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Effect of Biopotting Quality on Growth and Morphological Quality of Jackfruit Artocarpus Heterophyllus Lamk. Seedlings

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ABSTRAK

Penggunaan polybag sebagai tempat media pembibitan menyebabkan peningkatan sampah plastic dan dapat merusak perakaran bila bibit ditanam. Biopotting wadah media pembibitan dapat mempengaruhi pertumbuhan dan kualitas morfologi bibit nangka. Biopotting dibuat dari tanah liat, kompos limbah buah rambutan, nangka, durian, dan kompos dibeli dipasar serta tepung tapioca. Hasil analisis kualitas kimia contoh biopoting mengandung C organik berkisar 42- 44%, N total berkisar 0.21-0.35%, P total berkisar 28.14-38.25mgkg^{-1}, K berkisar 0.90-1.13me/100g dan pH berkisar 4.08-6.68. Analisis kualitas fisik biopotting mengandung air berkisar 2.04-3.09%, kerapatan berkisar 0.42-0.50gcm^{-3}, daya serap air berkisar 200-242% dan tingkat kerusakan biopotting ≤ 2% tremasuk kategori tidak rusak. Pertumbuhan dan kualitas morfologi bibit nangka umur 60 hari mempunyai tinggi rerata berkisar 17.85-27.6cm, rerata diameter batang berkisar 0.43-0.47cm, jumlah daun berkisar 3-4 helai, panjang akar berkisar 12.5-16.8cm dan indek kualitas morfologi berkisar 0.092-0099. Penelitian ini menyimpulkan biopotting M4 mempunyai kualitas kimia dan fisik terbaik sehingga menghasilkan pertumbuhan dan morfologi bibit nangka Artocarpus heterophyllus Lamk tertinggi.

ABSTRACT

The use of polybags causes an increase in plastic waste and can damage roots when seedlings are planted. Biopotting as a seedling media affects the growth and morphological quality of jackfruit seedlings. Biopotting is made from clay, compost from fruits waste of rambutan, jackfruit, durian, and compost from market and tapioca flour. The results of the chemical analysis of biopotting samples contained organic C ranged 42-44%, total N ranged 0.21-0.35%, total P ranged 28.14-38.25mgkg-1, K ranged 0.90-1.13me/100g and pH ranged 4.08-6.68. Analysis of the physical quality containing water ranged 2.04-3.09%, density ranged 0.42-0.50gcm-3, water absorption ranged 200-242% and the level of damage to biopotting ≤ 2%, included in the undamaged category. The growth and morphological quality of jackfruit seedlings aged 60 days had a height ranged 17.85-27.6cm, an average stem diameter ranged 0.43-0.47cm, a leaf number ranged 3-4 strands, a root length ranged 12.5-16.8cm and a morphological quality index ranged 0.092-0099. This study concluded that M4 biopotting had the best chemical and physical qualities resulting in the highest growth and morphology of the jackfruit Artocarpus heterophyllus Lamk seedlings.

1. INTRODUCTION

The use of polybags as a pot of growing medium for plant seedlings was not environmentally friendly. The use of polybags as pot of growing medium was common. At the time of planting, the polybags will be discarded and become waste (Iriany, Chanan, Hasanah, & Hariyanti, 2022; N. Lestari, Rahmah, Novitasari, & Samsuar, 2022). This of course was an activity that was not environmentally friendly. In the last of 5 years about 2.8 billion forestry plant seeds of various types have been planted in the field to rehabilitate degraded forests and lands. The production of that many seeds requires around 7,119 tons of polybags which have been used for growing media for plant seedlings. Therefore an alternative to polybags was needed as a pot of growing medium for plant seedlings. Biopotting was an organic media pot that can be an alternative to polybags. Biopotting was made from a mixture of clay, compost and adhesive. Biopotting was easy to make and practical because it can be planted directly into the soil without having to open the pot (Choi et al., 2022; Purba, Wahyudi, & Rotinsulu, 2022). The use of biopotting does not cause damage to the root system when the seedlings were transferred to the field, and can even be a source of nutrients because it was made of compost (Iriany et al., 2022). Biopotting has good benefits as a medium for plant

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growth because it was made of materials that contain nutrient for plants and increase soil fertility (Dina, Elyani, Indriati, & Zamzami, 2021).

