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THE EFFECT OF PROBIOTIC ADDITION IN MOIST FEED ON THE GROWTH OF SAND LOBSTER (*Panulirus homarus*)

Pengaruh Penambahan Probiotik Dalam Pakan Lembab Terhadap Pertumbuhan Lobster Pasir *(Panulirus homarus)*

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ABSTRACT

Lobsters are a potential fishery commodity with significant economic value. An alternative feed option that can be used is artificial feed, such as moist feed. One commonly known probiotic in the market is EM4, which can be used as a feed additive and can increase protein content to support growth processes. This study aims to determine the optimum probiotic dosage in moist feed to enhance the growth of sand lobsters (*Panulirus homarus*). The findings of this research are intended to provide insights and benefits for further research or practical applications. This study used an experimental method with a completely randomized design (CRD). It involved five treatments with three replications, resulting in 15 experimental units. The treatments included P0 (control), P1 (moist feed without probiotics), P2 (moist feed + 0.1% probiotic), P3 (moist feed + 0.2% probiotic), and P4 (moist feed + 0.3% probiotic). The results showed that after maintaining *Panulirus homarus* for 60 days in Teluk Ekas, the addition of different probiotic levels in moist feed produced the following average outcomes: absolute length growth ranged from 3.19 to 4.76 cm, absolute weight growth ranged from 42.90 to 62.30 g, specific growth rate ranged from 1.71 to 2.14 g, feed conversion ratio (FCR) ranged from 5.05 to 6.69, feed efficiency ranged from 69.12% to 87.26%, and survival rate ranged from 70% to 90%. Based on these findings, it can be concluded that the best treatment for absolute length growth, absolute weight growth, specific growth rate, feed efficiency, and FCR was P4 (moist feed + 0.3% probiotic), while the best survival rate was achieved in P2 (moist feed + 0.1% probiotic).

Keywords: Panulirus homarus, Moist feed, Probiotic

ABSTRAK

Lobster merupakan komoditas perikanan potensial dengan nilai ekonomi yang signifikan. Pilihan pakan alternatif yang dapat digunakan adalah pakan buatan, seperti pakan lembab.

Salah satu probiotik yang umum dikenal di pasaran adalah EM4, yang dapat digunakan sebagai aditif pakan dan dapat meningkatkan kandungan protein untuk mendukung proses pertumbuhan. Penelitian ini bertujuan untuk mengetahui dosis probiotik optimal dalam pakan lembab untuk meningkatkan pertumbuhan lobster pasir (*Panulirus homarus*). Hasil penelitian ini dimaksudkan untuk memberikan wawasan dan manfaat untuk penelitian lebih lanjut atau aplikasi praktis. Penelitian ini menggunakan metode eksperimental dengan completely randomized design (CRD). Ini melibatkan lima perawatan dengan tiga replikasi, menghasilkan 15 unit eksperimental. Perlakuan meliputi P0 (kontrol), P1 (pakan lembab tanpa probiotik), P2 (pakan lembab + probiotik 0,1%), P3 (pakan lembab + probiotik 0,2%), dan P4 (pakan lembab + probiotik 0,3%). Hasil penelitian menunjukkan bahwa setelah memelihara Panulirus homarus selama 60 hari di Teluk Ekas, penambahan kadar probiotik yang berbeda dalam pakan lembab menghasilkan hasil rata-rata sebagai berikut: pertumbuhan panjang absolut berkisar antara 3,19 hingga 4,76 cm, pertumbuhan berat absolut berkisar antara 42,90 hingga 62,30 g, laju pertumbuhan spesifik berkisar antara 1,71 hingga 2,14 g, rasio konversi pakan (FCR) berkisar antara 5,05 hingga 6,69, Efisiensi pakan berkisar antara 69,12% hingga 87,26%, dan tingkat kelangsungan hidup berkisar antara 70% hingga 90%. Berdasarkan temuan tersebut, dapat disimpulkan bahwa perlakuan terbaik untuk pertumbuhan panjang absolut, pertumbuhan berat absolut, laju pertumbuhan spesifik, efisiensi pakan, dan FCR adalah P4 (pakan lembab + probiotik 0,3%), sedangkan tingkat kelangsungan hidup terbaik dicapai pada P2 (pakan lembab + probiotik 0,1%).

