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EFFECT OF DIFFERENCES IN THE PERIOD OF LIVE FEED TRANSITION TO FERMENTED MANUFACTURED DIET ON THE SURVIVAL AND GROWTH OF THE SNAKEHEAD LARVAE (CHANNA STRIATA)

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ABSTRACT
First feeding on snakehead fish larvae plays an important role to the success of snakehead fish hatchery. Artemia is a live feed that is easily digested by snakehead fish larvae and provides high survival, but it has relatively expensive prices. While pellet feed has low digestibility towards the larvae of snakehead fish, but it is priced at best. Increasing feed digestibility can be done by adding probiotic through the fermentation process. Experiments to acquaint manufactured diet which are fermented early on snakehead fish larvae through transition from live feed need to be performed to reduce the dependence of snakehead fish larvae on Artemia. The study used the Complete Random Design (RAL) with 5 treatments and 3 replications. Treatment A: transition on day 10, treatment B: transition on day 15, treatment C: transition on day 20, treatment D: only fermented manufactured feed and treatment E: only Artemia. The results showed that the transitions made to the 20-day-old snakehead fish larvae were better than the transitions made to the snakehead fish larvae with 10 and 15 days of age with a survival average of 83.33%, an absolute length growth of 2.03 cm and an absolute weight growth of 5.13 grams.

KEY WORDS
Snakehead fish, survival, growth, live feed, manufactured diet.

South Borneo is a province that has great potential against its waters. According to Akbar (2017); Akbar & Iriadenta (2019), the area of public waters in South Borneo is about 1,000,000 hectares, thought to have contained about 200-300 species of fish scattered in those waters. One type of fish that is quite popular among South Borneo peoples is snakehead fish or commonly referred as "haruan".

Snakehead fish are fondled by many people because of its sturdy, white flesh texture, a bit of bone and a good taste, besides this fish is known to have an albumin content that can speed wound healing and it is widely utilized for pharmaceutical ingredients (Zakaria *et al*., 2007; Shafri & Manan, 2012; Rahman & Sadiqul, 2016). According to Akbar (2020) in 2020 the price of snakehead fish in the market reached Rp.40,000-85,000 per kg depending on size and season. The high market demand for snakehead fish impacts the high exploitation of this type of fish in nature. Further because of harmful effects of pesticides, chemicals and industrial wastes natural spawning grounds are destroyed day by day (Mollah *et al.,* 2009).

It can impact to the scarcity of snakehead fish.One way to prevent scarcity against snakehead fish is through aquaculture. Snakehead fish cultivation is still less developed, this is due to constraints in the cultivation process namely the high mortality of larvae in the hatchery of snakehead fish which is at 74% (Javanicus *et al*., 2016) and around 85-87% (Amin *et al.,* 2015).

High mortality can be caused by feed mismatch with the width of mouth openings as well as hard to obtain continuous feed availability (War & Altaff, 2014; Akbar, 2018), in addition to carnivorous, fish predatory and cannibalistic of snakehead fish characteristics (Diana *et al*., 1985; Qin & Fast, 1996; Rahman & Sadiqul, 2016). First feeding on snakehead fish larvae is an important thing in determining the success of hatchery of snakehead fish, so it takes management to this.

Research conducted by Munafi *et al* (2004) on snakehead fish larvae fed *Artemia, Moina*, bloodworms and pellet feed for 30 days shows that *Artemia* is the best feed with the greatest survival (94%) and the lowest on pellet feed (10%). *Artemia* has relatively high prices, it being a limiting factor in doing snakehead fish cultivation, while the use of artificial feed on snakehead fish larvae is still constrained due to its low digestibility.

To increase artificial feed digestibility can be done by probiotic administration (Agustina *et al*., 2014). Baskerville-Bridges (2000) in his research also introduced early weaning of artificial feed given gradually to the Atlantic Cod (*Gadus morhua*) fish; it could reduce the amount of rotifer required and make *Artemia* nonessensial. The change of live feed of *Artemia* to fermented manufactured feed gradually on the hatchery of snakehead fish needs to be performed to reduce dependence on *Artemia*.

