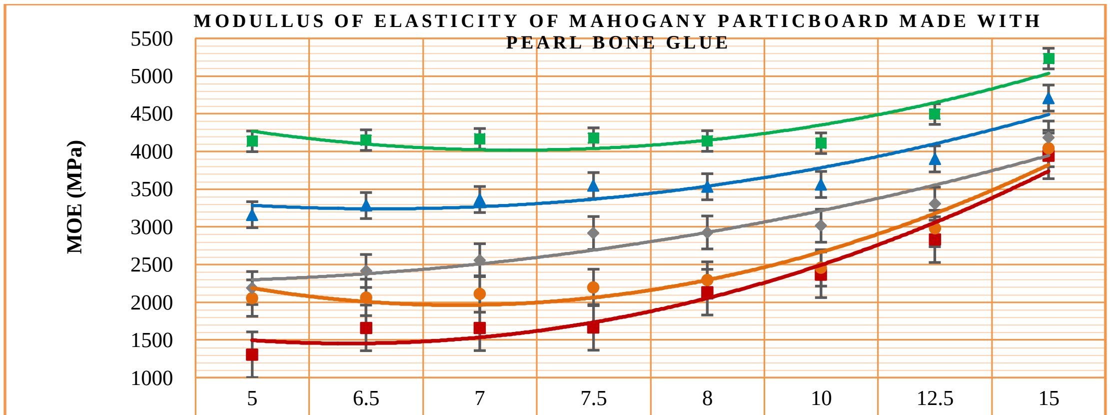
The variance and the interaction of factors on the MOE generated by the R software are presented in Table 7.The MOE of mahogany sawdust particleboards varies considerably with the rateofbinder(Figure 6).Theanalysisoftheinteractionsoftheabovefactors shows that the type of binder and the binder rate have a very significant effect on the MOE.

Table 7:- Effect of the factors on the MOE.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	7082271130	236090377	402.3347	< 2.2 e^{-16} ***
Binder rate	7	104818959	1497414137	25.5183	< 2.2 e^{-16} ***
Granular x Binder rate	28	3095534	1474059	2.5120	0.0004428 ***
Residuals	239	134377829	586801		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

Analysis of the mean with the Tukey test in the R software shows that the binder rates, the first six rates (5; 6.5; 7; 7.5 8; and 10) and the last two (12.5 and15)aredifferent.Thismeansthatintermsofqualityandprice,toassess the MOE of all the panels, only the two binder rates (5 and 12.5) instead of the eight are to be considered.



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	1305.29	1660.64	1662.56	1667.66	2134.28	2365.14	2830.69	3941.41
0,8 < g ≤ 1,6	2055.71	2065.12	2110.13	2197.34	2295.16	2455.95	2978.61	4039.02
1,6 < g ≤ 2,5	2189.1	2415.3	2558.23	2918.84	2926.25	3015.56	3307.36	4184.74
2,5 < g ≤ 5	3161.73	3282.77	3362.755	3547.955	3532.35	3562.415	3901.44	4708.17
Raw sawdust	4134.36	4150.24	4167.28	4177.07	4138.45	4109.27	4495.52	5231.6

Figure 6:- Variation of the MOE according to the particle size and the binder rate.

The modulus of elasticity is greater than 1725 MPa, thus satisfying the requirements of standard ANSI A208.1–2016 (MOE = 1725 MPa). These results areclearlysuperiortothoseobtainedby(SellersandHaupt, 1995)[15](MOE=125MPa), and (Xu et al., 2003)[16] (950 to 1750 MPa) in the case of panels without binder, treated by injection of water vapor, under a pressure of 6 MPa, at a temperature of 190 ◦C, in the presence of water vapor and for durations of 7 to 25 min.Theparticleboardsmadefromthepearlsbone gluearelowdensityclass2(LD–2)accordingtostandardANSI A208.1–2016[1].

Modulus of rupture (MOR)

The MOR (Figure 7) follows the MOE strength. It reaches a maximum of 21.65 MPa at the rate of 15% of the pearls bone glue.ThevaluesoftheMORofthe mahogany sawdust panels obtained are greater than the minimum values fixed by the standard ANSI A208.1–2016[1]which are 5 MPa for low density panels. The results of the analysis of the variance of the data relating to the MOR generated by the R software are recorded in Table 8.

