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TESTING OF ORGANIC POTS BASED ON MATERIALS OF GALAM SKIN WASTE (MELALEUCA CAJUPUTI), HYACINTH (EICHHORNIA CRASSIPES) AND MANURE

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ABSTRACT
Until now, especially in the forestry and plantation sectors, the mass provision of seeds still uses polybags made of plastic, even though on the other hand, large quantities of wetland waste are available which can be used as raw material for making environmentally friendly organic pots. The aims of this study were: 1) To analyze the physical and mechanical properties of organic pots from galam bark waste, water hyacinth and manure based on the type of adhesive, 2) To obtain the best composition and type of adhesive for developing organic pots. The research method used a completely randomized design Factorial with 2 factors where Factor A consisted of 4 levels of treatment which was the composition of galam skin waste, water hyacinth and organic fertilizer and Factor B consisted of 2 levels, namely the type of adhesive with 3 replications, so the number of samples needed a total of 24 samples. Tests for physical and mechanical properties were carried out at the ULM Faculty of Forestry Workshop and the Forest Product Technology Laboratory, Faculty of Forestry, Lambung Mangkurat University. The results showed that the water content of the organic pot of galam bark waste, water hyacinth and manure with tapioca and sago adhesives was the best in the A1B1 treatment, namely 14.51%, the best organic pot water absorption was in the A1B1 treatment, namely 123.69%, the A4B1 treatment. has the best average density of 1.712 gr/cm^3. The best organic pot dry weight average value was found in the A3B1 treatment, which was 261.48 gr and the best organic pot side thickness was 1.75 cm. The best organic pot flexural toughness (MOE) was in the A1B1 combination treatment, namely 8174.38 kgf/cm^2, while the best fracture toughness (MOR) and met SNI standards (min 80 kgf/cm^2) in the A1B1 treatment combination, namely 83.23 kgf/cm^2.

KEY WORDS
Organic pot, galam skin waste, water hyacinth, manure, adhesive.

The prospect of using environmentally friendly organic pots will be increasingly needed and can become a promising business opportunity in the future. The Ministry of Environment and Forestry (KLHK) is trying to reduce plastic waste from the use of polybags used as planting media. Plastic polybags have been used for forestry, agricultural and plantation plant nurseries. The use of polybags has the potential to pollute the environment because they cannot be decomposed by soil microbes. The process of tearing the polybags causes the destruction of the plant media and damage to the roots, thus allowing for stagnation after the seedlings are transplanted (Pudjiono et al, 2013). The torn polybags cannot be used anymore resulting in accumulation of plastic waste (Edi and Babihoe, 2010).

The increasingly widespread expansion of plantation areas and increasing agricultural activities using polybag plastic which is not environmentally friendly is a problem that requires a solution to prevent an increase in soil and land pollution. The results of field trials show that 1 kg of polybags contain 462 bags, for planting seeds covering an area of 1 hectare with a spacing of 3x3m requires 1,100 polybags, thus we can reduce 2.4 kg of polybag plastic waste (www.menlhk.go.id). This problem can be overcome through an approach that is by replacing plastic polybags with organic pots (biopolybags) which are environmentally friendly. Organic materials that can be used as organic potting mixes include rice husk, rice straw, manure and palm shoots (Nisa et al, 2021) as well as other wetland wastes, namely galam skin, water hyacinth and organic fertilizers (Sari et al, 2022).

In South Kalimantan, Galam grows in peat swamps and has a characteristic layered and peeling skin. Galam bark produces sheets and different widths depending on the diameter, and the bark has not been used and has no market value so it is simply wasted, rots and can pollute the environment. According to Ilmi's research (2020) the average result of the skinning of Galam wood waste is 24.14% with a yield of 75.86%.

