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Heavy Metal Controls in Cultivated and Natural Sea Grape (*Caulerpa Lentilifera*)

Kandungan Logam Berat Pada Anggur Laut (*Caulerpa Lentilifera*) Budidaya dan Alam

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ABSTRACT

Seaweed commodities are one of the products in the fisheries and marine sector that has the potential to be developed. One type is sea grape or commonly known as Caulerna lentillifera which is very widely spread in waters throughout Indonesia. This research method is descriptive quantitative, this research was conducted to determine the heavy metal content in natural sea grapes and cultivated sea grapes. The research procedure consisted of pre-research process to observation and checking of heavy metal content. The results of research on heavy metal content of cultivated sea grapes get good results, while for nature there are levels of heavy metals Pb so it can be said that it is not very good. The results of measuring the length of ramuli in the first week was 3.3 cm, the second week was 4.4 cm then increased in length in the third week to 5.8 cm, and ended in the fourth week with an increase in length of 6.9 cm. The results of the calculation of the number of ramuli in week 1 showed that the average number of ramuli was 12, the average number of ramuli in the first week increased to 14 in the second week and increased in the third week to 17 then ended in the fourth week with an average of 19 ramuli. The quality of water used in the cultivation of sea grapes in Musi Village and natural sea grapes is still in normal status.

ABSTRAK

Komoditas rumput laut adalah salah satu produk pada sektor perikanan dan kelautan yang sangat potensial untuk dikembangkan. Salah satu jenisnya adalah anggur laut atau yang biasa dikenal dengan Caulerna lentillifera yang sangat banyak tersebar di perairan seluruh Indonesia. Air sebagai media hidup anggur laut tidak lepas dengan adanya bahan-nahan tercemar dan salah satu yang membahayakan biota budidaya adalah logam berat (pb). Keberadaan logam berat tentunya dapat mengganggu kehidupan anggur laut yang dibudidayakan, sehingga perlu mengetahui kadar logam berat yang terkandung dalam anggur laut supaya tidak mempengaruhi kehidupan anggur laut di alam dan yang dibudidayakan serta tidak membahayakan manusia yang menjadi konsumen. Metode penelitian ini adalah deskriptif kuantitatif, penelitian ini dilakukan bertujuan untuk mengetahui kandungan logam berat pada anggur laut alam dan anggur laut budidaya. Prosedur penelitian yang dilakukan terdiri dari proses pra penelitian hingga pengamatan dan pengecekan kandungan logam berat. Hasil penelitian kadar logam berat anggur laut budidaya mendapatkan hasil yang baik, sedangkan untuk alam terdapat kadar logam berat Pb sehingga bisa dikatakan tidak terlalu baik. Hasil pengukuran panjang ramuli minggu pertama adalah 3,3 cm, minggu kedua 4,4 cm kemudian bertambah panjang diminggu ketiga menjadi 5,8 cm, dan berakhir diminggu keempat dengan bertambah panjang 6,9 cm. Hasil perhitungan jumlah ramuli minggu 1 menujukkan hasil penghitungan rata - rata ramuli adalah 12 ramuli, penghitungan ramuli di minggu pertama mengalami pertambahan rata – rata ramuli menjadi 14 pada minggu kedua dan bertambah ramuli di minggu ketiga menjadi 17 kemudian berakhir diminggu keempat dengan rata-rata 19 ramuli. Kualitas air yang digunakan dalam budidaya Anggur laut di Desa Musi dan anggur laut alam masih dalam status normal.

Kata Kunci	*Caulerpa lentillifera , kandungan logam berat, panjang ramuli, jumlah ramuli*
Keywords	*Caulerpa lentillifera, Heavy Metal Content, Ramuli Length, Number of Ramuli*
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INTRODUCTION

The seaweed commodity is one of the products in the fisheries and marine sector that has great potential for development. One type is sea grapes or commonly known as Caulerna lentillifera which is widely distributed in waters throughout Indonesia. Caulerpa is used not only for consumption as food but has also been used as a mixture for anti-fungal drugs (Suhartini, 2003). In Indonesia, Caulerpa is known as Latoh (Java), Bulung Boni (Bali), Lawi-Lawi (Sulawesi), while in Japan it is called Umi Budo. Data sourced from the Bali Province Maritime and Fisheries Service (2009) explains that the potential for seaweed cultivation in Bali covers five districts, namely Buleleng, Jembrana, Badung, Klungkung and Karangasem. C. lentillifera has a shape and taste that resembles caviar fish eggs, so it is known as "green caviar". According to Patang and Yunarti (2013), seaweed as a source of foreign exchange is a source of income for coastal communities, apart from being used as food, drink and medicine Saputra (2012).

