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PRODUCTIVITY OF *Artemia* sp. FED WITH FERMENTED FEEDING A CONTROLLED REARING SYSTEM

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ABSTRACT

Artemia sp. is a crustacean widely used as natural feed in fish and shrimp hatchery activities because of its high nutritional content, suitable size for larval mouth openings, and high digestibility. The success of *Artemia* sp. culture is strongly influenced by the quality of the culture medium and the availability of a feed that supports growth and biomass production. This study aimed to analyze the growth, biomass, and secondary productivity of *Artemia* sp. cultured using fermented feed. The study was conducted in the laboratory for 10 days at a stocking density of 800 individuals L^{-1} in seawater with a salinity of 35‰. Observations were conducted every two days on temperature, dissolved oxygen, pH, salinity, biomass, daily productivity, standing crop, and specific growth rate. Secondary production was calculated using the increment-summation method. The results showed that water temperature during the culture period ranged from 26.6 to 27.1 °C, dissolved oxygen from 4.1 to 6.5 mg L^{-1}, pH from 6.8 to 6.9, and salinity remained at 35‰. Biomass increased from 8.54 mg L^{-1} at the beginning of the culture period to 1,098.08 mg L^{-1} on day 10. The highest daily productivity was recorded during the T6–T8 interval, reaching 446.08 mg L^{-1} day^{-1}. The estimated total population production reached 1,098.09 mg L^{-1}, with a mean biomass of 477.2 mg L^{-1} and a production-to-biomass ratio of 2.30. These results indicate that the culture conditions and fermented feed supported the growth, biomass accumulation, and secondary productivity of *Artemia* sp. during the ten-day culture period.

Keywords: *Artemia* sp., Biomass, Fermented Feed, Secondary Productivity.

1. INTRODUCTION

The availability of natural feed is one of the primary factors determining the success of hatchery activities for aquatic organisms. *Artemia* is a lower crustacean that has been widely utilized as natural feed because of its high nutritional content, body size that is appropriate for the mouth opening of larvae, thin exoskeleton, and active movement, which can stimulate the predatory response of fish and shrimp larvae[1,2]. Specifically, the nutritional content of *Artemia* reaches approximately 47% during the nauplius stage and increases to 60% during the adult stage. Therefore, *Artemia* can be used as natural feed both during the nauplius and adult stages[3]. *Artemia* lives planktonically in saline waters with salinity levels ranging from 15 to 300‰. One of *Artemia*'s distinctive characteristics is its ability to tolerate a wide range of salinity conditions[4].

These advantages have led to the widespread use of *Artemia* as natural feed in hatchery activities. Therefore, *Artemia* culture plays an important role and has the

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potential to be developed as an independent industrial activity to meet the demand for live feed and frozen raw materials used in formulated feed production[5].

Nababan et al.[6] reported that the entire demand for *Artemia* in Indonesia is still fulfilled through imports, amounting to approximately 40–60 tons of *Artemia* cysts per year. To meet the demand for *Artemia* as natural feed in Indonesian hatchery activities, the development of local *Artemia* culture is necessary. One approach is to increase *Artemia* cyst production by optimizing both feed quality and quantity. Feed quality and quantity are important factors that determine *Artemia* growth rate and nutritional composition[7].

In its natural habitat, *Artemia* feeds on microalgae, bacteria, and organic detritus. These organisms and organic materials contain sufficient nutrients to support the growth of *Artemia* and are of an appropriate size for its mouth opening[8]. In efforts to develop *Artemia* sp. culture, various studies have investigated the use of different feed types, including combinations of *Tetraselmis chuii* and rice bran, rice bran and coconut meal, as well as trash fish silage[9]. Therefore, the management and development of *Artemia* culture using different feed types need to be investigated to determine the effectiveness of each feed in supporting *Artemia*'s successful grow-out.

2. RESEARCH METHOD

Time and Place

This experiment was conducted from February to March 2026 at the Secondary Laboratory of the Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University.

