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Growth Rate and Survival of Juvenile Sea Horses (Hippocampus Comes) with Different Natural Feeds in the Hatchery

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Abstract

Seahorses are marine ornamental fish with high economic value. This has led to an increase in market demand and high levels of capture in the wild. To address these issues, conservation efforts through restocking of these organisms are necessary. One of the efforts that can be undertaken is seed production in hatcheries, through controlled rearing of seahorse juveniles in laboratories with different natural feeds. The objective of this research is to determine the growth, survival rate, and the effect of different natural feeds on the growth and survival rate of seahorse juveniles in hatcheries. The research method used is a laboratory experiment. This study employed a completely randomized design (CRD) with 3 treatments and 3 replications. The natural feed treatments used were (A) Artemia, (B) Copepoda, and (C) Artemia + Copepoda (50:50%). The results of the research show that the best average growth in length of seahorse juveniles is found in treatment with natural feed C (a combination of Artemia + Copepoda) or an increase in length of 9.06 mm/week. The highest survival rate of seahorse juveniles (76%) is also found in treatment C. The analysis results indicate that natural feed significantly affects the growth and survival rate of seahorse juveniles.

Keywords: *Seahorse (Hippocampus Comes); Juveniles; Growth; Survival Rate; Natural Feed; Hatchery.*

1. Introduction

Seahorses, usually called horse tangkur, are a type of marine ornamental fish. Seahorses (Hippocampus sp.) have high ecological and economic value. Ecologically, it can function as a value for species diversity in a community. Economically, this biota has a high selling price because, apart from being kept as ornamental fish in aquariums, it is also used as antique objects and raw materials for efficacious traditional medicines (Vincent et al., 2011; Duthie et al., 2018; Namvar et al., 2018; Namvar et al. ., 2019; Rahman et al., 2020; Koning and Hoeksema, 2021). Prices for live seahorses collected from various sources in 2024, including online buying and selling sites, for example, yellow seahorses (Hippocampus horses) in live condition cost around IDR 100,000 per head, and dried seahorses per 10 grams cost between IDR 100,000 and 150,000.

Related With their high ecological and economic value, the demand for seahorses, both dry and live, is increasing. This also has an impact on the high catch and the number of seahorse populations in nature, which have decreased drastically. Although there are efforts to reduce the wild catch of seahorses through cultivation, many traditional fishermen still rely on the wild catch. Conservation efforts and international trade regulations such as CITES have helped regulate and reduce pressure on wild seahorse populations, but these practices still continue in many places (Koldewey and Martin-Smith, 2010; Vincent et al., 2011; Wandasari et al., 2024).

One way to overcome the increase in fishing is to carry out cultivation. Cultivation requires the availability of seeds in sufficient quantities, on time, of good genetic quality, free of disease and pathogens, and sustainable (Boyd and McNevin., 2015; Gjedrem et al., 2012; Wedemeyer, 2002; DeLong et al., 2016). Seed availability can be achieved artificially in hatcheries. The advantage of seed from a hatchery is that it can be mass produced, continuously controlled, and the size is uniform and does not depend on the season. The quality of hatchery seeds is very dependent on the quality of the parents (genetics), eggs, water, and feed (nutrition) provided (Ahmad et al., 2019; Cartagena, 2014; Erlangga et al., 2019; Koldewey and Martin-Smith., 2010; Job et al., 2002).

One of the limiting factors for keeping juvenile seahorses in a hatchery is feed. Types of feed consist of natural and artificial feed. Artificial feed is in the form of pellets, which can be modified for their nutritional content. Only the remaining pellet feed can reduce water quality if not managed properly. Meanwhile, natural food is more environmentally friendly, and its attractive movements really attract predatory biota to eat. The types of natural food commonly given are zooplankton, including Diaphanosoma, Artemia, Copepoda, and Rotifera

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(Setyono, 2020). Food availability needs to be considered, especially during the juvenile phase, because this phase is a critical period in the development of seahorses. Juwana are just starting their lives and receiving food intake from outside. Food functions as a source of energy for the life, growth, and development of seahorse juveniles.

