Improving on Polyculture Eels (*Anguilla bicolor*) and Nile Tilapia (*Oreocromis niloticus*) Using Artificial Feed for Growth and Survival Rate

Improving on Polyculture Eels (*Anguilla bicolor*) and Nile Tilapia (*Oreocromis niloticus*) Using Artificial Feed for Growth and Survival Rate

Istiyanto Samidjan*, Diana Rachmawati
Aquaculture Department,
Faculty of Fisheries and Marine Science,
Diponegoro University Jl. Prof. Soedarto, SH, Tembalang, Semarang, 50275 Indonesia.
Corresponding author: istiyanto_samidjan@yahoo.com

Abstract. The study was conducted to evaluate to mix combination different combinations of eels and nile tilapias on the growth and survival. The material used eels (*A. bicolor*) 5-7.95 ± 0.025 cm, and used mix were 5 and 10 fish tilapia/m^2 that used artificial feed of vitamin E at a dose of 3% per biomass per day. An experimental randomized completely design was used with 4 treatments and 3 replications. The treatments were T1 (5 fish/m^2 eels and 5fish of nile tilapia/m^2), T2 (10 indivls/m^2 eels and nile tilapia 5 fish/m^2), T3 (5 fish/m^2 eels and nile tilapia 10 fish/m^2 nile tilapia, T4 (given 10 fish/m^2 eels and given 10 fish/m^2 nile tilapia. The data obtained was the absolute weight of data growth, survival, FCR, and water quality data (pH, O_2, NO_2,) and were analyzed by analysis of variance. The experimental results showed significant effect (P <0.05) on the growth and survival eels and nile tilapia. Polyculture of eels and tilapia can increase of the highest absolute growth obtained from T4 treatment (187.85 ± 0.9 g), nile tilapia (60.65 ± 0.95 g).

1. Introduction

Three species are tilapia (*Oreochromis niloticus*), eel (*Anguilla anguilla)* and grey mullet *(Mugil cephalus*) are considered in Egypt as fish species of high market value. Addition of eel and tilapia response very good to pond polyculture however information on the integration of eel to polyculture in earthen ponds are very limited and new technology in Indonesia especially [1][2].

The problems that arise today in the cultivation of eels (*A. bicolor*) and nile tilapia (*O. niloticus*) are high mortality of 80-95%, attack bacteria, nutritional intake of feed for using fish waste as feed, low environmental water quality. Still conventional cultivation techniques and monocultures system will exacerbate degradation and production of Eels (*A bicolor)*and nile tilapia (*O niloticus*)[3][4].

Recently, aquaculture production has grown enormously, and among that of Eels (*A bicolor*) and nile tilapia (*O niloticus*) are one of the most important cultured species worldwide especially in Asia due to their high economic value and export Eels (*A bicolor*) and nile tilapia (*O niloticus*) [4][5][6]. Eels (*A bicolor*), nile tilapia (*O niloticus*) are annually produced but the current global demand for both the wild and farmed Eels (A bicolor) and nile tilapia are approximately more than 339 000 t [7].

Research that has been developed [2,3], those study were carried out in a fish farm at Fowwa, Kafir El-Sheik Governorate,A.R.A. The sudy aimed to investigate the growth performance of eel, grey mullet and Nile tilapia fishes reared in earthen ponds as well as pond productivity as affected by dietary protein levels. Nine earthen ponds,each total area of 2000 m^2representated three dietary protein level (20,32,44%) with there replicates for each protein level. Fish species were stocked in eachpond at densties of 2000, 1000 and 800 with and average initial weigh of 20,29 and 31 g for tilapia, mulled and eel respectively that resultobtained are summarized in the following final body weight of nile tilapia increased significantly with each increase in the dietary protein level from 20 to 32 or 44%. And final body weight of eel increased significantly with increased in the protein level fed. In polyculture fish, black tiger shrimp aquaculture and seaweed in Semarang but showed of the results not satisfactory [8][9]. Likewise some of the other research in applying the technology polyculture cultivation of Eels (A bicolor), black tiger shrimp, vannamei shrimp, seaweed and nile tilapia (O niloticus), has contributed in supporting the development of fisheries in Indonesia, the activities that have been done research team bill that was on the program Vucer Multi-year funding by DP2M Higher Education [8][10][11][12][13][14] with the theme "the application of hatchery technology and the enlargement of the cultivation of nile tilapia (*O niloticus*) and mud crab in polyculture with models of battery plastic in ponds in an effort to improve the quality and production to stimulate national export fishery" with the results showed that after the implementation of the program VCM