Water hyacinth is an aquatic weed which is a bad weed with very fast growth. These weeds can fill the water surface in a short time and can cause siltation of rivers or reservoirs caused by significant evaporation processes in the evapotranspiration process (Faqih, 2018). Water hyacinth has a chemical content of 60% cellulose, 8% hemicellulose and 17% lignin (Mustari et al, 2017).

Manure is fertilizer that contains organic compounds composed of living matter such as weathering of plant, animal and human remains. The use of tapioca adhesive has the advantage of being cheap, easy to use and produces a good bond, while sago adhesive contains amylose and amylopectin starch which are useful as adhesives (lestari et al, 2010).

The aims of this study were: 1) to analyze the physical and mechanical properties of organic pots from galam bark waste, water hyacinth and manure based on the type of adhesive, and 2) to obtain the best composition and type of adhesive for developing organic pots.

METHODS OF RESEARCH

The research method used a completely randomized design Factorial with 2 factors where Factor A consisted of 4 levels of treatment which was the composition of galam skin waste, water hyacinth and organic fertilizer and Factor B consisted of 2 levels, namely the type of adhesive with 3 replications, so the number of samples needed a total of 24 samples. Tests for physical and mechanical properties were carried out at the Workshop and Laboratory of Forest Product Technology, Faculty of Forestry, University of Lambung Mangkurat.

Garbage bark waste is collected at the Galam Wood sales location in Bati-bati District, while water hyacinth is collected from the Martapura River and organic fertilizer is obtained in Pengaron District. Processing of organic pots takes place in Mangkauk Village, Pengaron District because in that village there is a material chopping machine for making organic pots.

The equipment used in this study was a chopping machine for organic potting materials, an organic pot printing tool, UTM, calipers, analytical scales, gunny sacks, pans, basins for mixing raw materials, machetes, ovens, shovels, cameras and stationery. The materials used in this study were galam shell waste, water hyacinth, manure and tapioca adhesive.

The working procedure of this research is as follows:

- Prepare all the materials needed for making organic pots;
- Put the ingredients into the chopping machine for the basic ingredients for making organic pots according to the composition to be studied;
- The basic ingredients of organic pots that have been chopped are added with tapioca adhesive and sago each at 10% of the total weight of the ingredients and stirred so that they are completely mixed;
- Printing organic pots using a printer;
- Organic pots are dried in the sun until completely dry;
- After drying, tests for physical properties are carried out which include water content, water absorption and density, thickness of the organic pot and dry weight of the organic pot;
- Testing of mechanical properties includes MOE and MOR tests.

Organic pot water content is calculated by the formula:

$$\%\text{ Water content} = \frac{initial\ weight\ (g) - final\ weight\ (g)}{initial\ weight\ (g)}\ 100\%$$

Figure 1 – Organic pot mixed galam skin waste, water hyacinth and manure with the addition of sago and tapioca adhesive

The formula for water absorption is as follows:

$$\% \text{ absorption} = \frac{mb - ma}{ma} X\ 100\%$$

Where: mb = final weight after soaking 30 minutes (g) organic pot; ma = initial weight of pot before soaking.

Weigh the mass of the organic pot and Measure the volume of the organic pot. The density formula is:

$$\text{Density} = \frac{mass\ (g)}{volume\ (cm3)}$$

Organic Pot Thickness Test – using a caliper.

Organic Pot Dry Weight Test – using an analytical balance.

Testing the Mechanical Properties of Organic Pots:

a. Flexural toughness MoE (Modulus of Elasticity):

$$\text{MOE (kg/cm}^2) = \frac{\Delta \text{P x L}^3}{\text{4 x b x h}^3 \text{ x } \Delta \text{Y}}$$

Where: MOE - Modulus of elasticity (kgf /cm); ΔP - load below limit proportion (kgf); L - buffer distance (cm); ΔY - deflection at load P (cm); B - test sample width (cm); H - thickness of the test sample (cm).

b. MOR Fracture Toughness Test (Modulus of Rapture):

$$\text{MOR (kg/cm}^2) = \frac{\text{3 x P x L}}{\text{2 x b x h}^2 \text{ x } \Delta \text{Y}}$$

Where: P_{max} - max load (kg); L - test pedestal distance by 15 times the thickness (cm); b - test sample width (cm); h - thickness of the test sample (cm); ΔP - load (kg); ΔY - deflection (cm).

