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Dietary Macroalgae *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp. on Productivity Milkfish (*Chanos chanos*)

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A R T I C L E I N F O

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A B S T R A C T

Using macroalgae as an alternative feed for milkfish (*Chanos chanos*) is one of the innovative solutions for supporting sustainable aquaculture. This study examines the potential of *Eucheuma sp.*, *Sargassum sp.*, and *Ulva sp.* as a natural source of nutrients that can increase the growth and survival of milkfish. This study used a Complete Randomized DUsedesign (CRD) with four treatments, namely feed without macroalgae (A), feed with the addition of 20% *Eucheuma* sp. (B), feed with the addition of 20% *Sargassum* sp. (C), and feed with the addition of 20% *Ulva* sp. (D), each with three repetitions. The observed parameters include survival, absolute weight, length growth, feed conversion ratio (FCR), and water quality. The results showed that the survival rate in all treatments reached 100%. Dietary macroalgae *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp. 20% can provide higher growth in milkfish compared to the treatment without macroalgae. Water quality parameters during the study remained within the optimal range for milkfish growth.

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INTRODUCTION

Milkfish (*Chanos chanos*) is one of the commodities in the aquaculture industry. The demand for milkfish continues to increase in domestic and export markets, due to its high economic value and rich nutritional content, such as protein, omega-3 fatty acids, and essential minerals (Ayumasari, 2016). However, the fish farming industry faces significant challenges related to its dependence on fishmeal-based feeds. This dependence can impact high production costs and raise concerns about the sustainability of the cultivation. This follows Suprayudi's (2012) opinion that the most important factor that affects production costs is feed, which can reach 45–80% of the total cultivation cost.

Innovation in alternative feed formulations that are more economical, efficient, and environmentally friendly is needed to provide a source of cheap, beneficial, and environmentally friendly nutrition. One potential solution is using marine macroalgae as raw materials for fish feed. Using macroalgae as an alternative feed provides a rich source of nutrients and can potentially increase production efficiency in fish farming. Research on dietary macroalgae as natural feed shows increased growth and survival in certain cultivated species (Nurfajrie dkk, 2014).

Marine macroalgae such as *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp. contain nutrients that are beneficial for fish growth and health, including vegetable proteins, vitamins, minerals, fiber, and bioactive compounds that can increase the resistance of fish to disease (Jiang *et al*., 2020). Several studies show that the macroalgae in feed can improve feed efficiency and optimize fish growth. However, research on the specific effects of macroalgae as feed ingredients in milkfish cultivation is still limited. This study aims to determine the optimal formulation of macroalgae in feed to improve the productivity of milkfish. The results of this study are expected to provide new insights into more economical and sustainable feed alternatives for the milkfish farming industry.

METHODOLOGY

This research was carried out for two months, from August to October. Macroalgae diet was produced in the laboratory of the Faculty of Animal Husbandry, Marine and Fisheries of Nusa Cendana University, and a milkfish cultivation trial was carried out in Mbay, Nagekeo Regency, East Nusa Tenggara. This study used milkfish (*Chanos chanos*) measuring 9 to 11 cm and weighing 10 to 13 g, which were kept in a maintenance container according to the experimental design.

The test feed was formulated by replacing conventional feed ingredients with marine macroalgae, namely *Eucheuma sp.*, *Sargassum sp.*, and *Ulva sp.* This study applied a complete random design (RAL) with four treatments: control diet without macroalgae, feed with 20% *Eucheuma sp.*, feed with 20% *Sargassum sp.*, and feed with 20% *Ulva sp.* Each treatment is repeated three times. The treatment of the cultivation system that was tested was as follows.

A. Control diet (without macroalgae)
B. Diet with the addition of 20% *Eucheuma* sp.
C. Diet with the addition of 20% *Sargassum* sp.
D. Diet with the addition of 20% *Ulva* sp.

The observed parameters included fish survival rate, growth in absolute weight and length, feed conversion ratio (FCR), and physical condition and behavior of fish. Water quality measurements are regularly performed, including temperature, pH, and dissolved oxygen levels, to ensure optimal maintenance conditions. Data analysis was carried out using variance analysis (ANOVA) to test for differences between treatments, and if there were significant differences, followed by the Duncan test to determine the best treatment.

RESULTS AND DISCUSSION

A. Survival

Survival rate (SR) is the value of the ratio between the number of organisms living at the end of the rearing and the number of organisms at spawning, expressed in percent (%). The greater the percentage value indicates the more organisms live during maintenance (Mulyadi *et al.*, 2014). The high survival rate in a cultivation activity can be interpreted as a success in the maintenance activities carried out. The results of the calculation of milkfish survival can be seen in Figure 1.