was able to increase production and revenue SMEs 1, SME-2 and SME-3. 2 seed production in SMEs are able to increase the production and quality of seeds produced 5,000 young crab seed size 61.483 mm, while the production of soft-shelled crabs before VCM on SME-1720 kg Rp. 32,400,000, -, SME-2 (835.71 kg Rp. 57.85595 million, -) and SME-3 (749.71 kg Rp. 33.73695 million, - After the VCM program rose to the SME-1 (1028.6 kg worth Rp.46.285 .950, -), SME-2 (1285.7 kg, Rp.57.855.950 value, -) and SME-3 (1089.42 kg Rp. 49.0239 million, -). Furthermore, the results of research on probiotic technology shrimp Vannamei of isolation of bacteria from the gut of shrimp Vanamei results showed the results of the year I found kind of probiotic bacteria that can potentially inhibit the bacterium Vibrio sp, was able to degrade organic matter into elements of N, P, K, type of probiotic bacteria are *Lactobacillus, Bacillus, Flavobacterium,Alkaligenus, cinetobacter, Mycobacterium,Closteridium,* esulfovibrio. While the density of probiotic bacteria are included in the maintenance media gives a significant influence on the growth and survival of post larvae shrimp vannamei (P <0.01) and was able to inhibit the growth of bacteria *Vibrio sp* [15][16][17][18][19][21][22][22][23].

The objective to assess the role of technology engineering polyculture Eels (*A bicolor*) farming and nile tilapia (*O niloticus*) and mix different combinations of Eels (*A bicolor*) and nile tilapia (*O niloticus*)s and on the growth and survival.

2. Research Method

2.1.Sampling Location

The material in this study is Eels (*A bicolor*) 5-7.95 ± 0.025 cm, the number of seeds used about 5 and 10 individual of Eels (*A bicolor*)/ m^2 and nile tilapia (O niloticus) 5 and 10 individual / m^2 to 1200 m^2 pond culture that used to be given artificial feed with 35% protein content enriched with vitamin E at a dose of 3% perbiomas per day (Table.1).

Table 1 Feed ingredients formulation for Eels (*A bicolor*) and nile tilapia (*O niloticus*)

Material (g)	**Composition**
Vitamin E (mg)	0.8
Fish meal	34.5
Soybean	35
Corn meal	8.7
Rice bran	8.1
Dekstrin	10
Corn oil	1.42
Fish oil	1.1
CMC	1.1
Total	100
Energy (kkal)	300.02
Ratio E/P	8.7

2.2 *Sampling and Preparation*

The method used was experimental method that was done in the field, using a completely randomized design with 4 treatments and 3 replications namely as follows were T1=5E+5T (given seed 5 individuals / m^2Eels (*A bicolor*) and given 5 individuals of nile tilapia (*O niloticus*) / m^2), T2=10E+5T (given 10 individuals / m^2Eels (*A bicolor*) and given nile tilapia (*O niloticus*) 5 individuals / m^2), T3=5

E+10 T (given 5 individuals / m^2Eels (*A bicolor*) and given nile tilapia (*O niloticus*) 10 individuals / m^2 nile tilapia (*O niloticus*)), T4=10 E+10T (given 10 individuals / m^2Eels (*A bicolor*) and given 10 individuals / m^2 nile tilapia (*O niloticus*).

The data obtained was the absolute weight of data growth, survival, FCR, and water quality data (temperature, salinity, pH, O_2, NO_2, NH_3) Data were analyzed by analysis of variance (F test). And descriptive study was conducted in media technology maintenance polyculture of ± 1200 m^2, with each plot of 100 m^2 breadth of research.

3.Result and discussion

The results showed that the difference in the density of Eels (*A bicolor*) and Nile tilapia (*O niloticus*) significant effect (P <0.01) on the growth and survival Eels and Nile tilapia (*O niloticus*) with the highest growth in absolute weight in Eels and Nile tilapia (*O niloticus*)s obtained from T4 treatment (Eels (*A bicolor*) 187.85 ± 0.9 g), nile tilapia (*O niloticus*) (60.65 ± 0.95 g) and fish survival rate of 95% ± 0.3% and ± 2.3 nile tilapia (*O niloticus*) 95%) and feed conversion (FCR) lower (T4 = 1.54 ± 0.10) (Table.1).

