Fisheries Journal, 14(3), 1077-1085 (2024)
http://doi.org/10.29303/jp.v14i3.815

THE EFFECT OF ADDING ASTAXANTHIN TO COMMERCIAL FEEDING ON GROWTH AND SURVIVAL OF WINDU SHRIMP FRENCH (*Penaeus mododon*)

Pengaruh Penambahan Astaxanthin Pada Pakan Komersil Terhadap Pertumbuhan dan Kelangsungan Hidup Benur Udang Windu (Penaeus Monodon)

T. Fajar Khairullah[1], Suri Purnama Febri [1*], Hanisah [2], Salamah [3]

[1]Aquaculture Department, Faculty of Agriculture, Samudra University, [2]Agribusiness Department, Faculty of Agriculture, Samudra University, [3]Aquaculture Department, Faculty of Agriculture, Malikussaleh University

Meurandeh Street, Langsa Lama District, Langsa Regency, Aceh, 24416, Indonesia

[*]Coresponding author : suripurnamafebri@unsam.ac.id

(Received Januari 3rd 2024; Accepted Auguts 8th 2024)

ABSTRACT

Windu shrimp are a fishery commodity that has quite high economic value because windu shrimp taste delicious and tasty and their nutritional content is very high. The obstacles often faced in cultivation are slow growth and low survival of tiger prawn fry (Penaeus monodon), so this research aims to analyze the effect of adding astaxanthin to commercial feed on the growth and survival of tiger prawn fry (Penaeus monodon) and determine the best dose of astaxanthin. added to commercial feed can increase the growth and survival of windu shrimp (Penaeus monodon). The research method used was a Completely Randomized Design (CRD) with 4 treatments and 3 three replications. The treatments that will be carried out are: control, PA1 (150 g/ 1/2 kg feed), PA2 (250 g/ 1/2 kg feed) and PA3 (500 g/ 1/2 kg feed). Parameters observed: Absolute Length Growth, Absolute Weight Growth, Daily Growth Rate, Survival rate (SR), Feed Efficiency and Feed Conversion Ratio. The results of this research show that the best effect of Astaxanthin in commercial feed for the growth of windu shrimp is in the PA2 treatment (addition of astaxanthin at a dose of 250 g).

Keywords: astaxanthin, growth, survival rate, windu shrimp

ABSTRAK

Udang windu merupakan komoditas perikanan yang memiliki nilai ekonomis yang cukup tinggi karena rasa udang windu yang enak dan gurih serta kandungan gizinya sangat tinggi. Kendala yang sering dihadapi dalam budidaya yaiutu lambatnya pertumbuhan dan rendahnya kelangsungan hidup benur udang windu (Penaeus monodon), maka penelitian ini bertujuan menganalisis pengaruh penambahan astaxanthin dalam pakan komersil terhadap pertumbuhan dan kelangsungan hidup benur udang windu (Penaeus monodon) dan Menentukan dosis terbaik astaxanthin yang di tambahkan dalam pakan komersil yang dapat meningkatkan pertumbuhan dan kelangsungan hidup udang windu (Penaeus monodon). Metode penelitian yang digunakan

adalah Rancangan Acak Lengkap (RAL) dengan 4 perlakuan 3 tiga ulangan. Adapun perlakuan yang akan dilakukan adalah: kontrol, PA1 (150 g/ 1/2 kg pakan), PA2 (250 g/ 1/2 kg pakan) dan PA3 (500 g/ 1/2 kg pakan). Parameter yang diamati: Pertumbuhan Panjang Mutlak, Pertumbuhan Bobot Mutlak, Laju Harian Pertumbuhan, Survial rate (SR), Efisiensi Pakan dan Rasio Konversi Pakan. Hasil penelitian ini, pengaruh terbaik Astaxanthin pada pakan komersil bagi pertumbuhan udang windu yaitu pada perlakuan PA2 (penambahan astaxanthin dengan dosis 250 g).

Kata Kunci: astaxanthin, pertumbuhan, sintasan, udang windu

INTRODUCTION

Shrimp tiger is commodity fisheries that have mark quite high economical Because windu shrimp is very popular with consumers local and consumer abroad (Febri *et al,* 2022). However shrimp tiger own growth slow and level death high which is constraint main role in cultivation (Adiwijaya & Haliman, 2005). Giving drugs chemistry usually done to overcome this problem. Giving drugs chemicals or antibiotics in a way Keep going carry on give rise to new problem, namely emergence resistance bacteria, and residues on the body shrimp and pollute the environment which can ultimately kill them organism other (Phonna *et al,* 2022). One of efforts to improve production cultivation windu shrimp is increasing the amount of production in a fast time.