Kata Kunci: *Panulirus homarus*, Pakan lembab, Probiotik

INTRODUCTION

Indonesia is one of the largest suppliers of natural resources in the fisheries sector, including marine, freshwater, and brackish water fisheries. This is due to the fact that nearly 70% of Indonesia's territory is water. Over time, aquaculture in Indonesia has grown, including species such as star piranha, grouper, lobster, seaweed, and many others. Lombok Island in Indonesia is the only island where lobster seeds can be harvested in large quantities. West Nusa Tenggara (NTB) is the largest producer of high-quality lobster in Indonesia (Hilal, 2015). Every year, NTB produces about 78.5 tons of lobster with an economic value of IDR 55.25 billion. Additionally, the sale of lobster seeds from this region adds another IDR 16 billion annually. This data shows the great potential of NTB in the fisheries sector, particularly in lobster production, which significantly contributes to the regional economy. The cultivation of lobster, especially the Sand Lobster (*Panulirus homarus*), needs to be continuously developed to maintain the balance of the population and the availability of natural lobster stocks. The Sand Lobster is one of the most widely known and cultivated types of lobster in Indonesia, especially in NTB. This development is not only important for the sustainability of marine ecosystems but also provides significant economic benefits to local communities.

The Sand Lobster (*Panulirus homarus*) is a high-value fishery commodity with increasing demand in both domestic and international markets (Pratiwi, 2018 in Andrykusuma *et al*., 2022). According to Minister of Marine Affairs and Fisheries Regulation No. 12 of 2020, the value of lobster seed exports recorded by the Directorate General of Customs and Excise (DJBC) reached USD 74.28 million or approximately IDR 1.4 trillion. In fact, 80% of total lobster seed imports to Vietnam come from Indonesia, making lobster one of the main export commodities in the national fisheries sector. However, the high demand for lobster seed exports triggers intensive exploitation through capture from the wild, as Indonesia has not yet established hatcheries that can successfully produce lobster larvae or seeds independently. This reliance on wild capture raises concerns about the sustainability of lobster populations in the wild. This situation highlights the need for sustainable management of lobster resources to prevent negative impacts.

The Sand Lobster (*Panulirus homarus*) is a high-value fishery resource, making it a primary target for fishermen. The high market price and increasing demand (Wahyudin *et al*., 2017; Junaidi *et al*., 2010) have led to intensified lobster capture. However, according to Kadafi *et al*., (2006) intensive lobster capture can have a negative impact on the population balance in the wild. This could lead to stock depletion, imbalanced sex ratios, and even the extinction of species. Sustainable management efforts are needed to mitigate these adverse effects. Management strategies include regulating capture, developing breeding technologies such as hatcheries for lobster seed production, and implementing policies that support the preservation of marine ecosystems. With these steps, lobster, as a high-value commodity, can continue to be utilized without disrupting the ecosystem balance.

Many efforts have been made by breeders to improve the quality and production of cultivated species. One such approach is the selection of better feed. Commonly used feed includes natural feed derived from trash fish. However, the use of this feed faces challenges due to the limited availability of trash fish and its relatively high cost, especially during adverse weather conditions (Diamahesa *et al*., 2022). An alternative that can be used is artificial feed, such as moist feed. Moist feed is an artificial feed that contains protein and water content of approximately 30-40%. Feed is a crucial factor in the growth and survival of cultured fish. To ensure optimal feed utilization and to increase protein content for lobster body weight growth, additional components can be mixed into the feed. One method that can be used is the addition of probiotics (Ridwanudin *et al*., 2018).

Probiotics are live microorganisms that benefit the digestive system by maintaining balance in the intestines, as they contain bacteria that produce important digestive enzymes (Febriany *et al*., 2022). One of the probiotics widely used in aquaculture is EM4 (Effective Microorganism-4), which is known to enhance protein content in feed. According to Mitra, (2013) in Anugraheni, (2016) and Rachmawati, (2006) EM4 plays an active role in supporting growth by increasing protein content in feed, either as an additive or through spraying methods. Research on the use of EM4 in feed aims to improve the digestive capacity of fish or lobsters. By adding probiotics, digestive enzymes can hydrolyze proteins into simpler compounds that are more easily absorbed, thus supporting growth. This study specifically aims to determine the optimal dosage of EM4 probiotics in moist feed to improve the growth of Sand Lobster (*Panulirus homarus*), a high-value fishery commodity.

