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Effects of Some Feed Suplements Types to the Growth of Javaen Barb/Brek Fish (*Puntius orphoides*) Second Filial as Domestication Product

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Abstract

Aquaculture can be improved by a diversified approach in the form of domestication research of a wild fish. The research has been done by cultivating Javaen Barb/Brek (*Puntius orphoides*) from Serayu river, Banyumas at a natural pond and laboratory scale. Brek fish is relative slow in growth and development of gonad. This research is aimed to determine: (1) the rate of general growth of Brek in the provision of some kinds of additional food; (2) Relative Growth Rate (RGR); (3) Specific Growth Rate (SGR) and Feed Conversion (FC). The research used experimental methods. The method was a completely randomized design (CRD) of 4 treatments and 3 replicationsof: A = 100% pellet; B = 70% soybean sprout and 30% pellet; C = 70% *Ipomoea aquatica* leaf and 30% pellet; D = 35% soybean sprouts, 35% *I. aquatica* leaf and 30% pellet. Quantitative data were analysed by analysis of variance (ANOVA) of the fishes growth.The results show influence of feed types to the Relative Growth Rate (RGR) of Javaean Barb. The best RGR with the value of 72.40 was given by feed types in the D combination. Meanwhile, Specific Growth Rate (SGR) and Feed Conversion (FC) were not affected by the feed types. The study were expected to provide suggestions for efficient feeding techniques in attempts at domestication of wild fish.

How to Cite

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INTRODUCTION

Aquaculture intend to obtain not only the adequacy products but also the aspects of food security which can be achieved by diversification effort by trying to cultivate wild type fish. This cultivation is a kind of domestication. One effort to deal with the pre domestication activities of some types of catched fish is to conduct research activities in order to gain knowledge and techniques to prepare the fish in a condition for cultivating in aquaculture ponds, laboratory scale, as well as semi-natural pool and narrow area of household scale. This can be done through several activities both survey and experimental research. The internal approach can be done through an adequate understanding of aspects of reproductive biology of fish and some other physiological aspects such as growth.

The success of this domestication stage, which will be followed by further studies to pursue domestication should be able to complete at least one cycle of their life. The important problem that should be solved for javaean barb domestication in natural pond is its relatively delayed growth and late gonad ripening, compare to the other types of fish such as Bonylip barb and Nile tilapia.

Susatyo & Sugiharto (2011) have produced javaen barb/Brek's seed (the second filial/F2), which was offspring of F1 male and female Brek that has been domesticated since February 2009 in the natural pond. Brek origin (the first filial/ F1) were not yet capable to spawning again after 3-4 months from the earlier spawning period.This become a problem of this fish aquacultivation, as well as its slow growth (Susatyo et al., 2009).

Good nutrition in animal production systems is essential to economically produce a healthy, high quality product. In fish farming, nutrition is critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. The development of new species-specific diet formulations supports the aquaculture (fish farming) industry as it expands to satisfy increasing demand for affordable, safe, high-quality fish and seafood products (Soengas, 2014).

Experiment to test Javaean barb growth by providing some types of feed suplement is expected to support the fish growth acceleration that in the end will give an ideal weight for the fish to produce mature gonad and to be consumed by human. Thus, this research is aimed to determine: (1) the fish growth rate on a laboratory scale by treatment of feed types suplement, (2) Relative Growth Rate (RGR), (3) Specific Growth Rate (SGR) and Feed Conversion (FC).

METHODS

Javaean barb, pelleted feed, soybean sprouts and *Ipomoea aquatica*. The fishes were selected from the maintenance pool (stem stock as product of our earlier research (Susatyo et al., 2009; Susatyo & Sugiharto, 2010). The selected fishes were the second filial/F2 with an average length of 14 cm and an average weight of 35 grams.

Prepared as many as 12 pieces aquarium with size of 75 x 50 x 60 cm . Wells filled with water as high as two-thirds , and were equipped with aeration adequate and stable. Each aquarium was dotted with 10 Brek fish measuring an average length of 14 cm and an average weight of 35 grams. Brek fish to this growth test were the result of the sorting of the F2 stock (which was partly used as a parent for test gonadogenesis test and spawning test, some with have size of an average of 35 grams were used as the material of growth test).