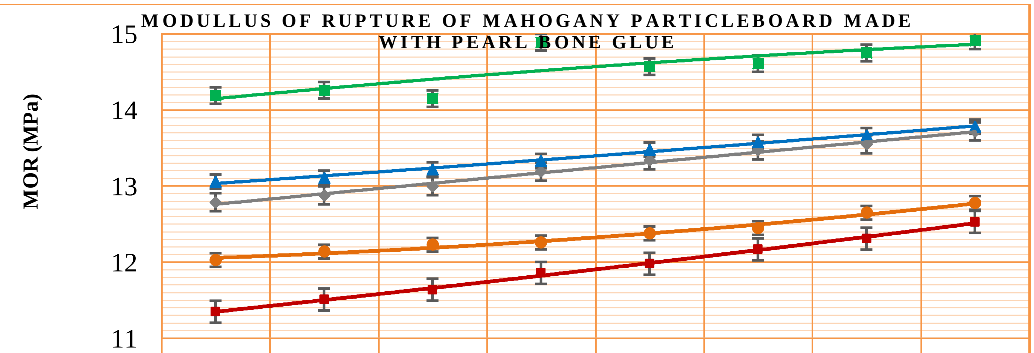
Table 8:- Effect of the factors on the MOR.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	878.9	292.97	175.3657	< 2.2e-16 ***
Binder rate	7	567.4	81.06	48.5211	< 2.2e-16 ***
Granular x Binder rate	28	37.3	1.78	1.0628	0.3900
Residuals	239	382.6	1.67		

Signification codes: 0. '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

The MOR of particleboards from mahogany sawdust varies considerably with the binder rate. The analysis of the mean with the Tukey test in the R software shows that for the binder rates, the first five rates (5; 6.5; 7; 7.5 and 8) and the last three (10; 12, 5 and 15) are different. This means that in terms of quality and price, we had to consider that the two binder rates (5 and 10) instead of the eight to characterize all the panels from sawdust of mahogany.

The Figure 5 represented the variation of the modulus of rupture of the mahogany sawdust particleboards according to the granular of particle.



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	11.35	11.51	11.64	11.86	11.98	12.17	12.31	12.53
0,8 < g ≤ 1,6	12.03	12.14	12.23	12.26	12.38	12.45	12.65	12.78
1,6 < g ≤ 2,5	12.79	12.88	13	13.19	13.34	13.47	13.55	13.72
2,5 < g ≤ 5	13.06	13.11	13.22	13.33	13.48	13.58	13.67	13.78
Raw sawdust	14.19	14.26	14.15	14.89	14.57	14.61	14.75	14.91

Figure 7:- Variation of the MOR according to the particle size and the binder rate.

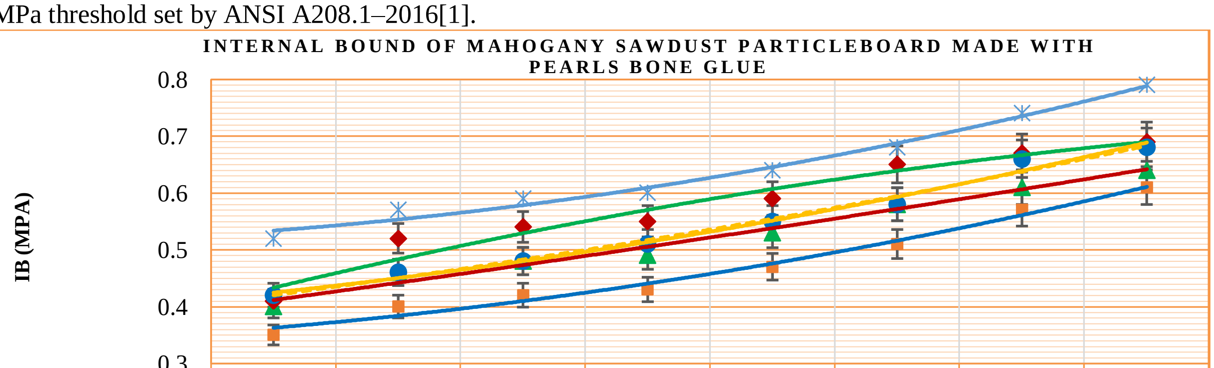
WenotethattheMORareinaccordancewiththoseobtainedbyChow, 2007[7]withpanelscontainingsawdustfromredoakandbyVilleneuve, 2004[17]with panelsbasedonbarkofpoplar,tremblingaspen.Theynotedthatmechanical properties are improved with increasing of binder content. They also noted that the modulus of rupture is influenced by the rate of binder.

