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DILUTION OF FERMENTATION LIQUID FROM BANANA WEEVIL MUSA PARADISIACA TO INCREASE THE GROWTH OF SEAWEED *Kappaphycus alvarezii*

Pengenceran Cairan Fermentasi Bonggol Pisang (*Musa paradisiaca*) Untuk Meningkatkan Pertumbuhan Rumput Laut *Kappaphycus alvarezii*

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ABSTRACT

Fermented liquid from banana weevils is a fermentation product involving banana weevils and microorganisms originating from the banana weevil itself. This fermented liquid contains nutrients and other compounds that have the potential to stimulate growth and control disease in seaweed. The aim of this research is to determine the effectiveness of administering banana weevil fermented liquid on the growth of Kappaphycus alvarezii seaweed. This research was carried out in the waters of Jayabakti Village, Pagimana District, Banggai Regency. This study used a completely randomized design with four treatments and three replications, namely A (control), B (1 L fermentation liquid/50 L seawater), C (1 L fermentation liquid/100 L seawater), and D (1 L fermentation liquid/150 L seawater). The test seaweed is immersed for one hour according to the dilution of each treatment. The parameters observed include absolute growth, daily specific growth, and water quality. The results showed that the dose of banana weevil fermentation liquid significantly affected the growth of seaweed. The highest average growth value was achieved in treatment B (1 L fermentation liquid/50 L seawater) with a daily growth rate of 3.07 ± 0.04% and absolute growth of 90.48 ± 1.51 g. This research shows that immersion in fermentation liquid in fermentation liquid for one hour can increase seaweed growth, with the best results at a dilution of 1 L of fermentation liquid/50 L of seawater.

Key words: Banana weevil, Fermentation liquid, Seaweed growth, Seaweed

ABSTRAK

Cairan fermentasi bonggol pisang adalah produk fermentasi yang melibatkan bonggol pisang dan mikroorganisme yang berasal dari bonggol pisang itu sendiri. Cairan fermentasi ini mengandung unsur hara dan senyawa lain yang memiliki potensi untuk merangsang pertumbuhan serta mengendalikan penyakit pada rumput laut. Tujuan penelitian ini adalah menentukan efektivitas pemberian cairan fermentasi bonggol pisang terhadap pertumbuhan rumput laut Kappaphycus alvarezii. Penelitian ini dilakukan di Perairan Desa Jayabakti, Kecamatan Pagimana, Kabupaten Banggai. Desain penelitian yang digunakan adalah rancangan acak lengkap dengan empat perlakuan dan tiga ulangan, yaitu A (kontrol), B (1 L cairan fermentasi/50 L air laut), C (1 L cairan fermentasi/100 L air laut), dan D (1 L cairan fermentasi/150 L air laut). Rumput laut uji direndam selama satu jam sesuai dengan pengenceran masing-masing perlakuan. Parameter yang diamati meliputi pertumbuhan mutlak, pertumbuhan spesifik harian, dan kualitas air. Hasil penelitian menunjukkan bahwa dosis cairan fermentasi bonggol pisang mempengaruhi pertumbuhan rumput laut secara signifikan. Nilai pertumbuhan rata-rata tertinggi dicapai pada perlakuan B (1 L cairan fermentasi/50 L air laut) dengan laju pertumbuhan harian sebesar 3,07±0,04% dan pertumbuhan mutlak sebesar 90,48±1,51 g. Penelitian ini menunjukkan bahwa perendaman dalam cairan fermentasi selama satu jam dapat meningkatkan pertumbuhan rumput laut, dengan hasil terbaik pada pengenceran 1 L cairan fermentasi/50 L air laut.

Kata Kunci: Bonggol pisang, Cairan fermentasi, Pertumbuhan rumput laut, Rumput laut

INTRODUCTION

Kappaphycus alvarezii seaweed is a type of red algae that is widely used in various fields, including the cosmetics industry, food industry and pharmaceuticals. *K. alvarezii* is generally cultivated to produce carrageenan, a compound used as a thickener and stabilizer in various products. However, the main challenge for seaweed cultivation to date is optimal growth which is influenced by environmental conditions and nutrients available in the waters (Rahman *et al.,* 2020).