The current prospects for cultivation are quite promising. With the current uptake in the local market, the impact of the Caulerpa lentillifera seaweed species has provided benefits for cultivators and it is hoped that Caulerpa lentillifera in the future can become a leading commodity overseas. However, sea grape cultivation activities are still limited and still rely on catches from nature because the Caulerpa lentillifera cultivation method faces many obstacles when cultivated, such as bad weather, pests and disease. If it is cultivated in a controlled container, the main obstacle is the lack of water flow needed for the growth of C. lentillifera and water quality control which must be carried out regularly (Putri, 2017).

Water as a living medium cannot be separated from human activities which can affect the condition of the waters where sea grapes live, both in the wild and cultivated. Sea grapes (Caulerpa lentillifera), which have a habit of absorbing organic materials in the water as photosynthetic material, are of course a special concern for researchers so that the sea grapes consumed by the public are free from dangerous organic materials. One of the dangerous organic materials in water is heavy metals. The presence of heavy metals in the waters where sea grapes live needs to be considered. So that the content of organic materials such as heavy metals in sea grapes can be known in terms of quantity and type.

The excessive presence of heavy metals, both non-essential and essential, in the aquatic environment can have a direct or indirect influence on organisms and humans. Caulerpa lentilifera seaweed has the ability to absorb and accumulate heavy metals in its thallus. Heavy metals in waters will find it difficult to degrade and settle to the bottom of the waters. The residence time of aquatic heavy metals is up to thousands of years and can accumulate in the bodies of marine biota organisms through bioaccumulation and biomagnification processes (Darmono, 2001). Therefore, it is important to carry out research to determine the heavy metal content in sea grapes (*Caulerpa lentilifera*) both in nature and in cultivated products. The benefit of this research is that it is an alternative for developing knowledge that can be used as a reference for determining heavy metal levels in natural and cultivated sea grapes.

METHODS

Types and Research Design

The research conducted was quantitative descriptive research. Descriptive research is research with a method of describing research results with the aim of providing validation of the phenomenon being studied, while quantitative is a systematic investigation of a phenomenon by collecting data that can be measured (Ramadhan, 2021). Quantitative descriptive research in this research is to see, review and describe with numbers the object being studied as it is and draw conclusions about this according to the phenomena that were visible at the time the research was carried out (Putra, 2015).

The test variable used in this research was to determine the heavy metal content in Caulerpa lentilifera with 2 treatments given in controlled cultivation containers at PT. Bulung Bali Sejahtera and cultivation containers that are purely sourced from open waters. Sample testing on the test variable uses GC (Gas Chromatography) which is a chromatography technique for a substance that is accompanied by high pressure to obtain the desired data. When testing variable samples, they are tested in duplicate, namely taking or testing a microorganism present in the sample or test material using a comparison between 2 samples whose microorganisms are observed.

Data collection was carried out using the observation method (observation). Data collection techniques for ramuli length, number of ramuli and water quality use manual methods, namely calculations, measurements and observations. Sample data for the heavy metal content of sea grapes in this study were checked using GC in the Gadjah Mada University laboratory, Integrated Research and Testing Laboratory with a duplo testing system.

RESULT AND DISCUSSION

Result

Sea Grape Ramuli Length

Figure 1. Sea Grape Ramuli Length Chart

Figure 1 shows the average length of sea grape ramuli, both cultivated and caught from nature, ranging from 3.3 cm to 6.9 cm..

