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The Effectiveness Of Water Hyacinth Root As A Substitution For Rockwool In Hydroponic Growing Media.

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Abstract: *Water hyacinth is a water weed that dominates in water bodies worldwide. Its utilization not only solves problems but also provides economic benefits. In developing countries, hydroponic farming requires a growing medium that is cheap, easily accessible, and sustainable. Therefore, the production of a substitute medium using rockwool with water hyacinth roots as the main material becomes very intriguing. The research was conducted by processing products based on water hyacinth roots using various adhesives (Rootwool) . The study used a Completely Randomized Design with 4 treatments and 5 replications, consisting of k0 (Rockwool) as the control, (a1) Water hyacinth roots with Phenol Resin adhesive, (a2) Water hyacinth roots with Tapioca Glue (Paper Glue), and (a3) Water hyacinth roots with Wood Glue (Construction Glue). The results of the study showed that the treatment of Rootwool with the mentioned adhesives significantly influenced the medium weight, water saturation weight, water retaining ability, and water holding capacity. The lightest dry weight of Rootwool was obtained from the average dry weight of Rootwool with Wood Glue (Construction Glue) adhesive, with an average medium weight of 1.940 grams and a texture and appearance similar to rockwool. This indicates that Rootwool, as a growing medium based on water hyacinth roots, has great potential as a substitute for rockwool media.*
Key Word*:* *adhesive, hydroponic medium; Rockwool; Soilless Culture.; Water hyacinth,*

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I. Introduction

Water hyacinth (Eichhornia crassipes) is one of the dominant introduced weed plants that have long been a weed in wetlands in South Kalimantan, especially in water areas and wetlands such as peatlands, tidal lands, and swamps. Its presence as a weed is not only a problem in Indonesia but has also become a concern in various parts of the world. The control of water hyacinth weeds currently can be considered less than ideal, as the use of biological and chemical control techniques can lead to new problems for ecology and the environment. Therefore, utilizing this weed can not only help solve problems but also provide economic benefits. (Su, Sun, Xia, & Wen, 2018)

The utilization of hydroponics is still not widespread, mainly due to the perception that hydroponic farming requires expensive costs both at the initial infestation and during operational stages. This is because of the installation, nutrient, and growing media costs, especially in the growing media aspect. Currently, hydroponic practitioners are highly dependent on hydroponic media made from Rockwool, which is mostly dominated by foreign products and thus still relatively expensive. This results in higher production costs, making it difficult to achieve efforts to produce quality and affordable agricultural products. (Taofik, Frasetya, Nugraha, & Sudrajat, 2019).

Hydroponic media has seen significant developments where hydroponic systems can use single or combined materials such as sand, gravel, stones, coconut fiber (cocopeat), perlite, Expanded Clay Pellets (LECA), or better known as Hydroton. The selection of the best growing media is one that can retain both air and water at nearly the same concentration. (Roberto, 2003)

Based on the problem of utilizing Water Hyacinth weed and reducing the cultivation costs of Hydroponics, it raises the question of how to utilize the abundant Water Hyacinth weed (Eichhornia crassipes) found in wetland areas in South Kalimantan. The goal is to not only control its growth but also derive economic benefits.

Hydroponics, a soilless cultivation technique, offers various types of growing media or substrates, such as perlite, volcanic rock, expanded clay granules, vermiculite, zeolite, pumice, sand, and other synthetic materials classified as inorganic substrates. Meanwhile, commonly used organic growing media are cocopeat and sphagnum peat. (Gruda, 2019) In some countries of Europe and USA, rockwool is the most dominant hydroponic growing medium used by farmers for greenhouse vegetable production due to its high yields.. (Allaire, caron, Menard, & dorais, 2005)

Rockwool is a fibrous material made from a mixture of basalt rock, limestone, and coke (Resh, 2012), which is melted at temperatures ranging from 1500°C to 2500°C in a furnace to form a lava-like liquid. This liquid is then spun into fibers, which are pressed to form blocks, bricks, and cubes. Afterward, they are coated with phenolic resin during the cooling process (Roberto, 2003). The first production of Rockwool for growing media was carried out by Grodan, a Dutch factory established in 1969 and is a subsidiary of the Rockwool Group (Resh, 2012).

The determination of using growing media must consider various factors, such as the distance to the source of raw materials, to ensure that the utilization of local raw materials is not only important from an economic perspective but also from a sustainable standpoint. A specific trend is the utilization of renewable materials that are locally sourced, natural, and fast-growing (Gruda, 2019). Numerous research studies have been conducted to find more eco-friendly substitute substrates. Some researchers have investigated options such as composted fir bark, wood shavings, and sawdust.

II. Material And Methods

All treatments were conducted in the Agricultural Biology Laboratory and Chemical Analysis Laboratory of the Agriculture Faculty, Lambung Mangkurat University, located in Banjarbaru. The research took place from January to May 2023. The materials and equipment used in this laboratory experiment were rockwool, water hyacinth roots, water, Resin adhesive, Tapioca Glue, Wood Glue, sample bags, and an Analytical Balance.