The analysis was Testing of their growth is an experimental test with a completely randomized design (CRD), 4 treatments and 3 repetitions. The treatments were tested consisting of :

A = feed with 100 % pellets

B = feed with 70 % of soybean sprouts and 30% pellets

C = feed with 70 %of *Ipomoea aquatica* leaf and 30 % pellets

D = feed with 35 % of soybean sprouts, 35 % *I. aquatica* leaf and 30 % pellets

The feeds were given amount of 4 % of the weight of the biomass with combined percentage of feed. The amount of the feeds were given in every two weeks. Frequency of feeding was twice a day (08:00 AM and 16:00 PM).The feeds were given by way of stocked (for pellets and soybean sprout), to soybean sprouts were made a little bruised before it is given) and with a hanging method of *I. aquatica* leaf.

The observed variables were the growth and feed conversion of Brek fish and water quality as a supporting variable. The measured parameters were Brek's body weight gain and the amount of feed given.

Physical and Chemical Analysis of Water includes temperature, pH, dissolved O2 and CO2 free content Measurement of the water tem-

Table 1. List of nutritional value of each feed treatment (%) (AOAC, 2005)

Treatment	Nutrient			
	Protein (%)	Fat (%)	Carbohydrate (%)	fiber (%)
A	34.90	13.29	32.38	8.15
B	28.39	12.31	37.21	20.49
C	25.36	8.37	44.95	18.61
D	26.87	11.24	40.08	11.53

Note :
The nutritional value of feed of each treatment was calculated based on the results of the proximate analysis oftest feed.
A = feed with 100 % pellets
B = feed with 70 % of soybean sprouts and 30% of pellets
C = feed with 70 % of *I. aquatica* leaf and 30 % of pellets
D = feed with 35 % of soybean sprouts, 35 % of *I. aquatica* leafs and 30 % of pellets

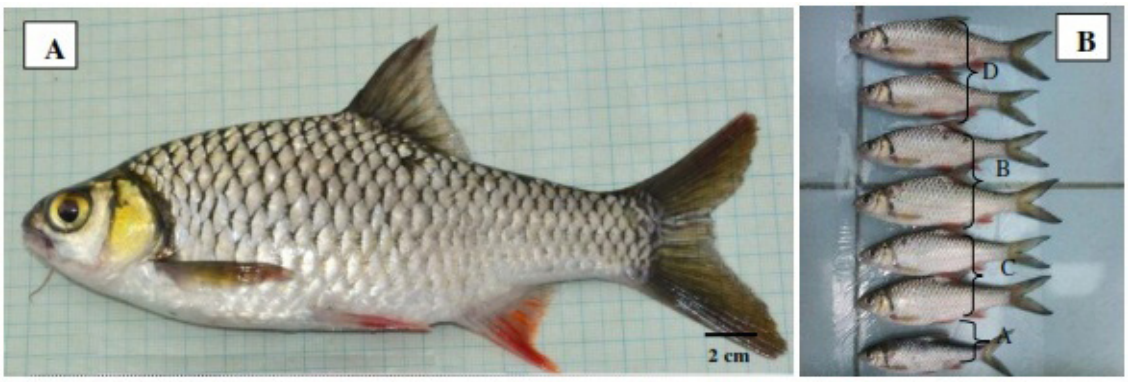

Figure 1. A. Adult javaen barb/Brek; B. seeds of Brek fish test with different growth responses against four types of additional feed

perature by dipping thermometer into the water surface media , in units of degrees Celsius. The degree of acidity Analysis Tool Using pH Meter after the calibration of the pH - meter with a buffer solution appropriate work instructions every time the tool will take measurements. Analysis of the levels of dissolved oxygen and CO2 using the Winkler titration method with modifications Azide .

The experiment of feed type treatment was carried out for 58 days. That were consisted of body weight, body length and the amount of feed were obtained. The parameters of growth parameters, namely Relative Growth Rate (RGR); SpecificGrowth Rate (SGR) and Feed Conversion (FC) were counted by using the formula according to Fiogber (1996) in Fontaine, Gardeur, Kestemont & Georges (1997) as follows :

$RGR = (Wt – Wo) Wo^{-1}.100\%$

$SGR = (\ln Wt – \ln Wo) \Delta t^{-1}. 100\%$

Note:
SGR = Relative Growth Rate (%)
SGR = Spesific Growth Rate (%d^{-1})
Wt = Body weight of Brekin the earlier of the study (g)
Wo = Body weight of Brekin the end of the study (g)
Δ t = The time of treatment (day)