Amount of Sea Grape Ramuli

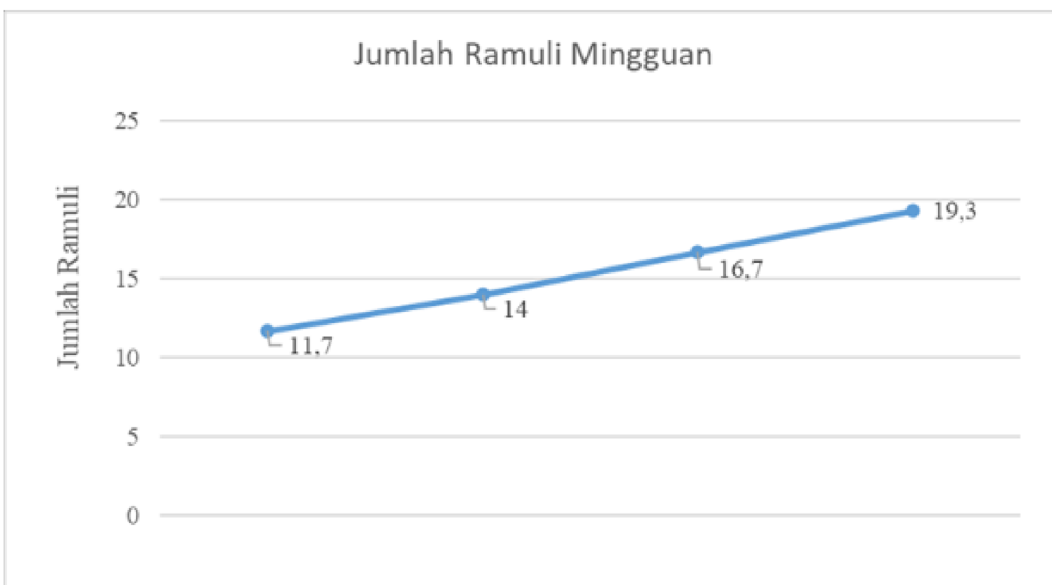

Figure 2. Ramuli Number Graph

Figure 2 shows the average value of the number of sea grape ramuli, both cultivated and caught from nature, ranging between 11.7-19.3.

Heavy metal content of Cultivated Sea Grapes

The heavy metal content of cultivated sea grapes is presented in table 1 as follows.

Table 1. Cultivated Heavy Metal Content

No	Test Parameters	Result	Unit	Method
1.	Cd (Kadmium)	Not detected	mg/kg	SSA- flame
2.	Cu (Tembaga)	15,17	mg/kg	SSA- flame
3.	Zn (Seng)	4,05	mg/kg	SSA- flame
4.	Pb (Timbal)	Not detected	mg/kg	SSA- flame
5.	Ni (Nikel)	Not detected	mg/kg	SSA- flame

Heavy metal content of Natural Sea Grapes

The heavy metal content of sea grapes from natural products is presented in table 1 as follows.

Table 2. Natural Heavy Metal Content

No	Test Parameters	Result	Unit	Method
1.	Cd (Kadmium)	Not Detected	mg/kg	SSA- flame
2.	Cu (Tembaga)	13,85	mg/kg	SSA- flame
3.	Zn (Seng)	8,25	mg/kg	SSA- flame
4.	Pb (Timbal)	0,24	mg/kg	SSA- flame
5.	Ni (Nikel)	Not Detected	mg/kg	SSA- flame

Water quality measurement

The results of water quality measurements during the research are presented in table 3 as follows.

Table 3. Water Quality

Water Quality Parameters	Cultivation	Attack waters	Reference
Temperature (˚C)	27-28	28-31	28-30[1)]
pH	7,9-9,7	9,0-10,3	6,5-8,0[2)]
Salinity (ppt)	29-33	30-32	28-32[3)]
Nitrate /NO4 (mg/l)	0,1-2,5	0,1-0,2	0,9-3,5[5)]
Phosphate /PO4 (mg/l)	0,1-2,0	0,1-0,5	0,09-0,1[6)]

Discussion

1. Sea Grape Ramuli Length

This research used a sea grape cultivation period lasting 45 days. The research results show that the average length of sea grapes is around 1.4 cm. This fairly good growth can be caused by the sea grapes being given regular fertilizer so that their growth is optimal. This is in accordance with Hendrajat (2008) who stated that an increase in length growth indicates that the growth in length of seaweed has entered the cell elongation stage, because the availability of sufficient nutrients for growth is due to the high amount of nitrogen affecting the growth (weight and length) of seaweed. This is in accordance with the opinion of Novizan (2000) that fertilizer in waters causes plants to grow well, so that production will increase. Nitrogen is a very important component for the growth of seaweed thallus. Apart from the element (N), seaweed also needs the element phosphate (P) for its growth.