Feed is one of them determinant in improving growth (Symbolon *et al.,* 2021), as well as shrimp. To increase quality The feed given to the fry can include feeding feed artificially added with supplements *astaxanthin*. *Astaxanthin* is a colored carotenoid pigment red. *Astaxanthin* can be obtained from various micro marine organisms, including plant known microscopic as micro algae, as well obtained from a number of types of fish like salmon, tuna and trout are also found in a group of crustaceans (Mohamad *et al,* 2012).

Astaxanthin often used as a source of pigment in fish and shrimp. *Astaxanthin* and vitamin E in feed also have an impact positive on level the maturity of the candidate's gonads parent shrimp vaname (Mita, 2013). It happens through an improvement process sour arachidonic acid as a derived essential fatty acid from giving *astaxanthin* and vitamin E which have antioxidant high, so prevent oxidation essential fatty acids and also increases storage fatty acids in eggs (Fajar *et al.*, 2017). Astaxanthin also plays a role in the growth and antioxidant status of gourami fish (Sofian *et al,* 2016). Based on the description is so researcher want to do something testing of influence addition *astaxanthin* in feed commercial to growth and continuity life fry windu shrimp.

RESEARCH METHODS

This research was carried out from August to September 2022 at the Green House Faculty Agriculture, Samudra University. The research method used was a Completely Randomized Design (CRD) with 4 3 treatments test. As for the treatment that will be done is: control, PA1 (150 g/ 1/2 kg feed), PA2 (250 g/ 1/2 kg feed) and PA3 (500 g/ 1/2 kg feed).

The tools used in this research are: Styrofoam as a container maintenance, Aerator, water pump, ruler, digital scale, bottles spray, as well as measuring tools water quality, namely pH meter, DO meter, Refractometer and Thermometer. The materials used in this research are fry windu shrimp, *Astaxanthin* as well feed pellets.

Preparation of containers and Test Biota

The container used is styrofoam size length, width and height each 40 x 25 x 38 cm, totaling 12 pieces with a volume of 20 L. Styrofoam then washed until clean use detergent and dry in the sun under ray sun until dry. After dry First fill the styrofoam with 5 liters of water.

Animals that will tested and given The treatment in this research was shrimp tiger (*Penaeus monodon)* with size PL 16.

Making *Astaxanthin* Feed

The feed used in this experiment is fodder commercial ones have composition adequate nutrition for the biota to be tested. Before dissolved in distilled water, *the astaxanthin* to be used is weighed first, next *astaxanthin* entered into the bottle Then dissolved with distilled water, *astaxanthin* sprayed evenly on the feed. To glue *astaxanthin* in feed, use 1 egg white for ½ kg of feed, then stirred evenly, then feed dried by air - drying.

Rearing

Rearing done for 30 days. Before done rearing, the water used will treated first. Other than that, do it Sterilization of tools and materials that will be used during rearing. During rearing of test biota will given feed 3 times a day, namely at 08.00, 13.00 and 18.00 WIB using the as full as possible. Rearing container totaling 12 solid pieces stock 30 heads fry windu shrimp per container.

Water Quality Management

Observation water quality will done once every 7 days . Observed parameters namely DO, temperature, pH and salinity.

Observation Parameters

A. Absolute Growth Weight (PBM)

Growth weight absolute during maintenance and can be calculated use formula (Ranggayoni *et al* , 2021):

$$PBM = Wt - Wo$$

Note: PBM = Growth Absolute (g); Wt = Weight biomass end of research (g); Wo = Weight biomass at the start of the study (g)

B. Daily Growth Rate (LPH)

Growth rate daily can be calculated use formula (Simamora *et al,* 2021):

$$LPH = \frac{\ln Wt - \ln Wo}{t} \times 100\%$$

Note: LPH = Growth rate daily (g); Wo = Initial weight (g); Wt = Final weight (g); t = Duration of research (days)

C. Survival (KH)

observed data is to calculate how much fry live shrimp after research. Shrimp survival rate determined at the end test. According to Haser *et al*. (2018) continuity life shrimp can be counted based on formula:

$$KH = \frac{Nt}{No} x\ 100$$

Note: KH = Continuity life (%); Nt = Number of shrimp at the end of the study (tail); No = Number of shrimp at the beginning spread (tail)

