

## Food Habits of Green Lobster (*Panulirus Homarus*) Fed with Calcium- and Phosphorus-Rich Feed Observed Using Artificial Intelligence “Smart Lobster-Culture”

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### ABSTRACT

This study aims to investigate the food habits of green lobsters (*Panulirus Homarus*) when fed with natural feed rich in calcium and phosphorus, and to assess their growth performance, survival rate, and water quality in relation to different feeding treatments. The research was conducted in 2024 at the Marine Station of Pangandaran University, located in Pangandaran Regency. The study utilized a Complete Random Design (RAL) with four different feeding treatments over 6 x 10 days: A (80% anchovy feeding), B (100% anchovy feeding), C (80% rebon feeding), and D (100% rebon feeding). The parameters observed include Growth Rate based on Length (LPP) and Weight (LPB), Survival Rate (SR), and Water Quality. Additionally, natural feed habits were monitored using the AI Smart Lobster Culture version 1. The results showed that lobsters fed with 100% anchovy and rebon (treatments B and D) exhibited the highest weight increase, with values of 61.4 and 65.1, respectively, while treatments A and C showed no significant differences. The Survival Rate (SR) across all treatments (A, B, C, and D) was excellent, with an SR of 96%. The findings indicate that both anchovy and rebon, rich in calcium and phosphorus, are effective in supporting lobster growth and survival. In conclusion, this study demonstrates that feeding green lobsters with 100% calcium and phosphorus-rich feed, such as anchovies and rebon, promotes optimal growth and survival, highlighting the importance of feed composition in lobster culture.

**Keywords:** green lobster, weight gain, survival rate, artificial intelligence version 1

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### INTRODUCTION

Lobster resources are an export commodity from the fisheries sector and are the target of catch (target species) which is quite important for fishing efforts in Indonesia, but now lobster is also cultivated. Spiny lobsters can live in tropical and subtropical seas around the world and generally inhabit rocky reefs or coral reefs in shallow water (Lipcius and Egglestone, 2000) and are mostly found in coastal waters with rocky sandy bottoms but are more commonly found in deeper waters up to 65 m (Hovel & Lowe, 2007), live in groups and are "nocturnal" (foraging at night) and during the day they hide in dark and sheltered places in holes in rocks and seagrass.

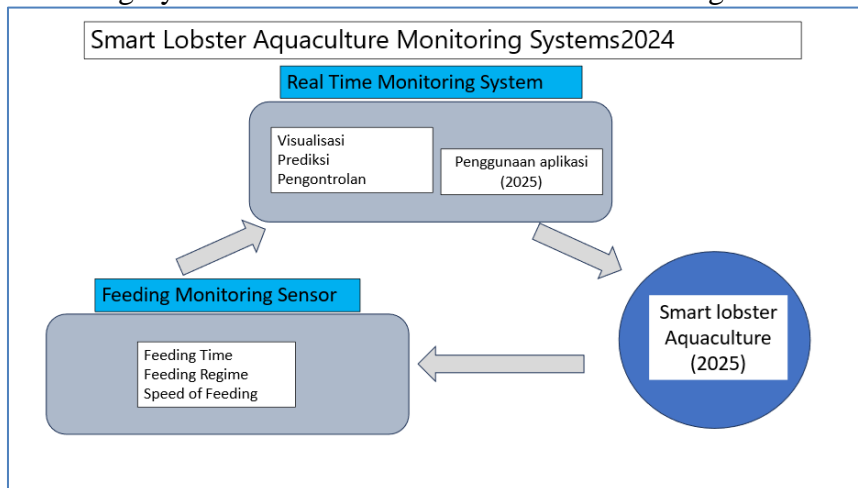
Information about the food habits of lobsters (*Panulirus* sp) can be used optimally so that steps are obtained to follow up on their existence. The habit of lobster feed (food habit) is to eat various types of food, both living and dead, including plants and animals. Seawater lobsters include omnivores, so the main feed of lobsters is mollusks, crustaceans, and detritus. Lobsters also eat zooplankton, krill, and fish larvae, in general the feed eaten is feed that contains high calcium (Amrillah, Sentanu, Andriani, & Fadjar, 2023).