RESEARCH METHODS

This study was conducted from May to July 2023 at the Floating Net Cages (KJA) in Teluk Ekas, Desa Ekas, Kecamatan Jerowaru, Kabupaten Lombok Timur, West Nusa Tenggara. Oxygen levels were observed at the Aquatic Environment Laboratory, Faculty of Agriculture, Aquaculture Study Program, University of Mataram. The study used various tools such as basins, meat stirrers, steamers, freezers, measuring cups, pH meters, refractometers, electric scales, and materials like calcium carbonate, EM4, trash fish, gluten flour, shrimp head powder, vitamins, and mineral mix. Sand Lobster (2-3 cm in size) was used as the research subject, with moist feed mixed with probiotics.

The research method used was an experiment with probiotic addition to moist feed, utilizing a Completely Randomized Design (CRD) with five treatments and three replications, resulting in a total of 15 experimental units. The probiotic doses in the treatments were based on the research of Junaidi and Scabra (2023). This study aimed to evaluate the effects of probiotics on sand lobster growth, focusing on determining the optimal dose to enhance the effectiveness of moist feed. The treatments applied were:

- P0: Trash Fish (control)
- P1: Moist Feed
- P2: Moist Feed + 0.1% Probiotic
- P3: Moist Feed + 0.2% Probiotic
- P4: Moist Feed + 0.3% Probiotic

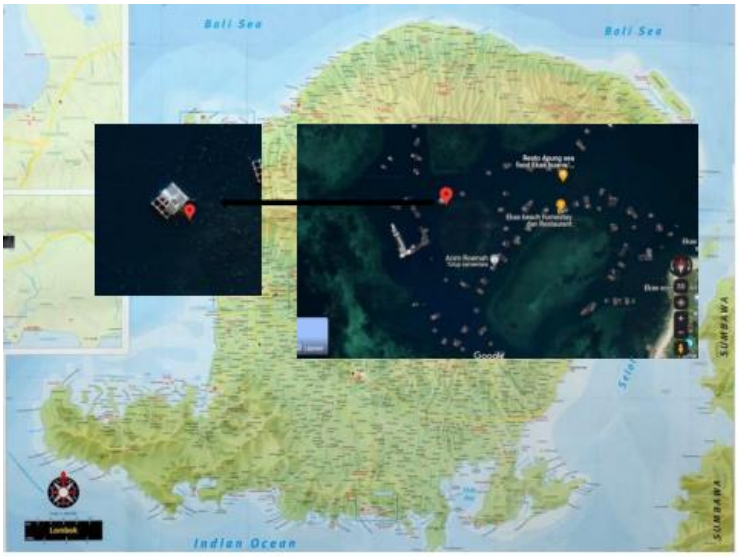

Figure 1. Research field location (Teluk Ekas waters, Jerowaru Subdistrict, East Lombok Regency, West Nusa Tenggara, Coordinates: 8°52'13.8"S, 116°26'59.3"E)

Procedure Implementaion

Container Preparation

The research procedure begins with the preparation of tools and materials. The containers used in this study were square-shaped nets (waring) with dimensions of 1 x 1 x 1 m³, totaling 15 units. Each unit was stocked with 10 lobster seeds per cubic meter. The surface of the floating net cage (KJA) was attached to wood and secured with nylon ropes. The nets were then placed in each cage and marked according to the design.

Seed Preparation

In this study, 150 sand lobsters measuring 2-3 cm in size were used as seeds. The lobster seeds were collected from the wild around the waters of Jerowaru Subdistrict, East Lombok. They were acclimatized for 7 days to prevent stress and allow adaptation to the new environment. During the acclimatization process, the lobster seeds were fed twice daily with trash fish. The seeds were then weighed to an accuracy of 0.01 grams using an analytical scale to determine their average weight and placed in each of the 15 prepared net units.