METHODS OF RESEARCH

The study is located in the Wet Laboratory of the Faculty of Fisheries and Marines of University of Lambung Mangkurat, Banjarbaru, South Kalimantan-Indonesia. The research is conducted for a month. The tools used at the study were: aquariums, aerators, scoop, plastic bowls, millimeter blocks, digital scale, 600 mL plastic bottles, plankton net, measuring glasses, plastic clips, pH meters, thermometers, oxygen test kits and NH_3 test kits. Whereas the ingredients used are the larvae of snakehead fish, *Artemia* cyst, non iodine salt, pellet feed (size 1 with protein levels of ≥ 40%), probiotics and molasses.

The medium used to nurture the larvae of snakehead fish on the experiments is in 15 units of aquarium. The aquarium was previously washed and dried, then filled with water as much as 12 Liter and given moderate aeration.

The snakehead fish larvae tested are larvae that are 3 days old after hatching. The stocking of the tested fish is done by the stocking density of 2 fish/L (Mollah *et al.,* 2009; Hidayatullah *et al*., 2015). The snakehead fish larvae stocked at the beginning of the study had a body length of 6 mm.

The *Artemia* cyst hatching method is based on Jusadi (2003) as follows: (1) the container used is a modified 600 ml plastic bottle, (2) the container is firstly cleaned, (3) mix the non-iodine salt with fresh water. The amount of salt needed ranges from 25-30 g/L of fresh water, (4) do a strong aerating, (5) *Artemia* will hatch after 18-24 hours, after hatching the color of the media turns to orange.

The manufactured feed used is MS PRIMA FEED pellet feed with feed size of <0.4 mm and nutrient content as follows: (1). a minimum protein of 40%, (2). Minimum fat is 6%, (3). Crude fiber is a maximum of 3%, (4) Ash is a maximum of 15% and a maximum moisture content of 10%. Arificial feed is then fermented using EM-4 at a dose of 15 mL/kg (Rachmawati *et al*., 2006) mixed with molasses at a dose of 1 mL/10 g of feed (Wardika *et al*., 2014) with a fermentation time of 2 days (Syahrizal *et al*., 2018).

Length and weight measurements were made at the beginning and end of the study. Measurement of the length and weight of the beginning and end of the study carried out by repeating as much as 4 times to reduce the bias. Water quality of temperature and pH is measured daily, while DO and ammonia are measured 3 times, at the beginning, middle and end of the study.

Feed began to be given from the beginning of stocking according to treatments. The feeding is carried out in accordance with the treatments made. The frequency of feeding is 3 times, which is carried out at 08.00, 12.00 and 17.00. The ammount of *Artemia* nauplius given is 500 individuals/larvae/day, while the manufactured fermented feed is 20 mg/larvae/day (Qin & Fast, 1997).

Feed transition is carried out for 5 days, fermented manufactured feed is added gradually and live feed gradually reduced by comparison of the amount, namely: (1). 100% *Artemia*: 0% Fermented manufactured feed on the first day of transition, (2) 75% *Artemia*: 25% Fermented manufactured feed on the second day of the transition, (3) 50% *Artemia*: 50% Fermented manufactured feed on the 3rd day transition, (4) 25% *Artemia*: 75% Fermented manufactured feed on the 4th day of the transition, (5) 0% *Artemia*: 100% Fermented manufactured feed on the 5th day of the transition.

The experimental design used in this study was a Completely Randomized Design (CRD) with 5 treatments and 3 replications, so that the experimental unit was 15 units. The snakehead fish larvae are maintained for 30 days after the eggs hatch.

The treatments consisted of A (transition on the 10th day), B (transition on the 15th day), C (transition on the 20th day) and control treatment on D (only given manufacutred fermented feed) and E (only given *Artemia*).

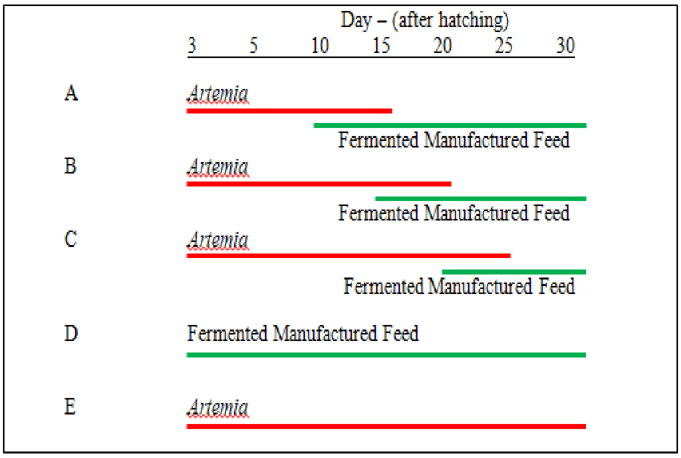

Figure 1 – Type of treatments

The data obtained are then tested for Normality and Homogeneity Tests, if the data are not homogeneous, then data transformation is performed. Furthermore, Anova test was tested. If testing the hypothesis is rejecting H_0 and accepting H_1, then proceed with the Continuation Test.