The bending strengths (MOE and MOR) complied with the minimum values required by standard ANSI A208.1–2016[1]which are respectively for:

– MOE:1725 MPa for mean density particleboard class 1 (MD –1);
– MOR: 11 MPa for those of mean density class 1 (MD – 1).

Internal bond(IB)

The panels made with tannic powder from the pearlsbone are more consistent than those made with tannic powder of the peel of Indian tamarind. The internal bound strength increases with the binder rate (Figure 8). It is above the 0.4 MPa threshold set by ANSI A208.1–2016[1].



	5	6.5	7	7.5	8	10	12.5	15
g ≤ 0,8	0.35	0.4	0.42	0.43	0.47	0.51	0.57	0.61
0,8 < g ≤ 1,6	0.4	0.46	0.48	0.49	0.53	0.58	0.61	0.64
1,6 < g ≤ 2,5	0.41	0.52	0.54	0.55	0.59	0.65	0.67	0.69
2,5 < g ≤ 5	0.42	0.46	0.48	0.51	0.55	0.58	0.66	0.68
Raw sawdust	0.52	0.57	0.59	0.6	0.64	0.68	0.74	0.79

Figure 8:- Variation of the IB according to the particle size and the binder rate.

TheresultsconfirmthoseofKonai et al., 2015[18]whocharacterizedtheanegretanninas anadhesiveresin and those of Drovou et al., 2019[19]withtheantiaristreesawdust panelswiththepodofthehuskof African locust bean and Indian tamarind.Theresultsobtainedfromtheanalysisofvarianceusingthe Rsoftware are collated in Table 1.

Table 9:- Effect of the factors on the IB.

Factors	Df	Sum. Sq	Mean Sq	F. Value	Pr (>F)
Granulometry	4	19.4612	4.8653	255.7046	$< 2.2\ e^{-16}$ ***
Binder rate	7	1.1936	0.1705	8.9616	$8.995\ e^{-06}$ ***
Granular x Binder rate	28	0.8865	0.0317	1.6640	0.09204
Residuals	239	0.5328	0.0190		

Signification codes: 0. ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘.’ 1 **: significative; ***: very significative
Df: Degree of freedomSum Sq.: Sum of squaresMeanSq: Mean of squaresPr: Probability of eventConfidence level: 0.05 (5%)

These results reveal that the factors have a significant effect on internal bound.For the binder rate, they are divided into three homogeneous groups (5; 6.5; 7 and 7.5); (8; 10) and (12.5 and 15) which are different from each other [20-22].
The determined mechanical characteristics, in bending (MOE, MOR) and tensile (IB) of the particleboards of mahogany sawdust, respected the requirements of standard ANSI A208.1, 2016[1].

The mechanical properties are improved with the increase of the binder rate. Chow, 2007 [7] reaches the same conclusion as Dost, 1971 [23] with regard to the proportional increase in the mechanical properties of the panels with the content of binder. The mechanical properties of the panels developed in this study are satisfactory.

Conclusion:-

This work shows that an unconventional binder such as the pearlsbone glue can be used to manufacture particleboards from the sawdust of wood, and particularly that of mahogany wood. The boards obtained have mechanical properties that meet international standards as with conventional binders (PF and UF resin) that cause environmental issues. These particleboards are classified among low density particleboards. The very good mechanical properties values that meet standard ANSI A208.1–2016 are obtained. The particleboards made with sawdust from Mahogany wood can replace non–green boards.

The high thickness swelling rate and water absorption rate that the boards developed indicate that their main use will be under dry conditions.

The analysis of the mean with the Tukey test in the R software shows that the levels of binders, the first five rates (5; 6.5; 7; 7.5 and 8) while having identical effects between them distinguish from the last three (10; 12.5 and 15) with similarly important effects.

The analysis of the interactions of the above factors shows that the rate of binderhas no effect on the physical and mechanical properties from the mahogany sawdust particleboards.

The ANOVA, of the binder rate, has very significative effect on the mechanical and physical properties of the mahogany sawdust particleboards made with pearlsbone glue.

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