3.1.Weight Absolute growth Eels (A bicolor)

The results showed that the highest growth in absolute weight in fish reared at T4 polyculture (a2b2/10 MF+10MC/m^2 = given 10 animals / m^2. Eels (*A bicolor*)and given 10 animals/m^2 nile tilapia (*O. niloticus*)) is 187.85 ± 0.9 g (Table 2).

Table 2 Absolute growth of Eels (*A bicolor*), nile tilapia (*O niloticus*) based on weight (g), survival rate (%) and FCR on a variety of treatments and replications

Parameter	Treatments in Polyculture*)			
	T1 (5E+5T)	T2 (10E+5T)	T3 (5E+10T)	T4 (10E+10T)
1. Absolute growth of Eels (*A bicolor*)(g)	181.18±3.14^{b}	185.2766667±0.49^{ab}	186.17±0.61^{a}	188.75±0.9^{a}
2. Absolute growth of nile tilapia (*O niloticus*) (g)	48.85±0.95^{c}	55.45±0.62^{b}	59.75±0.75^{a}	61.65±0.95^{a}
3. Survival rate Eels (*A bicolor*)(%)	82.67±1.81^{b}	86.4±4.15^{b}	95.07±2.16^{a}	96±0.3^{a}
4.Survival rate of nile tilapia (*O niloticus*) (%)	79.13±1.10^{b}	82±3.12^{b}	94.43±1.0^{a}	96 ± 2.4^{a}
5. FCR of Eels (*A bicolor*) and nile tilapia (*O niloticus*)	3.46±0.43^{a}	3.79±0.48^{a}	2.09±0.33^{b}	1.55±0.10^{b}

Note:
Highly significant (P<0.01)
E = Eels (*A bicolor*)
T = Nile tilapia (*O niloticus*)

***) Description:**

T1=5E+5T (given seed 5 individuals / m^2Eels (*A bicolor*) and given 5 individuals of nile tilapia (*O niloticus*) / m^2), T2=10E+5T (given 10 individuals / m^2Eels (*A bicolor*) and given nile tilapia (*O niloticus*) 5 individuals / m^2), T3=5 E+10 T (given 5 individuals / m^2Eels (*A bicolor*) and given nile tilapia (*O niloticus*) 10 individuals / m^2 nile tilapia (*O niloticus*)), T4=10 E+10T (given 10 individuals / m^2Eels (*A bicolor*) and given 10 individuals / m^2 nile tilapia (*O niloticus*).

Different superscript letter in the same column indicate significant differentces between samples at the level of (P<0.01).

3.2.Absolute growth of Eels (A bicolor)(g)

The growth of the weight of the absolute highest in T4=10E+10T(given 10 individuals / m^2Eels (*A bicolor)* and given 10 individuals / m^2 nile tilapia (*O niloticus*) was 188.75±0.9^{a} g, as the number

density and the amount of artificial feed containing 35% protein and enriched with vitamine E at a dose of 3% perbiomass per day according to the needs of fish, so as to enhance the growth of the weight of absolute Eels (*A bicolor*) (188.75±0.9[a] g) and able to increase the highest growth, compared to other treatments (T1, T2, and T3), while the analysis of variance showed a highly significant (P <0.01) in absolute weight on growth (Table.2).

