ABDIMAS TALENTA
Jurnal Pengabdian Kepada Masyarakat
Journal homepage: https://talenta.usu.ac.id/abdimas

Increasing the Economic Value of Hydrogel as an Alternative Planting Media at Madrasah Aliyah Swasta Muhammadiyah Sidomulyo

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ARTICLE INFO

Article history:
Received : 02 December 2023
Revised : 08 December 2023
Accepted : 05 March 2024
Available online: 30 June 2024

E-ISSN: 2549-418X
P-ISSN: 2549-4341

How to cite:
Hamid, M., Simanjuntak, C., Rianna, M., Amaturrahim, S. A., Saragi, I. R., Felly, P. A., Siahaan, C., Waruwu, D., Talanda, A., and Tambunan, M. (2024). Increasing the Economic Value of Hydrogel as an Alternative Planting Media at Madrasah Aliyah Swasta Muhammadiyah Sidomulyo. ABDIMAS TALENTA: Jurnal Pengabdian Kepada Masyrakat, 9(1), 79-84.

https://doi.org/10.32734/abdimastalenta.v9i1.16316

ABSTRACT

Hydrogel technology can be used as a solution for indoor growing media. Hydrogel is a three-dimensional polymer network with cross-linked hydrophilic polymers, which are capable of swelling or storing water and physiological solutions up to thousands of times their dry weight, and are not easily soluble. To increase knowledge about ornamental plant cultivation using hydrogel media, a service was carried out by using partners at the Madrasah Aliyah Swasta Muhammadiyah Sidomulyo. This service aims to provide solutions to partners in the form of alternative hydrogel-based planting media made from alginate that are environmentally friendly which can be used as moisture and nutrient control agents. This goal is achieved through outreach activities, training, and the application of alternative planting media on ornamental plants. The target of the results to be achieved is to increase the economic value of hydrogels and to foster the entrepreneurial spirit of the students of Madrasah Aliyah Swasta Muhammadiyah Sidomulyo.

Keyword: Hydrogel, Growing Media, Alginate, Economical

1. Introduction

Here The availability of water and nutrients is one of the requirements for plants to grow well. This is generally a problem in several regions in Indonesia, especially during the dry season. Under these conditions, the quantity and quality of groundwater can be reduced, which can inhibit plant growth. Therefore, it can be concluded that a good planting medium is one of the main factors in plant growth [1].

One of the growing alternative growing media that can be used for plant cultivation is using hydrogels. Hydrogel is a material consisting of a cross-linked network made of hydrophilic polymers that can absorb water and nutrients because it has a certain capacity in storage [2]. Hydrogel synthesis is widely done using synthetic monomers, modification of natural polymers such as cellulose derivatives [3]. They are produced from chemically or physically cross-linked polymers and they can find applications in various fields such as drug delivery, wound dressing, tissue engineering, heavy metal absorption, implants, and contact lenses [4].

Various polymers used in biomedical applications have important functional properties including biocompatibility and biodegradability. Among the materials established as polymers*, alginate* is an attractive polysaccharide. In addition, alginate has low toxicity, and is relatively inexpensive [5] thus it is favored for environmental applications due to its high carboxyl group content [6]. *Na-alginate is* used due to its gelling properties and non-toxicity [7]. The hydrogels in this activity were prepared by dropping 2% by weight sodium alginate into a 1% by weight calcium chloride solution. Calcium chloride causes the alginate to crosslink so that it diffuses through the alginate gel layer. When the calcium reaches the inside of the beads, it will cause the alginate there to crosslink and become a gel [8].

Modern Muhammadiyah Islamic Boarding School Kwala Madu Langkat which is located on Jalan Tanjung Pura KM 32, Kwala Madu Sugar Factory Intersection, Sidomulyo Village. This school has a vision and mission to encourage santri / female santri graduates to be able to explore superior creative economic fields. [9] so that graduates can become entrepreneurs who can utilize simple technology into appropriate products. Scientific advances have played an important role in the development of plant technology so that it can be used as a way to improve plant growth and development and can also be utilized as an entrepreneurial field.

In this service, hydrogel is applied as an alternative planting medium in kangkong vegetable plants and ornamental plants. The kale plant is one of the plants that can be cultivated and is thought to require sufficient organic matter. [10] and belongs to the *Convolvulaceae* tribe. Land kale has a different color from the water kale plant stem. Land kale has a greenish-white stem color, while land kale has segments that are larger than kale that grows in water. [11]. In vegetable crops the hydrogel is mixed with soil, forming an amorphous gelatin-like mass on hydration and is proficient in absorption and desorption for a long time, thus acting as a slow supply of unused water in the soil [12]. Hydrogels increase the moisture content in the soil and provide water during dry seasons. [13].