RESULTS AND DISCUSSION

The research results showed that the highest water content was in treatment A4B2 (50% manure + 0% galam shell waste + 50% water hyacinth with 10% sago adhesive) of 17.84% and the lowest was in treatment A1B1 (50% manure + 50% galam skin waste + 0% water hyacinth with 10% tapioca adhesive) which is 14.51%. The average high and low moisture content of the organic pot is shown in Figure 2.

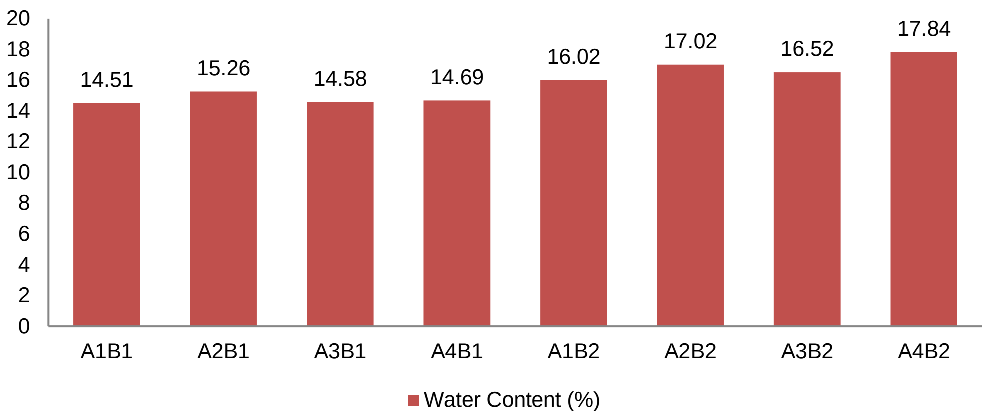

Figure 2 – Organic Pot Moisture Content

The average value of water content ranges from 14.51% to 17.84% indicating that all treatments did not meet the SNI standards, namely water content <14%, this is presumably due to the nature of tapioca and sago adhesives which are not moisture resistant or low water resistance and caused by raw materials that still contain a lot of water. The varying water content has an effect on accelerating the change and decomposition of organic matter in organic potted plant media (Widarti, 2015).

The average value of water content tends to decrease by using tapioca adhesive compared to using sago adhesive, this is presumably because tapioca adhesive has fairly good water resistance so that it blocks water from entering the cell cavities. Tapioca adhesive has better adhesive strength and hardens quickly at room temperature. This is in line with the research of Zulfian et al (2015) which stated that the adhesive type factor also influences the increase in water content. The use of sago adhesive tends to produce a higher water content than tapioca adhesive. In addition, the starch molecules in the adhesive have hydrophilic groups that can absorb water according to the humidity of the surrounding air.

High or low moisture content will determine the storage time of organic pots, high water content will cause damage to organic pots, both caused by microbiological damage and chemical reactions. This is in line with the research of Widarti et al (2015) which states that water content also has an effect on accelerating the change and decomposition of organic materials in planting media and organic pots. Furthermore, according to Purwanto (2015) the characteristics of galam bark are in the form of sheets of paper, rather thick, slightly reddish brown in color and contain lignocellulose which helps in the gluing process.

The results of the analysis of variance showed that the treatment had a significant effect on the water content value, factor A (raw material composition) had no significant effect on the water content value, factor (B) the type of tapioca and sago adhesive had a very significant effect on the water content and the interaction of factor AB (composition material and type of adhesive) had no significant effect on the water content value. Organic pot is a material that is hygroscopic depending on the surrounding air temperature. Variations in organic pot water content will affect the size and properties of the materials used. According to Noor (2022) the water content in organic pots will affect the strength and thickness of the organic pots.