D. Feed Efficiency (EP)

Efficiency utilization feed calculated by means add up feed given every day. Amount of feed calculated using the formula (Nazlia *et al*, 2023):

$$EP = \frac{Wt - Wo}{F} x100$$

Caption: EP = E efficiency utilization feed (%); Wt = Total weight of shrimp at the end research

(g); Wo = Total weight of shrimp at the beginning maintenance (g); D = Total weight of dead shrimp during maintenance (g); F = Total feed given

E. Feed Conversion Ratio (FCR)

Ratio Conversion feed can be calculated use formula (Adillah *et al.*, 2023):

$$RKP) = \frac{F}{(Wt+D)-W0}$$

Note: FCR = conversion feed ratio; Wt = Shrimp weight at the end of the study (g); Wo = Shrimp weight at the start of the study (g); F = Amount of feed consumed (g); D = Total weight of dead shrimp during rearing (g)

F. Water Quality

Measured water quality parameters during the research, namely pH, DO, temperature and salinity. Observation water quality is carried out every 7 days during the 40 days of the study.

G. Data analysis

This research uses ANOVA analysis to find out influence treatment to observed variables and to test different real between treatment. If there is different real between treatment so Further tests were carried out using the Duncan test.

RESULTS

Survival Rate (SR)

From the fingerprint test results variance (ANOVA) was obtained that difference astaxanthin dose had no effect real (P<0.05) against level continuity life shrimp tiger (Table 1).

Table 1. Average survival life *Survival rate* Windu shrimp

Treatment	Survival (SR)
PA0	97 ± 0.00 [a]
PA1	100 ± 0.00 [a]
PA2	100 ± 0.00 [a]
PA3	100 ± 0.00 [a]

Note: The letter that the same column indicates influence no different treatment significant (p<0.05). Value stated is average value and standard error.

Absolute Growth Weight

Based on fingerprint test results variance (ANOVA), obtained that difference from dose astaxathin influential real (P>0.05) against increase weight absolute shrimp tiger (Table 2).

Table 2. Average increase weight absolute shrimp tiger

Treatment	Weight (g)	Weight (g)	Weight Absolute (g)
PA0	0.517 ± 0.005	0.689 ± 0.003	0.181 ± 0.003 [a]
PA1	0.519 ± 0.012	0.721 ± 0.014	0.202 ± 0.013 [ab]
PA2	0.524 ± 0.009	0.729 ± 0.021	0.209 ± 0.015 [b]
PA3	0.517 ± 0.005	0.717 ± 0.004	0.200 ± 0.005 [ab]

Note: The letter that the same column indicates influence different treatment significant (p>0.05). Value stated is average value and standard error.

Daily Growth Rate

From the fingerprint test results variance (ANOVA), giving astaxathin provide impactful results real (P>0.05) against rate growth daily shrimp tiger (Table 3).

Table 3. Average growth rate daily shrimp tiger

Treatment	LPH (%)
PA0	1.29 ± 0.02 [a]
PA1	1.31 ± 0.06 [a]
PA2	1.32 ± 0.02 [a]
PA3	1.30 ± 0.06 [a]

Type: The letter that the same column indicates influence different treatment significant (p>0.05). Value stated is average value and standard error.

Feed Efficiency

From the fingerprint test results variance (ANOVA) shows that addition of astaxanthin to feed commercial influential significant (P>0.05) against efficiency feed (Table 4).

Table 4. Average Feed Efficiency Results

Treatment	EP (%)
PA0	10.221 ± 1.16 [b]
PA1	11.502 ± 1.01 [ab]
PA2	11.861 ± 0.29 [b]
PA3	11,858 ± 1.09 [b]

Note: The letter that the same column indicates influence different treatment significant (p>0.05). Value stated is average value and standard error.

Feed Conversion Ratio (FCR)

From the fingerprint test results variance (ANOVA) shows that addition of astaxanthin to feed commercial influential significant (P>0.05) against ratio conversion feed . Average ratio conversion feed can be seen in Table 5.

Table 5. Average Ratio Results Feed Conversion (FCR)

Treatment	FCR
PA0	9.78 ± 0.16 [a]
PA1	8.74 ± 0.81 [ab]
PA2	8.43 ± 0.20 [b]
PA3	8.47 ± 0.74 [b]

Note: The letter that the same column indicates influence different treatment significant (p>0.05). Value stated is average value and standard error.

Water quality

Water quality data during maintenance windu shrimp can be seen in Table 6.