Good and nutritious feed can determine the quality of lobster. The diet of species in nature is important for the formation of nutritional needs and interactions with other organisms.

Each organism in obtaining its food source is obtained in different ways. The results of the study (Radhakrishnan & Kizhakudan, 2019), stated that *P. Homarus* consumes invertebrates, sometimes feeding on coral algae (Díaz-Arredondo & Guzmán-de-Próo, 1995). Meanwhile, according to Verónica Castañeda Fernández-de-Lara et. al, 2005 stated that spiny lobster food in Mexico is in the form of Amphipoda, Gastropoda, Polychaeta, crustaceans and vegetation material. Knowing the diet in nature is important for the formation of nutritional needs and interactions with other organisms (Anggara, Kurniastuty, & Syarif, 2024).

The way lobsters get feed is as follows: lobsters swim using walking legs that have claws, then lobsters approach the source of feed, lobsters clamp the feed using walking foot claws, feed is brought to a safe place, then lobsters put the feed in their mouths. Each organism in obtaining its food source is obtained in a different way So the purpose of this study is to find out lobster feed habits that are useful for aquatic management, because feed quality is one of the factors that determine the growth of lobsters (Rita Rostika, Iskandar, Gumilar, Andhikawati, & Araf, 2023).

However, the feed habits of green lobsters raised at the East Coast of Pangandaran are not known for sure. Currently, Indonesia is one of the countries that has entered the 4.0 era, where Artificial Intelligence (AI) and the internet of Things (IoT) have begun to be used. In this era, technology has emerged to be able to help cultivators' efforts in food security (Rita Rostika et al., 2024). However, what helps ease the task of humans to learn food, feeding habits and molting lobsters has not been done much. Therefore, a series of tools have been designed that can observe the movements / behavior of lobsters related to Feeding Time and Feeding Regime (Bobadila, Syafril, & Susilo, 2023). The tool in question is the Smart Lobster Aquacultur Monitoring System with the construction as shown in Figure 1.



**Figure 1. Smart Lobster Aquacultur Monitoring System version 1.0**

### **Feed Rich in Calcium and Phosphorus**

Currently, lobster cultivation can be said to be underdeveloped because almost all of the Clear Lobster Seeds (BBL) in Indonesian waters are exported legally or illegally because they are profitable, so that the cultivation aspect is relatively lagging behind, including by Vietnam, which is one of the destination countries for BBL exports, which makes the country a world lobster producer (Putra et al., 2021).

### **Natural Feed of Sand Lobster**

Lobsters need to be fed fresh feed in the right amount and at the right time, suitable feed for lobsters based on Aquatec (2020) are minced fish, small shrimp, and crushed shellfish, however based on Rostika et al., (2020) effective natural feed containing Calcium and Phosphorus is anchovies (*Stolephorus* sp), rebon (*Acetes* sp). Feeding is carried out at 4 pm,

then cleaning the rest of the feed is carried out every morning by scooping. The Food Conversion Ratio (FCR) of lobsters is 9-18 (R Rostika, 2020).

The way to feed lobsters is ad libitum. The total feed given is approximately 20% grams per day for each experimental unit.

Research shows that natural feeds rich in Ca and P for lobster from some of the natural feed ingredients studied (anchovies, rebon, golden snails and barnacles), it turns out that the best are anchovies (increases body weight gain) and rebon (increases survival) (Ulkhay & Efendi, 2025).

**Anchovy (*Stolephorus sp*)**

They also contain large amounts of selenium, a mineral that plays a role in heart health, thyroid, immunity, and bone health. Anchovies are also a source of iron and calcium minerals. Iron is needed by the body to transport oxygen from the lungs, while calcium is important for strong bones (Amrillah et al., 2023).

Anchovies are also a source of iron and calcium minerals. Iron is needed by the body to transport oxygen from the lungs, while calcium is essential for strong bones, rich in omega-3 fatty acids. In fact, they are also considered oily or fatty fish, such as salmon, tuna, sardines, and mackerel. The nutritional content of anchovy feed is 70% protein content, 5.30% fat content and 7.60% carbohydrates (Wahjuningrum et al., 2022).