2. Amount of Sea Grape Ramuli

The increase in the length of sea grapes has implications for the number of research ramuli grains. Calculation results from the first week to the fourth week. Week 1 the average ramuli calculation result was 11.7 ramuli. The ramuli count in the first week experienced an increase in the average ramuli to 14 in the second week and an increase in ramuli in the third week to 16.7 then ended in the fourth week with an average of 19.3 ramuli. This is not in accordance with the opinion of Antara et al, 2022. Increasing the number of ramuli in the cultivation treatment resulted in a yield of 8.1 ramuli, which was not significantly different from Caulerpa lentillifera which was cultivated with abalone wastewater without adding fertilizer. This shows that fertilization up to a dose of 8 ppm cannot stimulate Caulerpa lentillifera to increase the number of ramili in the assimilator significantly. Comparison of ramili density in Caulerpa lentillifera shows differences in ramili density from several treatments. Ramilli density is related to the chemical composition of Caulerpa lentillifera, if it is fresh it is very easily damaged because its composition is dominated by water. The differences in research results are thought to be due to external factors such as water quality, season, distance between planting and placing sea grapes in super nets, whether they are sterile or not during the treatment process in sea grape cultivation so that they can support optimal growth.

3. Cultivated Heavy Metal Content

The heavy metal Cu content in cultivated sea grapes was 15.17 mg/kg. The value of heavy metal content in cultivation has not exceeded the maximum threshold when compared with the maximum permitted content of heavy metals in food, according to the Decree of the Director General of Food and Drug Supervision No.03725/B/SK/VII/1989 concerning the Maximum Limit of Heavy Metal Contamination in Food of 30 mg/kg. The content of the heavy metal Cu in cultivated sea grapes is thought to come mostly from waste from ponds and hatcheries around the cultivation site. Parawita et al., (2009) in their research stated that waste is often dumped into waters, triggering an increase in the concentration of dissolved materials such as heavy metals and this can endanger the life of organisms.

The heavy metal content Zn in natural sea grapes was 4.05 mg/kg. Zn metal is actually not toxic and is good if consumed, but within reasonable limits. According to a statement from The National Academy of Sciences, the highest dose of Zn that can be tolerated by the body, but not for treatment, is 4 mg for children aged 0-6 months, 5 mg for children aged 6-12 months, and children aged 1-3 years is 7 mg, children aged 4-8 years are 12 mg, aged 9-13 years are 23 mg, aged 14 -18 years are 34 mg, aged >19 years, and pregnant women are 40 mg (Paik, 2001).

4. Natural Heavy Metal Content

The heavy metal Cu content in natural sea grapes was 13.85 mg/kg. The value of heavy metal content in nature has not exceeded the maximum limit when compared with the maximum permitted content of heavy metals in food, according to the Decree of the Director

General of Food and Drug Control No.03725/B/SK/VII/1989 concerning the Maximum Limit for Heavy Metal Contamination in Food of 30 mg/kg. The Cu copper levels in sea grapes that were checked can be said to be still safe for consumption. However, there are heavy metals contained in sea grapes, even in low levels, the public or consumers must also pay attention to the quality when consuming sea grapes. If copper metal is consumed in high concentrations in the body and deposition occurs, it will be toxic and become toxic to the human body (Tambunan, 2019).

The heavy metal content Zn in natural sea grapes was 8.25 mg/kg. The high content of the heavy metal Zn in natural sea grapes is thought to come mostly from transportation activities, fishing boat activities, densely populated areas that are less aware of the environment, some suburban communities throw rubbish on the beach, thereby increasing the heavy metal content in the waters. According to Kulla et al. (2020) Heavy metals come from several fishing boat activities, diesel waste, oil and waste from community activities which are thought to trigger the presence of heavy metals, heavy metals in waters will be dangerous both directly and indirectly to living organisms and human health.

