

Immunostimulant Application of *Chlorella Vulgaris* on the Growth of Vaname Shrimp (*Litopenaeus vannamei*) in Gresik

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ABSTRACT

Keywords:

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This activity aims to improve the defense of harvests and the bodies of vaname shrimp (*Litopenaeus vannamei*) in ponds in Gresik Regency through the application of immunostimulants from *Chlorella vulgaris*. The main problems faced by farmers include high shrimp mortality rates due to declining water quality and pathogen infections. The use of antibiotics has proven to be ineffective and causes residues in aquaculture products, which are harmful to health. Therefore, an environmentally friendly biotechnology approach through the use of natural immunostimulants is a more sustainable alternative. The implementation method included collaboration between the community service team, the Fisheries Service, and farmer groups in Mojoasem and Pangkah Wetan villages, Ujung Pangkah subdistrict, Gresik Regency. The stages of the activity consisted of socialization, training in the production and application of *Chlorella vulgaris* based immunostimulants, and assistance in applying the technology in ponds. The results of the activity showed that the use of *Chlorella vulgaris* immunostimulants had a significant effect on the growth and survival parameters of vaname shrimp. The 28-day maintenance period yielded the best results in terms of survival rate (SR) of 100%, specific growth rate (SGR) of 4.17%, and absolute weight and length growth of 1.39 grams and 1.10 cm. The application of immunostimulants can enhance immune response, maintain water quality stability, and reduce shrimp mortality rates. Thus, this technology has the potential to become an innovative strategy in the development of shrimp farming in the coastal areas of Gresik.

INTRODUCTION

Vaname shrimp (*Litopenaeus vannamei*) was introduced to Indonesia around 2002 and was approved for development in Indonesia. Vaname shrimp production, both fry and consumption size, increased from <10% to 50% with a selling price of Rp. 170,000 per kg for size 30 shrimp. However, the productivity of vaname shrimp has fluctuated, and various breakthroughs to overcome this have been attempted (Shoo *et al.*, 2005).

Gresik Regency has enormous potential in the fisheries sector, which consists of the capture fisheries sub-sector, the aquaculture sub-sector (ponds, ponds, and cages), and the

fisheries processing sub- sector, all of which have great potential for development. The total production of the fisheries sector aquaculture is 10,067,346 kg/Ha (Wu and Zhidong, 2005). Several pond locations that have great potential for shrimp farming are in Ujung Pangkah District and Sidayu District. Based on the aquaculture potential in Gresik, the target partners of this community service activity are two productive farmer groups, namely the Sidodadi Farmer Group and the Farmer Group in Pangkah Wetan Village, Ujung Pangkah District and Sidayu District. However, both locations often experience crop failures.

Shrimp mortality in ponds is mainly caused by declining water quality and disease outbreaks. This can result in up to 100% mortality and crop failure. To meet the demand for shrimp, various efforts have been made, such as the use of antibiotics, but these have not been able to meet the target. In fact, the use of antibiotics has resulted in residues in shrimp, which are unsafe for consumption by consumers. Meanwhile, shrimp production in both districts up to 2023 has only reached 6,978,483 tons from 5,392.00 hectares of pond area out of the total pond area of 8,569.32 hectares. 876.00 hectares and 5,679.324 tons from a total pond area of 5,392.00 hectares. This figure remains low compared to the year before the mortality incident, which reached 7,654.13 tons in 2016 (Taslihan *et al.*, 2005).

The main problems hindering efforts to revitalize shrimp ponds in Indonesia in general and East Java in particular are slow or low growth and high mortality rates in ponds due to declining water quality and disease/pathogen attacks. Attacks of white spot virus disease, known as "white spot" (WSSV), IMNV, WFD, and AHPND, are major obstacles and serious problems in shrimp farming. Moreover, traditional shrimp pond farming generally relies on and is highly dependent on tidal conditions.

The application of immunostimulants is aimed at solving the problem of decreased immunity and the emergence of disease outbreaks. The use of these immunostimulants can increase shrimp survival (harvest) in ponds by up to 83%, which is higher than when not using these two products, where the harvest only reaches around 17% (Liao, 2000). The application of shrimp farming technology using immunostimulants can yield high- quality, disease-free shrimp harvests with a 360% increase. The pond water will remain in optimal condition, preventing diseases from emerging during cultivation and allowing the shrimp to grow well and healthily.