Procedures

Preparation of Equipment and Materials

The experiment began with preparing a hatching container, using seawater as the ice medium. Other equipment prepared included an electric blower, aeration tubing, and air stones to supply oxygen during the culture period. The feed was prepared before the culture activity. The ingredients used for feed preparation consisted of rice bran, rice flour, molasses, probiotics, and seawater. The quantities of all ingredients were determined using an analytical balance: 16.65 g of rice bran and 8.35 g of rice flour, and a measuring cylinder: 2 mL of molasses and 1.25 mL of probiotics. All ingredients were placed into a jar and then dissolved in 500 mL of seawater[4].

The aquarium containers were sterilized by washing them with soap and clean water. The volume of seawater used in each container was 1 L, equivalent to approximately 33.3% of the total aquarium volume. *Artemia* cysts were weighed using an analytical balance and hatched at a dosage of 1 g L^{-1} in a cone-shaped hatching container. The *Artemia* cysts were incubated for 18–24 h. The hatched *Artemia* were subsequently transferred to culture containers consisting of jars filled with 1 L of seawater at 35‰ salinity. The seawater had been aerated for 1 day prior to use. The stocking density was 800 individuals L^{-1}, as used in this study.

Culture of *Artemia* sp.

The culture period lasted for 10 days, starting from the stocking of *Artemia* into the culture containers. Feeding was carried out daily with the previously prepared fermented feed to support *Artemia* sp. growth. To maintain optimal water quality, siphoning was performed daily to remove 30% of the culture water. Siphoning was performed to remove waste and sediment from the culture containers.

Sampling was conducted every two days and included measurements of water-quality parameters, namely pH, dissolved oxygen (DO), salinity, temperature, and density, as well as growth observations using an Olympus SZ61 stereo microscope. Growth observations were conducted by measuring the body length and diameter of *Artemia* using the BettaView application connected to the microscope. Measurements of body length and diameter were performed

in three replicates for each container to obtain the mean body length and diameter of *Artemia* sp.

Water Quality Parameters

Water quality was monitored to assess environmental conditions in the culture medium during the rearing period. The parameters measured included pH, dissolved oxygen (DO), salinity, density, and water temperature. Measurements were carried out using a pH meter, a DO meter, a refractometer, and a temperature-measuring device.

Biovolume

Biovolume is the body volume of an organism and is used to estimate the biomass of *Artemia* in culture medium. Measurements were conducted by observing *Artemia*'s body size under a microscope. The body-size data obtained were subsequently used to calculate biovolume using the plankton biovolume formula. he biovolume was calculated by approximating the organism to a prolate spheroid using the following equation[10]:

$$V = \frac{\pi}{6} b^2 a$$

Where:
V: biovolume (µm³)
a : body lenght (major axis)
b : body widht (minor axis)

Secondary Productivity

Secondary productivity was calculated based on the increase in biomass or the number of *Artemia* individuals over a specified period. This parameter was used to determine the production rate of heterotrophic organisms in the culture medium during the study secondary production was estimated using the increment-summation method[11]:

$$P = \sum \left(\frac{N_i + N_{i+1}}{2} \right) (W_{i+1} - W_i)$$

Where:
P : secondary production (mg L^{-1})
N_i : number of individuals at time i
N_{i+1} : number of individuals at time i+1
W_i : mean individual biomass at time i (mg)
W_{i+1} : mean individual biomass at time i + (mg)

Increment-Summation

The increment-summation method is a standard method used in aquatic ecology to estimate a population's secondary production. This approach is particularly suitable for populations cultured within a single age group or single cohort. The basic principle of this method is to calculate production by determining the increase in individual weight (ΔW) between two observation times and multiplying it by the average number of surviving individuals (N) during that interval. The production values obtained for each observation interval are then summed until the end of the culture period.

3. RESULT AND DISCUSSION

Water Quality

The water quality parameters observed in this study included dissolved oxygen (DO), temperature, pH, and salinity. The results of water quality measurements during the culture period are presented in Table 1.