The results of testing the water absorption capacity of organic pots varied, namely the lowest value was 123.69% and the highest was 153.51%. The highest percentage of water absorption was in treatment A1B2 (50% manure + 50% galam shell waste with 10% sago adhesive) and the lowest water absorption was in treatment A1B1 (50% manure + 50% galam shell waste with 10% tapioca adhesive). The average water absorption test results can be seen in Figure 3.

Figure 3 shows that the lowest organic pot water absorption value of 123.69% was found in the A1B1 combination treatment (50% manure + 50% galam skin waste with 10%

tapioca adhesive) in other words the A1B1 treatment had better strength compared to other combination treatments. According to Maharay et al (2021) the low water absorption in the A1B1 combination treatment was caused by the tightness of the surface of the water pot using tapioca adhesive which can inhibit the entry of water into the organic pot and the nature of the tapioca adhesive which hardens quickly. Furthermore, after baking the organic pot, it will prevent larger cracks from occurring. Roza (2009) said that tapioca adhesive makes it easier to close capillary cavities, so that water is not easily absorbed by organic pots.

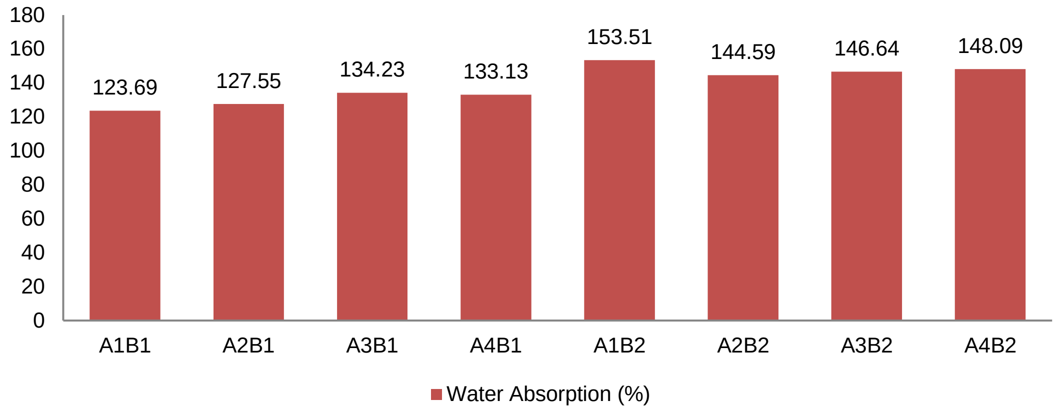

Figure 3 – Absorbency of Organic Pot Water

The high absorption capacity of organic potting water was found in the combined treatment of A1B2 treatment (50% manure + 50% galam shell waste + 0% water hyacinth) with sago adhesive, namely 153.51% due to poor water resistance of sago adhesive. According to Sutrisno et al (2017) water absorption is related to the chemical properties of wood fiber as a constituent. The presence of cellulose components from wood and non-wood fibers causes the binding capacity of water molecules to increase. Figure 3 shows that the addition of adhesive has an effect on the resulting water absorption value.

The combination of treatment of organic pot raw materials from galam bark waste, water hyacinth and manure with tapioca and sago adhesives has a significant effect on the water absorption capacity of organic pots. Factor B (type of adhesive) had a very significant effect on water fiber content while factor A (combination of organic potting materials) and AB interaction (combination of raw materials and type of adhesive) had no significant effect on organic potting.

According to Budi et al (2012) the type and composition of the adhesive has its own influence on the quality of the seedling containers. Organic pot with tapioca adhesive has lower absorption power and high water repellent properties compared to sago adhesive. Furthermore, according to Bowyer et al (2003) said that water absorption occurs due to the adsorption force which is the attractive force of water molecules at the hydrogen bond sites contained in cellulose, hemicellulose and lignin. SNI 03-2105-2006 does not require a water absorption value.