$FC = Jp (B1 – B0)^{-1}$

Note :
FC = Feed Confersion
Jp = Total number of feed which were given (g)
B1 = Total weight of Brek in the end of the study (g)
B0 = Body weight ofBrekin the end of the study (g)

The obtained growth data (RGR and SGR) and Feed Conversion (FC) were analysed by analysis of variance/F Test and if there were real differences, it will be followed by test of Least Significant Difference (LSD) to determine the best treatment (Steel & Torie, 1989) with their mean is presented in tables and bar charts. The supporting data were water quality during the study.

Table 2. Weight gain, Relative Growth Rate (RGR), Specific Growth Rate (SGR), and Feed Conversion (FC) of Brek fish during the experiment

Treatment	Weight gain (g)	RGR (g)	SGR (g day)	FC
A	9.38	26.73	0.39	6.58
B	10.02	31.21	0.45	6.41
C	9.52	27.84	0.42	9.33
D	24.71	72.41	0.94	3.45

Note :A = feed with 100 % of pellets
B = feed with 70 % of soybean sprouts and 30% of pellets
C = feed with 70 % of *I. Aquatica* leaf and 30 % of pellets
D = feed with 35 % of soybean sprouts, 35 % of *I. Aquatica* leafs and 30 % of pellets

RESULTS AND DISCUSSION

Based on observations over 58 days (2 months), Brek fish kept in the aquarium on laboratory For growth experience. Groups of Brek treated with feed D (35 % germination of soybean, 35 % of *I. Aquatica* leaf and 30 % of pellets) was the highest achievement of growth than the treatment of feed B (70 % germination of soybean and 30 % of pellets), meanwhile, the lowest result is feed A treatment (100 % of pellets). Observation data of Relative Growth Rate (RGR), Specific Growth Rate (SGR), and Feed Conversion (FC) of the fish during the experiment is shown in Table 2.

RGR calculations were made based on the observation of javaen barb/Brek fish growth. The highest values of RGR obtained in the treatment of feed D by 72.4%, followed treatment B 31.21%, treatment C 27.84% and the lowest values in treatment A is 26.73% (Figure 2). Results of analysis of variance of the RGR (after the data is transformed by arc.sin $\sqrt{x}$) give an assumption that the treatments tested produce a significance difference the best treatment by Least Significant Difference test (LSD), Treatment D that the best. The complete LSD can be seen in Table 3 below.

According Arula, Laur, Simm & Ojaveer (2015), the rate of growth depends on the given feed, space, temperature, depth of water and other factors. It still is alleged observations of how eating fish of Brek. Method of hanging on the leafs of *I. Aquatica* leaf provides meaningful opportunities for this test fish/Brek to cut off its food. In the group treated by spinach, hanging would be more successful to stimulate the fish appetite.

Although, sometimes at mealtime, javaen barb/Brek will perform their movements such as jumping quickly from the bottom for grabbing food on the water surface. It still shows its natural wild character of javaen barb/Brek fish. A feed of treatment A (100% of pellets) when given, will tend to be eaten at once, causing the Brek fish will satiety before the entire feed consumed, consequently still plenty of food remains uneaten. This condition resulted in insufficient feed for growth. The conditions is in accordance with the opinion of Devlin & Nagahama (2012) which states that the feed is needed as a source of energy that will be used by the fish to move, maintain and repair damaged organs, then the extra energy is used for growth. The growth will occur when the feed is greater than it is needed by the fish to maintain body weight.

Table 3. Least Significant Difference (LSD) test against the value of the Relative Growth Rate (RGR)

Treatments	Mean	
D	59.05^{a}	
B	33.32^{bc}	$LSD_{0.05} = 19.64$
C	31.73^{bc}	$LSD_{0.01} = 25.58$
A	29.85^{c}	

Description : Different superscript letters indicate significant differences between treatments