One of ingredients that can be used as a natural immunostimulant is *Chlorella vulgaris*. *Chlorella* contains vitamin A (β - carotene) and vitamin C, which can act as immunostimulants in boosting the ctivity of the body's defense cells. The vitamin content of A (β -carotene) is physiologically synthesized to enhance growth (Ramadhan *et al.*, 2016). The absolute best weight gain yielded a weight of 2.09 grams during one month of maintenance (Rahman and Putra, 2016). According to Scabra *et al.*, (2023), the specific growth rate in vaname shrimp is >2.97% per day. According to Jadhav *et al.*, (2006), there is a relationship between immunostimulants and growth when immunostimulants are used in shrimp, showing better growth rates along with increased immune defense.

METHOD

Based on the results of problem identification, the approach method in solving the main problems faced by partner farmers in Mojoasem and Pangkah Wetan villages involved the Community Service Team collaborating with the Gresik Regency Fisheries and Marine Affairs Office, community leaders, and religious leaders. The purpose of this approach was to convey activities to resolve the problems that had arisen. To increase crop yields, an environmentally friendly and blue economy- based vaname shrimp farming method using immunostimulants and probiotics in ponds will be implemented.

Tools and Materials

The tools used in this activity were rulers, digital scales, DO meters, pH pens, ammonia test kits, aerators, gallons, and measuring cups. The ingredients used to make the

immunostimulant were seawater, *Chlorella vulgaris* seeds, and walnut fertilizer. The ingredients used to measure growth were shrimp in both ponds.

Implementations of The Use of Probiotics and Immunostimulants in Pond

The implementation of this activity consists of three stages, namely: (1) the stage of delivering material and training on immunostimulant production, (2) the stage of mentoring and preparing independent production cadres, (3) the application of immunostimulant use in shrimp ponds, and independent production of immunostimulants and marketing of probiotics at the local sub-district, district, and national levels.

1. Socialization Phase of Community Service Activities

The socialization or outreach program was aimed at increasing knowledge about immunostimulants and was carried out in the villages of Mojoasem and Pangkah Wetan, Ujung Pangkah Subdistrict, Gresik Regency. These locations were chosen based on the effectiveness and efficiency of the community service team and the ease of access for the target audience. The methods used in this stage were tutorials and visualizations, followed by discussions on the outreach material. The outreach material covered the cultivation of vaname shrimp using immunostimulants in ponds. The outreach program was attended by 25 participants from each partner.

2. Immunization Training and Immunostimulant Multiplication Stage

This training stage is aimed at improving immunization skills and multiplying probiotics, which was carried out in Mojoasem and Pangkah Wetan, Ujung Pangkah District, Gresik Regency. These locations were chosen based on the effectiveness and efficiency of the community service team's work and the ease of access for the target audience. The methods used in this stage were tutorials and visualizations, followed by discussions on the extension material.

3. Implementation Stage of Immunostimulant Use in Shrimp Farming

This stage involved the direct application of vaname shrimp farming using immunostimulants in ponds. This stage began with a re-check of the recirculation plots used in the application of this technology. The provision of seeds, materials and tools for checking water quality, and immunostimulants were provided by the Unair community service team. In this case, the extension team acted as mentors during one shrimp maintenance cycle, which lasted approximately 3 months. Equipment such as ponds, saprodi, and others are prepared by Mitra. Two ponds are used with two treatments, namely pond 1) without the addition of immunostimulants from *Chlorella vulgaris*, and pond 2) using the addition of immunostimulants from *Chlorella vulgaris*. During the one-cycle shrimp farming period, activities carried out include monitoring the circulation plots, water quality, and the health and growth of the shrimp as supporting data for evaluating the success rate of the applied farming method.

4. Training for Immunostimulant Production Cadres from *Chlorella vulgaris*

The objective of this stage is to form cadres need to be conducted Careful selection of candidates. The criteria for candidates are: they must be members of partner groups 1 and 2. Five cadres are provided from each partner farmer group, and training is conducted at least three times during the activity.

5. Establishment of *Chlorella vulgaris* Immunostimulant Production Centers

The production center for probiotics and immunostimulants at each partner is implemented in the second year. Each partner must appoint 5 cadres to carry out the production of probiotics and immunostimulants.