Feed Preparation

The main ingredients for the feed in this study were moist feed and trash fish, including lemuru, layang, and anchovies. The preparation of moist feed followed the method of Ridwanuddin *et al*. (2018). The procedure begins by adding small amounts of feed ingredients and sorting them according to the specified amounts. Separate the scales and bones of the trash fish, then blend them. Once all ingredients are mixed, knead the mixture until homogeneous. Next, steam the mixture in a pot of boiling water for 5 minutes to activate the binding agents in the feed. After steaming, let the mixture cool for several minutes. The cooled feed is then divided into 5 portions, with probiotics added at the specified dosage, injected into the feed, and then molded into moist feed pellets. The formed feed can be left in the air for about 30 minutes before being fed to the cultured organisms or stored in a freezer.

Feed Provision

This study used two types of feed: trash fish for the control treatment (P0) and moist feed with different probiotic doses for treatments P1, P2, P3, and P4. Feeding was done twice a day, in the morning at 08:00 WITA and in the afternoon at 17:00 WITA. The feeding schedule followed Mustafa (2013), with 60% of the feed provided in the afternoon and 40% in the morning, to accommodate the nocturnal behavior of lobsters. The amount of feed provided was 15% of the lobster's biomass, adjusted to the initial weight of the sand lobsters.

Data Analysis

The data obtained from this study, including absolute length growth, absolute weight, specific weight, FCR, feed efficiency, and lobster survival rate, will be analyzed using Analysis of Variance (ANOVA) at a significance level of 0.05. If significant differences ($p < 0.05$) are found, Duncan's test and homogeneity tests will be applied to determine the significance of the data. Water quality data will be presented descriptively.

RESULTS AND DISCUSSION

Absolute Length Growth

Based on the variance analysis, the influence of different feed treatments on the absolute growth length of sand lobster can be seen in Figure 2.

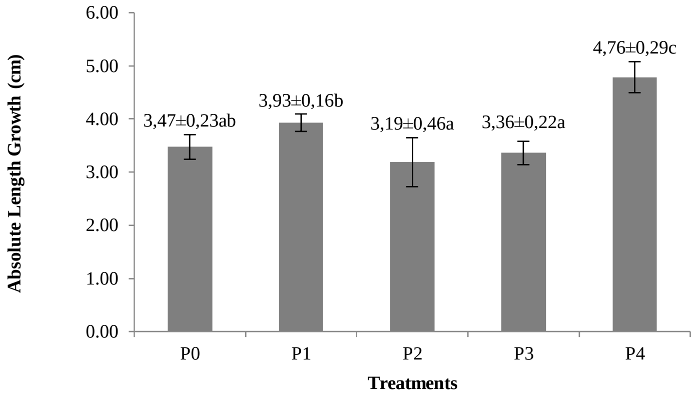

Figure 2. Absolute length growth of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The results of the ANOVA test at a 0.05 significance level showed that the different feed treatments significantly affected the absolute length growth of the sand lobster ($P<0.05$). Based on Duncan's test, absolute length growth for P0 did not significantly differ from P1, P2, and P3, but it was significantly different from P4. P1 showed significant differences from P2, P3, and P4, but not from P0. P2 did not differ significantly from P0 and P3 but differed significantly from P1 and P4. P4 was significantly different from all other treatments (P0, P1, P2, and P3).

Absolute Weight Growth

Based on the variance analysis, the effect of different feed treatments on the absolute weight growth of sand lobster can be seen in Figure 3.

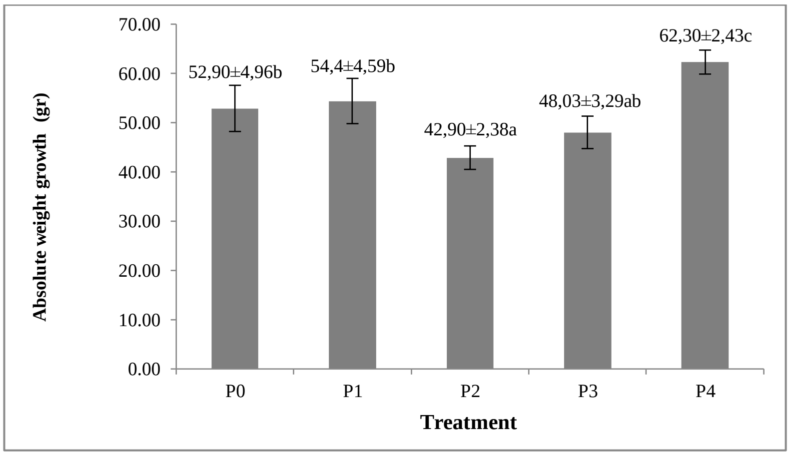

Figure 3. Absolute weight growth of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The study showed that the different feed treatments significantly affected the absolute weight growth of sand lobsters (P<0.05). Duncan's test results indicated that absolute weight growth for P0 significantly differed from P2 and P4, but not from P1 and P3. P1 showed significant differences from P2 and P4 but not from P0 and P3. P2 significantly differed from P0, P1, and P4, but not from P3. P3 differed significantly from P4 but not from P0, P1, and P2. P4 showed significant differences from all other treatments.