According to Garcia-Manchón et al. (2013), Garcia and Garrick-Maidment (2010), Shields and Lupatsch (2012), and Kim et al. (2022), seahorses' main natural food is small crustaceans, such as Copepods, Rotifera, Artemia (Brine Shrimp), Amphipods, Carideans, and Mysid Shrimp, whose size corresponds to their mouth opening. Copepod nutrition is very good for marine fish larvae and has good quality. Copepods have a high protein content (44–60%) and a good amino acid profile (Militz et al., 2013; Lee and Frost., 2002; Lavens and Sorgeloos., 1996). Artemia is commonly used as feed for juvenile seahorses (larvae) because it has high nutritional content (40–60% protein), appropriate size, attractive appearance, high palatability, is easy to cultivate, and increases survival and growth rate (Dhont and Van Stappen. , 2003; Sorgeloos et al., 2001; Palma et al., 2023). Based on these considerations, it is necessary to carry out research to obtain information regarding the type of natural feed that is best given to juvenile seahorses (Hippocampus comes) in the hatchery.

The aim of this research is to find out the best type of natural feed for the growth rate and survival rate of juvenile seahorses.

2. Material and Methods

The research was carried out from January to March 2021 at the Seahorse Hatchery of the Lampung Center for Marine Aquaculture (BBPBL). Research stages include:

2.1. Preparation

Prepare research facilities, such as a 20-liter plastic container filled with 10 liters of seawater, then arrange it in a 1-ton fiberglass tub and give it aeration as a source of oxygen.

2.2. Provision of Natural Feed

The natural feed used to treat juvenile seahorses is zooplankton, namely Artemia salina and Copepoda. Hatching of artemia eggs or cysts is done by immersing the cysts in a plastic container filled with sea water with a cone-shaped bottom and providing aeration. The aim of using aeration is so that the eggs do not settle to the bottom and get enough oxygen. After 15 hours, the eggs will start to hatch. To get maximum results, the media used for hatching is given lighting and aeration so that it can stimulate the development activity of A. salina embryos (Sukardi and Winanto, 2011). nature (pond) using a 0.5-mm planktone. Next, the copepods are accommodated in a container in the form of a fiberglass tub and given aeration to meet oxygen needs (Al Qodri et al., 1997).

2.3. Preparation of Test Animals

The biota used in this research are juvenile seahorses. The hippocampus comes 1-2 days old after leaving the stomach of the male seahorse and has a length of 8 mm. Each research medium was filled with 25 juvenile seahorses or containers (Aslianti et al., 2010; Al Qodri et al., 1997).

2.4. Maintenance of Test Animals

Maintenance of test animals was carried out for 28 days using a stagnant water system with added aeration. The addition of water media is only done to replace water lost due to evaporation or siphoning so that the water surface level of the media is maintained constant (Effendi and Mulyadi., 2002). Every 4 days, siphoning is carried out at the base of the media to clean feces, food remains, and other impurities (Al Qodri et al., 1997).

2.5. Experimental Design

The experimental design used was a completely randomized design (CRD) with 3 treatments and 3 repetitions. Feeding uses 3 different natural zooplankton food treatments, namely (A) Artemia, (B) Copepods, and (C) Artemia + Copepods (50:50).

Food is given twice a day at 100 mL per day (morning 50 mL and afternoon 50 mL). It is known that the density of zooplankton is 3–4 individuals/mL (Redjeki, 2007).

2.6. Research Parameters

The parameters measured were the growth and survival of seahorse juveniles.

a) Length Growth

Length growth of seahorse juveniles was carried out using a micrometer by randomly taking samples of seahorse juveniles from the research container and then transferring them into a small container. filled with seawater and given millimeter blocks, then the total body length was measured from the tip of the snout to the gill slits plus from the gill slits to the tip of the tail perpendicularly (Al-Qodri et al., 1998).