6. Parameters Key and Supporting

The main parameters used in this activity are survival rate (SR), specific growth rate (SGR), weight absolute, and absolute length. Meanwhile, the supporting parameter used is water quality.

a) Survival rate (SR)

Survival rate (SR) is the percentage of live shrimp at a certain time compared to the number of shrimps at the start of cultivation. The survival rate is calculated using the formula according to Gompi et al., (2023), namely:

$$SR = \frac{N_t}{N_0} \times 100\%$$

Note:

SR = Survival Rate (%)

N_t = Number of live shrimps at the end of cultivation (pieces)

N_0 = Number of shrimps at the start of stocking (tails)

b) Specific Growth Rate (SGR)

The specific growth rate (SGR) is the percentage of the difference between the final weight and the initial weight divided by the duration of the cultivation period. The daily growth rate uses the formula according to Hanief et al., (2014), namely:

$$SGR = \frac{L_n W_t - L_n W_0}{t} \times 100\%$$

Note:

SGR = Specific Growth Rate (%)

W_t = Final weight of test animals at the end of the study (grams)

W_0 = Initial weight of test animals at the start of the study (grams)

c) Absolute Weight

Absolute weight gain can be calculated using the formula according to Nurhijrah (2019), namely:

$$Wm = W_t - W_0$$

Note:

W_m = Absolute weight gain (g)

W_t = Average final weight (g)

W_0 = Average initial weight (g)

d) Growth Length

Calculation growth length can be calculated using the formula according to Nurhijrah (2019), namely:

$$Lm = L_t - L_0$$

Note:

L_m = Absolute length growth (cm)

L_t = Average length at the end of the period (cm)

L_0 = Average length at the beginning (cm)

Data Analysis

The research data were analyzed using Analysis of Variance (ANOVA) through Statistical Product and Service Solution (SPSS) version 25 (Jayanti et al., 2022). Survival rate (SR), specific growth rate (SGR), and absolute growth (GR) were analyzed using Factorial RAL to determine the interaction between *Chlorella vulgaris* extract administration and maintenance period (Dahlia et al., 2015). If this study found significant differences and results, it was followed by Duncan's Multiple Range Test (DMRT) with a significance level of 5% (Fauzan et al., 2015).

Monitoring and Evaluation

Monitoring and evaluation of this program's activities will be conducted periodically at least once every three to four weeks. The indicators that will be used to assess the implementation and success of this program are the response of participants in this activity, the number of participants or shrimp farmers who participate in and benefit from this program, improvements in the quality or production of traditional shrimp ponds cultivated using this

science and technology, and the dissemination of information about the program to the wider community.

RESULT AND DISCUSSION

Shrimp Growth

The results of measuring the growth of vaname shrimp after administering the immunostimulant *Chlorella vulgaris* show that the survival rate of shrimp is higher when the immunostimulant *Chlorella vulgaris* is administered or added. The best immunostimulant administration results over 28 days produced an absolute survival rate (SR) of 100%, specific growth rate (SGR) of 4.17%, absolute weight growth of 1.39 grams, and absolute length growth of 1.10 cm. The average survival rate (SR) data for vaname shrimp can be seen in Table 2.

Table 2. Average survival rate (SR) of vaname shrimp during 28 days of cultivation.

Chlorella vulgaris administration	Survival Rate (SR)				
	Rearing Duration				
	0 days	7 days	14 days	21 days	28 days
Pond 1 (without feeding)	100 ^a ± 0,00	72 ^{cd} ± 8,37	56 ^{gh} ± 5,48	46 ⁱ ± 5,48	36 ^j ± 5,48
Pond 2 (given Immunostimulants)	100 ^a ± 0,00	94 ^b ± 0,00	88 ^{cd} ± 0,00	86 ^{fg} ± 0,00	86 ⁱ ± 0,00

Note: Pond 1 = without immunostimulant from *Chlorella vulgaris*, Pond 2 = given immunostimulant from *Chlorella vulgaris*. Superscripts in the same column indicate significant differences ($p < 0.05$).