Table 1. Water quality measurements during *Artemia* sp culture

Parameters	Results	Range tolerance[12]
Dissolved oxygen (DO)	4,1 - 6,5	>4
Temperature (˚C)	26,6 – 27,1	25-30
pH	6,8 – 6,9	7 – 8,5
Salinity (‰)	35	35 - 80

The survival of the *Artemia* sp. population during the culture period was strongly influenced by the stability of the measured water quality parameters. The relatively stable water temperature, ranging from 26.6 to 27.1 °C, and dissolved oxygen concentrations of 4.1–6.5 mg L^{-1} were within ranges capable of supporting

metabolic processes, digestive enzyme activity, and the respiratory requirements of *Artemia*, particularly during the critical stage of carapace shedding or molting[3]. These conditions were also supported by the culture medium's salinity, which was maintained at 35‰. Physiologically, an appropriate salinity level can reduce the osmoregulatory burden, allowing a greater proportion of the energy obtained from feed to be allocated to somatic growth[13].

The measurement results showed that the culture medium pH ranged from 6.8 to 6.9. These values were slightly lower than the FAO[12] tolerance range of 7.0–8.5. The decrease in pH toward slightly acidic conditions was presumably associated with the population's high respiratory activity, which may have increased CO_2 accumulation at a stocking density of 800 individuals L^{-1}. In addition, the use of fermented feed may have produced dissolved organic acids that affected the culture medium pH[14].

Although the pH values were slightly below the recommended range, these conditions did not produce lethal effects on *Artemia* sp. during the study. This was indicated by the absence of mortality in the experimental population until day 10. The slightly acidic conditions of the culture medium were also presumed to limit the proliferation of certain pathogenic bacteria in the water column. However, this assumption requires further investigation through microbiological analysis.

Increment-Summation

In this culture experiment, the density of *Artemia* was maintained at 800 individuals L^{-1}. Therefore, the production values obtained were primarily derived from increases in individual *Artemia* body weight (Figure 1). The development of absolute individual body weight in *Artemia* sp. during the 10-day culture period showed a fluctuating growth pattern. This pattern represented several stages of metamorphosis and carapace shedding (molting) in the life cycle of *Artemia* (Figure 1). Based on the individual growth curve, *Artemia*'s growth dynamics can be divided into several phases as follows.

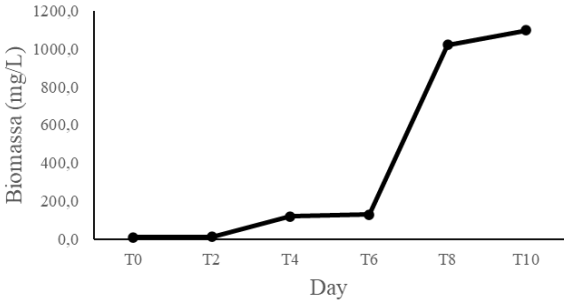

Figure 1. Individual body weight of *Artemia* sp. during the culture period

Endogenous and adaptation phase (T0–T2). From the beginning of hatching until day 2, individual body weight increased only slightly, from 0.011 to 0.013 mg. This occurred because, during the early stage of Instar I, *Artemia* had not yet developed a fully functional mouth opening and digestive tract. Energy requirements during this phase were still met endogenously through the utilization of yolk-sac reserves. The available energy was primarily used for basal metabolism and preparation for the molting process toward the subsequent developmental stage[3].

Exogenous transition phase (T2–T6). From day 2 to day 4, individual body weight increased to 0.149 mg. This increase occurred concurrently with *Artemia*'s transition to the Instar II and III stages, during which the organisms began actively feeding on exogenous food sources through filter-feeding. However, the growth rate appeared to slow during the T4–T6 interval, with body weight increasing only slightly to 0.161 mg. This temporary slowdown is a natural biological phenomenon that may result from increased energy allocation to the molting process and the development of appendages, such as thoracopods, which function in swimming and food filtration. Consequently, the increase in somatic mass was temporarily reduced[15].

Exponential growth phase (T6–T8). After passing through the energy-intensive organ-development phase, the *Artemia*

individuals entered the juvenile stage. Between day 6 and day 8, body weight increased sharply from 0.161 to 1.276 mg. During this phase, the digestive tract had become more fully developed, enabling *Artemia* to filter, ingest, and assimilate larger quantities of feed particles. The nutrients obtained could subsequently be allocated to the formation of somatic tissue[16]. The increase in body weight was also presumed to have been supported by the provision of fermented feed, which supplied nutrients for *Artemia* growth.