Specific Growth Rate (SGR)

Based on the variance analysis, the influence of feed treatments on the specific growth rate of sand lobster is presented in Figure 4.

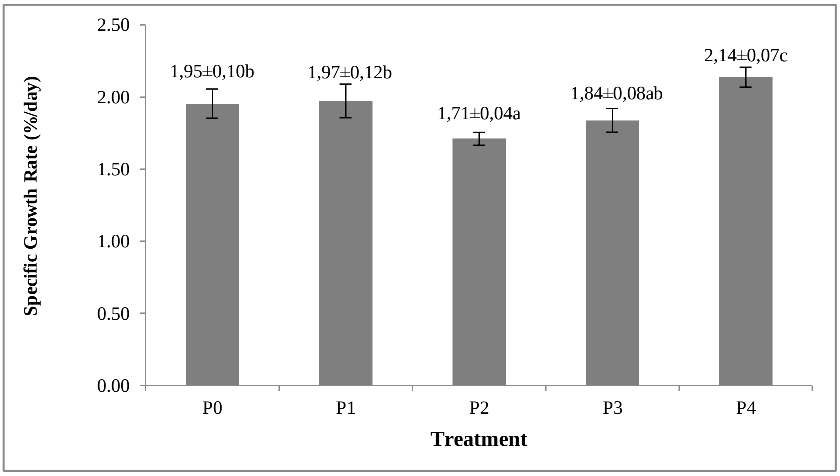

Figure 4. Specific growth rate of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The results of the study indicated that different feed treatments had a significant effect (P<0.05) on the specific growth rate of sand lobster. Duncan's test showed that specific growth rate for P0 significantly differed from P2 and P4, but not from P1 and P3. P1 was significantly different from P2 and P4 but not from P0 and P3. P2 differed significantly from P0, P1, and P4 but not from P3. P3 showed significant differences from P4 but not from P0, P1, and P2. P4 significantly differed from all other treatments.

FCR (Feed Conversion Ratio)

Based on the variance analysis, the effect of different feed treatments on the FCR (Feed Conversion Ratio) of sand lobsters can be seen in Figure 5.

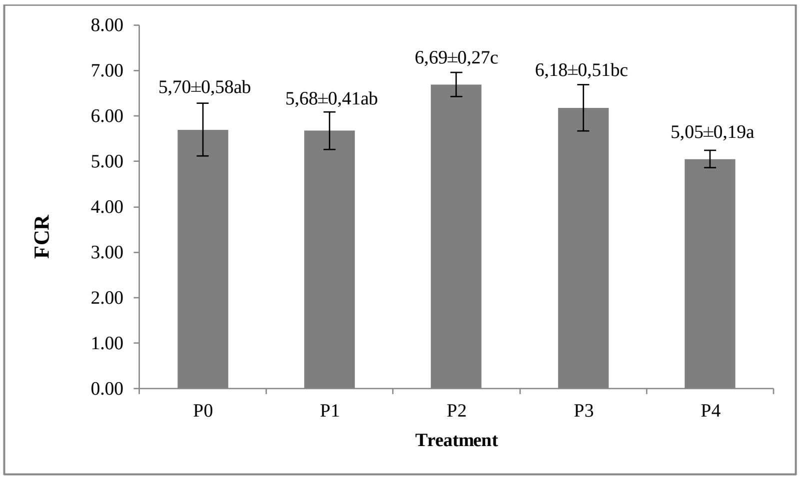

Figure 4. Feed Conversion Ratio (FCR) of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The research results showed that the different feed treatments significantly affected the FCR (P<0.05). Duncan's test revealed that FCR for P0 did not significantly differ from P1, P3, and P4 but differed significantly from P2. P1 did not significantly differ from P0, P2, and P4 but differed significantly from P2. P2 showed significant differences from P0, P1, and P4, but not from P3. P3 significantly differed from P4 but did not differ significantly from P0, P1, and P2. P4 was significantly different from P2 and P3 but not from P0 and P1.