Cultivation of ornamental plants can be done by generative or vegetative propagation [14]. Ornamental plants have a high economic value, so the need for high quality is also needed so that ornamental plants can be utilized as an alternative source of community income, especially during the current pandemic. [15]. With this planting media, it will save the use of as much as when compared to conventional planting media.

The mechanism of water absorption depends on the diffusion of water into the 3D hydrogel network and the consequent relaxation of the polymer chain. The phenomenon of water transport in swelling hydrogels is significantly influenced by different factors, including the chemical composition of the hydrogel, the equilibrium moisture content, and the degree of swelling [16]. Hydrogels can be used as a material for absorbing water that is environmentally friendly by utilizing natural resources around us. [17].

2. Implemetation Methhod

2.1. Tools and Materials

The tools used in the manufacture of hydrogels are *hotplate*, stative, separatory funnel, *magnetic bar,* beaker glass, spatula, and sieve. The materials used are *sodium alginate*, $CaCl_2$, urea, and distilled water. In addition, the tools used for planting media are *polybags* and shovels. The materials used are soil, compost, husks, kale plants and ornamental plants.

2.2. Community Service Location

Community service was carried out at Madrasah Aliyah Swasta Muhammadiyah Sidomulyo which is located on Jalan Tj. Pura No.Km 32, Kwala Begumit, Kec. Stabat, Langkat Regency, North Sumatra. the partner location is 33 km from the Universitas Sumatera Utara with a travel time of about 55 minutes by car via the Medan-Binjai Toll Road, as shown in Figure 1 below.

(a) **(b)**

Figure 1. (a) Madrasah Aliyah Swasta Muhammadiyah Sidomulyo, **(b)** Partner network location map of Universitas Sumatera Utara

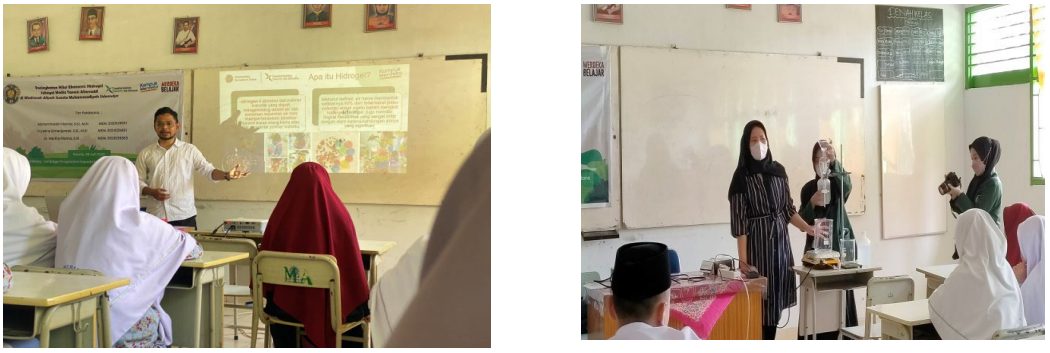
2.3. Hydrogel manufacturing process

a. Preparation of solutions (*sodium alginate*, $CaCl_2$, and urea)
Natirum alginate solution was prepared by dissolving 2wt% *sodium alginate* (2 g *sodium alginate* in 100 ml distilled water) in a beaker glass until homogeneous by stirring using a *magnetic bar*. Then, the homogenized *sodium alginate solution* was stored in the refrigerator. CaCl2 solution is made by dissolving 2wt% CaCl2 (2 g CaCl2 in 100 ml distilled water) in beaker glass until homogeneous. Meanwhile, urea solution was made by dissolving 1wt% urea (2 g CaCl2 in 100 ml distilled water) in a beaker glass until homogeneous. Next, 2 wt% CaCl2 solution was mixed with 1 wt% urea solution that had been made separately before.

b. Formation of *gel* beads
The formation of gel beads occurs when the *sodium alginate solution is* dripped using a separatory funnel into a beaker glass containing a mixture of CaCl2 solution and urea solution while rotating with a *magnetic bar*. This is due to the crosslinking process between the *sodium alginate solution* that is dripped into the CaCl solution2 so that *gel beads are* formed. This process is carried out until the sea of *sodium alginate* that is dripped runs out and then the *gel beads are* allowed to stand for 15 minutes. After that, the *gel beads* can be filtered using a filter. Hydrogel is ready to be applied to the planting media.

3. Result and Discussion

The development of planting media is currently very diverse, one of which is the use of hydrogels as a planting medium. Hydrogel is one of the alternative planting media used to reduce the intensity of watering on plants. Hydrogels function to store water and nutrients needed by plants that will be released slowly according to the needs of the plant. Hydrogels can also still be used in combination with soil growing media. The advantages of using hydrogels include that they can absorb and store water and nutrients optimally so as to reduce the frequency of watering in plants so that it does not need to bother and is more economical. The material for making hydrogels is also very diverse, one of which we use in this service is a hydrogel based on sodium alginate as a gelling agent and CaCl2 as a crosslinker that is more environmentally friendly and biodegredeble. In this community service activity, socialization of hydrogel as a planting medium is carried out starting from the introduction of tools and materials, demonstration of hydrogel making, to the application of hydrogel as a planting medium in kale plants and ornamental plants to students of Madrasah Aliyah Swasta Muhammadiyah Sidomulyo as can be seen in Figure 2 below.