Total length growth (TL) was calculated from the difference between the length at the end of the observation (Lt) and the length at the beginning of the observation (Lo), or with equation (1) as follows:

$$TL = Lt - Lo \quad \text{(1)}$$

b) Survival Growth Rate

Specific length growth rate is the growth in length of seahorse juveniles over a certain period of time and is calculated using equation (2) Crane et al. (2020) as follows:

$$SGR = \frac{Ln\ Lt - Ln\ Lo}{\Delta t} x\ 100\% \quad \text{(2)}$$

Description:

SGR: Specific length growth rate of seahorse juveniles (%/day)

Lt: Total length of seahorse juveniles on day t (mm)

Lo: Total length of seahorse juveniles on day 0 (mm)

Δt.: Length of observation time (days)

c) Survival Rate

The survival of seahorse juveniles is calculated at the end of the observation by calculating the percentage of the number of seahorse juveniles still alive at the end of the observation (Et) divided by the number at the beginning of the observation (E0) or by equation (3) (Santoso, 2006) as follows:

$$SR = \frac{Et}{Eo} x\ 100\% \text{...}(3)$$

2.7. Data Analysis

The data obtained was tabulated and analyzed descriptively to determine the effect of natural food on the growth and survival of juvenile seahorse, data analysis was carried out using ANOVA, if there was a significant difference between treatments (P<0.05), then a further test with Tukey was carried out. Data Processing was carried out using SPSS software.

4. Results and Discussion

4.1. Results

4.1.1. Length Growth

The results of observations made during rearing showed that the highest average length of seahorse juveniles was in treatment C (Artemia + Copepoda), and the lowest length growth was in treatment B (Figure 1). Based on observations, it is known that the growth in length of juvenile seahorses increases every week, along with increasing maintenance time. Treatment A experienced an average increase in length of 3.6 mm/week, treatment B experienced an increase of 6.8 mm/week, and treatment C experienced an increase of 9.06 mm/week. Based on the results of the analysis of variance (Anova) and Tukey's test, it shows that natural food treatments A (Artemia), B (Copedoda), and C (Artemia + Copedoda) have a significant effect (P < 0.05) on the growth in length of seahorse juveniles.

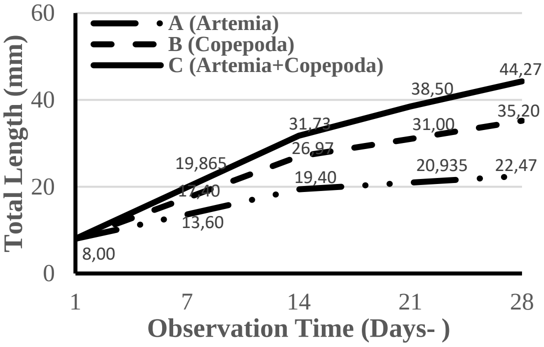

Figure 1. Average Total Length of Seahorse Juveniles

4.1.2. Spesific Growth Rate

Based on the results of observations made during rearing, it showed that the specific length growth rate of seahorse juveniles was highest in treatment C and the lowest in treatment B (Figure 2). It is known that the highest specific length growth rate on day 28 was in treatment C, which experienced daily growth of 6.11%. Treatment B (copepod feed) experienced daily growth of 5.29%, whereas the lowest specific length growth was in treatment A (artemia feed), with daily length growth of 3.69%.

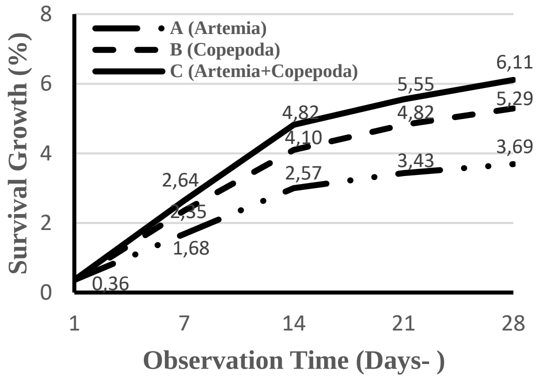

Figure 2. Average Spesific Growth Rate Seahorse

4.1.3. Survival Rate

Based on observations during the research, it was found that the survival rate of juvenile seahorses in treatment A was 53.3%, in treatment B it was 60%, and in treatment C it was 76% (Figure 3). The results of the analysis of variance (Anova) and Tukey's test showed that natural food treatments A (Artemia), B (Copedoda), and C (Artemia + Copedoda) had a significant effect (P < 0.05) on the survival of juvenile seahorses.