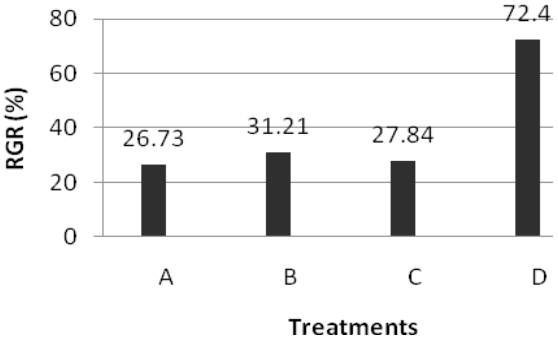

Figure 2. Diagram of Relative Growth Rate (RGR) during Trial
Note :A = feed with 100 % of pellets
B = feed with 70 % of soybean sprouts and 30% of pellets
C = feed with 70 % of *I. Aquatica* leaf and 30 % of pellets

D = feed with 35 % of soybean sprouts, 35 % of *I. Aquatica* leaf and 30 % of pellets

Protein is the main nutrient in fish feed, then the second is fat, and the last is carbohydrate (Ganga et al., 2015). As given in table 1, (Table 1, in research methods), nutrient content in treatment D consisted of proteins 26.87%, 11.24% fat, carbohydrates 40.08% and 11.53% crude fiber can be mentioned as a good composition. In general proteins by 20-25% and the fat of 5.9 - 14% already can give good results for the growth of herbivorous fish. While the levels of carbohydrates for herbivorous fish can reach 61%. Protein consumed will be used for growth, but fats and carbohydrates as energy resources to support the other activities. Although the protein is a major factor in feed, but the needs of fish is limited to proteins. Therefore feed to support optimal growth of fish should be the best composition of proteins, fats and carbohydrates (Ganga et al., 2015).

Feed D treatment with a composition of 35% soybean sprouts, *I. Aquatica* leaf 35% and 30% pellets has the advantage as complementary nutritional needs for fish feed. The protein content in treatment D which is to 26.87% is capable of causing a high growth compared to protein in treatment A by 34.90%. According to Kamalam, Medale & Panserat (2016), herbivorous fish which is able to digest carbohydrates are high, so that the protein can be utilized for growth. Carbohydrates will be used as a source of energy if it is offset by the presence of other nutrients. carbohydrates are converted into energy that is partially stored in the liver (hepatic) in the form of glycogen, while the fat is converted to muscle and other organs. Carbohydrates in fish feed is in the form of crude fiber and nitrogen-free extract. According to Kamalam et al. (2016), crude fiber is actually not kinds of nutrients, because these components stodgy but it is necessary to enhance / improve the intestinal peristalsis, so the rest of the digestive metabolism easily excreted from the digestive organs.

Fat levels in treatment D 10.31% is quite good, because it is in accordance with the opinion of Campos et al. (2006), that the levels of good fats in the feed in fish farming is less than 10%, because the increase in the provision of fat does not cause increase in growth. Fat levels in treatment A is which is high and enough to support growth but was not good for the fish.

Specific growth rate

the result of the calculation of the Specific Growth Rate (SGR) shows that treatment D which is 0.94 %/day is better than treatment Bwhich is 0.45%/day, treatment C 0.42%/day and treatment A 0.39%/day. The result of the calculation of variance analysis showed that the difference in treatment of the feed does not give a real impact on SGR of Brek fish kept in the aquarium (laboratory scale) for testing in 58 days. It means that feeding with different nutrient content provides weight gain per day which were similar for all types of treatment. Feeding with high protein food such as A, is not necessarily accelerate the growth because it must be balanced with other nutrients, especially fats and carbohydrates.

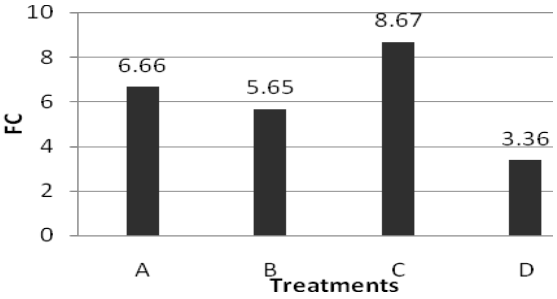

Figure 3. Diagram of Specific Growth Rate (SGR) during trial

Note : A = feed with 100 % pellets

B = feed with 70 % of soybean sprouts and 30% of pellets

C = feed with 70 % of *I. aquatica* leaf and 30 % of pellets

D = feed with 35 % of soybean sprouts, 35 % of *I. aquatica* leaf and 30 % of pellets

Specific growth rate is highest in treatment D (0.94%/day) because the nutrients can be used to increase the body weight of javaen barb/Brek. Rabegnatar & Tahapari (2002) states that the need for protein content in the diet depends on the type and size of the fish, protein quality feed, energy and feed composition as a whole.