This was in accordance with [8][9] that the artificial feeding with a protein content of 35% enriched with vitamin E given to the Eels (*A bicolor*) was able to increase the growth of the absolute weight of Eels (*A bicolor*)179.5 s / d 185.25 g, Addition [3][4][5] results obtained in this study and on the economical evaluation it could be conclude that tilapia, mullet and eel can be cultured together in earthen ponds and growth paframeters on the three species improved with each increase in dietary protein level fed from containing 32% seemed to be the best in terms of ratio of returns to total costs.The opinion of [3][24][25][26][27] said physical growth occurs with the change in the number or size of the cells making up the body tissue, morphologically visible growth of body shape changes so that growth performance of Eel (*Anguilla Anguilla*), nile tilapia (*Oreochromis niloticus) and grey mullet (Mugil cephalus)* cultured in cages under two feeding system. Growth will happen when the energy needs for the metabolism and maintenance of body tissues are met in accordance with the needs of the fish if the amount of feed consumed was greater than the amount needed for the maintenance of the body and used as an energy source fish [24][25][26] [27][28[29][30] [31][32][33][34][35][36] [37]. Result showed response of grey mullet (*Mugil cephalus* L) cultured in earthen ponds, to diets of varying protein levels. There were some previous study about the effect of dietary protein level on body weight of tilapia, eel and mullet [3][38][39][41]. At the start of the experiment averages of initial weigh of tilapia, eel and mullet ranged between 20.28 to 20.87, 31.60 to 32.5 and 29.86 to 30.25 g,

3.3.Absolute growth of Nile tilapia (O niloticus)

The results showed that the treatments in the culture of polyculture system with maintaining simultaneously Eels (*A bicolor*) and nile tilapia (*O niloticus*) in the pond with each plot of 100 m^2., Giving a highly significant effect on the growth of the weight of absolute nile tilapia (P <0.1) (Table. 2, Figure 2). Based on Table 2, shows that the highest growth in absolute weight T4 =10 E+10T (given 10 individuals / m^2Eels (*A bicolor*)and given 10 individuals / m^2 nile tilapia (*O niloticus*)) ie the absolute weight of nile tilapia (*O niloticus*) (61.65±0.95[a] g).

Furthermore, based on the analysis of variance showed a high;y significant on the growth of the absolute weight of nile tilapia (P <0.01). This was due to nile tilapia are maintained simultaneously with eel can grow well and there was a good relationship synergistically. The growth Nile tilapia good was due to artificial feed given enriched with Vitamin E in the diet acts as an antioxidant to prevent oxidation of HUFA (Highly Unsaturated Fatty Acid), so as to maintain the availability of HUFA in the feed and prevent oxidation HUFA in cell membrane or prevent intracellular free radicals. In addition, to the enrichment of vitamin E in feed indirectly also play a role in the growth and survival rate of metabolism due to run well [3][4][8][9][41][42][43][44][45][46][47].

Nile tilapia was able to increase the growth of absolute weight as nile tilapia (*O niloticus*) has a broad ability to accumulate vitamin E, especially in the liver. as antioxidant vitamin E may protect against oxidative destruction, for example, the destruction of carotene in the gut or on the network. Vitamin E prevents peroxidation of unsaturated fatty acids to become free radicals and hyperperoxida that can damage the integrity of the cells that cause metabolic disorders [3][4][5] [8]. Mentioned [3][8][30][31][32] that vitamin E has been known to effectively prevent damage to cell membranes so that the metabolic processes in the cell will run better and elements - elements of food was expected to enter the cells completely [3][4][9][37][48]. The need for vitamin E herbivorous fish thought to be greater than the needs of carnivorous fish, eel, tilapia [24][25][27][28][47]. Requirement of vitamin E for each species also differ. Red sea bream fish require 442 mg / kg of feed [37][38]. Fish beronang require 40 mg / kg of feed [33][34] to evaluate the use of feed containing vitamin E are fat soluble against Penaeid shrimp larvae (*Penaeus vannamei*), the results obtained are shrimp fed without vitamin E had the lowest survival compared with treatment using vitamin E. the Atlantic Salmon, Salmon Salar with a weight of 16.9 g were fed semi-pure containing DL- tokopheryl acetate. At doses

of 0 and 15 mg / kg feed caused a 100% mortality rate. Dose of 30 mg / kg of feed are still experiencing symptoms of deficiency[31][32][34][35] examined. Levels of vitamin E 60 mg / kg of feed can provide a high fish survival [32][33]. In normal feed composition of vitamin E needs satisfied about 100-150 mg -tocopherol / kg of fish feed, but in some cases the range of 20-50 mg / kg feed was sufficient. Growth is change or increase the size of the body was kept too. Growth of weight absolute on the nile tilapia (*O niloticus*) period stated in the growth rate of the width and length of carapace (shell) [43][44][45]. Growth of absolute weight be crucial for nile tilapia because the body can not grow linier. Nile tilapia can grow when to increase the growth of absolute weight as nile tilapia has a broad ability to accumulate vitamin E, especially in the liver. as antioxidant vitamin E [2][3][8][10][20] reported at the experimental end (32 week after start) final body weights of tilapia were found to be 173.51, 202.91 and 224.89 g for fish fed the experimental diets 20, 32 and 44% dietary protein,weight increased in a significant linear manner with each increase in the dietary protein level fed from 20 to 32 and 44%.