The highest density was in treatment A4B1 (50% manure + 0% galam shell waste + 50% water hyacinth with 10% tapioca adhesive) of 1.712 gr/cm^3 and the lowest was in treatment A3B1 (30% manure + 30% galam shell waste + 40% water hyacinth with 10% tapioca adhesive) which is 1.322 gr/cm^3.

Based on the research results, the density value obtained exceeds the SNI 03-2105-2006 standard limit, which is between 0.5 gr/cm3 – 0.9 gr/cm^3. This is thought to have something to do with the different properties of tapioca and sago adhesives on their solubility in water. Another factor that affects the density of organic pots is the difference in the composition of the raw materials, namely the waste of galam bark, water hyacinth and manure.

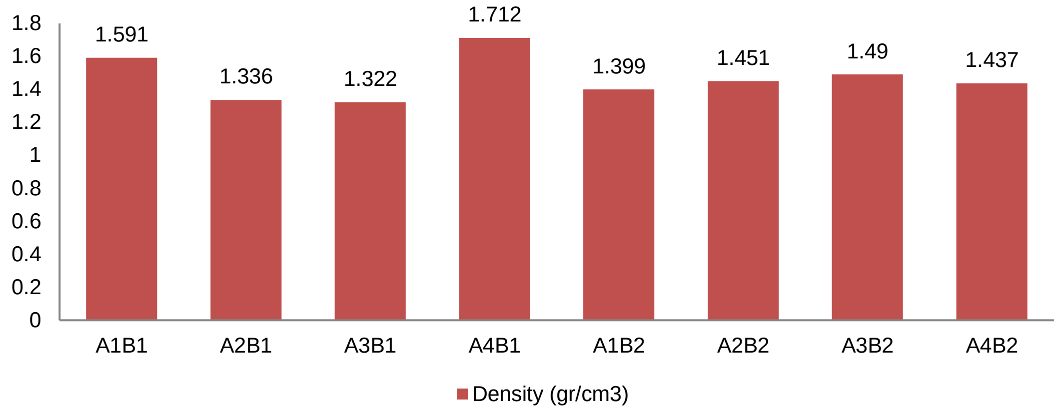

Figure 4 – Organic Pot Density

High or low levels of lignin will cause a decrease in flexibility and stiffness coefficient. Lignin is very closely related to cellulose and functions to provide strength to cells and lignin has an effect on changes in fiber dimensions (Sutrisno, et al, 2017). The lignin content of water hyacinth was 17% and that of galam bark was 18.28%. In addition to the lignin content in the raw material, the addition of adhesives will improve the performance of the resulting product.

Density is affected by the adhesion of each type of adhesive. According to Hidayat et al (2022) the density of tapioca adhesive is higher than other adhesives, this is because tapioca flour contains 17% amylose which functions to give a hard effect and 83% amylopectin which plays a role in giving a sticky effect.

The highest dry weight test results were in treatment A3B1 (30% manure + 30% galam shell waste + 40% water hyacinth with 10% tapioca adhesive) of 261.48 gr and the lowest was in treatment A1B2 (50% manure + 50% galam skin waste with 10% sago adhesive) which is 233.10 gr. The average dry weight test results can be seen in Figure 5.