According to research by Harefa (2018), shrimp survival rates of $\geq 50\%$ are categorized as good, 30-50% as moderate, and $\leq 30\%$ as poor. The addition of *Chlorella vulgaris* can reduce mortality, which can increase shrimp appetite and endurance. Along with high survival rates, shrimp mortality is inevitable. Factors that can affect shrimp survival include density, cultivation methods, cannibalism, water quality, and feed (Irianti *et al.*, 2016). Shrimp mortality occurs due to high cannibalism, during which vaname shrimp shed their entire body skin. This is in line with the statement by Romano and Zeng (2017) that crustaceans such as shrimp undergo molting (shedding of skin), which requires them to shed their outer skeleton in order to grow. The molting process makes shrimp unable to defend themselves and very vulnerable to cannibalism. The administration of immunostimulants is expected to increase resistance to disease infection. *Chlorella vulgaris* was applied by adding it to the feed. According to Kristiyaningrum *et al.*, (2013), the growth rate of shrimp fed with *Chlorella vulgaris* was relatively faster because it contains carotenoids that can increase immune resistance. The average specific growth rate (SGR) of vaname shrimp can be seen in Table 3.

Table 3. Average specific growth rate (SGR) of vaname shrimp during 28 days of cultivation

Chlorella vulgaris administration	Specific Growth Rate (%)				
	Rearing Duration				
	0 days	7 days	14 days	21 days	28 days
Pond 1 (without feeding)	2,56 ^f ± 0,21	3,25 ^{de} ± 0,19	3,39 ^{cd} ± 0,14	3,48 ^{cd} ± 0,21	3,49 ^{cd} ± 0,17
Pond 2 (given Immunostimulants)	3,04 ^e ± 0,08	3,39 ^{cd} ± 0,09	3,65 ^{bc} ± 0,30	3,89 ^{ab} ± 0,25	4,17 ^a ± 0,39

Note: Pond 1 = without immunostimulant from *Chlorella vulgaris*, Pond 2 = given immunostimulant from *Chlorella vulgaris*. Superscripts in the same column indicate significant differences ($p < 0.05$).

Growth is the process of increasing weight and length beyond previous measurements. The good and optimal growth of vaname shrimp is influenced by the compounds contained in *Chlorella vulgaris*, which can be used as an immunostimulant because it contains vitamin A, vitamin C, minerals, carbohydrates, fats, chlorophyll, beta carotene, and protein, which dominates 60% with a molecular weight of 15-33 kDa (Yanuhar et al., 2020). Data on the absolute length and absolute weight of vaname shrimp at days 0, 7, 14, 21, and 28 of cultivation can be seen in Tables 4 and 5.

Table 4. Measurement of absolute weight of vaname shrimp during 28 days of cultivation

Chlorella vulgaris administration	Absolute Weight (gram)				
	Rearing Duration				
	0 days	7 days	14 days	21 days	28 days
Pond 1 (without feeding)	0,29 ^J ± 0,03	0,44 ^{hi} ± 0,05	0,59 ^g ± 0,07	0,76 ^e ± 0,09	0,98 ^d ± 0,06
Pond 2 (given Immunostimulants)	0,37 ^J ± 0,02	0,51 ^{sh} ± 0,03	0,70 ^{ef} ± 0,05	0,98 ^d ± 0,11	1,39 ^a ± 0,18

Note: Pond 1 = without immunostimulant from *Chlorella vulgaris*, Pond 2 = given immunostimulant from *Chlorella vulgaris*. Superscripts in the same column indicate significant differences ($p < 0.05$).

Table 5. Measurement of the absolute length of vaname shrimp during 28 days of cultivation

Chlorella vulgaris administration	Length Absolute (cm)				
	Rearing Duration				
	0 days	7 days	14 days	21 days	28 days
Pond 1 (without feeding)	0,19 ^{hi} ± 0,05	0,43 ^g ± 0,02	0,56 ^f ± 0,02	0,67 ^e ± 0,04	0,83 ^c ± 0,04
Pond 2 (given Immunostimulants)	0,27 ^h ± 0,08	0,51 ^f ± 0,06	0,64 ^e ± 0,02	0,84 ^c ± 0,04	1,10 ^a ± 0,07

Note: Pond 1 = without immunostimulant from *Chlorella vulgaris*, Pond 2 = given immunostimulant from *Chlorella vulgaris*. Superscripts in the same column indicate significant differences ($p < 0.05$).

Water Quality

The results of water quality monitoring in the ponds are presented in Table 6.