RESULTS AND DISCUSSION

The percentage of survival rate of snakehead fish larvae treated varies from 0-100%. The lowest survival percentage was found in all replications in treatments that were given only fermented manufactured feed (treatment D) at 0% while the greatest survival was found in treatments given *Artemia* nauplius (treatment E) with a mean of percentage is 95.83%, followed by treatments with transitions on day 20 (treatment C) (83.33%), treatment with transition on day 15 (treatment B) (55.56%) and treatment with transition on day 10 (treatment A) (13.89%).

Table 1 – Average of Survival Rate of Snakehead Fish Larvae during the Study

Repeat	SR (%)				
	A	B	C	D	E
1	25	50	75	0	95.83
2	12.50	41.67	83.33	0	91.67
3	4.17	75	91.67	0	100
Total	41.67	166.67	250	0	287.50
Average	13.89^a	55.56^b	83.33^c	0^a	95.83^c

Note: Value in each column with different superscripts are significantly different at < 0.05 level of significance.

Based on statistical tests (ANOVA) the treatments affect the survival rate, it can be seen from the significance values (0) < α (0.05) and α (0.01) and F_{count} (53.10) > F_{table} 5% (3.48) and 1% (5.99). Based on Duncan's test, treatment A was not significantly different from treatment D, but it was very significantly different from treatment B, C and E. Treatment B was very significantly different to all treatments. Treatment C was not significantly different from treatment E, but very significantly different from treatments A, B and D.

The low survival rate of snakehead fish larvae in treatment D is thought to be due to the inability of the digestive organs of snakehead fish larvae to digest fermented artificial feed. This is similar to Munafi *et al* (2004) in his study in which snakehead fish larvae fed artificial feed had the lowest survival at 0% in phase 1 (larval age 1-15 days), where snakehead fish larvae died within 10 day. While in this study, in treatment D (fermented manufactured feed without transition) snakehead fish larvae totally died on the 16th day. It can be assumed that the fermentation bacteria in manufactured feed has an influence even though it has not worked effectively. Similarly, in treatment A, although survival was higher than treatment D, it was not statistically significantly different. This shows that the transition of live feed to fermented manufactured feed in snakehead fish larvae at the age of 10 days is still less effective.

The highest survival was found in treatment E, namely by providing live feed in the form of *Artemia* with an average percentage of 95.83%. This shows that *Artemia* is the suitable first feeding for snakehead fish larvae. *Artemia* is superior to artificial feed because it has digestive enzymes contained in it so that *Artemia* is easily digested by snakehead fish larvae even though the digestive organs are incomplete. *Artemia* also has a size that corresponds to the mouth opening of the snakehead fish larvae, and *Artemia* is a live feed that moves actively, it fulfills the characteristics of snakehead fish that are carnivorous and predatory (Rahman & Sadiqul, 2016).

According to Dabrowski (1982), simple morphological structure of the digestive tract correlates with low enzyme production. The ability of fish larvae to digest feed, especially artificial food, is highly dependent on the completeness of digestive organs including the availability of digestive enzymes, so that if artificial feeding is not at the right time based on the availability of digestive enzymes, the larvae are unable to digest and utilize artificial feed optimally. *Artemia* eaten by snakehead fish larvae contributes as an exogenous enzyme and triggers the development of endogenous enzyme activity in snakehead fish larvae. The enzymes found in *Artemia* that play a role in the growth of snakehead fish larvae are proteases and lipases.

The second highest survival after treatment E was treatment C with a mean percentage of 83.33%. Treatment C also showed results that were not significantly different from treatment E by statistical tests. This shows that treatment C is as good as treatment E. The high percentage of survival in treatment C is thought to be due to snakehead fry already have complete digestive organs resembling adult fish at the age of 20 days after hatching as Haniffa *et al* (2000) stated, so it is assumed there was an increasing activity of digestive enzymes in the digestive organs of snakehead fish fry so that they are able to digest the artificial fermented feed given. Transitions made at the age of 20 days are more effective at providing high survival compared to larvae aged 10 or 15 days.