One way to make seaweed grow better is by improving the quality of the nutrients available in the rearing media. One potential ingredient to use is the *Musa paradisiaca banana tuber* . Banana stems, which are often considered waste, actually contain various important nutrients that can be used as a source of natural fertilizer. Through the fermentation process, the nutrients in banana weevils can be broken down and converted into more easily absorbed plants, including seaweed, namely by soaking the seaweed in banana weevil fermentation liquid, which contains potential bacteria and nutrients (Budiyani *et al.,* 2016).

Previously, much research had been carried out on the use of nutrients and microbes to increase growth and control *ice-ice disease* in seaweed, one of which was *Avicennia marina leaves* (Rahman *et al.,* 2019, 2022, 2023; Rahman & Mutalib, 2020), test the results of extracts from *A. marina leaves* to control bacteria that cause *ice-ice disease* (Rahman, Mutalib, *et al.,* 2020), local microorganisms originating from maja fruit (Rahman & Mutalib, 2015), as well as nutrients originating from inorganic fertilizer (NPK) (Syamsuddin & Rahman, 2014).

Research on fermented banana weevils as liquid fertilizer has shown promising results in increasing the growth of various land plants. However, not much research has been done on the use of banana weevil fermentation to develop *K. alvarezii*. Thus, this study aims to evaluate the effect of diluting banana weevil fermentation liquid on the growth of *K. alvarezii*.

It is hoped that in this research an effective method can be found to increase the growth *of K. alvarezii* and provide greater economic benefits for seaweed cultivators. Apart from that, this research also has the potential to develop the use of agricultural waste such as banana stems into value-added products, supporting more sustainable agricultural practices.

RESEARCH METHODS

Time and place

This research was conducted from April to June 2023 in Jayabakti Village, Pagimana District, Banggai Regency.

Making Fermentation Liquid

Clean and mash the banana tubers using a blender, then add sterile sea water and brown sugar, the ratio of each ingredient is 1:2:1/4. Then the ingredients that have been mixed evenly are put into the fermentator and closed, and wrapped in black plastic. During the fermentation process, storage is carried out in a dark place and left for two weeks. The successful fermentation process is indicated by a tape aroma in the fermentation liquid. Next, the fermentation liquid is filtered using a sieve, namely *cheese cloth* , and the results are put in a closed bottle (Rahman *et al.,* 2019, 2022, 2024; Rahman & Mutalib, 2020; Rahman & Sukenda, 2020).

Preparation of Test Organisms

Kappaphycus alvarezii type seaweed , weighing 100 grams per bundle, using the *long line method* . Seaweed that has been acclimatized for three days is soaked for one hour in banana weevil fermentation liquid based on each treatment.

Experimental Design

The design used in the research was a completely randomized design, consisting of four treatments: A (control), B (1 liter of fermentation liquid/50 liters of seawater), C (1 liter of fermentation liquid/100 liters of seawater), and D (1 liter of fermentation liquid/150 liters of sea water). Each treatment was carried out three times.

Observed Parameters

This research uses absolute growth parameters and daily specific growth, as well as water quality.

Daily Specific Growth Rate

Daily growth rate can be calculated using the formula of Dawes *et al.,* (1993) as follows:

$$\mathbf{DGR} = \frac{Ln\, Wf - Ln\, Wo}{t} x100\%$$

Where:
DGR = Daily specific growth rate (%)
W_f = Average weight of seaweed on end of research (g)
W_0 = Average weight of seaweed at the start of the study (g)
t = Maintenance Time (days)

Absolute Weight Growth

Absolute weight growth can be calculated using a formula (Effendie, 1997) as follows:

$$G = Wt - Wn$$

Where :
G = Absolute growth (g)
W_t = Average weight of seaweed at the end of the study (g)
W_n = Average weight of seaweed at the start of the study (g)

Water quality

The observed water quality includes temperature, salinity, pH, DO, brightness, current speed and depth, measured every day, with measurement periods twice a day, namely morning and evening.

Data analysis

Data on daily growth and absolute growth of seaweed were analyzed using analysis of variance using the SPSS version 20 program, and if there were significant differences in each treatment, then continued using the *Tukey test* and descriptive analysis was carried out for water quality data.

RESULTS

Growth

The average values of daily growth and absolute growth are presented in Table 1.