Table 6. Average results of water quality parameter tests during 28 days of cultivations

Parameter	Value Range
Temperature (°C)	26,2 – 26,7
Salinity (ppt)	21 – 24
pH	7,2 – 7,8
Dissolved Oxygen (ppm)	6,2 – 6,9
Ammonia (mg/l)	0,5

Table 1 shows that the water quality parameters of the ponds are always within the optimal range for shrimp growth. According to Supriatna et al., (2020), the optimal temperature for vaname shrimp growth ranges from 26-32 °C, which is in line with the results, namely a minimum of 26.2 °C and a maximum of 26.7 °C. Vaname shrimp farming has an optimal level above 4 mg/l, but if DO reaches a lower level of 1.5 mg/l, it will cause shrimp mortality. The optimal pH level for shrimp farming is 7.0-8.5. Water conditions within the optimal pH range will affect the shrimp's appetite and support molting (shedding of skin), while pH levels below or above the optimal value can cause difficulties in molting. Nababan *et al.*, (2015) found that

the ideal salinity for vaname shrimp growth is 10-30 ppt. Salinity can affect shrimp osmoregulation; if the salinity is not at the optimal level, the osmoregulation process will require a lot of energy for growth. The optimal range for ammonia in vaname shrimp farming is <0.1 mg/l. Ammonia levels in vaname shrimp farming over 28 days have not reached the optimal limit. Ammonia levels exceeding the optimal limit can cause gill damage and inhibit oxygen uptake during growth (Taqwa *et al.*, 2014).

Evaluation Results Socialization/ Extension Activities

The evaluation of the socialization/extension results, conducted by directly visiting the farmers, showed an increase in knowledge about the immunostimulant from *Chlorella vulgaris* to enhance the growth and productivity of vaname shrimp in the Mojoasem and Pangkah Wetan Village ponds, Gresik. This proves that the farmers who participated in this activity have already implemented the production of immunostimulants independently.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The administration of *Chlorella vulgaris* as an immunostimulant affected the survival rate (SR), specific growth rate (SGR), and absolute growth (GR) of vaname shrimp (*Litopenaeus vannamei*) over a period of 28 days. The best growth of vaname shrimp resulted in SR (100%), SGR (4.17%), absolute weight growth (1.39 grams), and absolute length growth (1.10 cm).

Recommendation

Regular monitoring of vaname shrimp growth and water quality is necessary during the application of *Chlorella vulgaris* based immunostimulants to assess the effectiveness of immunostimulant use in vaname shrimp cultivation and maintain optimal water quality parameters.

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REFERENCES

- Dahlia, I., S. Rejeki, dan T. Susilowati. 2015. Pengaruh Dosis Pupuk Dan Substrat Yang Berbeda Terhadap Pertumbuhan *Caulerpa lentillifera*. *Jurnal Manajemen Akuakultur dan Teknologi*, 4(4): 28-34.
- Fauzan, Y. S. A., E. Sandra, dan D. Mulyono. 2015. Kajian Elongasi Pada Tanaman In Vitro Gaharu (*Aqualaria beccariana* van Tiegh). *Jurnal Bioteknologi dan Biosains Indonesia*, 2(2): 65-72.
- Gompi, W., H. Sambali, O. J. Kalesaran, E. L. Ngangi, J. D. Mudeng dan W. M. Mingkid. 2023. Studi Kasus Rasio Konversi Pakan (FCR) di Tambak Intensif Udang Vanname (*Litopenaeus vannamei*) CV. Sinar Limunga. *E-Journal Budidaya Perairan*, 11(2): 309-320.
- Hanief. M. A. R, Subandiyono, and Pinandoyo. 2014. The Effect of Feeding Frequencies on The Growth and Survival Rate of Java Barb Juveniles (*Puntius javanicus*). *Journal of Aquaculture Management and Technology* 3 (4): 67-74
- Harefa, D. 2018. Pemanfaatan Fermentasi Tepung Maggot (*Hermetia illucens*) Sebagai Substitusi Tepung Ikan Dalam Pakan buatan Untuk Benih Ikan Baung (*Hemibagrus nemurus*). Skripsi. Pekanbaru: Fakultas Perikanan dan Kelautan, Universitas Riau. 79.
- Irianti, D. S. A., A. Yustiati, dan H. Hamdani. 2016. Kelangsungan Hidup Dan Pertumbuhan Udang Galah (*Macrobrachium rosenbergii*) Yang Diberi Kentang Pada Media Pemeliharaan. *Jurnal Perikanan Kelautan*, 7 (1): 23- 29.