Feed Efficiency

Based on the variance analysis, the effect of different feed treatments on the feed efficiency of sand lobsters is presented in Figure 5.

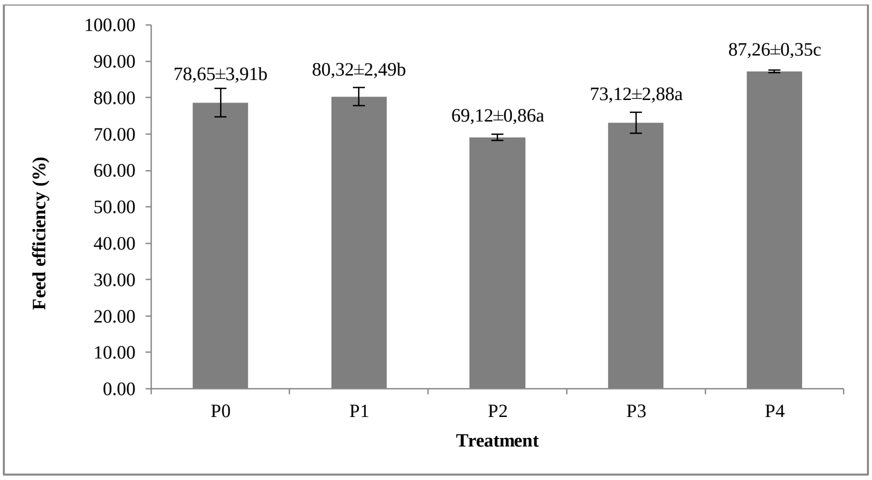

Figure 5. Feed efficiency of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The study showed that feed efficiency significantly differed (P<0.05) based on the feed treatments (P<0.05). Duncan's test results indicated that feed efficiency for P0 significantly differed from P2, P3, and P4 but not from P1. P1 showed significant differences from P0, P2, P3, and P4 but not from P0. P2 significantly differed from P0, P1, and P4 but not from P3. P3 significantly differed from P0, P1, and P4 but not from P2. P4 showed significant differences from all other treatments.

Survival Rate (SR)

Based on the variance analysis, the effect of different feed treatments on the survival rate of sand lobsters is presented in Figure 6.

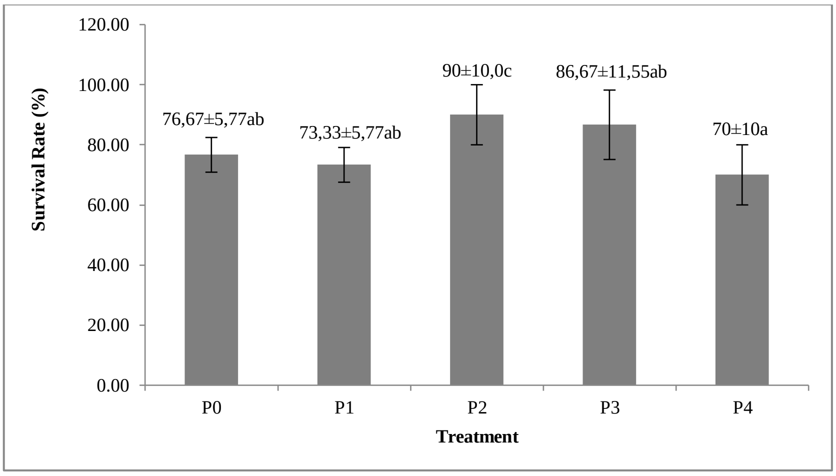

Figure 6. Survival rate of sand lobster with varying probiotic doses

Note: (P0: Control (Trash Fish), P1: Moist Feed without Probiotics, P2: Moist Feed + 0.1% Probiotics, P3: Moist Feed + 0.2% Probiotics, P4: Moist Feed + 0.3% Probiotics). Superscript letters (a,b,c,d) indicate no significant difference. Vertical lines show standard deviation.