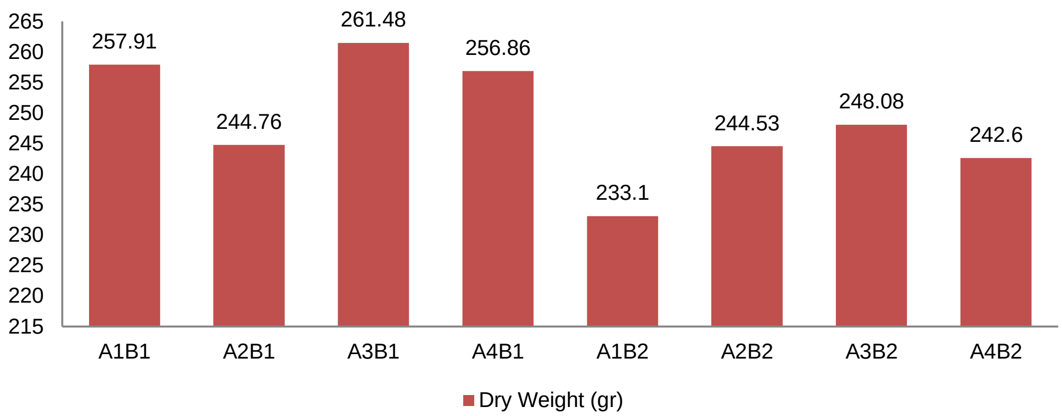

Figure 5 – Graph of dry weight (gr)

The average dry weight value of organic pots ranges from 233.10 gr – 261.48 gr. The difference in dry weight of organic pots was caused by differences in the composition of the types of raw materials for organic pots and the type of adhesive used (tapioca and sago). Based on the weighing of organic pots with tapioca adhesive, the weight was higher than that of sago adhesive, which was 261.48 gr. According to Azzaki et al (2020), the weight of the cocopot is directly proportional to the sturdiness of the cocopot. The heavier the cocopot, the stronger it will be, on the other hand, the cocopot which has a lighter weight quickly gets damaged. Judging from the heavy aspect of making organic pots using tapioca adhesive is better than sago adhesive, this happens because of the adhesive properties of starch which hardens when it is dry.

The results of the analysis of variance showed that all treatments (factors A, B and AB interactions) had no significant effect on the dry weight of the organic pots because the calculated F was less than the F table of 5% and 1%, so no follow-up tests were carried out.

The thickness of the organic pots of galam bark waste, water hyacinth and manure with tapioca and sago adhesives can be seen in Figure 6.

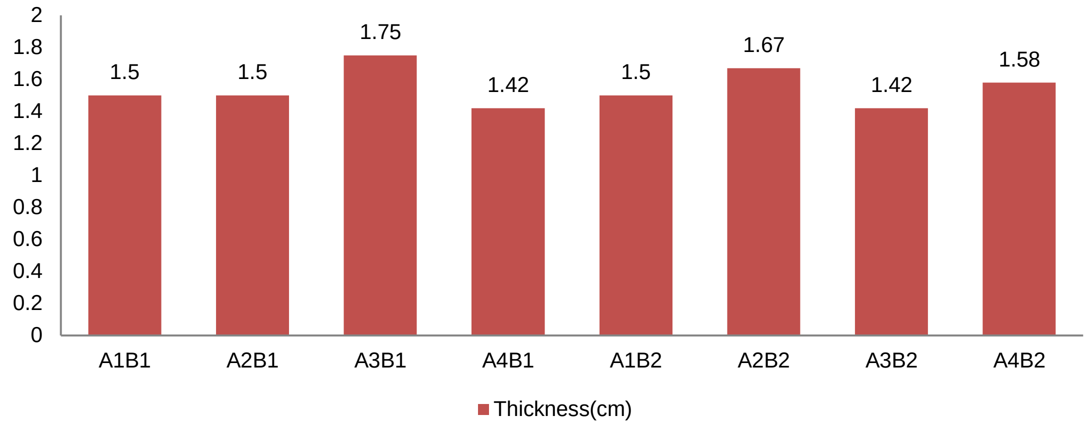

Figure 6 – The thickness of the organic pot

The thicker the organic pot is thought to contain more nutrients needed by plants. However, in terms of the high thickness of the organic pot, the more empty spaces are filled with air which can result in accelerated damage to the organic pot. material will be bigger.