Protein excess or lack of quality can not be used for body protein synthesis. This is supported also by Sánchez-Lozano et al. (2009) which states that the addition of higher protein causes SGR low when the optimal level of protein level has been reached. Fenkes et al. (2016) explained that not all the energy contained in the feed is used for growth. Fish require greater energy in flowing water because the media must continue to move to adjust to the flow of water. The energy contained in the feed used for the growth and metabolic functions. Energy to support the activities expected to be obtained from nonprotein energy like carbohydrates and fats. Protein will be used for growth because carbohydrates and fats into energy resources to support the activities. If the

feed contains less energy, protein for growth part will be used for metabolic function (Hu et al., 2014).

Absorption capacity of the digestive system may experience burn out if the protein content of the feed beyond the maximum absorption capacity of the digestive tract. A further increase protein levels often do not lead to better growth. The important factor for the effective feed is feed containing the material needed for metabolism and support growth. According to Soengas (2014), feed the appropriate treatment is essential to optimize the growth and feed conversion values.

Feed conversion

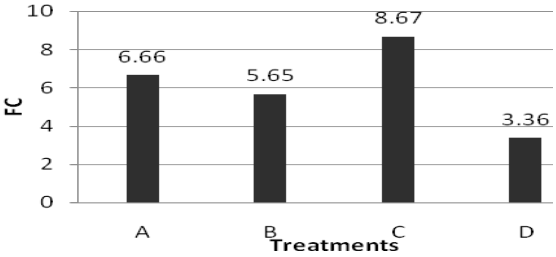

Figure 4. Diagram of Feed Conversion of Brek-Fish During Trial

Note :A = feed with 100% of pellets

B = feed with 70% of soybean sprouts and 30% of pellets

C = feed with 70 % of *I. aquatica* leaf and 30% of pellets

D = feed with 35% of soybean sprouts, 35%of *I. Aquatica* leaf and 30% of pellets

Feed conversion is a number that indicates the amount of feed needed to raise the body weight. Feed conversion value obtained from the comparison between the amount of feed given to the difference in body weight in the end and the beginning of treatment. The results of analysis of variance calculation of feed conversion showed no real difference which of the four treatments of feed, feeding means different types of feed ingredients and nutritional content provides value for feed conversion is relatively same (Loh, 2012).

Feed conversion value of D is the lowest at 3.36, then treatment B 5.65, treatment A 6.66 and treatment C on highest value 8.67. In accordance with the statement Soengas (2014), that the feed conversion rate was measured to assess the quality of the feed. The value of the conversion factor ranging from 1.5 to 8 depending on the source of feed ingredients, and is considered good if the value is not more than 3. The source of vegetable feed has a conversion factor of greater than-based animal feed. Feed conversion value is more than 3 in the experiment due to the feed mixture that is more derived from plant materials ie leaf spinach and soy sprouts. However, one aspect of testing of Brekgrowth with 4 different kinds of feed is more to weigh the cost of production, feed requirements and the future is production.

Based on the research results of Susatyo, Windiarini & Sugiharto (2009) about the value index of preponderance types of feed of Brek from the results of testing the content of the stomach contents of Brek during maintenance in the natural domestication pond, managed observable data indicating that the feed components derived from animals demonstrates the value that is quite important (32.633%) compared to the component vegetable feed (zooplankton 9.986%, worms 7.622%, 0.002% animal pieces, gastropods 15.023%).

Test of Javaen barb/Brek's growth with four types of feed treatment in this study, an initial attempt to determine the needs of the ideal feed for Brek with consideration of production costs of cultivation. But, considering at one stage of reproduction, namely the female gonadal maturation who take a relatively long time in the natural pond (Susatyo et al., 2009), it is still necessary stages of further research to determine the needs of optimal protein (which are the main ingredients of the formation of the yolk eggs at the stage of ripening eggs in preparation for spawning phase/marriage), so that the components of feed versus production is expected to be impartial. Also expected in future studies, it is necessary tests on animal feed ingredients that come from other production wastes, which may still be used to convert the needs of animal feed ingredients from Brek fish.