Anchovies have many vitamins and minerals that are beneficial for Health, this fish that has a strong aroma contains high vitamin B3 or niacin, a vitamin that helps convert food into energy. They also contain large amounts of selenium, a mineral that plays a role in heart health, thyroid, immunity, and bone health.

**Rebon (*Acetes sp*),**

One of the alternative feeds that can be used for feed ingredients is rebon shrimp. Rebon shrimp is easy to get because it is widely traded by the public at relatively low prices, the results of Sholicin's research, et. al. (2012), also showed that the addition of dried shrimp had an effect on fish growth.



**Figure 2. Best Calcium and Phosphorus Rich Natural Feed For Lobster**

All the food eaten will enter the stomach, then to the midgut, foregut and hind gut, before finally coming out through the anus. In general, the role of heaptopancreas is as a storage bag and initial digestion, here has begun a decrease in feed size, as well as chemical digestion which is characterized by the presence of digestive juices and enzymes. Feed that was originally complex in structure and molecules has been simplified, and is ready to be absorbed (RIVAIE, 2022).

Furthermore, the digested feed enters the foregut, midgut, and hindgut, here the biological digestion process occurs which is characterized by the presence of small bodies that help the digestive process. Then there is a process of absorption of molecules that have been digested to become simpler to enter the blood vessels by "active transport" to be disseminated

to the body's cell cells. Indigestible feed is brought to the anus to be expelled (Soffa, Pratama, Ridwanudin, & Fahmi, 2019).

Undigested feed is generally a complex material that is difficult to break down physically, chemically and biologically, usually in the carbohydrate/fiber group. What feed do lobsters like in nature? Based on the analysis of the stomach contents of lobsters from nature, it can be seen that the 'prey' in nature are zooplankton, krill, filter feeder animals, fish larvae that contain a lot of protein, minerals and enzymes. If we cultivate lobsters, we should be given chopped rucuh fish, small shrimp, squid and shellfish that are crushed in a fresh state, as much as 10 percent of the weight of the lobster per day.

Lobsters will attack their fellow lobsters if they are not given enough and fresh feed. Therefore, lobsters need to be given fresh food in the right amount and at the right time, besides that lobster cultivation containers need to be added shelters to hide. Knowing the best type of natural feed for juwana/juvenile size lobsters, whether anchovies (*Stolephorus* sp) or rebon (*Acetes* sp) in various doses to produce good growth and survival rate. Knowing the extent of the influence of the AI Smart Lobster Culture technology in terms of observation: natural feed of lobsters raised in cages 5 meters below sea level.

The urgency of this research lies in the growing demand for sustainable and efficient lobster cultivation practices, especially as Indonesia continues to be a key player in the global lobster market. Given the increasing pressure on wild lobster populations and the need for more effective aquaculture methods, understanding the dietary needs and habits of green lobsters (*Panulirus Homarus*) is crucial for improving production practices. The findings from this study are vital for addressing the challenges in lobster farming, including optimizing growth rates, improving survival rates, and reducing the dependency on wild-caught juvenile lobsters.

While there has been research into lobster feeding habits, particularly regarding the effects of calcium- and phosphorus-rich feed, there is limited research focusing on the specific food habits of green lobsters (*Panulirus Homarus*) raised in aquaculture systems. Existing studies often generalize feeding practices or focus on species such as the spiny lobster without specifically addressing green lobsters, which have different feeding preferences and growth patterns. This study aims to fill the gap by focusing on green lobsters and evaluating the effectiveness of anchovies and rebon shrimp as feed sources in enhancing their growth and survival rates.

The novelty of this research lies in the application of Artificial Intelligence (AI) and IoT-based monitoring systems, specifically the Smart Lobster Aquaculture system, to observe and analyze the food habits of green lobsters. Unlike traditional methods that rely on manual observation, this technology offers real-time data on feeding behaviors and environmental factors, providing more accurate insights into the lobster's dietary needs. By combining AI with natural feed experiments, this study introduces a modern, technological approach to lobster aquaculture, setting it apart from conventional studies.

The main objective of this research is to analyze the food habits of green lobsters (*Panulirus Homarus*) when fed natural feed rich in calcium and phosphorus, specifically anchovies and rebon, and to evaluate their growth and survival rates. The study aims to provide actionable recommendations for improving lobster cultivation practices and enhancing aquaculture efficiency. The benefits of this research include the development of more sustainable lobster farming practices, better feed management strategies, and the use of technology to monitor and optimize lobster growth. These insights will contribute to the long-term sustainability of lobster farming, improving both the economic viability and ecological impact of the industry.