Biopotting was very beneficial for the future of the environment. However, in its development, good quality was needed so that this pot can become a source of nutrients and was sustainable (Jaya, M.I, Ilmannafian, & Sanjaya, 2019; Saragih, Oktoria, Oktaviani, Ekawati, & Saputri, 2022). Biopotting can be tested physically, namely water content, density, water absorption capacity and pH (Iriany et al., 2022; N. Lestari et al., 2022). Compactly molded biopotting makes it denser and stronger Tikupadang (2014),. Biopotting with a low density category can cause oil palm plant growth to be quite good, because roots can penetrate and absorb nutrients contained in biopotting.

The growth of plant seedlings was influenced by the pot of growing medium which ultimately determines its morphological quality. The use of biopotting made from compost can increase the growth of plant seedlings. This research used biopotting made from clay, tapioca flour (adhesive) and compost of *durian* fruit waste, jackfruit fruit waste, *rambutan* fruit waste, market compost and without compost. Compost was an organic fertilizer that contains nutrients that lead to good growth and morphological quality of plant seedlings. Seed quality was determined by measuring seedling growth, namely: 1) height and stem diameter of seedlings and 2) root dry weight, stem dry weight + leaf and total dry weight (Junaedi, 2012). This study aims to increase the growth and morphological quality of jackfruit *Artocarpus heterophyllus* Lamk seedlings with the availability of nutrients in biopotting through the addition of compost made from fruits waste.

2. METHOD

This research was conducted in the experimental garden of biology and the laboratory of chemistry and soil fertility, Hasanuddin University, Makassar for 10 months in 2021. This study used a completely randomized design with 5 biopotting treatments tested on jackfruit seedlings. The materials used were clay, *rambutan* fruit waste, *durian* fruit waste, jackfruit fruit waste, market compost, tapioca flour, effective microbial (EM4), water, jackfruit seeds, sand, biopot mold, plastic bucket, ruler, caliper and scales..

Composting of Fruits Waste

The compost material used were *rambutan* fruit waste, *durian* fruit waste and jackfruit fruit waste. Each type of fruit waste was cut 1-2cm^2 and then dried in the sun to dry with a moisture content of 10%. Dried fruit waste was composted with an effective microbial (EM4) 5% in a plastic bucket for 1 month. Then the compost was ground and filtered with a size of 80 mesh. This research also uses compost that was sold in the agricultural market.

Biopotting Treatment

Biopotting was made from clay, compost and tapioca flour as adhesive. The percentage of materials used were 95% clay+5% tapioca flour (M0), 60% clay + 35% market compost + 5% tapioca flour (M1), 60% clay + 35% *rambutan* fruit waste compost + 5% tapioca flour (M2), 60% clay + 35% jackfruit fruit waste compost + 5% tapioca flour (M3), 60% clay + 35% *durian* fruit waste compost + 5% tapioca flour (M4). Making of biopotting was done by mixing clay, compost and tapioca flour until homogeneous. The material that has been mixed evenly was put into the biopotting press and pressed until the biopotting was printed. Furthermore, the biopotting was dried in the sun for 2 days.