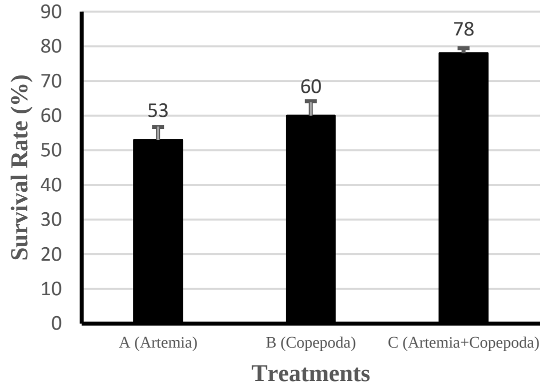

Figure 3. Survival rate seahorses juvenile

The results of water quality measurements during maintenance, including temperature, salinity, pH, and DO, show that the range is still suitable for the growth and survival of juvenile seahorses Table 1.

Table 1. Water quality of seahorse juvenile rearing media.

Treatments	Parameters			
	Temperature (ºC)	pH	Salinity (ppt)	DO (mg/l)
A	27-29	7,1-8,2	32-33	5,3-6,5
B	26,8-28	7,7-8	33-36	4,1-5,8
C	26-29	7,8-8,2	33-35	4,1-5,6

4.2. Discussion

4.2.1. Length Growth

The growth in length of juvenile seahorses (hippocampuses) per month can vary. At the age of 1–3 months, juvenile seahorses can grow around 10–15 mm per month, then slow down to 5–10 mm per month for the next three months or 4–6 months of age, and after 7–12 months, the growth is around 2–5 mm per month (Foster and Vincent, 2004; Kuiter, 2000; Woods, 2000). The length growth of seahorse juveniles in this study is still in the same range as in several previous studies, such as BBL (2005), where seahorse juveniles kept in hatcheries with a length of between 6 and 7 mm and a rearing period of 30 days can reach a length of 20 and 35 mm. with a weight between 0.195 and 0225 gr.

The growth in length of seahorse juveniles is different in each treatment; it is suspected that each type of feed has a different nutritional content, so the effect on the growth of seahorse juveniles is also different. According to Payne and Rippingale. (2000), the correct type, quality, dosage, and frequency of feeding greatly influence the determination of success during the rearing of juvenile seahorses.

Based on the results of observations, it was found that the average growth in length of seahorse juveniles in treatment C had a higher growth in length compared to other treatments. This is because the feed in treatment C has more complete nutritional content than other treatments, considering that the feed given is a combination of Artemia nauplii and Copepoda. According to Epram et al. (2022), Artemia nauplii has a protein content of 60.01%, a fat 3.26%, and a and a fiber content of 8.40%. Copepods have a protein content of 29% fat, 10% carbohydrates, 17% protein, and 34% minerals. Meanwhile, the slowest growth occurred in juveniles given treatment A (Nauplii arthemia). This is because Artemia has good nutritional content, but its agile movements make it difficult for juvenile seahorses to catch food. According to Redjeki (2007), juvenile seahorses are visual feeders, namely biota that rely on their eyesight and then suck up the food around them and cannot move quickly. While the copepod feed is higher than the artemia feed, it is suspected that the copepods move more attractively, thereby increasing their appetite. juvenile seahorse. In accordance with Nugraha's (2011) statement, the copepod's movements are agile, namely short, broken zig-zag glides, and they have a flexible, fat, long, and large body with a short tail, making juvenile seahorses able to catch prey easily. Apart from that, the fat and mineral content in Copepods is higher than Artemia, where fat and minerals can meet the body's calorie needs. According to Nasution (2002), it is known that the growth process is not only triggered by the high protein value but is also influenced by the fat content. The fatty acid content in feed is very important, namely because it can influence growth, feed quality, and the survival of marine biota. Fat is the largest source of energy for the body's biota. For the maintenance of the body, energy can be obtained from fats and carbohydrates. Therefore, limited fats and carbohydrates can be used to replace the role of protein as an energy source in body maintenance (Aslianti et al., 2010). According to Iswandi (2021), in general, the functions of minerals include being a basic element of the exoskeleton, maintaining balance in osmotic pressure, being a basic element in tissue structure, playing a role in central nervous transmission and muscle contraction, being a component of enzymes, vitamins, hormones, pigments, cofactors in metabolism. , catalysts, and enzyme activity. One of the minerals needed by marine biota larvae to support growth is the mineral phosphorus.