Table 6. Average water quality parameters during the study

Parameter	Treatment				Quality standards
	PA0	PA1	PA2	PA3	
Salinity (ppt)	32	30	32	31	30-37
DO (mg/l)	4.9	3.8	4.2	4.9	4.5-7
pH	7.1	7.5	7.3	7.5	7-8.5
Temperature (◦C)	29	29	30	30	26-3

DISCUSSION

Based on Table 1, continuity life shrimp tiger highest obtained in treatments PA1, PA2 and PA3 was 100%, whereas Lowest obtained in the PA0 treatment was 97%. Continuity life windu shrimp obtained Still included in the good category (Kholifah *et al.*, 2008). The addition of astaxanthin to feed had no impact negative to continuity life (Tankitti, 2014). At PA0 experiencing death caused shrimp tiger own characteristic individuals and cannibals, if intake the feed given is insufficient will give rise to characteristic cannibal between each other to fulfill need intake the food, the consequences shrimp dead tiger (Mangampa *et al*., 2008). Additionally, level Death in shrimp is also triggered by stress that occurs during distribution, quality mains and water changes.

Based on Table 2, the results of PA2 treatment with a dose of 250 g astaxathin experience enhancement of 0.209 g. This is because use astaxathin in feed very real effect to growth weight windu shrimp. Astaxanthin supplementation at the level of 250 mg/ ½ kg feed in a way real increase weight. This condition is suspected caused by the role of astaxanthin in preventing damage cell consequence stress oxidative stress that appears during the environmental adaptation process (Sofian, *et al.,* 2016). Growth fry windu shrimp can be caused by several factor like giving feed, difference dosage, water quality, and solids stock seeds (Mohamad *et al*., 2012). It happened growth Because exists increase cells in the body , increase cells in the the body is due to the process of protein retention . Composition The most important nutrients are used to be converted become energy because it is very necessary to do activity body the shrimp itself.

Based on Table 3, the research results show that rate growth daily shrimp tiger own different values for each treatment. At PA0, speed growth daily is at 1.29 %, PA1 shows the figure is 1.31%, in PA2 it is 1.32%, and in PA3 it is 1.30 %. Growth rate daily highest found in PA2 treatment, namely 1.32%. In the results of the Duncan test, there is influence at each treatment is no different real.

Growth in shrimp tiger during maintenance show that addition of astaxanthin to 250 gr/ ½ kg of feed give response best when compared to PA0. Astaxanthin supplements on PA2 as a source antioxidant exogenous allegedly capable prevent damage molecule biologically caused by environmental stress so utilization feed can be more efficient and energy feed can be used for support growth shrimp. Composition nutrients are used to be converted become energy to do activity body shrimp itself (Erma *et al,* 2014). If shrimp do not require Lots energy so will converted become meat so that happen addition size on the body shrimp (Meiyana and Minjoyo, 2011).

Based on Table 4, after the fingerprint test was carried out variance (ANOVA) of the results obtained that is ($P>0.05$) which means addition of astaxanthin to feed at different doses influential real to efficiency feed. In the PA0 treatment, percentage conversion feed namely 10.221%, PA1 11.502%, PA2 11.861% and PA3 11.858 %. Obtained that the best treatment found in treatments PA2 and PA3.

According to Wilson and Hardy (2002), that mark efficiency and ratio conversion feed influenced by feed protein, feed protein according to needs nutrition shrimp result giving feed more efficiently. In the protein itself it has Lots function One of them is as a substance regulators and substances builder, because that which forms new and maintaining networks existing network formed is protein (Syahputra *et al.*, 2023). So that the presence of sufficient protein can increase formation cells new network in the form of happen growth in the body shrimp.

Based on Table 5, it is known that ratio conversion feed Lowest found in the PA2 treatment with addition dose *astaxanthin* as much as 250 g ie of 8.43, meanwhile ratio conversion feed highest found in the PA0 treatment, namely of 9.78. In this case it shows that

giving astaxsanthin in maintenance media influence on the ratio conversion feed fry windu shrimp.

Ratio value conversion more feed small or low show quality the better the feed which level clarity the feed is increasing tall. It's small ratio conversion feed influenced by several factor that is quality feed for growth, size and water quality (Zainuddin *et al*., 2014). Conversion value low feed show that feed given almost fully utilized. So, increasingly low mark conversion feed so feed given the more efficiently used for growth and vice versa . If more tall mark conversion feed, then feed given increasingly inefficiently used for growth (Saltin *et al* ., 2016).