The research results showed that the different feed treatments significantly affected the survival rate of sand lobster (P<0.05). Based on Duncan's test, survival rate for P0 did not significantly differ from P1, P3, and P4, but it significantly differed from P2. P2 showed significant differences from P0, P1, P3, and P4. P4 significantly differed from P2 but not from P0, P1, and P3.

Water Quality

Tabel 1. Presents the water quality results measured during the study.

No	Parameter	Measuring Tool	Result	Optimal	Source
1	DO (ppm)	DO Meter	5,3-6,1	>5	Patty (2018)
2	pH	pH meter	7,5-8,7	7,5-8,7	Kordi (2011)
3	Salinity (ppt)	Refractometer	30-33	30-35	Fadjar *et al*., (2022)
4	Suhu (°C)	Thermometer	24-30	27-31	Kordi (2017)

The growth in body length of sand lobster reflects the total increase in body length from the beginning to the end of maintenance. Based on the study results, the highest length growth was observed in treatment P4 (moist feed + 0.3% probiotics) with 4.76 cm, while the lowest was in treatment P1 (moist feed + 0.1% probiotics) with 3.19 cm. The addition of 0.3% probiotics in treatment P4 fulfilled the nutritional needs of sand lobster, enhancing bacterial activity in digestion and maximizing nutrient absorption. The balance between beneficial bacteria in the digestive system helped combat pathogenic bacteria, improved metabolic efficiency, and supported lobster growth.

The study found the highest absolute weight growth in treatment P4 at 62.30 g and the lowest in treatment P2 at 42.90 g. Optimal probiotic doses, as in treatment P4, enhanced the activity of Lactobacillus sp. bacteria, which significantly improved digestion and nutrient absorption. The provision of feed equal to 15% of lobster biomass further supported weight gain. These results align with findings that sufficient nutrients and high-protein content in feed significantly influence sand lobster growth rates.

The feed conversion ratio (FCR) measures the amount of feed required for weight gain over 60 days. The best FCR was achieved in treatment P4 at 5.05, while the worst was in treatment P2 at 6.69. A lower FCR in P4 indicates optimal feed utilization. Feed with adequate protein content that meets lobster nutritional needs contributes to this efficiency. Lobster growth depends on their ability to digest food effectively, and FCR is inversely related to growth efficiency.

The highest feed efficiency was observed in treatment P4 at 87.26%, while the lowest was in treatment P2 at 69.12%. The high efficiency in P4 shows that probiotics at optimal doses enhance lobster digestion and nutrient absorption. However, excessive probiotics can lead to bacterial competition for substrates, reducing feed efficiency. This study demonstrates that a 0.3% probiotic dose is optimal for improving feed efficiency in sand lobsters.

The highest survival rate was recorded in treatment P2 at 90%, while the lowest was in treatment P4 at 70%. The lower survival rate in P4 was attributed to molting and cannibalism. Molting increases lobsters' vulnerability to attacks from others. Providing shelters can reduce cannibalism risks during molting by offering adequate protection. Ensuring sufficient feed availability is also critical to minimizing cannibalism and supporting lobster survival.

Water quality significantly affects the growth and survival of sand lobsters. Parameters measured in this study included dissolved oxygen (5.3–6.1 mg/L), temperature (24°C–30°C), salinity (30–35 ppt), and pH (7.5–8.7). All parameters were within the optimal range for lobster growth. Adequate dissolved oxygen levels (>5 mg/L) supported metabolic activity, while stable temperature and salinity provided a conducive environment for growth.

This study showed that treatment P4 (moist feed + 0.3% probiotics) resulted in the best outcomes for body length, absolute weight growth, and feed efficiency. However, the lower survival rate in this treatment indicates the need for improvements, such as providing shelters to reduce cannibalism. Maintaining optimal water quality also plays a vital role in successful lobster cultivation. Adjusting probiotic doses to optimal levels is essential to avoid adverse effects such as bacterial competition and feed spoilage.

CONCLUSION

Based on the research data, the best treatment for absolute weight growth, absolute length growth, specific growth rate, feed efficiency, and FCR was P4 (moist feed + 0.3% probiotics). Meanwhile, the best treatment for survival rate was P2 (moist feed + 0.1% probiotics). The use of probiotics in lobster feed should be optimized with the appropriate dosage to achieve the best results.

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