4.2.2. Survival Growth Spesific Rate

As observed in other studies, growth of juvenile seahorses increases with age, growth slows after the first few months, and growth tends to slow significantly after 7–12 months of age or after a period of rapid initial growth. Under optimal conditions, juvenile hippocampus can grow around 1.2–1.5 cm per month (Kuiter, 2000; Woods, 2000). Santoso's (2006) research on rearing juvenile seahorses fed artemia naupli enriched with squalene showed an average growth rate of 5.03–5.43% per day.

The growth rate in treatment C (combination feed) was better than in treatment On the other hand, this is thought to be because the combination feed given is able to meet the nutritional needs required by juveniles. In accordance with Al Qodri's statement (1997), seahorses are stenophagic; this is because the juveniles have a habit of liking and eating a wide variety of feed. It is also suspected that the nutritional needs of juveniles will be met by consuming a combination of feeds. Fitrianingsih (2013) believes that combination feed provides the best growth compared to single feed because the combination of two or more types of feed can provide better nutritional needs and suit the needs of biota.

Al Qodri et al. (1997) and Sukardi and Winanto (2011) stated that one of the factors that influences growth rate is the type of feed. If the feed given is of good quality and fits the mouth opening, then the feed will be useful and can be consumed well. According to Redjeki (2007), seahorse juveniles have a mouth opening size of 300.24 ± 30.47 µm. Copepods themselves have a size of ±174 µm, so juveniles can prey on them. Meanwhile, the size of Artemia is ± 400 µm, or 0.4–0.5 mm (Tombinawa et al., 2016; Sukardi and Winanto, 2011), which makes it difficult for juveniles to catch and eat prey. In this research, juvenile seahorses in treatment A or fed Artemia grew the slowest.

4.2.3. Survival Rate

In optimal captive conditions, where factors such as water quality, temperature, and food can be controlled, the survival rate of juvenile hippocampus can increase to 50–70% or even higher (Koldewey and Martin-Smith, 2010; Woods, 2000). According to Al Qodri (1998), the survival rate of juvenile seahorses kept in hatcheries is around 70%, while for fry, the survival rate ranges from 40–50%. Santoso's (2006) research on rearing juvenile seahorses fed artemia naupli enriched with squalene showed survival between 53.30 and 69.97%.

In this study, the survival rate of juvenile seahorses was between 53.30 and 76.00%. Treatment C (a combination of Artemia and Copepoda feed) showed the highest survival compared to other treatments. This is because giving combination feed is more effective in meeting the nutritional needs required, especially to support survival and growth, when compared to the nutritional content contained in single feed. Meanwhile, in treatment A, survival was the lowest (53.3%) compared to other treatments. This is thought to be because Artemia's agile movements and relatively large size make it difficult for the juveniles to get food, and it is thought that the juveniles' ability to move at the start of rearing is still slow, making it difficult to find food. (Redjeki, 2007). Maintaining environmental factors in the rearing media can also support survival and reduce stress conditions that allow death to occur during rearing (Yustianti, 2013).