Early asymptotic phase (T8–T10). At the end of the observation period, from day 8 to day 10, the growth curve began to level off, with individual body weight reaching 1.373 mg. This reduction in the growth rate indicated that the individuals were beginning to enter the pre-adult stage. During this phase, the energy obtained was no longer allocated entirely to somatic growth but began to be used for body maintenance and the initiation of reproductive organ (gonadal) development[13].

Biomass of *Artemia* sp.

Observations conducted over the 10-day culture period showed that the biomass growth of *Artemia* sp. followed a sigmoid curve, characterized by an initial growth phase, an exponential growth phase, and a deceleration phase (Figure 2).

Based on the graph, the dynamics of *Artemia* sp. biomass growth could be classified into three main phases, as follows. Adaptation and initial growth phase (T0–T2). During the first two days, biomass increased relatively slowly, from 8.54 to 10.43 mg L^{-1}. This phase represented a transitional period during which *Artemia* was in the early nauplius stages, namely Instars I and II. At the Instar I stage, the digestive tract of *Artemia* had not yet fully developed; therefore, its nutritional requirements still depended on endogenous food reserves in the form of yolk. During this phase, energy was allocated primarily to adaptation to environmental conditions and the first molting process rather than to the formation of somatic tissue[3].

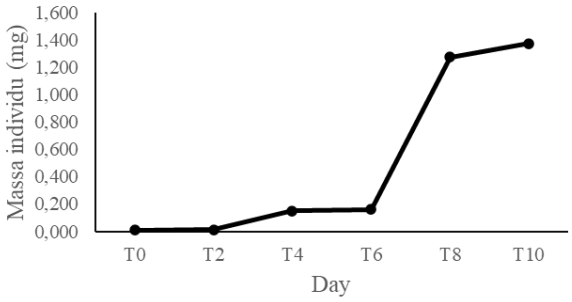

Figure 2. Biomass of *Artemia* sp. during the culture period

Exponential growth phase (T2–T8). After day 2, as the digestive organs developed from the Instar II stage onward, *Artemia* began actively filtering and consuming feed from the environment through exogenous feeding. This condition promoted accelerated biomass growth, with the greatest increase occurring during the T6–T8 interval. During this interval, biomass increased sharply from 128.65 to 1,020.83 mg L^{-1}. This increase indicated that feed consumption and nutrient assimilation occurred effectively, allowing a substantial proportion of the energy obtained from feed to be allocated to tissue formation and biomass accumulation[16].

Growth deceleration phase (T8–T10). From day 8 to day 10, the rate of biomass increase began to decline, while total biomass continued to increase, reaching a maximum of 1,098.08 mg L^{-1}. The deceleration of the growth curve was presumably associated with increasing body size in individuals and the transition of *Artemia* from the late juvenile to the pre-adult stage. At this stage, the proportion of energy used for body maintenance metabolism increased, thereby reducing the proportion of energy available for somatic growth[13].

Daily Productivity of *Artemia* sp.

The secondary productivity performance of the *Artemia* sp. population was visualized using a daily production rate

curve for each observation interval, as shown in Figure 3.

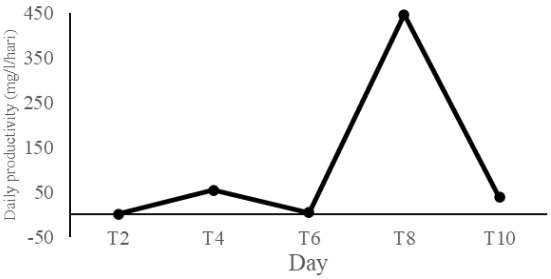

Figure 3. Daily productivity of *Artemia* sp. at each observation interval

The daily productivity graph showed a fluctuating pattern across the observation intervals. This pattern indicated changes in growth rate and energy allocation during the development of *Artemia* sp. Initial production phase (T0–T2 and T2–T4 intervals). During the T0–T2 interval, the daily production rate was at its lowest, 0.94 mg L^{-1} day^{-1}. The low production rate during this interval was associated with the early nauplius stage of the individuals. At this stage, feeding activity had not yet reached an optimal level, and energy requirements still depended on endogenous energy sources. The production rate subsequently increased to 54.45 mg L^{-1} day^{-1} during the T2–T4 interval. This increase marked the successful transition of *Artemia* to exogenous feeding as the digestive tract developed and began to function[3].