**METHOD**

The research design/design and the selected research method are quantitative Complete Random Design (RAL) for testing a combination of Calcium and Posfor-rich feed types. The tools used in research activities are; KJA cage size M, boat, digital scale (0.1 grams), a set of tools to build an AI (Smart lobster culture) system, thermometer, scissors, freezer, waring, refractometer, pH meter, DO kit, bucket, brush, rag, pot, basket, gloves, seser, weight, and 5 cm plastic rope. The materials used in the research activities are; Sand Lobster (*Panulirus homarus*) measures between 60 grams - 80 grams, Anchovies (*Anchoviella* sp), Rebon (*Acytes* sp) salt, ice cubes, white sand, newsprint, and water.

**Data collection techniques**

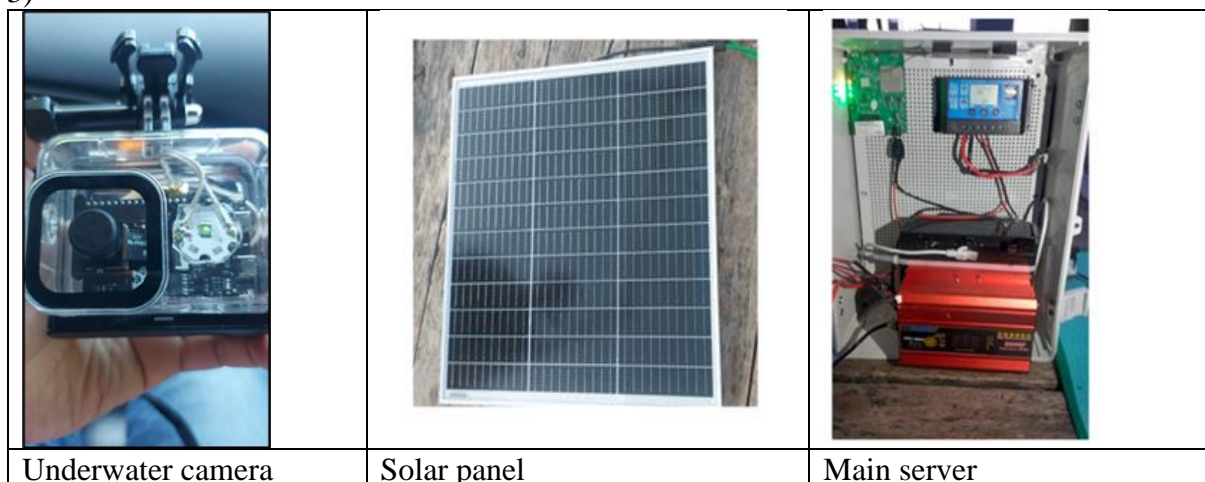
The preparation stage for lobster cultivation begins with the procurement of KJA fittings, the installation of KJA and the sinking of KJA carried out for 4 months. After the KJA is ready, the next thing is the procurement of AI support equipment, then juwana-sized lobsters and natural feed (anchovies, rebon). Lobsters that are cultivated for 2 months are measured in weight every 10 days. Observation of feed and feeding habits is carried out weekly in each cage. Water quality measurements at KJA are measured at the beginning and end of activities.

This research method is a Complete Random Design method with 4 treatments and as a replica is the number of lobsters cultivated in each treatment, which is about 25 lobsters each. The difference in response from lobster was analyzed using the F statistical test, if there is a difference in eating, a further test will be carried out. Juvenile lobster cultivation is carried out for 60 days. The two designs used in this study were a Complete Randomized Design (RAL) consisting of 4 treatments and 25 replicates (the number of individuals in each cage). The treatment is as follows:

- A : juvenile lobster fed anchovies 80%
- B : juvenile lobster fed with 100% anchovy feed
- C : juvenile lobster fed rebon 80%
- D : juvenile lobster fed 100% rebon feed

**Smart Lobster Aquaculture version 1**

The following is a tool that has been assembled to become Smart Lobster Aquaculture (Figure 3)