- Jadhav, V. S., S. I. Khan, M. M. Girkar, and M. J. Gitte. 2006. The Role of Immunostimulants in Fish and Shrimp Aquaculture. *Aquatic Animal Health*, 24-27.
- Jayanti, S. L. L., A. A. Atjo, R. Fitriah, D. Lestari, dan M. Nur. 2022. Pengaruh Perbedaan Salinitas Terhadap Pertumbuhan dan Sintasan Larva Udang Vaname (*Litopenaeus vannamei*). *Aquacoastmarine Jurnal Akuatik dan Sains Perikanan*, 1(1): 40-48.
- Kristiyaningrum, D., H. P. Kusumaningrum, dan E. Kusdiyanti. 2013. Analisis Kandungan Fusan Intraspecies *Chlorella vulgaris* dan Aplikasinya Sebagai Pakan Tambahan Pada Post Larva Stadia 1 Udang Windu (*Penaeus monodon*). *Jurnal Biologi*, 2(3): 1-7.
- Liao, I. C. 2000. *Aquaculture Development: Challenges for the 21st Century*.
- Nababan, E., I. Putra dan Rusliadi. 2015. *Pemeliharaan Udang Vaname Dengan Perentase Pemberian Pakan Yang Berbeda*. Skripsi. Fakultas Perikanan dan Ilmu Kelautan Universitas Riau. 1-9.
- Rahman, F. dan Putra, I. 2016. Pertumbuhan Dan Kelangsungan Hidup Udang Putih Barat (*Litopenaeus vannamei*) Pada Salinitas Berbeda. *Jurnal Online Mahasiswa (JOM) Bidang Perikanan dan Ilmu Kelautan*, 3(1): 1-9.
- Ramadhan, Umar, dan W. Santiadjinata. 2016. Aplikasi Pakan Berkaratenoid Pada Udang Windu Di Tambak. *Teknik Litkayasa Akuakultur*, 14(2): 105-109.
- Romano, N. and C. Zeng. 2017. Cannibalism of Decapod Crustaceans and Implications for Their Aquaculture: A Review of its Prevalence, Influencing Factors, and Mitigating Methods. *Review in Fisheries Science and Aquaculture*, 25(1):42-69.
- Scabra, A. R., M. Junaidi, dan L. A. O. Rinaldi. 2021. Pengaruh Penambahan Daun Ketapang (*Terminalia catappa*) Terhadap Pertumbuhan Larva Udang Vaname (*Litopenaeus vannamei*) Pada Salinitas 0 PPT. *Jurnal Perikanan*, 11(2): 218-231.
- Shoo, J. P., T. Xiao and Y. Bao. 2005. Dynamic Changes of total Bacterian and *Vibrio* in an Integrated Seaweed Abalone Culture System. *Journal of aquaculture* (06) (50): 289-297.
- Supriatna, M. Mahmudi, M. Musa, dan Kusriani. 2020. Hubungan pH Dengan Parameter kualitas Air Pada Tambak Intensif Udang Vannamei (*Litopenaeus vannamei*). *Jurnal Penelitian Perikanan dan Kelautan*, 4(3): 368-374.
- Taqwa, F. H., Marsi, dan A. Praja. 2014. Pemanfaatan Sari Buah Pepaya (*Carica papaya* L.) Untuk Peningkatan Vitalitas Pascalarva Udang Vaname (*Litopenaeus vannamei*) Selama Masa Adaptasi Penurunan Salinitas. *Jurnal Akuakultur Rawa Indonesia*, 2(1): 93-104.
- Taslihan, A., Supito, E. Sutikno dan R. B. Callinan. 2005. *Teknik Budidaya Udang Secara Benar, Balai Besar Pengembangan Budidaya Air Payau. Ditjen Perikanan Budidaya. Jakarta*
- Wu, X and Z. Zhidong, 2005. Closed Recirculating System for Shrimp-Moluscha Polyculture. *J. oceano- limno*, 24(4): 461-8.
- Yanuhar, U. M. Musa, D. Arfiati, Q. Sholihah, A. Khumadi, and N. R. Caesar. 2020. Influence of a Pigment Protein Fraction from *Chlorella vulgaris* Isolated in Indonesia on β - Actin and MHC-1 Response to Viral Infected Humpback Grouper. *Systematic Reviews in Pharmacy*. 11(7): 352-362.