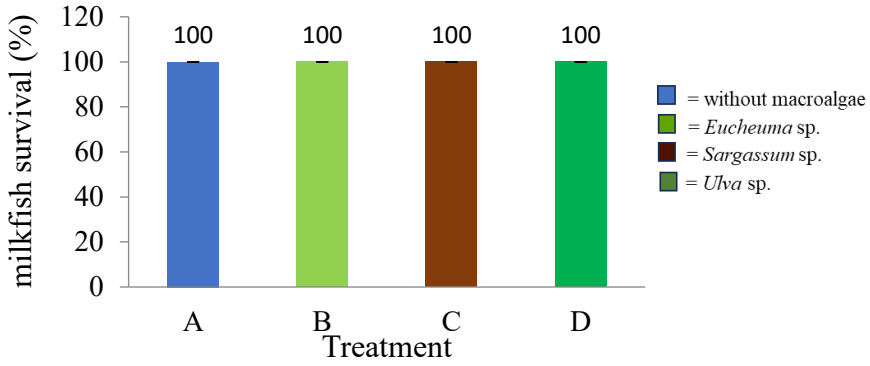

Figure 1. Milkfish Surviv

The results showed that the survival rate of milkfish reached 100% in all treatments, including control and treatment with the addition of *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp. This shows that macroalgae-based diets do not harm fish survival. This result follows the opinion of Kordi (2009), who stated that the low survival of a cultivated biota can be influenced by inappropriate feed nutritional quality. In addition, Murjani (2011) also mentioned that the survival of fish is highly dependent on the adaptability of fish to food and the environment, as well as adequate water quality. Handayani (2014) states that survival is categorized as good if it reaches more than 80%, so the results of this study show that macroalgae-based feed can be used without harming milkfish.

B. Absolute Weight Growth

The results of measuring the average amount of absolute weight growth of milkfish during the study can be seen in Figure 2.

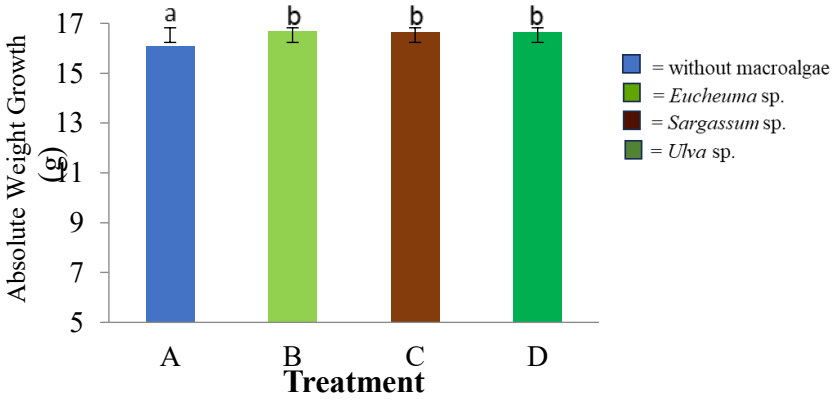

Figure 2. Absolute Weight Growth of Milkfish

Anova results showed that diet treatment significantly affects the growth of fish weight (P<0.05). Duncan's test showed that the absolute weight growth of milkfish fed with the addition of 20% *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp., in each treatment, had a higher weight growth than the weight growth of milkfish fed without macroalgae. These results are supported by research by Aslan (2021) who found that the addition of 20-25% *Eucheuma* sp. in feed can increase milkfish growth due to the content of carrageenan which functions as a binder in feed, thereby increasing the stability of feed in water and facilitating the absorption of nutrients by fish.

In addition, Arifin et al. (2020) show that *Ulva* sp. contains 20-26% protein, while crude fiber can improve feed efficiency in milkfish. Meanwhile, Putri *et al*. (2021) reported that *Sargassum* sp. contains alginate and iodine minerals that may improve fish metabolism, while the effects are not as good as *Eucheuma* sp. and *Ulva* sp.

C. Absolute Length Growth

The results of the measurement of the average length of milkfish can be seen in Figure 3.

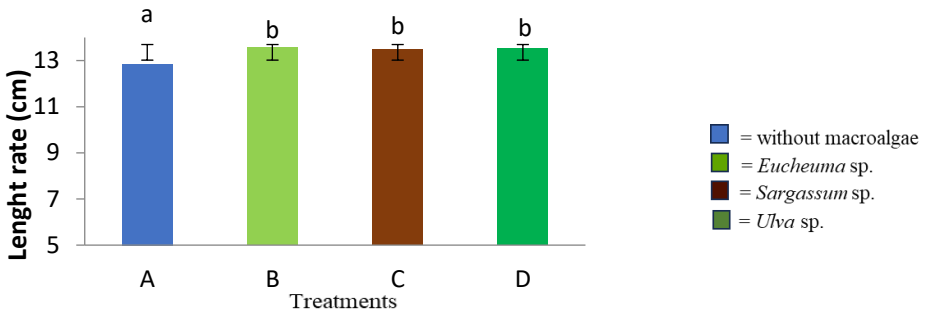

Figure 3. Long Growth of Milkfish

ANOVA analysis showed a significant difference between treatments on the length growth of fish (*P<0.05)*. Duncan's test showed that the absolute length growth of milkfish fed macroalgae in each treatment showed a higher increase in length compared to the milkfish fed without macroalgae. This result is in line with the research of Aslan (2021), who found that *Eucheuma* sp. increases nutrient absorption due to its ability to maintain the stability of feed in water, thereby supporting fish metabolism better. Arifin *et al*. (2020) also found that *Ulva* sp. has protein and mineral content that play an important role in fish metabolism, thus supporting optimal growth length. Meanwhile, Sargassum sp. still provides good growth results, although not as high as *Eucheuma* sp. and *Ulva* sp., because the content of alginate and its bioactive compounds plays more of a role as an immunostimulant than as protein.