Treatment factors A, B and AB interaction had no significant effect on the thickness of the organic pot. The calculation of the analysis of variance showed that the calculated F was smaller than the F table of 5% and 1%, so no further tests were carried out.

The results of the organic pot flexural toughness (MOE) test showed that the highest average value of flexural strength was in the A1B1 combination treatment (50% manure + 50% galam shell waste + 0% water hyacinth with 10% tapioca adhesive) namely 8174.38 kgf/cm^2 and the lowest value was found in the A4B2 combination treatment (50% manure + 0% galam shell waste + 50% water hyacinth with 10% sago adhesive) namely 3328.26 kgf/cm^2. The average results of the flexural toughness test (MOE) can be seen in Figure 7.

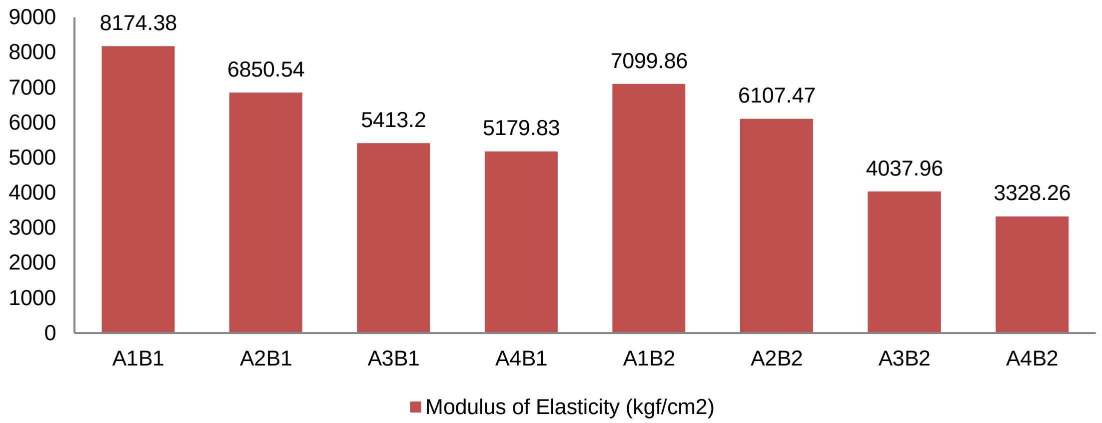

Figure 7 – Flexural Strength of Organic Pots

The use of adhesive can increase the rigidity (more elastic) of organic pots, while the use of sago adhesive can reduce the stickiness, especially A4B2 (50% manure + 0% galam skin waste + 50% water hyacinth with sago adhesive). Based on the raw materials used, the addition of 50% water hyacinth and 50% manure (A4B2) actually causes a decrease in the strength of the organic pot, this is presumably due to the nature of the water hyacinth which easily absorbs water, due to the hygroscopic nature of the organic pot. contains lignin and cellulose, because all materials containing lignin and cellulose are very easy to absorb and release water. This is in line with the research of Said et al (2021) which states that the higher the water absorption, the material particles can absorb water thereby weakening the bonds between the particles. Water hyacinth cellulose content is 72.63% and lignin content is 17%.

Maloney (1993) states that the value of flexural toughness (MOE) is influenced by the content and type of adhesive used, adhesive bonding power and fiber length. The results of the analysis of variance showed that the treatment factor (B) type of adhesive had a very significant effect on flexural toughness (MOE), factor (A) of raw materials had a significant effect and interaction (AB) had no significant effect. All treatments did not meet the SNI standard, namely 200,400 kgf/cm^2.

The highest treatment was in the A1B1 treatment combination (50% manure + 50% galam shell waste + 0% water hyacinth with 10% tapioca adhesive) which was 83.23 kgf/cm^2 and met the Indonesian National Standard which required a value of 82 kgf/cm2. The lowest treatment was in the A4B2 treatment (50% manure + 0% galam shell waste + 50% water hyacinth with 10% sago adhesive) which was 20.40 kgf/cm^2 and this treatment was not included in the Indonesian National Standard.