Analysis of Biopotting Quality

The quality of biopotting analyzed were chemical and physical quality. The chemical qualities analyzed included content of organic carbon (C), total nitrogen (N), total phosphorus (P), potassium (K) and acidity (pH). The content of organic C was analyzed by the Walkey and Black method, the total N content was analyzed by the Kjeldhal method. Content of total P and K were analyzed using a Morgan-Wolf extractor. Measurement of pH was carried out using a pH meter. While the physical qualities analyzed include water content, density, water absorption capacity, and the level of damage. The water content was analyzed by weighing the initial weight (IW) of the biopotting sample and then in an oven at 105^{o}C for 3 hours, then cooled in a desiccator for 15 minutes. After the cold was weighed to determine the final weight (FW). The water content (WC) was calculated using the following formula (Sijabat, Rohanah, Rindang, & Hartono, 2017): $WC = \frac{IW-FW}{FW}$. Density analysis was carried out by taking samples measuring 5cm x 5cm x 1cm, weighing (W), and measuring the volume (V) of the biopotting sample. Density was calculated using the following formula (Sijabat et.al, 2017): $D=\frac{W}{V}$. Analysis of water absorption capacity (WAC) was carried out by taking a sample measuring 5cm x 5cm x 1cm, then weighing the initial weight (IW). Then immersed in cold water until it sinks, after that the sample was removed, wait until the water does not drip and then weighed as a weight after immersion (FW). The water absorption value was calculated by the following formula (Akhir, Allaily, Syamsuwida, & Budi., 2018): WAC $= \frac{FW-IW}{IW}$. The level of damage to biopotting and calculated using the following formula (Nursyamsi & Tikupadang., 2014): I = $\frac{\sum(nixVj)}{\sum Z \times N}$ x 100%. Description : I = Damage level : ni = Number of damaged biopotting in each category of damage; V = Scale value on each damage; Z = The highest scale value used; N = Total number of observed biopotting.

Analysis of Growth and Morphological Quality Index

Jackfruit seeds aged 14 days were planted on growing media in biopotting. The growing media used was sterile sand which was assumed to be very low in nutrient content. Jackfruit seedlings were maintained by providing field capacity water every morning for 60 days (Ardan, Nuraeni, & Adelina, 2020; Khan et al., 2021). Furthermore, the jackfruit seeds were measured for height, stem diameter, number of leaves and root length. Height measurement was carried out using a ruler from the root neck to the top of the plant. Stem diameter above ground level, measured using a caliper. The number of leaves was counted manually for each leaf that had fully opened. While the root length was measured using a ruler starting from the root neck to the tip of the root. For analysis of morphological quality, biopotting was carried out and the growth medium was removed. The analysis of the morphological quality of jackfruit seeds began by weighing the wet and dry weights of stems, leaves and roots. Morphological quality was determined using the following formula (Santosa, 2016); MQI= $\frac{RDW+SLDW}{RDW/SLDW+H/D}$, Description : MQI = Morphological quality index, RDW = Root dry weight, SLDW = Stem+leaves dry weight, H = height, D = stem diameter.

Data Analysis

The observed parameters included the content of organic C, total N, total P, K, pH, water content, density, water absorption capacity, level of biopotting damaged, height, the diameter of stems, leaves number, and root length.. The obtained data were analyzed with analysis of variance and continued with the Duncan Multiple Range Test at the 95% level.

3. RESULT AND DISCUSSION

Result

The biopotting made was categorized as undamaged because only ≤ 2% of the biopotting was cracked and broken. The results of the chemical analysis of the biopotting samples showed that the content of organic C ranged from 42- 44%, total N ranged from 0.21-0.35%, total P ranged from 28.14-38.25mgkg^{-1}, Potassium (K) ranged from 0.90-1.13me/100g and the acidity (pH) ranged from 4.08-6.68 (Table 1). While the results of the physical analysis obtained water content ranged from 2.04-3.09%, density ranged from 0.42-0.50gcm-^{3}, water absorption ranged from 200-242% and the level of damage to all biopotting ≤ 2% included in the undamaged category (Table 2).