Based on Table 6, observations water quality is carried out every once a week for 40 days during the research. Average value results water quality such as pH, DO, temperature and salinity is in a good range for sustainability fry windu shrimp. Temperature at each treatment during the research range between 29-30 °C. This temperature is very favorable for life shrimp. This is in accordance with the statement by Dede *et al*. (2014), who stated that good water temperature for maintenance shrimp around 26 - 30 °C. The pH value obtained during maintenance ranges from 7.1 to 7.5. This condition can still be said to be normal. This is in accordance with the statement Soemardjati & Suriawan (2007), that the pH of shrimp can live well when reared shrimp ranges from 7-8.5. DO value during maintenance between 3.8-4.9 mg/L. This condition still exists is said to be normal, this is in accordance with Sutanti's (2009) statement which states oxygen involved in maintenance shrimp range between 4-8mg/L. Meanwhile, salinity value during maintenance range between 30-32 ppt, this condition is still said to be normal. This is in accordance with the statement by Fajar *et al*, (2017), that optimal salinity for shrimp range 30-37 ppt.

CONCLUSION

Conclusions obtained from this research, namely addition of astaxanthin to feed influential real increase weight absolute, speed growth daily, ratio conversion feed and efficiency feed (EP) given Astaxanthin in the maintenance medium influential real, will but on a level continuity life has no effect. Measurement water quality during maintenance still at normal levels and in a good range for cultivation windu shrimp and the addition of astaxanthin of 250 gr/ ½ kg of feed produce weight end , speed growth daily and efficiency feed shrimp tiger best for 40 days rearing.

ACKNOWLEDGEMENT

Writer say Thank you to Papa and Mama who have Lots give help as well as give material to the author . Thank you to the two supervisors who have provided Lots guide writer as well as Lots give input to the author . To friends who have help during research.

REFERENCES

Adiwijaya, D., & Haliman, R. W. (2005). *Udang vannamei pembudidayaan dan prospek pasar udang putih yang tahan penyakit*. Jakarta: Penebar Swadaya.

Adillah, M. A. F., Febri, S. P., Putriningtias, A., Haser, T. F., & Islama, D. (2023). Pengaruh pertumbuhan probiotik Nitrobacter pada wadah pemeliharaan terhadap sintasan dan pertumbuhan ikan bawal (Colossoma macropomum). *Jurnal Akuakultura*, 7(2), 33–37.

Dede, H., Riris, A., & Gusti, D. (2014). Evaluasi tingkat kesesuaian kualitas air tambak udang berdasarkan produktivitas primer PT. Tirta Bumi Nirbaya Teluk Hurun Lampung Selatan (Studi kasus). *Maspari Journal*, 6(1), 32–38.

Erma, S. Y., Henni, W. M., & Rara, D. (2014). Efektifitas pemberian astaxanthin pada peningkatan kecerahan warna ikan badut (Amphiprion ocellaris). *Jurnal Rekayasa dan Teknologi Budidaya Perairan*, 3(1).

Fajar, M., Harton, A., Mita, I., & Mia, S. (2017). Supplementation of astaxanthin and vitamin E in feed on the development of gonads white shrimp broodstock Litopenaeus vannamei Boone 1931. *Journal of Aquaculture*.

Febri, S. P., Purba, F. A., Hanisah, & Gigentika, S. (2022). Development strategy of tiger shrimp (Penaeus monodon) cultivation in traditional ponds in East Aceh District, Aceh Province, Indonesia. *Bioflux - Aquaculture, Aquarium, Conservation & Legislation*, 15(4), 2142–2151.

Haser, T. F., Febri, S. P., & Nurdin, M. S. (2018). Pengaruh perbedaan suhu terhadap sintasan ikan bandeng (Chanos chanos Forskall). *Prosiding Seminar Nasional Pertanian*, 1(1).

Kholifah, U., Trasyani, N., & Yuniar, I. (2008). Pengaruh padat tebar yang berbeda terhadap kelangsungan hidup dan pertumbuhan pada polikultur udang windu (Panaeus monodon Fab) dan ikan bandeng (Chanos chanos) pada hapa di tambak Brebes-Jawa Tengah. *Neptunus*, 14(2), 152–158.

Mangampa, M., Busran, & Suswoyo, H. S. (2008). Optimalisasi padat tebar terhadap sintasan tokolan udang windu dengan sistem aerasi di tambak. *Journal of Aquaculture*.

Meiyana, M., & Minjoyo, H. (2011). Pembesaran clownfish (Amphiprion ocellaris) di bak terkendali dengan penambahan astaxanthin. *Balai Besar Pengembangan Budidaya Laut Lampung*, 1–8.