Physiological pause phase (T4–T6 interval). During the T4–T6 interval, the production rate decreased sharply to 4.65 mg L^{-1} day^{-1}. This decline was presumed to be associated with a physiological pause during development. During this phase, part of the metabolic energy was presumably redirected from somatic growth toward the molting process and the formation of appendages, such as thoracopods, which function in swimming and food filtration. Energy allocation to these developmental processes may temporarily reduce the rate of biomass accumulation[15].

Peak productivity phase (T6–T8 interval). After passing through the molting and organ-development phases, the population entered its maximum growth phase. This condition was indicated by a sharp increase in the daily production rate, which reached 446.08 mg L^{-1} day^{-1} during the T6–T8 interval. At this juvenile stage, *Artemia* had developed a more efficient food-filtration capacity and a more advanced digestive system. These conditions allowed nutrients from the feed to be assimilated more effectively and allocated to the formation of new biomass[16].

Post-peak decline phase (T8–T10 interval). During the final observation interval, the daily production rate decreased again to 38.62 mg L^{-1} day^{-1}. Although total biomass continued to increase, the rate of new biomass formation declined significantly. This decline is characteristic of organisms entering the pre-adult stage. At this stage, the nutrients and energy obtained were allocated not only to somatic growth but also to body maintenance, metabolism, and the initial development of the gonads[13].

Based on calculations using the increment-summation method over the 10-day observation period, with a population density of 800 individuals L^{-1} maintained, the estimated total population production was 1,098.09 mg L^{-1}. During the culture period, the mean cohort biomass was recorded at 477.2 mg L^{-1}. This value represented the mean standing-stock biomass in the culture system during the observation period.

Population production efficiency was measured by the production-to-biomass ratio (cohort P/B), which reached 2.30. This value indicated that the production of new biomass during the 10-day culture period was equivalent to 2.30 times the mean cohort biomass. The high P/B ratio indicated a relatively rapid biomass turnover rate, supported by individual growth during the exponential phase and the absence of mortality throughout the culture period. Overall, these results showed that nutrients obtained from the feed could be utilized to support increases in individual body weight and the secondary production of the *Artemia* sp. population.

Standing Crop of *Artemia* sp

The dynamics of the standing crop of the *Artemia* sp. population during the 10-day culture period are presented in Figure 4.

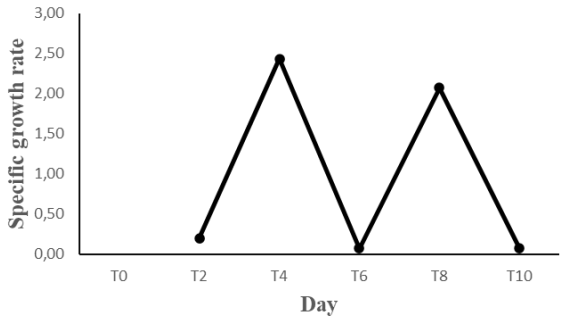

Figure 4. Standing crop of *Artemia* sp. during the culture period

The curve represents the actual biomass of the population at each observation time, from T0 to T10. The standing crop value was also used as the biomass parameter (B) in the calculation of the instantaneous growth rate. The development of the standing crop tended to form a sigmoid curve, which could be divided into several phases as follows.

Initial stock preparation phase (T0–T2). At the beginning of the culture period, the standing crop was at its lowest level and increased only slightly, from 8.54 to 10.43 mg L^{-1}. This low value corresponded to the early nauplius stage, during which individuals had not yet performed exogenous feeding optimally. Consequently, only a limited amount of external nutrients could be converted into new biomass within the culture system[3].