Table 1. Analysis of Chemical Quality of Biopotting Samples

Biopotting Samples	Organik C	Total N	Total P	K	pH
	%		mgkg^{-1}		me/100g
M0	42	0.21	28.14	0.90	6.36
M1	44	0.21	28.99	1.11	6.34
M2	43	035	38.25	1.10	4.08
M3	44	0.26	35.64	1.13	6.68
M4	43	0.29	35.08	1.11	5.57

Table 2. Analysis of Physical Quality of Biopotting Samples

Biopotting Samples	Density	Water Content	Water Absorption Capacity	Level of Damage
	gcm^{-3}		%	
M0	0.50	2.04	200	≤ 2
M1	0.46	2.88	235	≤ 2
M2	0.46	3.09	235	≤ 2
M3	0.42	2.88	240	≤ 2
M4	0.42	2.04	242	≤ 2

The results of measuring the growth of jackfruit seedlings in biopotting aged 60 days showed an average height ranged from 17.85-27.6cm, an average stem diameter ranged from 0.43-0.47cm, a number of leaves ranged from 3-4 strands and a root length ranged from 12.5-16.8cm (Table 3). Then the results of statistical analysis showed that the height growth of jackfruit seedlings on M2, M3 and M4 biopotting was not significantly different, but significantly different from the height growth on M0 and M1 biopotting. The growth of stem diameter showed no significant difference in all biopotting. The growth of leaves on M3 and M4 biopotting was not significantly different, but significantly different from leaves growth on M0, M1 and M2 biopotting. Meanwhile, the growth of root on M0 biopotting was significantly different with M1, M2, M3 and M4 biopotting. The growth of root on M1 and M2 was not significantly different but significantly different from M3 and M4 biopotting (Table 3). The growth rate of jackfruit seedlings in M4 biopotting showed the best compared to M0, M1, M2 and M3 biopotting (Figure 1). The results of morphological quality index ranged from 0.092-0.098 (Figure 2).

Table 3. Growth of Jackfruit Seedlings in Biopotting Aged 60 Days

Biopotting Samples	Height	Stem Diameter	Root Length	Leaves Number
	cm			Strands
M0	17.8a	0.43a	12.5a	3a
M1	23.5b	0.44a	14.9b	3a
M2	27.6c	0.46a	15.3b	3a
M3	26.9c	0.47a	16.2c	4b
M4	27.4c	0.47a	16.8c	4b

Description : Numbers followed by the same letter were not significantly different at the 95% level

Figure 1 Jackfruit Seedlings in Biopotting Aged 60 Days

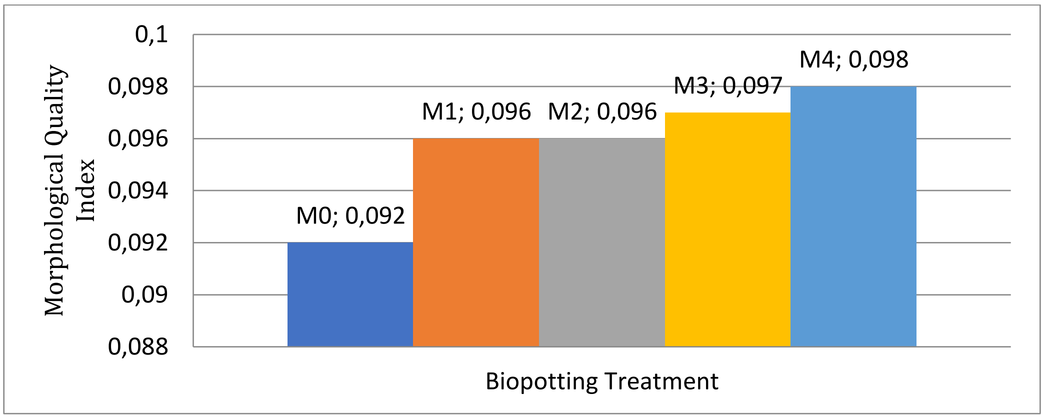

Figure 2. Morphological Quality Index of Jackfruit Seedlings in Biopotting Aged 60 Days

Discussion

The quality analysis, it shows that biopotting made from fruit waste compost of *rambutan*, jackfruit, *durian*, and market compost or without compost was good and can be developed sustainably. The biopotting contains nutrients and the number of cracks and breaks was only ≤ 2%. The manufacture of biopotting with the level of damage ≤ 5% was grouped in the undamaged category (Nursyamsi & Tikupadang., 2014). Compactly molded biopotting makes it denser and stronger. Jaya et.al. (2019), the development of biopotting requires good quality so that this pot was in demand and sustainable. Nutrient content, water content, density and water absorption in biopotting can be external factors for the growth of plant seedlings.