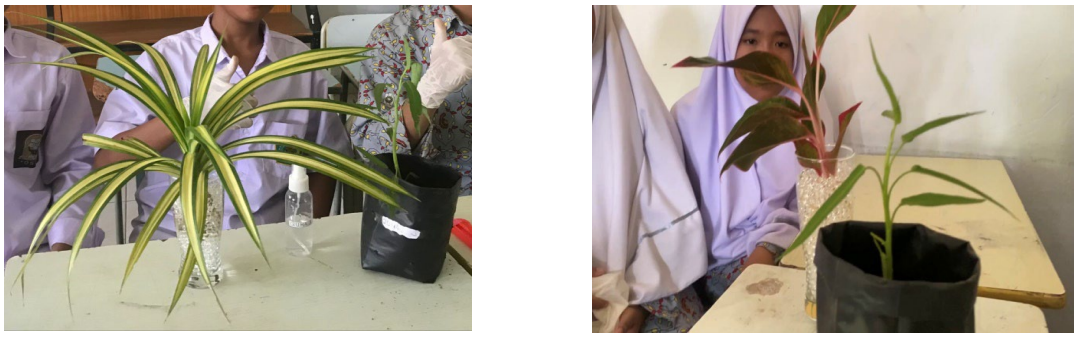


(a) **(b)**

Figure 2. **(a)** Socialization of hydrogels, **(b)** Demonstration of tools and making hydrogels

Furthermore, in this service, plant preparation and preparation of various planting media were carried out for two types of plants, namely kangkong plants and ornamental plants.

a. Plant preparation
The plants that will be applied in this service are kale plants and ornamental plants (aglonema and paris lilies). Kale plants were chosen because these plants are easy to grow and have a relatively short harvest time of about 30-40 days. While aglonema ornamental plants are used because these ornamental plants are easy to find and can live in water as seen in Figure 3.



(a) **(b)**

Figure 3. (a) Kale plants and ornamental plants (paris lilies) **(b)** Kale plants and ornamental plants (aglonema)

b. Preparation of growing media
Planting media used for kale plants are soil mixed with compost and husk in a ratio of 2: 1 soil and compost and 10% husk placed in *polybags as* high as 10 cm that has been allowed to stand for 1 night before planting time and also the addition of hydrogel in the soil. While the planting media used in ornamental plants is only hydrogel placed in a glass container. The application of planting media was done directly by students of Madrasah Aliyah Swasta Muhammadiyah Sidomulyo as shown in Figure 4.

Figure 4. Making kale plants and ornamental plants by students

The participants of the hydrogel making training were very enthusiastic in this service activity. This can be seen from Figure 5.

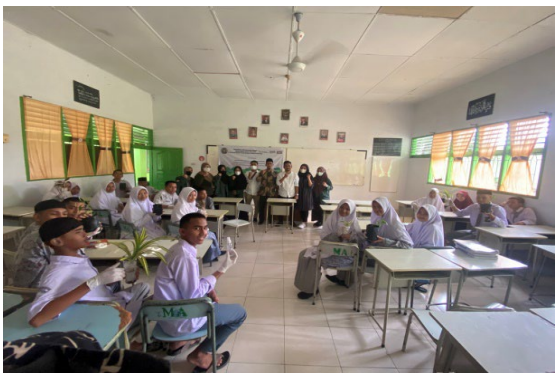


Figure 5. Enthusiasm of the Hydrogel Making Training Participants

4. Conclusion

- The manufacture of alginate-based hydrogels has been successfully carried out at Madrasah Aliyah Swasta Muhammadiyah Sidomulyo.
- Alginate-based hydrogels that are environmentally friendly and safe to use can be used as alternative growing media that can store water and nutrients for plants so that their use can reduce the frequency of watering plants.
- Alginate-based hydrogels have been successfully tested using kale and ornamental plants.
- Hydrogels can be applied to vegetable, medicinal and ornamental plants. Making hydrogels is expected to increase economic value and foster the spirit of entrepreneurship.

5. Acknowledgements

The author would like to thank the Rector of the Universitas Sumatera Utara for the Community Service research fund through the Pioneer Scheme in 2022 with Contract Number: 440/UN5.2.4.1/PPM/2022. In addition, to all parties who helped this service run well.