The heavy metal Pb content in natural sea grapes was 0.24 mg/kg, this value exceeds the quality standard set by SNI 2690:2015. The content of the heavy metal Pb content in seaweed was determined to be 0.3 mg/Kg. The high content of the heavy metal Pb in natural sea grapes is thought to come mostly from industrial, household waste, boat or ship fuel spills/leaks in the vicinity of the attack waters. Based on the analysis of heavy metal accumulation in sea grapes when compared with Kep-51/KMNLH/2004, it has a high concentration. Sources of heavy metals are thought to come from industry and nature in the form of erosion of rocks and sediments (Istarani and Pandebesie, 2014).

5. Water quality

The results of water quality measurements show that the average temperature in the tank ranges from 27 - 28℃, while at the beach the attack ranges from 28-30℃, these temperature conditions are sufficient to support the survival of organisms in the water. According to Romimohtarto and Juwana (2001), a good temperature to support the survival of organisms in the sea ranges between 28 - 30℃. Meanwhile, according to Soegiarto et al. (1978) a good temperature for seaweed life is around 27.5℃. Temperature is an environmental factor that greatly influences the growth and development of sea grapes because it has a direct effect on their metabolic processes.

pH measurements were carried out in the morning and obtained results in the cultivation tanks of 7.9-9.7, while the pH produced at the attack beach was around 9.0-10.3. The pH value of waters is very dependent on the presence of hydrogen ions, where the pH value increases as hydrogen ions decrease and conversely the pH value decreases as hydrogen ions increase in the water (Zulfia and Aisyah, 2013).

The salinity measured during research in the tank averaged around 29-33 ppt, while on the beach it ranged from 30-32 ppt. This salinity is reasonable enough to support algae life. According to Perry (2003), sublittoral algae can tolerate salinity 0.5 - 1.5 times normal salinity (16 - 50 ppt). Meanwhile, intertidal algae are able to live in a salinity range of 0.1 - 3.5 times normal salinity. Furthermore, Dawes (1987) said that macroalgae can still live at salinities between 5 - 35 ppt.

Nitrate (NO_3) is a nutrient compound that is important in the synthesis of animal and plant proteins. High nitrate concentrations in waters can stimulate the growth and development of aquatic organisms if supported by nutrient availability (Pong-Masak and Nelly, 2015). The results of nitrate measurements during the sea grape cultivation period were 0.1-2.5 mg/l. Measurements of sea grapes on the beach of Attack yielded results of 0.1-0.2 mg/l. The nitrate concentration data obtained in the field is in accordance with the opinion of Pong-Masak and Nelly (2015), who stated that the nitrate range for optimum growth of seaweed is 0.9 – 3.5 mg/l. This is reinforced by the opinion of Masyahoro and Mappiratau (2010) in Fikri et al. (2015), the main nutrient content required by seaweed, such as nitrate and phosphate, greatly influences its reproductive stage. If these two nutrients are available, the fertility of seaweed increases rapidly. Alamsjah (2009) in Fikri et al. (2015) said that nitrate is a very important component for the growth of seaweed thallus.

Phosphate is a form of phosphorus which functions as an essential element for higher plants and algae, so that this element becomes a barrier for aquatic plants and algae and influences the level of aquatic productivity (Effendi, 2003; Zulfia and Aisyah, 2013). Based on the results of phosphate measurements in cultivated sea grapes, it was found that the range was between 0.1-2.0 mg/l, while the results for sea grapes from the sea grapes were 0.1-0.5 mg/l. According to Azizah (2006), the optimum nitrate for the feasibility of sea grape cultivation is in the range of 0.9-3.5 mg/L. Based on the results of nitrate measurements in this study, it is still in the feasible category.

CONCLUSSION

The water quality in cultivated and natural waters is still within normal limits, so the water quality can be said to be sufficient for sea grape cultivation activities. The growth of sea grape ramuli was marked by an increase in the number of ramuli from the calculation results in the first week to the fourth week. Week 1 showed that the average ramuli calculation was 12 ramuli, then ended in the fourth week with an average of 19 ramuli. The heavy metal levels in cultivated sea grapes that were identified were only Cu (Copper) of 15.17 mg/kg and Zn (Zinc) of 4.05 mg/kg, while the results of the analysis of heavy metal levels in natural sea grapes were only identified. the heavy metal content Cu (Copper) is 13.85 mg/kg, Zn (Zinc) is 8.25 mg/kg, and Pb (Lead) is 0.24 mg/kg.

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