The nutrient content in biopotting showed that total N ranged from 0.21-0.35%, total P ranged from 28.14-38.25 $mgkg^{-1}$ and the potassium (K) ranged from 0.90-1.13me/100g (Table 1). That the level of fertility can be seen from the availability of nutrients, the higher the nutrient content, the more fertile the soil (Pinatih, Kusmiyarti, & Susila, 2015; Yunanto, Amanah, Wulansari, & Wisnu, 2022). The availability of N nutrients, which ranged from 0.2-0.75%, included a moderate fertility of N when N nutrients were between 0.10-0.20% including low fertility levels. The availability of P nutrients whose value was ≥ 35 $mgkg^{-1}$, includes a high fertility of P. The availability of K nutrients whose value was ≥ 1.0 me/100g, includes a high fertility of K. Based on the analysis, it was shown that M0, M1, M2, M3 and M4 biopotting had moderate fertility of N. The high fertility of P showed in M2, M3 and M4 biopotting and moderate fertility of P in M0 and M1 biopotting. While the high fertility of K showed in M1, M2, M3 and M4 biopotting and moderate fertility of K in M0 biopotting (Table 1). The availability of nutrients N, P, K can support the growth of plant seeds. With the availability of N nutrients, it can stimulate the formation of green leaf substance or commonly called chlorophyll which is very important for the photosynthesis process (Lukman & Kusrianty., 2021). Nitrogen is able to stimulate growth above the soil and one of them is the growth of stem diameter (Hasibuan, Ferry, & Wulandari, 2021; Lubis, 2021). Sahana et.al., (2018), nutrient of P serves to help stimulate of root growth. Meanwhile, the acidity value (pH) of biopotting ranged from 4.08 to 6.68 including the acid category. .Theoretically the best pH for plant growth was between 6.0-7.0, because in this pH range most nutrients are easily soluble in water so they are easily absorbed by plant roots. The acidity value (pH) of biopotting was expected to be close to the soil pH, which will later help the growth of seedlings.

The water content analysis showed that M0 and M4 biopotting had the lowest water content of 2.04% (Table 2). The lower the water content from biopotting the better (Jaya et al., 2019). Because the high water content will allow the growth of microorganisms and animals to develop so that there will be changes in the form of damage or decay of materials during biopotting storage. Meanwhile, the analysis of the density ranged from 0.42-0.50gcm^{-}(Table 2). Density was a cohesiveness of the ingredients that make up the biopotting it self, while its value was highly dependent on the density of the fibers of the material used and the amount of pressure applied during the bottling molding. Analyzed the density of biopotting made from empty fruit bunches of oil palm plant ranged from 0.27-0.30 gcm (Jaya et al., 2019). In general the density value of biopot fiber board was classified as low density. The standard density of fiberboard was between 0.40 - 0.90 gcm^{-}(Sutrisno & A. Wahyudi, 2015).

This study indicate that M4 biopotting made from *durian* fruit waste compost has the highest water absorption capacity of 242%. The presence of high cellulose will form a strong tendency to form hydrogen and intermolecular bonds (Sutrisno & A. Wahyudi, 2014). This will increase its ability to absorb water molecules. Cellulose in wood binds to many different substances, including hemicellulose and lignin. Meanwhile, M0 biopotting has the lowest 200% water absorption because the material was 95% clay with low pores. The low water absorption capacity was caused by the tightness of the surface of the biopotting due to the use of materials plus adhesive (Akhir et al., 2018). This affects the water entering the biopotting becomes blocked, it is possible that the high concentration of the material and adhesive makes the biopotting harden, especially after drying.