The absolute length growth of snakehead fish larvae increased successively from treatments A, B and C, this shows that the more mature the snakehead fish larvae, the better in accepting the transition of live feed to fermented manufactured feed. While the lowest absolute length growth was found in treatment D, this shows that the provision of fermented manufactured feed without the transition to snakehead fish larvae gave a low absolute length growth, while the largest absolute length growth was found in treatment E which was 2.23 ± 0.05 cm. It shows that *Artemia* gave a large growth of absolute length to snakehead fish larvae.

Table 2 – Average of Feed Conversion Ratio of Snakehead Fish Larvae during the Study

Repeat	Absolute Length Growth (cm)				
	A	B	C	D	E
1	1.20	1.50	1.99	0.30	2.22
2	1.23	1.47	1.97	0.20	2.28
3	1.10	1.58	2.14	0.30	2.19
Total	3.53	4.55	6.10	0.80	6.69
Average	1.18^{a}	1.52^{b}	2.03^{c}	0.27^{d}	2.23^{e}

Note: Value in each column with different superscripts are significantly different at < 0.05 level of significance.

Based on statistical tests (ANOVA) the treatments affect the survival rate, it can be seen from the significance values (0) < α (0.05) and α (0.01) and F_{count} (53.10) > F_{table} 5% (3.48) and 1% (5.99). Based on Duncan's test, treatment A was not significantly different from treatment D, but it was very significantly different from treatment B, C and E. Treatment B was very Based on statistical tests (ANOVA) treatments affected the growth of absolute length of snakehead fish larvae (significance values (0) < α (0.05) and α (0.01) and F_{count} (415.12) > F_{table} 5% (3.48) and 1% (5.10)). Based on continued testing Tuckey's HSD with α = 0.05 showed that all treatments significantly very different.

Growth in absolute weight of snakehead fish larvae increased respectively from treatments A, B and C. While the lowest absolute weight growth was found in treatment D. The largest absolute weight growth was found in treatment E which was 6.27 ± 0.20 grams, this shows that the provision of live feed in the form of *Artemia* gives the large absolute weight growth of snakehead fish larvae.

Table 3 – Average of Absolute Weight Growth of Snakehead Fish Larvae during the Study

Repeat	Absolute Weight Growth (gram)				
	A	B	C	D	E
1	0.29	1.24	4.58	-0.24	6.11
2	0	1.13	5.92	-0.24	6.21
3	-0.16	2.33	5.52	-0.24	6.50
Total	0.13	4.70	15.39	-0.72	18.82
Average	0.04^{a}	1.57^{b}	5.13^{c}	-0.24^{a}	6.27^{c}

Note: Value in each column with different superscripts are significantly different at < 0.05 level of significance.

Based on statistical tests, absolute weight growth data is not homogeneous so data transformation is needed. After the data is transformed with root square X + 0.5, the data is normal and homogeneous at level 1%.

LSD test results with a level of 1% (α = 0.01) showed that treatment A was not significantly different from treatment D, but significantly different from treatment B, C and E. Treatment B was very significantly different from all treatments, while treatment C did not differ significantly with E treatment, but very different from other treatments.

Growth can be formulated as an increase in length or weight in a certain time (Fujaya, 2004). In this study, growth is measured by absolute length growth and absolute weight growth. The results of absolute length and weight growth in this study indicate the value varies among all treatments.

Growth is closely related to food and fish eating habits. The low growth in absolute length and weight of snakehead fish larvae in treatments A and D can be caused by the lack of the nutrition received by snakehead fish larvae compared to the amount of nutrients needed by larvae for their growth. This was seen during the study where treatments A and D had left over food that was not eaten and settled in the bottom of the aquarium. Fermented manufactured feed that is not consumed shows that snakehead fish larvae are not able to properly digest feed given early in their life.