The high and low values of the average fracture toughness (MOR) of organic pots of galam bark waste, water hyacinth and manure with tapioca and sago adhesives can be seen in Figure 8.

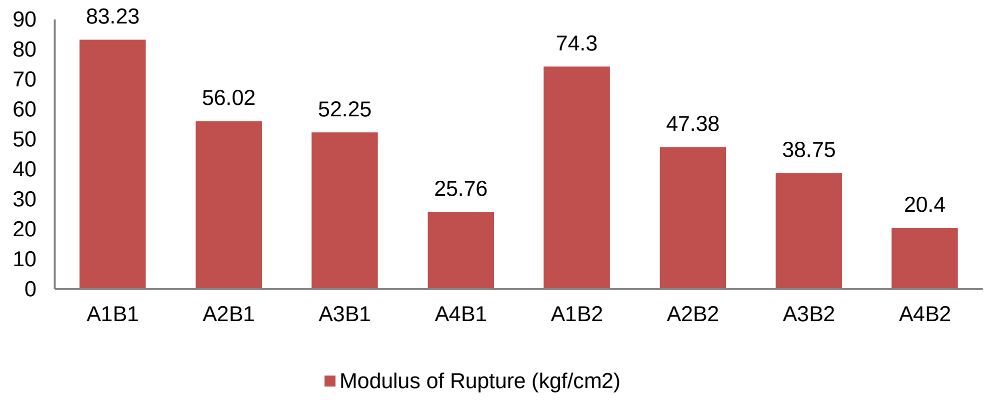

Figure 8 – Fracture Firmness (MOR) of Organic Pots

Based on the results of the study using tapioca flour with the composition of the ingredients (50% manure + 50% galam bark waste + 0% water hyacinth), namely the A1B1 treatment, it is included in the SNI standard for fracture toughness (MOR), namely 83.23 kgf/cm^2 (SNI 82 kgf/cm^2).

Based on the test results of analysis of variance in treatment and factor B (adhesive) had a very significant effect on fracture toughness (MOR), factor A (composition of materials) had a significant effect and interaction AB had no significant effect. The fracture toughness (MOR) is closely related to the amount of adhesive composition, compactness of the adhesive, moisture content and density, extractive substances and chemical components in the material.

CONCLUSION

The organic pot water content of galam bark waste, water hyacinth and manure with tapioca and sago adhesives was highest in treatment A4B2, namely 17.84% and lowest in treatment A1B1, namely 14.51%, the highest water absorption was found in treatment A1B2, namely 153.51% and the lowest water absorption was in treatment A1B1 which was 123.69%, the highest density was in treatment A4B1 which was 1.712 gr/cm3 and the lowest density was in treatment A3B1 which was 1.322 gr/cm3, the highest dry weight was found in treatment A3B1 which was 261, 48 gr and the lowest was in treatment A1B2 which was 233.10 gr and the highest organic pot thickness was in treatment A3B1 of 1.75 cm and the lowest thickness was found in treatments A4B1 and A3B2 which was 1.42 cm.

The results of testing the mechanical properties of organic pots, namely the highest bending strength (MOE) of organic pots were in the A1B1 combination treatment, namely 8174.38 kgf/cm^2 and the lowest was in the A4B2 combination treatment, namely 3328.26 kgf/cm^2. The highest average fracture toughness (MOR) was in the A1B1 treatment combination, which was 83.23 kgf/cm^2 and the lowest was in the A4B2 treatment, which was 20.40 kgf/cm^2.

The water content does not meet the SNI standard (> 14%), the density does not meet the SNI standard (0.5 – 0.9 gr/cm^2). The MOE test also does not meet the SNI standard of 20,000 kgf/cm^2. Treatment A1B1 meets SNI standards (min 80 kgf/cm^2) MOR is 83.23 kgf/cm^2.

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