REFERENCES

[1] M. Siregar, Refnizuida, and N. Lubis, "Potential Of Using Types Of Planting Media On The Establishment Of Some Red Chicken Varieties (Capsicum annum L.)," *Rice ServicesJournal Anim. Sci. Agron. Panca Budi*, vol. 3, no. 1, pp. 11-14, 2018, [Online]. Available: http://jurnal.pancabudi.ac.id/index.php/jasapadi/article/view/249/230

[2] K. Kuo and P. X. Ma, "Maintaining dimensions and mechanical properties of ionically crosslinked alginate hydrogel scaffolds in vitro," *J. Biomed. Mater. Res. - Part A*, vol. 84, no. 4, pp. 899-907, 2008, doi: 10.1002/jbm.a.31375.

[3] M. Nasir, "Water Absorption Properties and Water Absorption Stability of Composite Polymer Hydrogels," *Jkti*, vol. 12, no. 2, pp. 80-82, 2010.

[4] I. Díez-García, M. R. de C. Lemma, H. S. Barud, A. Eceiza, and A. Tercjak, "Hydrogels based on waterborne poly(urethane-urea)s by physically cross-linking with sodium alginate and calcium chloride," *Carbohydr. Polym.*, vol. 250, 2020, doi: 10.1016/j.carbpol.2020.116940.

[5] R. da Silva Fernandes, M. R. de Moura, G. M. Glenn, and F. A. Aouada, "Thermal, microstructural, and spectroscopic analysis of Ca2+ alginate/clay nanocomposite hydrogel beads," *J. Mol. Liq.*, vol. 265, pp. 327-336, 2018, doi: 10.1016/j.molliq.2018.06.005.

[6] B. B. Lee, B. R. Bhandari, and T. Howes, "Gelation of an alginate film via spraying of calcium chloride droplets," *Chem. Eng. Sci.*, vol. 183, pp. 1-12, 2018, doi: 10.1016/j.ces.2018.02.049.

[7] Z. Mashwani, M. Hussain, M. Ejaz, and D. A. N. Z. Chaudhry, "Evaluation of Sodium Alginate and Calcium Chloride on Synthetic Seed Development," 2019, doi: 10.30848/PJB2019-5(36)KUTIPAN.

[8] P. Gel, "Making Gel Beads".

[9] "The Role Of Website In Improving The Citra Of The Institution (Descriptive Study on the website by: MARYAM ULFA Communication Studies Program Concentration in Public Relations," 2016.

[10] T. Juniyati, A. Adam, and P. Patang, "Effect Of Composition Of Organic Planting Media Of Chickenhouse Chemicals And Solid Pupilization Of Sapi Farm Land On The Growth And Livelihability Of Dark Corn (Ipomea reptans Poir) PLANT," *J. Educ. Technol. Pertan.*, vol. 2, no. 1, p. 9, 2018, doi: 10.26858/jptp.v2i1.5149.

[11] N. Rahmah, M. Wijaya, and P. Patang, "Planting media engineering on growth, survival and production of vegetables," *J. Educ. Technol. Pertan.*, vol. 1, no. 1, p. 69, 2018, doi: 10.26858/jptp.v1i1.5146.

[12] W. Abobatta, K. W. Abobatta, L. P. Horticulture, and P. P. Agriculture, "Impact of hydrogel polymer in agricultural sector," *Adv. Agric. Environ. Sci. Open Access*, vol. 1, no. 2, pp. 59-64, 2018, doi: 10.30881/aaeoa.00011.

[13] U. Agriculture, N. Deva, and P. Citation, "Sardar Vallabhbhai Patel University of Agriculture and Technology Hydrogels and their effect on soil moisture status and plant growth. A review of Rahul Kumar, Shipra Yadav, Vikash Singh, Mukesh Kumar and Monu Kumar Abstract 2030. Agriculture will m," 2020.

[14] L. D. Cahyanti, A. Laila, M. Hamawi, U. Etica, and H. Setyaningrum, "Students Empowerment to Ornamental Propagation Development at Gontor For Girls 1 Mantingan," *J. Pengabdi. Masy. Univ. Merdeka Malang*, vol. 2, no. 1, pp. 50-53, 2017, doi: 10.26905/abdimas.v2i1.1291.
[15] A. Cost, M. Hydrogel, and S. Alternatives, "1) 2) 3)," vol. 1, no. 1, pp. 43-46, 2022.
[16] B. Tomadoni, M. F. Salcedo, A. Y. Mansilla, C. A. Casalongué, and V. A. Alvarez, "Macroporous alginate-based hydrogels to control soil substrate moisture: Effect on lettuce plants under drought stress," *Eur. Polym. J.,* vol. 137, 2020, doi: 10.1016/j.eurpolymj.2020.109953.
[17] S. Absorbent and L. Berat, *Faculty of science and technology* , *islamic state university alauddin macassar 2021*. 2021.