Mohamad, A., Rosidah, I., & Walim, I. (2012). Peningkatan kecerahan warna udang red cherry (Neocaridina heteropoda) jantan melalui pemberian astaxanthin dan canthaxanthin dalam pakan. *Journal of Aquaculture*, 3(4), 243–252.

Mita, I. (2013). Pemberian astaxanthin dan vitamin E dalam pakan terhadap perkembangan gonad calon induk udang vaname (Litopenaeus vannamei). Jawa Timur: Institut Pertanian Bogor.

Nazlia, S., Nurhayati, Riski, A. M., Aprita, I. R., Sabri, M., Afriana, S., & Febri, S. P. (2023). Growth performance of gouramy (Osphronemus gouramy) with the addition of activated charcoal from tuna (Thunnus sp.) bone waste in feed. *Acta Aquatica: Aquatic Sciences Journal*, 10(1), 62–66.

Phonna, Z., Febri, S. P., & Hanisah. (2022). Efektivitas penambahan astaxanthin pada pakan komersil untuk meningkatkan kecerahan warna, pertumbuhan dan sintasan ikan komet (Carassius auratus). *MAHSEER: Jurnal Ilmu-Ilmu Perairan dan Perikanan*, 4(1), 17–26.

Ranggayoni, N. P., Febri, S. F., Isma, M. F., & Hasri, I. (2021). Pengaruh penambahan ekstrak kunyit (Curcuma domestica) pada pakan komersil terhadap pertumbuhan dan kelangsungan hidup ikan peres (Osteochillus kappeni). *Arwana: Jurnal Ilmiah Program Studi Perairan*, 3(2), 75–81.

Saltin, A., Muhammad, I., & Agus, K. (2016). Pengaruh penambahan minyak ikan salmon dalam pakan terhadap pertumbuhan dan sintasan post larva udang windu (Penaeus monodon). *Media Akuatika*, 1(4), 234–242.

Simamora, S. D., Febri, S. P., & Rosmaiti. (2021). Pengaruh dosis probiotik EM-4 (effective microorganism-4) dalam pakan komersil terhadap peningkatan pertumbuhan dan kelangsungan hidup ikan patin siam (Pangasius hypophthalmus). *Acta Aquatica: Aquatic Sciences Journal*, 8(3), 131–137.

Simbolon, S. M., Mulyani, C., & Febri, S. P. (2021). Efektivitas penambahan ekstrak buah pepaya pada pakan terhadap peningkatan kecerahan warna ikan mas koi (Cyprinus carpio). *Jurnal Kelautan dan Perikanan Indonesia*, 1(1), 1–9.

Soemardjati, W., & Suriawan, A. (2007). Petunjuk teknis budidaya udang vannamei (Litopenaeus vannamei) di tambak. *Departemen Kelautan dan Perikanan, Direktorat Jenderal Perikanan Budidaya, Balai Budidaya Air Payau Situbondo*, 12–16.

Sofian, D., Jusadi, S., & Nuryati. (2016). Pertumbuhan dan status antioksidan ikan gurami yang diberi level suplementasi astaxanthin berbeda. *Jurnal Akuakultur Indonesia*, 15(1), 24–31.

Syahputra, N., Febri, S. P., Komariyah, S., Haser, T. F., & Aprita, I. K. (2023). Efektivitas pemberian kitosan pada pakan terhadap organoleptik ikan lele dumbo (Clarias gariepinus). *Jurnal Agroqua*, 21(2), 408–415.

Sutanti, A. (2009). Pengaruh pemberian bakteri probiotik Vibrio SKT-b melalui Artemia dengan dosis yang berbeda terhadap pertumbuhan dan kelangsungan hidup pasca larva udang windu (Panaeus monodon). *Institut Pertanian Bogor*.

Tantikitti, C. (2014). Kelezatan pakan dan sumber protein alternatif pada pakan udang. *Songklanakarin Journal of Science and Technology*, 36, 51–55.

Wilson, & Hardy. (2002). Population dynamics and reproductive traits of the ornamental crab Porcellana sayana: Implications for fishery management and aquaculture. *Journal of Aquaculture*.

Zainuddin, Haryati, Siti, A., & Surianti. (2014). Pengaruh level karbohidrat dan frekuensi pakan terhadap rasio konversi pakan dan sintasan juvenil Litopenaeus vannamei. *Jurnal Perikanan (J. Fish. Sci.)*, 16(1), 29–34.