3.4.Survival Rate of Eels (A bicolor)

The results showed that the highest survival rate in fish reared at T4=10E+10T(given 10 individuals / m^2 Eels (*A bicolor*) and given 10 individuals / m^2 nile tilapia (*O niloticus*)) was 96 ± 0.3^a % (Table 2). Based on Table 2, analysis of variance showed a highly significant ($P < 0.01$) on the survival of the Eels (*A bicolor*). Survival rate of the Eels (*A bicolor)* was higher because used water quality preservation media-preserved fish polyculture system very good so that with eel and Nile tilapia them suitable for life.

This was supported Good water quality in polyculture fish farming with Nile tilapia and tiger shrimp (*Penaeus monodon* Fabricius) can increase the survival rate reaches 80-90%, good water quality was due to an essential requirement in the cultivation of fish. Water quality affects the survival, proliferation and growth[8][9][48][49][50]. This opinion was also supported by researchto maintain water quality by using of biofilter system used seaweed applied to polyculture vanamei shrimp and Eels (*A bicolor*) can improve the survival rate reaches 80-90%[42][49][50].

3.5.Survival rate of nile tilapia (O niloticus)

The results showed that the treatment in polyculture farming systems with simultaneously maintaining Eels (*A bicolor*) and nile tilapia (*O niloticus*)s in the pond with each plot of 100 m^2., Giving a highly significant effect ($P < 0.01$) in to the nile tilapia (*O niloticus*) survival rate. The highest survival rate of nile tilapia (*O niloticus*) was found in treatment T=10E+10T(given 10 individuals / m^2Eels (*A bicolor*)and given 10 individuals / m^2 nile tilapia (*O niloticus*)) was $95 \pm 2.3\%$ (Table 2).

Effect of the difference in the density ofEels (*A bicolor*) and nile tilapia (*O niloticus*)on the survival rate of nile tilapia (*O niloticus*) (%) in polyculture systems

Based on Table 2, showed that the T4 treatment resulted in the highest survival rate (96 ± 2.4^a %) due to water quality maintenance polyculture system media in accordance with this nile tilapia (*O niloticus*), in accordance with the opinion of Boyd *et al*., [42] Good water quality is an essential requirement in the cultivation of fish. Water quality affects the survival, proliferation and growth.

3.6.Food Conversion Ratio (FCR) in polyculture fish farming system Eels (A bicolor) farming and nile tilapia (O niloticus)s and nile tilapia (O niloticus)

The feed conversion ratio is a very important role in the system of polyculture Eels (*A bicolor*) farming and nile tilapia (*O niloticus*)s, to see whether the feed was able to increase the growth of fish and nile tilapia (*O niloticus*) that kept growing well [38][39][42][43][44]. The feed conversion values are also able to see how far the feed was converted widened nile tilapia (*O niloticus*) meat or fish that are kept. There was a tendency feed conversion rate (FCR) lower ($T4 = 1.54 \pm 0.10$) gives the absolute weight of high growth, meaning more efficient feed given (Table.2).

Based Table.2, suggesting that artificial feed given to the cultivation of polyculture system with low relative its FCR values are T=10E+10T(given 10 individuals / m^2Eels (*A bicolor*) and given 10 individuals / m^2 nile tilapia (*O niloticus*) was 1.54 ± 0.10 that was efficient enough to boost growth of nile tilapia (*O niloticus*).