Water quality condition

Table 5. Chemical and physical condition of water in maintenance aquarium in the laboratory duringthe research

Parameter	Unit	Value
Air temperature	^{0} C	23 – 32
Water temperatur	^{0} C	24.5 –28.5
Depth	Meter	1 – 1.25
pH		6.0–7.0
dissolved oxygen	Ppm	4.6 – 6.8
CO2 -free	Ppm	5.36 – 6.3

During the study, physical and chemical conditions of the water both in the maintenance media and an aquarium in the laboratory experi-

ment is still in good condition bearing capacity. The content of dissolved oxygen which is good for the life of freshwater fish ranged from 4-12 ppm (APHA, 2012). This is consistent with the statement Djamhuriyah & Mayasari (2012), the degree of acidity between 6-8, a temperature of 24^0C-31^0C is the condition of freshwater is very supportive pisciculture. During the study, Kaligarang water temperature varies between 26^0C – 27^0C. Temperature plays an important role in the metabolism of the fish. In general the increase in temperature can be lowered immune system of Tilapia fish and gold fish to toxins. Cd accumulation in fish body is influenced by factors other than fish physiological chemical and physical properties of the heavy metal, also influenced by environmental factors such as water temperature (Dewi et al., 2014). The condition of fresh waters with dissolved oxygen content from 4.01 to 5.36; The pool's temperature from 26.3^0C to 32.4^0C; and pH, from 8 to 7.8 strongly supports the growth of Tilapia fish that are kept around the town of Bima in West Sumbawa.

This research activity is expected to provide information on the result of the efforts of domestication javaen barb/Brek fish (*Puntius orphoides*) of some aspects of the physiology-reproduction. These aspects of reproductive physiology research complements a series of studies of reproduction that has been studied previously in this Brek fish, as the basis for acceptance of new aquaculture fish species (*P. orphoides*) of wild fish domestication from Serayu river, Banyumas; and to support the diversification of farmed fish and food security.

CONCLUSION

Relative Growth Rate (RGR) of Brek fish which were kept Brek fish in the aquarium scale was influenced by a mixture of feed pellets, soy sprouts and *I. Aquatica* leaf; Specific Growth Rate (SGR) and Feed Conversion was influenced by a mixture of feed pellets, soy sprouts and *I. Aquatica* leafs. The mixture of feed which is best for Relative Growth Rate (RGR) were obtained from treatment D witha combination of 35% soybean sprouts, *I. Aquatica* leafs 35% and 30% pellets with a value of 72.40.

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REFERENCES

Association of Official Analytical Chemists, & Association of Official Agricultural Chemists (US). (1920). *Official methods of analysis of the Association of Official Analytical Chemists (Vol. 2) 18th ed*. Washington, D.C.: Association of Official Analytical Chemists

Arula, T., Laur, K., Simm, M., & Ojaveer, H. (2015). Dual impact of temperature on growth and mortality of marine fish larvae in a shallow estuarine habitat. *Estuarine, Coastal and Shelf Science*, 167(1), 326-335.

American Public Health Association (APHA). (2012). Standard Methods for the Examination of Water and Wastewater. 22nd edition.A joint publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF). APHA Publisher.

Campos, P., Martino, R. C., & Trugo, L. C. (2006). Amino acid composition of Brazilian surubim fish (Pseudoplatystoma coruscans) fed diets with different levels and sources of fat. *Food chemistry*, 96(1), 126-130.

Devlin, R. H., & Nagahama, Y. (2002). Sex determination and sex differentiation in fish: an overview of genetic, physiological, and environmental influences. *Aquaculture*, 208(3), 191-364.

Dewi, N. K., Prabowo, R., & Trimartuti, N. K. (2014). Analisis Kualitas Fisiko Kimia dan Kadar Logam Berat pada Ikan Mas (Cyprinus carpio L.) dan Ikan Nila (Oreochromis niloticus L.) di Perairan Kaligarang Semarang. *Biosaintifika: Journal of Biology & Biology Education*, 6(2), 109-116.