**Figure 3. Smart Lobster Culture version 1**

**Observation Variables**

1. Weight gain (PB)

$$PB = (Wt - Wo)$$

Information:

PB : Weight gain (gr)

Wo : the average length of lobsters at the beginning of the study (g)

Wt : the average length of the lobster at the end of the study (g) Lobster survival

$$2. SR = \frac{Nt}{It} \times 100\%$$

Information:

SR : Fish survival (%)

Nt : Number of fish alive at the end of the study (tail)

It : Number of fish at the beginning of the study (tail)

The water quality parameters observed are Dissolved oxygen, pH and salinity

**RESULTS AND DISCUSSION**

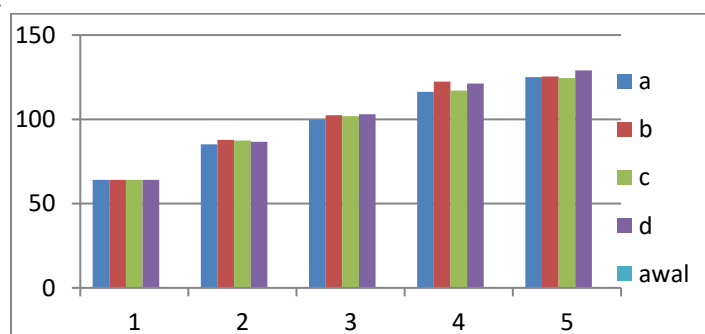
**Weight Gain Lobster body fed with various types of natural feed**

Natural feeding has been carried out where the response of the lobster is as follows:

**Table 1. Lobster weight (grams) in response to the administration of various types of natural feed with various doses for 40 days**

Treatment	A/anchovy feed 80%	B/anchovy feed 100%	C/feed rebon 80 %	A/anchovy feed 100%
T0	64	64	64	64
T 1	85,2	87,9	87,5	86,6
T 2	99,7	102,5	101,8	103,1
T 3	116,4	122,3	117,1	121,3
T 4	125,1	125,4	124,5	129,1
Delta	61,1	61,4	60,5	65,1

Based on the data in Table 2, it appears that the weight of lobsters after 4 x 10 days/weight subjected to different natural feed treatments is not different. An image of the bar chart is shown in Figure 4.



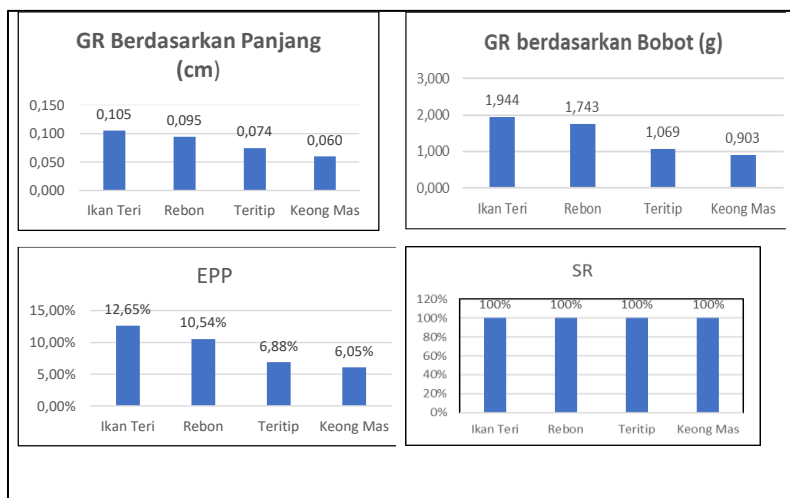
**Figure 4. Bar diagram of lobster weight gain in A,B,C and D treatment**

From the figure, it appears that every time the weight is measured, there is a significant increase, this shows that the natural feed given is able to be converted into lobster meat. There was a significant enlargement in treatment D, namely the administration of rebon shrimp with a delta weight of 65.1 grams (Table 1).

The development of good and profitable lobster cultivation is the one that produces lobster production with a good survival rate and growth rate. Lobster cultivators in Lombok, the Lobster Survival Rate ranges from 40-50% (Priyambodo, 2021, personal communication).