Nile tilapia (*O niloticus*) is consistent with research findings feeding artificial enriched with vitamin E may reduce the value of FCR around 1.08 ± 0.03[9][10]. in addition of opinion of feed conversion ratio is defined how many grams of a given amount of feed to produce one gram of body weight of Eels (*A. bicolor*). In opinion [28] states the feed conversion rate (FCR) as the value of the weight of feed consumed by the fish weight is achieved, known as feed efficiency.Good quality feed is the feed conversion ratio resulted in lower[24][25][24][25][28] expressed as an index of feed conversion of the total feed utilization for growth where the smaller the value, the better feed conversion feed was used. The value of feed conversion was efficient when less than 3 [1][2][3][4][31][32][33] Supplementation of vitamin E in the diet may act as antioxidants in order to preserve the vitamins and unsaturated fatty acids are easily oxidized both in food, food ingredients and mix in the body. The availability of adequate nutrients in the feed will affect the utilization rate of feed so as to enhance the growth of the test Eels (*A bicolor*) and nile tilapia (O niloticus) in polyculture [5][32][33][34][38][50].

3.7.Water quality

Water Quality Maintenance Media polyculture system of Eels (*A bicolor*) and nile tilapia (*O niloticus*)s during the study showed feasible for the second life kultivan (Table.3)

Table 3. Water quality media polyculture system of eels (*A bicolor*) and tilapia (*O niloticus*).

Parameter of water quality	range	worthiness
Dissolve oxygen (mg/l)	4,87 – 6,25	>4 mg/l *
Temperature (^{0}C)	27,5 – 31,25	26,5 – 35 ^{0}C **
Salinity (ppt)	22 – 28,5	15 – 30***
Ph	7.5 – 8,5	7,5 – 8,7 *
Ammonia (mg/l)	0.02– 0,256	<1 mg/l ****

Based Tabel.3, showed that the dissolved oxygen content (4.87-6.25 mg / l), temperature (27.5-31.25 ° C), salinity (22-28.5 ppt), pH (7.5-8.5) and ammonia (0.02-0.256 mg / l) is still in the range of viable and capable of supporting Eels life and nile tilapia reared polyculture.

4.Conclusions

The results showed that the difference in the density of Eels (*A bicolor*) and nile tilapia (*O niloticus*) significant effect (P <0.05) on the growth and survival Eels (*A bicolor*) and nile tilapia (*O niloticus*). Mix combinations in polyculture cultivation system can increase the weight of the highest absolute growth in Eels (*A bicolor*) and nile tilapia (*O niloticus*) obtained from T4 treatment (Eels (*A bicolor*) 188.75±0.9^a g), nile tilapia (*O niloticus*) (61.65±0.95^a g) and eel of survival rate of 96±0.3^a%, and nile tilapia (O niloticus) 96 ± 2.4^a%, and feed conversion (FCR) lower (T4 = 1.55±0.10^b).

The water quality was still decent for the life of Eels (*A bicolor*) and nile tilapia (*O niloticus*).

Aknowledment

Our thanks goes to the Director DP2M, Dean FPIK Undip and Undip LPPM Chairman and Mr. H.Chambali which has provided facilities for the study ponds.