Djamhuriyah, M. & Mayasari, N. (2012). Determinas Potensi Penyakit Aeromonas pada Ikan Budidaya untuk Mengamankan Produksi Perikanan di Lombok Dan Sumbawa. *Laporan PKPP Ristek 2012. pkpp.ristek.go.id/_assets/upload/docs/363_doc_2.pdf.* Acceced 14 March 2016

Fenkes, M., Shiels, H. A., Fitzpatrick, J. L., & Nudds, R. L. (2016). The potential impacts of migratory difficulty, including warmer waters and altered flow conditions, on the reproductive success of salmonid fishes. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, 193(3), 11-21.

Fontaine, P., Gardeur, J. N., Kestemont, P., & Georges, A. (1997). Influence of feeding level on growth, intraspecific weight variability and sexual growth dimorphism of Eurasian perch Perca fluviatilis L. reared in a recirculation system. *Aquaculture*, 157(1), 1-9.

Ganga, R., Tibbetts, S. M., Wall, C. L., Plouffe, D. A., Bryenton, M. D., Peters, A. R., ... & Lall, S. P.

(2015). Influence of feeding a high plant protein diet on growth and nutrient utilization to combined 'all-fish'growth-hormone transgenic diploid and triploid Atlantic salmon (Salmo salar L.). *Aquaculture*, 446, 272-282.

Hu, Z., Lee, J. W., Chandran, K., Kim, S., Sharma, K., & Khanal, S. K. (2014). Influence of carbohydrate addition on nitrogen transformations and greenhouse gas emissions of intensive aquaculture system. *Science of the Total Environment*, 470(1), 193-200.

Kamalam, B. S., Medale, F., & Panserat, S. (2016). Utilisation of dietary carbohydrates in farmed fishes: New insights on influencing factors, biological limitations and future strategies. *Aquaculture*. In Press

Loh, R. (2012). *Do goldfish grow to the size of their tank?* Retrieved from Thegoldfish Online website: http://thefishvet.wordpress.com/2012/02/28/do-goldfish-grow-to-the-size-of-theirtank/. Acceced 13 April 2016

Rabegnatar, I. N. S. & Tahapari, E. (2002). Estimasi Kebutuhan Kadar Protein Optimal untuk Pertumbuhan Benih Ikan Tawes (*Puntius goniono-tus*). *Jurnal Penelitian Perikanan Indonesia*. 8(2), 21-29.

Sánchez-Lozano, N. B., Martínez-Llorens, S., Tomás-Vidal, A., & Cerdá, M. J. (2009). Effect of high-level fish meal replacement by pea and rice concentrate protein on growth, nutrient utilization and fillet quality in gilthead seabream (Sparus aurata, L.). *Aquaculture*, 298(1), 83-89.

Soengas, J. L. (2014). Contribution of glucose-and fatty acid sensing systems to the regulation of food intake in fish. *A review. General and comparative endocrinology*, 205(1), 36-48.

Steel, R. G. D. & Torie, J. H. (1989). *Prinsip dan Prosedur Statistik: Suatu Pendekatan Biometrik. (Edisi III)*. Diterjemahkan oleh B. Sumantri. Jakarta: PT. Gramedia.

Susatyo, P., Windiarini, L. & Sugiharto. (2009). Penelusuran Aspek Bioreproduksi, Ekologis, Filogenetis Beberapa Jenis Ikan Tangkapan dari Sungai Serayu Banyumas Sebagai Dasar Domestikasi dan Diversifikasi Budidaya**.** *Laporan Penelitian Insentif Dasar RISTEK tahun 2009*. Purwokerto: Lembaga Penelitian Universitas Jenderal Soedirman.

Susatyo, P. & Sugiharto. (2010). Budidaya Awal Induk dan Benih Ikan TangkapanSungai Serayu Banyumas Rawan Punah, Lukas (*Puntius bramoides*) dan Brek (*P.orphoides*) Produk Predomestikasi pada Kolam Alami serta Pemetaan Karakter Reproduksinya. *Laporan Penelitian STRANAS Tahun I*. Purwokerto: Lembaga Penelitian Universitas Jenderal Soedirman.

Susatyo, P. & Sugiharto**.** (2011). Early Parent and Seed Cultivation of Serayu's Catchment Fish, Lukas (*Puntius bramoides*) and Brek (*Puntius orphoides*) as Predomesticated Products on Natural Ponds and Mapping of Their Reproductive Characteristics. *Seminar Nasional Pembangunan Sumber Daya Pedesan dan Kearifan Lokasl Berkelanjutan* I. LPPM Unsoed. 23-24 November 2011.