Table 1. Average values of daily growth and absolute growth during the study

Treatment	Observation parameters	
	Daily Growth (%)	Absolute Growth (g)
A (Control)	1.79 ± 0 . 10 [a]	45.79 ± 3 . 09 [a]
B (1 L fermentation liquid/50 L sea water)	3.07 ± 0 . 04 [b]	90.48 ± 1 . 51 [b]
C (1 L fermentation liquid/100 L sea water)	2.56 ± 0 . 07 [c]	71 . 11 ± 2 . 66 [c]
D (1 L fermentation liquid/150 L sea water)	2.22 ± 0 . 06 [d]	59.32 ± 2 . 13 [d]

* Different real values are shown with different numbers of letters in the same superscript in the same column (P<0.05)

Based on the table above, the results of analysis of daily specific growth and absolute growth of seaweed show that treatments A (control), B, C, and D are significantly different (P<0.05). Treatment B had the highest average daily growth value (3.07 ± 0.04%), followed by treatment C (2.56 ± 0.07%), D (2.22 ± 0.06%) and A (Control) (1.79 ± 0.10%). The same thing was also shown by the results of the average absolute growth with the highest value shown by treatment B (90.48 ± 1.51 g), followed by enrichment C (71.11 ± 2.66 g), D (59.32 ± 2.13 g) and A (Control) (45.79 ±3.09 g).

Water quality

Water quality values at seaweed rearing locations during the research are shown in Table 2 below.

Table 2. Water quality data during maintenance

No	Parameter	Mark
1	Temperature (°C)	25-31
2	Salinity (g/L)	30-32
3	pH	6.9-8
4	Dissolved oxygen (DO) (mg/L)	5.3-6.9
5	Brightness (cm)	90-135
6	Current speed (m/sec	0.35-0.48

Based on Table 2, maintenance media water quality parameters seaweed , that is temperature ranges between 25-31°C, while the temperature value during the day ranges from 28-31°C, and the temperature in the afternoon ranges from 25-28°C , the salinity of the waters obtained During the research, the pH value measured was around 30-32 g/L during the study, namely 6.9-8, and oxygen dissolved 6.9-8.4 mg/L. Water brightness measurements during the study ranged from 90-135 cm, and speed measured current ranges from 0.35-0.48 m/ sec . The water quality of the rearing media is still in a suitable condition for the growth of *K. alvarezii* seaweed .

DISCUSSION

The results of this study indicate that administering *Musa paradisiaca banana weevil fermented liquid at a high dose or low dilution is more effective than a low dose in increasing the growth of Kappaphycus alvarezii* seaweed . This condition shows that the nutritional needs of seaweed are well met at high doses, which provide higher concentrations of nutrients and bioactive compounds. This is thought to be caused by a more complete and balanced nutritional content, as well as the presence of bioactive compounds that can stimulate optimal growth and metabolism of seaweed. The use of banana weevil fermentation liquid at the right dosage can be an effective alternative in an effort to increase the productivity of seaweed cultivation.

Banana weevil fermented liquid contains various essential nutrients such as nitrogen, phosphorus and potassium which are very important for the growth of seaweed. In addition, fermentation also produces enzymes and hormones that stimulate growth, as well as potential bacteria that can increase growth and control disease. These nutrients play an important role in photosynthesis, metabolism and seaweed cell development. According to research by Rahman *et al.,* (2023), the increase in seaweed weight after immersion in fermentation liquid is caused by primary metabolite compounds, both macro and micro nutrients contained in the liquid. Research by Rahman & Mutalib (2015) also shows that fermentation liquid or local microorganisms from maja fruit can increase the growth of seaweed.

Fermentation produces bioactive compounds such as bacteriocins, lactic acid, and phytochemicals which function as antibacterial agents. These compounds are able to control pathogenic bacterial infections which can inhibit the growth of seaweed. Pathogenic bacterial infections are known to be one of the factors that can degrade the chemical components of seaweed (Vairappan, 2006), so controlling pathogenic bacteria is very important in seaweed cultivation. According to Darma *et al.,* (2021), that pathogenic bacterial infections can slow down the growth of seaweed. However, fermented liquid from *A. marina mangrove leaves* , which contains secondary metabolites such as bacteriocins and lactic acid, has been proven to be able to control bacteria that cause *ice-ice disease* (Rahman *et al.,* 2019). This assumption also applies to banana weevil fermented liquid, which can provide a similar effect in controlling pathogens and increasing seaweed growth. Apart from its antibacterial ability, the bioactive compounds in the fermentation liquid also play a role in increasing seaweed's resistance to less than optimal environmental conditions. Thus, the use of banana weevil fermentation liquid not only improves the growth but also the overall health of the seaweed.