According to Asri et al. (2019), the death of juveniles at the beginning of rearing is usually caused by juveniles still in the process of adapting to the conditions of the rearing environment, and the habit of juveniles wrapping their tails around other parts of the juvenile's body or on the substrate can make it difficult for juveniles to move and get food. According to Romimohtarto and Juwana (2001), factors that influence the survival of biota include water quality, competition between species, age, and the ability to adapt to the environment. and DO shows relatively stable numbers, so it can still support it as a medium for rearing juvenile seahorses. The results of temperature measurements during maintenance ranged from 26–29 ºC; this temperature corresponds to the optimum temperature in nature and in the laboratory. According to Syafiuddin et al. (2011), a temperature of 28 ºC is the optimum temperature for the development of juvenile seahorses. The salinity value during maintenance is between 33 and 35 ppt. According to Syukri (2016), salinity greatly influences the osmoregulation process, namely the efforts of aquatic biota to control the balance of water and ions between the body and the environment. The pH value during maintenance is 7.70–7.90. According to Al Qodri et al. (1997), a good water pH for captive seahorse juveniles is between 7.0 and 8.5. Meanwhile, the dissolved oxygen (DO) value during maintenance is around 4.10–5.2 mg/l. Almost the same condition was stated by Al Qodri (1998): good dissolved oxygen for cultivated seahorse juveniles is between 5.10 and 6.40 ppm. During the metabolic process, aquatic biota requires energy obtained from dissolved oxygen for the osmoregulation process.

4.3. Effect of Feed on Growth and Survival

Research shows that giving Artemia and copepods as the main food for seahorse juveniles increases the survival rate and growth rate of juveniles when compared to other feeds (Sheng et al., 2006; Olivotto et al., 2011; McCauley et al., 2017).

4.3.1. Effect of Length Growth

When rearing juvenile seahorses, providing natural food such as artemia and copepods has a significant effect on growth. According to the statements of Lin et al. (2007), Santoso (2006), and Schubert et al. (2016), providing different natural foods not only influences seahorse growth but also influences gonad development. The combination of natural feeds has complete nutritional content and meets the needs of biota. The growth of juvenile seahorses is not only influenced by feed nutrition but is also influenced by the availability, quantity, and size of feed.

Some authors, such as Schubert et al. (2016), Payne and Rippingale (2000), and Celino et al. (2012), have indicated relatively high survival rates and growth rates in young seahorses reared on copepods. However, copepod-based rearing is expensive due to fluctuating survival and reproduction rates in copepod cultures (Lavens and Sorgeloos, 1996; Kaminski et al., 2014). Therefore, feeding protocols for seahorse larvae are generally based on a mixed diet of rotifers, copepods, and/or strains of brine shrimp, Artemia spp.

4.3.2. Effect of Feed on Survival Rate

According to Sukardi and Winanto (2011), feed is a limiting factor for cultivated aquatic biota because their movement is limited and there is not enough natural food available as in nature, so the need for feed is very dependent on what the farmer provides. This causes natural foods to have a real influence on each treatment. According to Maryam et al. (2015), to obtain good survival, it is necessary to provide the right natural food, both in the right amount, size, and nutritional content.

Yusup et al. (2015) said that the factors that influence the survival rate of aquatic biota are the quality of feed and the quality of water in the rearing media. Natural food given to cultivated biota does not cause changes in water quality because natural food given in sufficient quantities is usually consumed directly by juveniles. During maintenance, the droppings are also carried out regularly, filtering out food remains that are not eaten by the juveniles, so that water quality conditions are maintained and the juveniles can adapt well. In accordance with the statement by Hasanah et al. (2020), the survival of marine biota is very dependent on the adaptability of the biota to food and the environment, as well as stocking density and good water quality so that it can support the growth and survival of the biota.

5. Conclusion

Based on the results of the research that has been carried out, it can be concluded that the best average length growth and survival rate for seahorse juveniles is fed with a natural combination of Artemia (50%) + Copepoda (50%).

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