Initial stock accumulation phase (T2–T6). The standing crop began to increase substantially at T4, reaching 119.34 mg L^{-1}, as the digestive tract of *Artemia* developed and began to function. However, the rate of increase slowed at T6, when the standing crop reached only 128.65 mg L^{-1}. This slowdown in biomass accumulation was presumably associated with an increased allocation of energy to carapace shedding (molting) and the development of body structures rather than exclusively to somatic growth[15].

Exponential stock expansion phase (T6–T8). After passing through the physiological slowdown phase, the standing crop showed its greatest increase, reaching 1,020.83 mg L^{-1} on day 8. In the instantaneous growth approach, the biomass value at the beginning of an interval is used together with the specific growth rate to estimate biomass production. The high growth rate recorded during the T6–T8 interval, with G=2.07, contributed to the greatest increase in biomass production during the culture period.

Asymptotic stock phase (T8–T10). At the end of the observation period, the standing crop curve began to level off and reached its highest value of 1,098.08 mg L^{-1}. This leveling off indicated a reduction in the rate of biomass accumulation. The condition was presumably associated with the transition of *Artemia* into the pre-adult stage, during which part of the available energy was allocated to body maintenance metabolism and the initial development of reproductive organs[13].

Specific Growth Rate of *Artemia* sp.

The specific growth rate represents the rate of body weight increase in *Artemia* sp. during each observation interval. The calculated specific growth rates are presented in Figure 5.

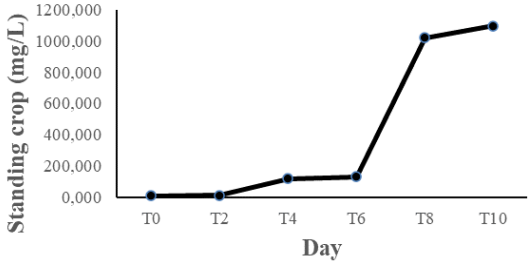

Figure 5. Specific growth rate of *Artemia* sp. at each observation interval

The specific growth rate (G) indicates the magnitude of the increase in individual body weight relative to the body weight recorded at the preceding observation time. Unlike some aquatic organisms that exhibit continuous growth, crustaceans such as *Artemia* possess an exoskeleton, leading to

growth in stages. Body size increases primarily after the old exoskeleton is shed through the molting process. Between molting cycles, body-weight gain may proceed more slowly because energy is used for the formation and hardening of the new exoskeleton and for organ development.

The specific growth rate of the *Artemia* sp. population fluctuated throughout the culture period (Figure 5). This pattern reflected the stepwise growth process, influenced by the molting cycle and ontogenetic changes at each instar. Based on the graph, the dynamics of the specific growth rate could be divided into four phases as follows.

First peak feeding transition (T2–T4). The specific growth rate showed its first sharp increase, reaching G = 2.44. This value occurred because the initial individual body weight was relatively low, at 0.013 mg, and subsequently increased to 0.149 mg, representing an increase of more than tenfold. Biologically, this phase marked the transition of *Artemia* from endogenous yolk utilization to active feeding as a filter feeder. The initiation of exogenous feeding and nutrient assimilation promoted a high relative growth rate[3].

First decline energy allocation for morphogenesis (T4–T6). During the T4–T6 interval, the specific growth rate declined sharply to G = 0.08. This decline was presumed to indicate a physiological slowdown phase. During this phase, part of the metabolic energy was allocated to metamorphosis, molting, and the formation of thoracopods, which function in swimming and food filtration. Consequently, the energy available for somatic tissue growth was temporarily reduced[15].

Second peak exponential somatic growth (T6–T8). Following organ development and molting, the body size of *Artemia* increased again, supported by more fully developed filtering appendages. This condition resulted in a second growth peak, with G = 2.07. Because the initial body size during this phase was substantially greater than that during the early culture period, the high growth rate at the juvenile stage contributed to the greatest absolute biomass increase observed during the culture period[16].