The effectiveness of the performance of the banana weevil fermentation liquid can be seen in the daily growth of seaweed treated with the fermentation liquid. Daily growth rates were in the range of 1-3% per day, with treatment B (1 L fermentation liquid/50 L seawater) showing the best results. This treatment produced an average daily growth value of 3.07 ± 0.04% and absolute growth of 90.48 ± 1.51 g. This result was much better compared to the control, both at daily growth of 1.79 ± 0.10% and absolute growth of 45.79 ± 3.09 g.

Sulistijo (1985) stated that with daily growth of 2%, seaweed harvesting can be done in 35 days. If the growth reaches 3%, harvest can be done in 25 days, while at 4% growth, harvest can be done at 20 days. Therefore, treatment B, which showed daily growth of 3.07%, indicated that seagrass harvest was carried out more quickly, namely around 25 days.

Water temperature parameters recorded during maintenance ranged from 25-31°C. According to Anggadiredja *et al.,* (2010), that the ideal water temperature for seaweed growth is between 26-30°C. Thus, the recorded temperatures were mostly within the optimal range for seaweed growth. However, there were times when the temperature reached 31°C, which is slightly above the ideal range, but can still be considered favorable for overall seaweed growth.

The salinity values measured during maintenance ranged from 30-32 g/L. Based on Zatnika & Angkasa (1994), the ideal salinity for the growth of *K. alvarezii* seaweed ranges from 28-34 g/L. The salinity recorded in this study was within the optimal range, ensuring that seaweed can grow well and utilize available nutrients efficiently.

The pH conditions of the waters during the study ranged from 6.9-8.0. According to Sudradjat (2009), the pH that supports seaweed growth ranges from 7.3-8.2. Although the pH recorded was slightly below the ideal range at its lowest value (6.9), most pH values still supported seaweed growth. A stable pH within this range is important for maintaining balanced water chemistry and seaweed health.

Dissolved oxygen levels measured ranged from 5.3-6.9 mg/L. According to Nur *et al.,* (2016), that the optimal dissolved oxygen level for seaweed growth is above 4 mg/L. Sufficient oxygen levels are essential to support seaweed respiration and metabolism. The recorded dissolved oxygen values are within a supportive range, indicating that oxygen conditions in the water are adequate for seaweed growth.

Water brightness measured during maintenance ranged from 90-135 cm. Good brightness is important to ensure sufficient light penetration into the water, which is required for seaweed photosynthesis. The recorded brightness values indicate that light can penetrate quite deeply, providing good conditions for photosynthesis and seaweed growth.

Water brightness measured during maintenance ranged from 90-135 cm. According to Numberi *et al.,* (2021), that the ideal brightness for seaweed growth is above 5 m. Good brightness is important to ensure sufficient light penetration into the water, which is required for seaweed photosynthesis. The recorded brightness values indicate that light can penetrate quite deeply, providing good conditions for photosynthesis and seaweed growth.

The current speed recorded during the study ranged from 0.35-0.48 m/sec. According to Sujatmiko (2009), the ideal water current for the growth of *K. alvarezii* is 20–40 cm/sec (0.2-0.4 m/sec). The recorded current speed is slightly higher than the ideal range, but still supports seaweed growth well. Sufficient current helps in the circulation and transport of nutrients, increases oxygen solubility, and reduces organisms attached to seaweed thallus.

Overall, water quality data during rearing indicated favorable conditions for the growth of the seaweed *Kappaphycus alvarezii* . Most parameters are within the optimal range or close to ideal values. Water quality data shows that water conditions during the research were good enough to support optimal seaweed growth.

CONCLUSION

Musa paradisiaca banana weevil fermentation liquid significantly increased the growth of *Kappaphycus alvarezii* with the best seaweed growth being a dilution of 1 L of fermentation liquid/50 L of seawater.

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