The feed conversion ratio (FCR) obtained during 60 days of maintenance can be seen in Figure 4 below.

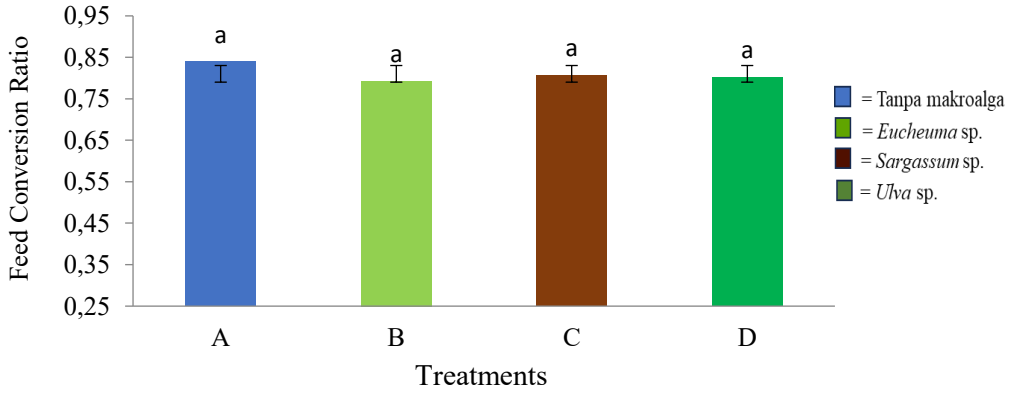

Figure 4. Feed Conversion Ratio

The results of the variance analysis showed that the differences between treatments were insignificant. This indicates that although there are numerical differences in FCR values between treatments, the difference is not large enough to be considered real based on statistical analysis. However, in terms of data, it can be seen that the value of feed conversion ratio (FCR) obtained during the study shows that *the Eucheuma* sp. treatment has an FCR of 0.79, followed by *the Ulva* sp. treatment of 0.80, the *Sargassum* sp. of 0.81, and the control of 0.84. Lower FCR values indicate better feed utilization efficiency, where less feed is consumed to produce the same growth. These results follow the research of Wong *et al.* (2019), which shows that dietary *Eucheuma* sp. in fish feed can improve the efficiency of feed utilization. According to Serdiati (2011), the lower the feed conversion rate, the less diet is needed to produce fish body weight, the more efficient.

E. Physical Condition and Behavior of Fish

The physical condition and behavior of milkfish during the maintenance period show excellent results. No morphological abnormalities or disease symptoms were found in all treatments. Fish fed a diet of macroalgae showed a good feeding response, reflected in the efficient FCR value. Optimal weight and length growth also indicate that the feed provided can be digested and utilized well by milkfish. The following research by Handayani (2023) found that the bioactive compounds in *Sargassum* sp. contribute to the increase of the fish's immune system, thereby increasing the fish's immunity to environmental stress. Rahmawati (2022) also mentioned that the mineral and vitamin content in macroalgae such as *Ulva* sp. plays an important role in fish metabolism and activity, so that it can improve feeding response and feed utilization efficiency.

F. Water Quality

Table 1. Water Quality in Milkfish Farming Media

Parameters	Treatment				Optimum range
	A	B	C	D	
Temperature (℃)	27-30	27-29	27-30	27-28	27-30
pH	7-8,5	7-9	7-8,5	7-9	7-9

The water quality during the study remained within the optimal range for milkfish farming. The water temperature during the study ranged from 27-30°C, while the pH range was 7 - 9, which is the optimal condition for milkfish growth. This is in accordance with the opinion of Sustianti *et al.* (2014), which states that the optimal temperature for milkfish ranges from 27-29°C. The pH range observed during the study is also in accordance with the results of the research of Hardjowigeno and Widiatmaka (2007), who stated that milkfish grow optimally at a pH between 8 to 9. Previous research by Aslan (2021) showed that the addition of 20% *Eucheuma* sp. in milkfish feed did not affect water quality, which is in line with the results of this study. In addition, the research of Arifin *et al.* (2020) found that the use of *Ulva* sp. in milkfish feed formulations provided better feed conversion values than controls, without causing significant changes in water quality parameters. This shows that using macroalgae as feed materials does not harm the quality of the milkfish rearing environment.

CONCLUSION

1. Dietary macroalgae *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp. 20% can provide higher growth in milkfish compared to the treatment without macroalgae.
2. The survival rate of milkfish reached 100% on all treatments, indicating that macroalgae-based feeds did not negatively impact the fish.

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