The chemical quality of the biopotting affects the growth and morphological quality of jackfruit seedlings. This was evidenced by the availability of total N with moderate fertility in M0, M1, M2, M3 and M4 biopotting which gave higher growth of jackfruit seedlings. The height growth of jackfruit seedlings aged 60 days ranged from 17.65-27.6cm (Table 3). The results of the research, the height growth of jackfruit seedlings aged 120 days ranged from 17.43 -48.71cm, stem diameter ranged from 0.34 - 0.55cm and the number of leaves ranged from 4 – 6 strands. Element N was a macro nutrient that was needed by plants for protein synthesis and protein was used in the process of cell division, forming tissues and then becoming plant vegetative organs . Nitrogen was a nutrient that plays a major role in plant vegetative growth. Tthat nitrogen plays a role in increasing the growth of plant seed height (Arkan Setiaji, 2020). Similarly, the elements P and K were also macronutrients that are needed for plant growth. This study showed that M3 and M4 biopotting containing high P and K caused the highest growth of leaves and longest roots. Element P was needed for root growth (D.A & Koesriharti, 2018). The combination of P and K had a significant effect on growth in height, stem diameter and number of leaves (Oyewole & Ameh, 2015; Qu et al., 2020). Nnutrients of K and P were interdependent. Elements of K can increase available P, on the other hand, P nutrients can also increase K (Kaya, 2012; M. W. Lestari, Arfarita, & Indriani, 2021).

While the physical quality, namely the density and water absorption capacity of biopotting , affects the growth of roots and leaves. Low density makes it easier for roots to penetrate and absorb water in biopotting. This study showed that M3 and M4 biopotting with the lowest density and highest water absorption had a significant effect on root and leaves growth (Table 3). This low biopotting density causes growth of oil palm plant to be quite good, because roots can penetrate and absorb nutrients in biopotting (Nursyamsi & Tikupadang., 2014). The ability to absorb water in biopotting causes the availability of water so that the roots easily absorb nutrients. Water serves as a transport medium and nutrient solvent. , available water in sufficient quantities can control the occurrence of turgor pressure. Turgor pressure causes cell enlargement and division to become normal so that plant growth was also normal. Deficiency of water causes a decrease in plant growth rate, including stem diameter. The decrease in stem diameter growth was often caused by deficiency of water (Marjenah, 2010; Nurfaeiza, Juliana, Shamsul, & Shukor, 2022).

The height, stems diameter, leaves and roots growth were well correlated with the assessment of the morphological quality index of jackfruit seedlings. Morphological quality of plant seeds was an indicator of feasibility if the seeds were planted in the field or forest. Based on the results of the morphological quality assessment, the value was 0.09 in all biopotting. Then the visual appearance of the jackfruit seedlings showed their sturdiness which was suitable for planting in the field (Figure 2). The quality of plant seeds was determined from the results of an assessment of 3 criteria, namely genetic quality, physical quality and physiological quality. The genetic quality was seen from the seed source, while the physical qualities such as sturdiness, stem diameter and number of leaves and plant health. Physiological quality reflects physiological processes that have implications for the growth and development of plant seeds. Seed quality was influenced by 2 factors, namely internal factors such as genes, physical and physiological seeds and external factors such as temperature, sunlight, air humidity, and growing media. That the morphological quality of seedlings can be determined from the measurement of seedling biomass which produces root shoot ratio (Akhir et al., 2018; Syamsuwida, Aminah, Nurochman, Sumarni, & Ginting, 2014). A low root shoot ratio will indicate the seedlings are able to survive and have high adaptation when planted in the field. Meanwhile, the Indonesian national standards (SNI) for seedlings were: 1) general requirements, seeds come from quality seeds; 2) special conditions, the seeds look tall and have green leaves. The value of the morphological quality index of seedlings ≥ 0.09 indicates the seedlings were easy to live and have high adaptability when planted in the field. Seedlings that have a growth height of 15 cm are suitable for planting.

4. CONCLUSION

The quality of biopotting is influenced by the organic matter used as a mixture. The biopotting of M4 is the best quality of chemistry and physics so as to produce the highest growth and morphological quality index of jackfruit *Artocarpus heterophyllus* Lamk seedlings.

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