References

[1] Abded-Hakim N P N F and Moustafa S T 2000 *Egypt. J. Aquat. Biol & Fish.* **4** (2): 95-116
[2] Abdel-Hakim N F, Bakeer M N and Soltan M A 2000 Proc.3rd All Africa Conf. Anim. Agric. & 11th Conf. Egyptian Soc. Anim. Prod., Alexandria, Egypt, 6-9 November, 2000: 329 - 335
[3] Abdel-Hakim N F and Sadek S M 1986 *J.Agric. Res.* **6**: 169 - 176
[4] Abdel –Maksoud A M S 2000 *Egypt. J. Anim. Prod.* **37** (1): 57 - 66
[5] Aslam A, G S Hossain, M M R Biswas, S K Barman and K Anisulhuq 2009 *Int.J.. Sustain. Crop Prod.* **4** (4): 23 – 27
[6] Yuvaraj D, R Karthik, and R Muthezhilan 2015 *Asian Journal of Crop Science* **7**(3): 219-232
[7] Kementerian Kelautan dan Perikanan 2004 *Produksi Udang dan Ikan Bandeng di Jawa Tengah, Indonesia* [Production of Shrimp and Eels (*A bicolor*) in Fisheries Central Java, Indonesia]. Jakarta: KKP. [Bahasa Indonesia]
[8] Istiyanto S and Rachmawati D 2014 *Pena Journal* **27** (2): 265 - 281
[9] Istiyanto S and Rachmawati D 2015 *Pena Journal* **28 (**1): 265-280
[10] Istiyanto S, Arini E, and Rachmawati D 2012 *Application of science and technology in (IbM) business group polyculture of shrimp, fish and seaweed (Gracyllaria Sp) based on the biological filter Mangkang Wetan village, District Monument, City Semarang*. Laporan Ibm Science program TA.2011 / 2012 DP2M Higher Education.
[11] Istiyanto S 2007[a] *Analysis of aquaculture development efforts shelled crab (soft shell) From type Mangrove crab (Scylla paramamosain) Model Battery.* FPIK Undip (Proceedings of the National Seminar Indonesian Aquaculture Society at Hotel Equator Surabaya 5 to 7 June 2007).
[12] Istiyanto S 2007b *Analyse nile tilapia (O niloticus) hatchery development effort (Scylla paramamosain). FPIK Undip Intensive Systems* (Proceedings of the National Seminar Indonesian Aquaculture Society at Hotel Equator Surabaya 5 to 7 June 2007).
[13] Istiyanto S 2001a *Effect of Various Combinations Natural Feed (Tetraselmis chui, Chlorella sp, Brachionus plicatilis Muller, Nauplius Artemia salina Leach) on growth and survival rate Mangrove crab (Scylla paramamosain)*. Papers Presented at the National Seminar Crustacean 2001 organized by Centre for the Study of Biological Sciences Fak of Fisheries and Marine Sciences Research Center of Coastal and Marine Resource IPB supported by the Directorate of Small Islands, the Directorate General of Coastal and Island Small Island DKP, NAM Center, Oro 2 FM , Hotel Salak.
[14] Istiyanto S 2001b *Enlargement Mangrove crabs (Scylla paramamosain) In Pond With Feed Given trash In contrast dose*. Papers Presented at the National Seminar Crustacean 2001 organized by Centre for the Study of Biological Sciences Fak of Fisheries and Marine Sciences Research Center of Coastal and Marine Resource IPB supported by the Directorate of Small Islands, the Directorate General of Coastal and Island Small Island DKP, NAM Center, Oro 2 FM , Hotel Salak.
[15] Hadi Endrawati, Istiyanto Samidjan, and Agus Indarjo 2001 *Journal Info* **IV** (1): 6-18
[16] Istiyanto S 2008a *Engineering of Technology battery system culture on nile tilapia (O niloticus) ((Scylla paramamosain) using different feeds on the growth and survival rate*. presented Proceedings of the International Seminar of Dies Natalis VII study program Aquaculture (Aquaculture Department), Fac.Of Veterinary Medicine, University of Airlangga . 4 August 2008.
[17] Istiyanto S 2008b *The analysis of the Feasibility Study on soft shell crab effort mangrove crab (Scylla paramamosain) in the district of Patebon, Kendal regency*. In Proceedings of the International Seminar of Dies Natalis VII study program Aquaculture (Aquaculture Department), Fac.Of Veterinary Medicine, University of Airlangga. 4 August 2008.
[18] Istiyanto S 2010a *Optimization of artificial feed with vegetable fat as a source of technology engineering effort cultivating mangrove crab (Scylla paramamosain)*. Prosiding VII Annual National Seminar on Fisheries and results of marine research, Yogyakarta, July 24, 2010, ISBN: 979-99781-1-4.