Second decline pre-adult transition (T8–T10). During the final observation interval, the specific growth rate declined again to G = 0.07. This slowdown was presumably associated with a shift in energy allocation as the individuals entered the pre-adult stage. During this phase, part of the energy obtained from the feed began to be used to maintain the increasingly larger body size and to support the initial development of reproductive organs. Consequently, the rate of somatic tissue formation declined again[13].

An appropriate stocking density is required to maintain the stability of the *Artemia* population. However, excessively high stocking densities may increase competition for feed, restrict living space, and reduce individual growth rates[3].

4. CONCLUSION

The 10-day culture of *Artemia* sp. at a stocking density of 800 individuals L^{-1} resulted in high secondary productivity, with an estimated biomass of 1,098.09–1,437.03 mg L^{-1}. Fermented feed and water with a pH range of 6.8–6.9 supported the growth and survival of *Artemia* sp.

REFERENCES

1. Wibowo, S., Utomo, B.S.B., Suryaningrum, T.D. *Artemia untuk Pakan Ikan dan Udang*. Penebar Swadaya Grup, 2013.
2. Irawan, F., Ilham, I. Identifikasi Masalah Budidaya *Artemia* di CV. Manunggal 23, Anyer, Banten: Studi Kasus. *Buletin Jalanidhitah Sarva Jivitam*, 2023; 5(1): 23-36.
3. Lavens, P., Sorgeloos, P. *Manual on the Production and Use of Live Food for Aquaculture*. FAO, 1996.

4. Van Stappen, G. *Zoogeography*. *Artemia: Basic and Applied Biology*. Springer Netherlands. Dordrecht, 2002; pp. 171-224.
5. Muthiah, A.L. *Teknik Penetasan Kista Artemia Salina di PT. Esaputlii Prakarsa Utama Barru Sulawesi Selatan.* Tugas Akhir, 2018.
6. Nababan, B.O., Christian, Y., Afandy, A., Damar, A. Integrated Marine and Fisheries Center and Priority for Product Intensification in East Sumba, Indonesia. *IOP Conference Series: Earth and Environmental Science*, (2020; 414(1): 012014.
7. Firmansyah, M.Y., Kusdarwati, R., Cahyoko, Y. Effect of Different Live Feed Type (*Skeletonema* sp., *Chaetosceros* sp., *Tetraselmis* sp.) to the Growth Rate and Nutritional Content on *Artemia* sp. *Jurnal Ilmiah Perikanan dan Kelautan*, 2013; 5(1).
8. Erniati, E., Erlangga, E., Hairina, H. Pemberian Mikroalga yang Berbeda terhadap Pertumbuhan *Artemia salina*. *Berkala Perikanan Terubuk*, 2012; 40(2): 13-19
9. Djunaedi, A. Pertumbuhan *Artemia* sp. dengan Pemberian Ransum Pakan Buatan Berbeda. *Jurnal Kelautan Tropis*, 2016; 18(3): 133-138
10. Sun, J., Liu, D. Geometric Models for Calculating Cell Biovolume and Surface Area for Phytoplankton. *Journal of Plankton Research*, 2003; 25(11): 1331-1346.
11. Benke, A.C. A Modification of the Hynes Method for Estimating Secondary Production with Particular Significance for Multivoltine Populations. *Limnology and Oceanography*, 1979; 24(1): 168-171.
12. FAO. *Manual on Artemia Production and Use*. FAO Fisheries and Aquaculture Technical Paper. Rome, 2024.
13. Treece, G.D. *Artemia Production for Marine Larval Fish Culture* (Vol. 702). Stoneville, Mississippi: Southern Regional Aquaculture Center, 2000.
14. Boyd, C.E. *Water Quality in Ponds for Aquaculture*. Alabama Agricultural Experiment Station, Auburn University, 1990; pp 482.
15. Isnansetyo, A., Kurniastuty, E. *Teknik Kultur Phytoplankton dan Zooplankton. Pakan Alami untuk Pembenihan Organisme Laut*. Penerbit Kanisius. Yogyakarta, 1995.
16. Mudjiman, A. *Makanan Ikan*. Penebar Swadaya, 2004.