The observed variables consisted of Media Weight (g), obtained by weighing rockwool and rootwool after being cut to the usage size in the net pots (2.5 cm x 2.5 cm), then weighed using a Digital Analytical Balance. Saturated Weight (g), Water retaining ability (g), obtained by calculating the difference between the saturated weight with water and the weight of the growing media, and the Water Holding Capacity. The data obtained will be analyzed using analysis of variance (ANOVA). If there is a significant effect, further testing will be conducted using Orthogonal Contrasts Comparison Test, which will compare the control groups that use rockwool media with those that use water hyacinth root media or rootwool.

Media Processing Procedure.

Water hyacinth collected from the waters is processed as follows: a) The collected water hyacinth is cut to remove the upper part, including the upper stem and leaves; b) Separation of water hyacinth roots from the lower part of the stem; c) Cleaning the separated water hyacinth roots with flowing clean water using a fishing net to prevent them from being carried away by the water current, then draining the water; d) The water hyacinth roots are placed in a tray and oven-dried at 80 degrees Celsius for 2 days to reduce the moisture content; e) After 2 days of oven-drying, the water hyacinth roots are taken out and cooled at room temperature; f) Preparation of the adhesive material, namely fiberglass adhesive (Phenol Resin), which has the same content as the adhesive used to attach rockwool. Additionally, treatments with Tapioca Glue and Wood Glue are prepared; g) The water hyacinth roots are placed in a container measuring 20x10x7 cm to be molded into block-shaped molds; h) Application of the adhesive material to each treatment. The adhesive is applied using a brush, with the water hyacinth roots arranged and the adhesive gradually applied. After applying the adhesive on the top layer, more water hyacinth roots are added to a thickness of approximately half a centimeter, followed by pressing using wood and hands. This process is repeated until the desired thickness of 2.5 cm is achieved; i) After reaching the desired thickness, the tray is covered with a wooden lid; j) The water hyacinth root media is placed in an oven at 150 degrees Celsius for 2 sets of 40 minutes each. This heating process aims to accelerate the bonding process by the adhesive material; k) After the first 40 minutes, the media is flipped, and the same temperature (150 degrees Celsius) is maintained for the next 40 minutes; l) After the specified time, the tray is taken out of the oven and allowed to cool; m) The water hyacinth root media is now ready. Replications are made using the same process. The results of the processing can be seen in Appendix 1.

III. Result and Discussion

Characteristics of hydroponic growing media are crucial in relation to water and air availability for plant roots (Savvas & Gruda, 2018). Therefore, a good hydroponic growing medium should ensure sufficient aeration, water, and nutrients (Gruda, 2019). Based on the research conducted in the laboratory, a physical quality test was carried out on the produced media, and the results were compared with the control media. The analysis of variance showed that the treatments involving rootwool with Phenol Resin adhesive, Tapioca Glue, and Wood Glue significantly affected the weight of the growing media, saturated weight, water retaining ability, and water holding capacity.

The analysis of variance indicates that the treatment of rootwool with Phenol Resin adhesive, Tapioca Glue, and Wood Glue significantly and markedly affects the weight of the growing media, saturated weight, water retaining ability, and water holding capacity.

The weight of the growing media.

The weight of a hydroponic medium plays a crucial role in its ease of use and practicality. A physically lighter medium is easier to handle and transfer, leading to more efficient management of resources. Media with good porosity can support root anchorage, allowing plants to stand upright and receive light effectively (Wahyuningsih, Fajriani, & Aini, 2016). Additionally, a well-aerated substrate facilitates root growth. According to Auliyah (2021), a good substrate should not be too dense to ensure proper aeration, allowing roots to easily access oxygen and enabling smooth root elongation as they don't require extra effort to push through the growing medium. This, in turn, positively impacts root development, allowing them to grow to their fullest potential.

Table 1 shows that rockwool is the lightest among the media, followed by rootwool with Tapioca Glue adhesive, and the heaviest is rootwool with Phenol Resin adhesive. The weight of rockwool is still lighter than rootwool, attributed to the advanced processing of rockwool, which produces lightweight fibers despite being made from mineral materials. Additionally, the even application of Phenol Resin using machinery results in a more evenly distributed adhesive, making it lighter than rootwool with water hyacinth root material. Nevertheless, the dry weight of rootwool is still relatively light. Table 1 also indicates that each adhesive used has a different effect on the dry weight of the resulting rootwool. In this case, rootwool with Wood Glue adhesive performs better/lighter compared to the other two rootwools.

Table no 1 : The data for the weight of rockwool and rootwool media with dimensions of 2.5cm x 2.5cm x 2.5cm.

Contrast Ortogonal Test	Means			JKQi		F tab	
						0,05	0,01
k_0 vs $a_1;a_2;a_3$	0,842	Vs	2,771	13,95**		3,24	5,29
a_1 vs a_2 ; a_3	3,486	Vs	2,413	3,84**			
a_2 vs a_3	2,886	Vs	1,940	2,24**			
Galat				0,086			

* = significant

The saturated weight of the media.