The biggest challenge today is besides feed rich in Calcium and Phosphorus that is suitable for food and feeding habits, but it is difficult to do because lobsters are cultivated in cages that are 5 meters below sea level

Based on data obtained from previous research (Rostika, 2023), it can be seen that a good parameter is lobsters fed with anchovies and rebon, as seen in Figure 5.



**Figure 5. Growth Rate based on Length and Weight, Feed Efficiency and Survival Rate Lobster Initial Size 75 grams fed with natural feed rich in Calcium and Phosphorus (anchovies, rebons, barnacles and golden snails). Source : Rostika et al (2023)**

In general, based on Figure 4, it can be seen that the natural feed of anchovies and rebon provides the best parameters on the Growth Rate and Feed Efficiency of green lobster, compared to barnacles and golden snails. Anchovy protein is composed of several kinds of essential amino acids, the most prominent essential amino acids are isoleucine, leucine, lysine and valine. The nutritional value contained in 100 g of anchovies is energy 77 kcal, protein 16 g, calcium 500 mg, phosphorus 500 mg, and iron 1 mg (Ministry of Health, 2005). Dried shrimp contains about 59.4 grams of protein per 100 grams. In addition to protein, rebon shrimp also contains various minerals, such as calcium, phosphorus, and iron. Here are some of the benefits of shrimp for health, namely helping to maintain the density and strength of the bone system, helping to maintain muscle health, helping to strengthen the immune system, helping growth and development, The survival rate of lobsters with these 4 treatments is equally good at 92% ((Table 2)

**Table 2. Lobster Survival Rate Data with 3 treatments (%)**

Treatment	A/anchovy feed 80%	B/anchovy feed 100%	C/feed rebon 80 %	A/anchovy feed 100%
Initial (T0)	25	25	25	25
Total (T30)	24	24	24	24
%	96	96	96	96

Based on data in the field, the SR of lobsters after being kept for 40 days is 92%. This shows high SR data, compared to data elsewhere, with an average of 50%. This is due to the natural feed of anchovies and rebon which is rich in the mineral Calcium which plays a role in increasing lobster immunity.

**The results of food *habit* observation using Smart Lobster Aquacultur are as follows.**

*Panulirus homarus*, also known as sand lobster, is an omnivorous crustacean that feeds on a wide variety of foods, including: mollusks, worms, sea urchins, starfish, fish, macroalgae, small crustaceans, and detritus.

Lobsters are opportunistic eaters and generally eat fresh food, but they are also known as cannibals. In this research, the two types of natural feed, namely anchovies and rebon, are both preferred. They are most active at night, and their eating behaviors usually include looking at food, grasping food with its claws and feet, breaking food into small pieces with its paws, moving food to its mouth with its jaws.

The availability of food and shelter is important for the survival of lobsters. If this is not present, the lobsters can become more cannibals, which can lead to many deaths inside the rearing container. Gdrive for observation results using underwater CCTV is as follows: [drive.google.com/drive/folders/1-fA\\_JQpTgN9RIU\\_SceeC4LrPdIzahShv](https://drive.google.com/drive/folders/1-fA_JQpTgN9RIU_SceeC4LrPdIzahShv). You can see the food habits of lobsters when fed natural feed.

**CONCLUSION**

Lobster cranes using natural feed that is high in Calcium and Phosphorus as much as 100% is the right dose. There was a significant weight increase in treatment D, namely the administration of shrimp with a delta weight of 65.1 grams (food habit). The monitored lobster feed habit data is that lobsters are nocturnal eaters with the habit of eating them and liking both types of natural feed (anchovies and lobsters).