[19] Istiyanto S 2010b *Engineering technology cultivation of soft shell nile tilapia (O niloticus)-based food made with animal fat sources with a closed system is environmentally friendly.* Proceedings of the VII Annual National Seminar on Fisheries and marine Penelitisn results, Yogyakarta, July 24, 2010, ISBN: 979-99781-1-4.
[20] Indarjo A and Istiyanto 2010 *Improved product quality seed crab (Portunus pelagicus, Linn) through the engineering of artificial feeding and natural feeds on the growth and survival.* Proceedings of the VII Annual National Seminar on Fisheries and marine Penelitisn results, Yogyakarta, July 24, 2010, ISBN: 979 – 99781 - 1-4.
[21] Istiyanto S 2002a *Journal of Sciences Water and Fisheries of Indonesia* **II(**1): 77-86
[22] Istiyanto S 2002b *Journal of Aquatic Sciences and Fisheries of Indonesia* **II** (1):87-95
[23] Istiyanto S 2002c *Journal of Sciences Water and Fisheries of Indonesia* **II** (1):87-95
[24] Halver J E 1980 *Fish Nutrition. Academic Press Inc*. New York. 711 pp.
[25] Halver J E and T Lovell 1989 Nutrition and Feeding of Fish. Van Nostrand Reinhold. New York. pp 269 - 274.
[26] He H L and R Liv 1992 Evaluation of Dietary Fat Solable Essential of Vitamins A, D, E and K for Penaeid Shrimp (*Penaeus shrimp* windui*) Aquaculture* **103**: 177-185
[27] Huet M 1971 *Fish Culture, Breeding and Cultivation of Fish. Fishing New* (Books) Ltd. London. pp 251 - 262
[28] Hepher B and Y Praginin Comercial 1981 *Fish Farming.* New York. Cickesten. Brisbane. Toronto. 388 pp
[29] Hepher B 1988 *Nutrition of Pond Fishes, Formerly of Fish and Aquaculture Research Station*. Cambridge. University Press. 385 pp
[30] Lall S P 2000 *Nutrition and Health of Fish. Simposium Internacional de Nutrición Acuicola*. Mérida. Yucatán. Mexico. pp 209 - 233
[31] Laxmappa B, S M Khrisna 2015 *International Journal of Fisheries and Aquatic Studies* **2**(4): 147–152
[32] Li D S and S L Dong 2000 *J. Chinese Journal of Oceanology and Limnology* **8**: 61 – 66
[33] Maurice and E Stansby 1990 Fishoils in Nutrition. Van No Strand Reinhold. New York. pp 56 - 61.
[34] Steffens 1989 *Principle of Nutrition* Ellis Horwood Limited England pp 209-233.
[35] Squibb 1987 *Fish and Invertebrate Culture, Second Edition* United Nation of America pp 100-102.
[36] Wahid N 1999 *Effect of Combination of Natural Feed (Brachionus plicatilis) and Artificial Feeds on Growth and SurvivalEels (A bicolor) larvae. Essay*. Faculty of Fisheries and Marine Sciences. UNDIP. Semarang. 51 p.
[37] Watanabe 1988 *Fish Nutrition and Marineculture*. Department of Aquatic Biosciences. Tokyo. pp 60 - 65.
[38] Xie B, W Jiang and H Yang 2011 *J. Bulgarian Journal of Agricultural Science* **17** (6): 851–858
[39] Yang Y and K Fitzsimmons 2002 *Tilapia Shrimp Polyculture in Thailand [Research Report]*. Thailand: Asian Institute of Technology.
[40] Zonneveld N E, A Huisman and J H Boon 1991 *Principles of Fish Culture*. PT Gramedia Pustaka Utama. Jakarta. 318 pp.
[41] Kanazawa A 1985 *Nutrition of Penaeid and Shrimp. In: Y. Taki, J.H. Primavera, and J.A. Liobrera (Eds).* Proceedings of First International Conference on Culture of Penaeid/Shrimp. Aquaculture Dept. Seafdec. Iloilo. Philipphines pp 123-130
[42] Boyd, H E Burgess, Pronek, and Walls 1982 *Water Quality in Warm Water Fish Pond*. Auburn University. Aquaculture Experiment Station. Auburn. pp 75-80
[43] Davis J 2011 *Polyculture Opportunities in The Mid-hills of Nepal for Resource Poor Farmers. Ecological Aquaculture Studies & Reviews.* Kingston: University of Rhode Island
[44] De Silva S S and T A Anderson 1995 *Fish Nutrition in Aquaculture*. Chapman and Hall. New York. 319 pp
[45] Djajasewaka H 1985 *Fish Feed*. CV Yasaguna. Jakarta. Pp 23-29
[46] Effendie M I 1979 *Methods of Fisheries Biology*. Yayasan Dewi Sri. Bogor. 325 pp

[47] Furnichi M 1988 *Dietary Requirement in Fish Nutrition in Marriculture.* Japan: Japan International Coorporation Agency
[48] Solomon J R and M N Ezigbo 2010 *New York Science Journal* **3**(10): 42 – 57
[49] Stickney R R 1979 Principle of Warm Water Aquaculture. John Weley and Sons Inc. New York. pp 223 - 229
[50] Tacon 1987 *Nutrition and Farmed Fish and Shrimp. A Training Manual. The Essential Nutrients Food anf Agricultural Organization of the United Nations.* Brasillia Brazil 117 pp