The saturated weight of the media indicates its ability to retain water and bind the necessary nutrients for plants. It is closely related to plant transpiration (Tai & Park, 2014). This ability also influences the plant's resilience in facing various planting conditions, such as drought stress in the field or high temperatures in a greenhouse.

Table 2 shows that rootwool from all three types of adhesives has a saturated weight that can be considered comparable to rockwool in terms of water storage capacity, which serves as a reservoir for plant nutrients. Moreover, rootwool has the advantage of a simpler manufacturing process and readily available materials. Based on this table, it can also be observed that rockwool with Tapioca Glue and Wood Glue adhesives has almost the same mean saturated weight. However, rootwool with Phenol Resin adhesive has the highest mean saturated weight compared to other rootwool types, even exceeding the mean saturated weight of rockwool

Table no 2 : The data for the saturated weight of rockwool and rootwool media with dimensions of 2.5cm x 2.5cm x 2.5cm.

Contrast Ortogonal Test	Means			JKQi		F tab	
						0,05	0,01
k_0 vs a_1;a_2;a_3	13,980	Vs	13,515	0,81ns		3,24	5,29
a_1 vs a_2 ; a_3	16,346	Vs	12,100	60,09**			
a_2 vs a_3	12,474	Vs	11,726	1,40ns			
Galat				2,466			

ns = non-significant

Water Retaining Ability

Table 3 shows that rockwool still has a better water retaining ability. In the comparison between rootwool with Phenol Resin adhesive and the other two adhesives, it is found that Phenol Resin adhesive has better water retaining ability than the other adhesives used in rootwool. The mean water retaining ability of rootwool with Phenol Resin adhesive approaches that of rockwool. This aligns with the findings of Meriati (2021), who concluded that rockwool remains the best growing medium compared to rice husk charcoal and cocopeat. In the comparison between rootwool with Tapioca Glue and Wood Glue adhesives, the water retaining ability is almost the same.

Table no 3 : The data for the water retaining ability of rockwool and rootwool media with dimensions of 2.5cm x 2.5cm x 2.5cm.

Contrast Ortogonal Test	Means			JKQi		F tab	
						0,05	0,01
k_0 vs a_1;a_2;a_3	13,138	Vs	10,745	21,48**		3,24	5,29
a_1 vs a_2 ; a_3	12,860	Vs	9,687	33,56**			
a_2 vs a_3	9,588	Vs	9,786	0,01ns			
Galat				2,121			

Water Holding Capacity

Table 4 shows that rockwool has a much better water holding capacity compared to rootwool. This is because the weight of rockwool is very light, indicating its high efficiency in retaining water and nutrients for plants in each gram of dry weight. In the comparison between rootwool with Phenol Resin adhesive and the other two adhesives, it is found that there is no significant difference in their water holding capacity. This table also indicates that rootwool with Wood Glue adhesive is better than rootwool with Tapioca Glue adhesive in terms of water holding capacity.

Table no 4 : The data for the water holding capacity of rockwool and rootwool media with dimensions of 2.5cm x 2.5cm x 2.5cm

Contrast Ortogonal Test	Means			JKQi		F tab	
						0,05	0,01
k_0 vs a_1;a_2;a_3	16,616	Vs	5,062	27,58**		3,24	5,29
a_1 vs a_2 ; a_3	4,711	Vs	5,238	0,0002ns			
a_2 vs a_3	4,331	Vs	6,145	8,75**			
Galat				0,57			

ns = non-significant

Some other important findings during the testing, observation, and cutting of Rootwool materials revealed that Rootwool made with tapioca glue and wood glue had textures and appearances that closely resembled conventional rockwool. Moreover, when cutting Rootwool into smaller sizes, it was relatively easy for the ones made with tapioca glue and wood glue. However, cutting Rootwool made with phenolic resin adhesive was more challenging compared to conventional rockwool. This difficulty arose from the phenolic resin's fast-drying nature, requiring quick application with machinery to achieve thin and evenly distributed bonds with strong adhesion. Improper application of phenolic resin adhesive led to a harder texture in Rootwool compared to the other two types developed with different adhesives, making it more challenging to cut. Nevertheless, this issue can be resolved by soaking the Rootwool before cutting, making the cutting process easier. These findings emphasize the significance of selecting the appropriate adhesive and applying it correctly to achieve optimal Rootwool quality, texture, and ease of handling during the cutting process.

IV. Conclusion

Rootwool, as a growing medium made from water hyacinth roots, has great potential as a replacement for rockwool media. Not only is the availability of raw materials easily accessible, but it is also economically affordable and a more environmentally friendly alternative. Among the various adhesive options tested, Rootwool with wood glue (building glue) as the adhesive showed the lightest growing medium weight, with an average dry weight of 1.940 grams. Additionally, it has a texture and an appearance similar to rockwool.

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