**REFERENCES**

- Amrillah, Attabik Mukhammad, Sentanu, I. Gede Eko Putra Sri, Andriani, Dwi Retno, & Fadjar, Mohamad. (2023). Aplikasi Teknologi Underwater Lobster Apartment Untuk Pembesaran Lobster Pasir (*P. Homarus*) Pada Kelompok Pembudidaya Ikan (Pokdakan) Pesona Bahari, Banyuwangi, Jawa Timur. *Journal Of Innovation And Applied Technology*, 9(1), 25–30.
- Anggara, Heru, Kurniastuty, Kurniastuty, & Syarif, Ahmad Fahrul. (2024). Pembesaran Lobster Pasir (*Panulirus Homarus*) Di Balai Besar Perikanan Budidaya Laut, Lampung. *Amreta Meena*, 1(2), 10–16.
- Bobodila, Nadia Audy, Syafril, Muhammad, & Susilo, Heru. (2023). Analysis Of The Farming Culture Of The Pearl Lobster (*Panulirus Ornatus*) And Bamboo Lobster (*Panulirus Versicolor*) In Floating Net Cages At The Bontang Eta Maritime Fishermen Cooperative In Bontang City. *Fish Scientiae*, 13(2), 267–279.
- Díaz-Arredondo, M. A., & Guzmán-De-Próo, S. A. (1995). Feeding Habits Of The Spiny Lobster (*Panulirus Interruptus* Randall, 1840) In Bahía Tortugas, Baja California Sur. *Ciencias Marinas*, 21(4), 439–462.
- Hovel, Kevin, & Lowe, Chris. (2007). *Shelter Use, Movement, And Home Range Of Spiny Lobsters In San Diego County*.
- Putra, Riswanda Rangga, Nugraha, Dimas Putra Wahyu, Albarkah, M. Rafly, Ma'arif, M. Chusnan, Fatih, M. Fachrul, Hadi, Moch Irfan, Violando, Wiga Alif, & Nusa, Raras Widya. (2021). Budidaya Lobster (*Panulirus* Spp.) Di Indonesia. *Biometric*, 1(03), 205–2011.
- Radhakrishnan, E. V, & Kizhakudan, Joe K. (2019). Health Management In Lobster Aquaculture. *Lobsters: Biology, Fisheries And Aquaculture*, 571–601.
- Rivaie, Arief Rahman. (2022). *Kajian Penggunaan Pakan Berbeda Pada Pendederan Benih Lobster Pasir, Panulirus Homarus (Linnaeus, 1758) Dalam Panti Nurseri Terkontrol*. Universitas Lampung.
- Rostika, R. (2020). Pentingnya Penentuan Lokasi Budidaya Lobster. *Investor Wajib Tahu*.
- Rostika, Rita, Iskandar, Iskandar, Gumilar, Iwang, Andhikawati, Aulia, & Araf, Muhammad Hafizh. (2023). The Effect Of Different Submerged Cage (Vietnamese Style) Depth On The Growth Of Green Lobster (*Panulirus Homarus*) In The East Coast Of Pangandaran District. *Journal Of Social Research*, 2(9), 2990–2999.
- Rostika, Rita, Maulida, Yulvina, Zidni, Irfan, Cu, Mochhammad Ihsan, Khan, Alexander M., & Pasaribu, Buntora. (2024). Growth And Gastrointestinal Conditions Of Green Lobster (*Panulirus Homarus*) With Different Natural Feeding, Which Are Raised In A Longline Submerged Cage System On The East Coast Of Pangandaran Regency. *Journal Transnational Universal Studies*, 2(2), 98–109.
- Soffa, Fawzan Bhakti, Pratama, Idham Sumarto, Ridwanudin, Asep, & Fahmi, Varian. (2019). Color Alteration And Growth Performance Of Spiny Lobster (*Panulirus Homarus*) Juveniles Fed With Different Spirulina Concentration In Formulated Diet. *Oldi (Oseanologi Dan Limnologi Di Indonesia)*, 4(2), 101–112.
- Ulkhag, Mohammad Faizal, & Efendi, Irzal. (2025). Pemeliharaan Lobster Pasir (*Panulirus Homarus*) Menggunakan Keramba Jaring Dasar Di Perairan Selat Bali. *Jago Tolis: Jurnal Agrokompleks Tolis*, 5(1), 1–8.
- Wahjuningrum, Dinamella, Effendi, Irzal, Hadiroseyani, Yani, Budiardi, Tatag, Diatin, Iis, Setiawati, Mia, Hastuti, Yuni Puji, Sudrajat, Agus Oman, Nuryati, Sri, & Utami, Putri. (2022). Health Status Of Spiny Lobster *Panulirus Homarus* With Sub-Mersible Net Cage System In The Different Depths At Kepulauan Seribu, Dki Jakarta. *Jurnal Akuakultur Indonesia*, 21(1), 68–80.