While the highest absolute length and weight growth were found in treatment E and followed by treatment C. This still proves that live feed is an effective feed in increasing the growth of snakehead fish larvae, this is in line with the eating habits of snakehead fish that eat live feed according to their mouth opening and aggressive in foraging. However, the transition of live feed to fermented manufactured feed that starts in snakehead fish larvae that are 20 days old gives a weight growth that is not significantly different from the growth of snakehead fish larvae given only *Artemia*, this shows that the digestive organs of snakehead fish larvae at the age of 20 days are already able to digest fermented manufactured feed and the activity of protease and lipase enzymes in snakehead fish larvae is thought to work effectively in snakehead fish larvae aged 20 days.

In treatment D (fermented manufactured feed) survival was low at 0% while there was growth even though it was very small. This happens because the growth in snakehead fish larvae is assumed to be obtained from the contribution of amino acid and fat reserves in egg yolks which are then absorbed by snakehead fish larvae for their growth. Probiotic bacteria in fermented feed is also thought to contribute to the growth of snakehead fish larvae. Soeka *et al*. (2011) mentions that *Bacillus licheniformis* is a bacterial species that is able to produce proteases. However, the digestive organs of snakehead fish larvae that have not been completed causes the fermented manufactured feed not fully digestible by snakehead fish larvae in treatment D so that they then slowly die.

The feed conversion ratio (FCR) of snakehead fish larvae varies among treatments from 2.49-80. The lowest FCR was found in treatment E with a mean of 2.57, while the highest FCR was found in treatment D with a mean of 63.07 followed by treatment A (15.31), treatment B (7.33) and treatment C (2.81).

Table 4 – Average of Feed Conversion Ratio of Snakehead Fish Larvae during the Study

Repeat	Feed Conversion Ratio (FCR)				
	A	B	C	D	E
1	12	8.08	2.87	42	2.63
2	13.44	6.86	2.75	67.20	2.49
3	20.49	7.06	2.81	80	2.58
Total	45.30	21.99	8.43	189.20	7.71
Average	15.31[b]	7.33[c]	2.81[d]	63.07[a]	2.57[e]

Note: Value in each column with different superscripts are significantly different at < 0.05 level of significance.

Based on statistical tests, feed conversion ratio data was not normal and homogeneous, so data transformation is needed. After the data is transformed with 1 / X, the data is normal and homogeneous at level 1%. Based on statistical tests (ANOVA) treatments affected the conversion ratio of snakehead fish larvae feed (significance values (0) < α (0.05) and α (0.01) and F_{count} (648.12) > F_{table} 5% (3.48) and 1% (5.10). LSD test results showed that all treatments were significantly different.

Feed Conversion Ratio (FCR) is a unit to calculate the ratio between the amount of food consumed with the body weight gain. Small number of feed conversion ratio means that the amount of feed used to produce one kilogram of meat is getting less (Edjeng & Kartasudjana, 2006). The higher feed conversion ratio means the more wasteful of feed used (Fadilah *et al*., 2007).

The high FCR in treatment D shows that the use of fermented manufactured feed without transition in snakehead fish larvae is very wasteful, this is because the feed is not able to be digested by snakehead fish larvae maximally so that the feed given is wasted and not consumed by snakehead fish larvae and this has an impact on the inhibition of growth of snakehead fish larvae so it resulting to a very high number of FCR. This is inversely related to treatment E where the FCR is much lower and significantly different than other treatments. This shows that the live feed in the form of Artemia is digested quite effective by snakehead fish larvae so that the amount of feed used is far less than other treatments.

The feed efficiency of snakehead fish larvae varies among treatments from 1.25-40.12%. The lowest feed efficiency was found in treatment D with an average of 1.71%, while the highest feed efficiency was found in treatment E with the average was 38.92% followed by treatment C (35.59%), treatment B (13.71%) and treatment A (6.88%).

Table 5 – Average of Feed Efficiency Percentage of Snakehead Fish Larvae during the Study

Repeat	Feed Efficiency (%)				
	A	B	C	D	E
1	8.33	12.38	34.88	2.38	37.98
2	7.44	14.58	36.31	1.49	40.12
3	4.88	14.17	35.59	1.25	38.69
Total	20.65	41.13	106.79	5.12	116.78
Average	6.88[b]	13.71[c]	35.59[d]	1.71[a]	38.93[e]

Note: Value in each column with different superscripts are significantly different at < 0.05 level of significance.

Snakehead larvae feed efficiency increased successively from treatments A, B and C. The lowest feed efficiency was found in treatment D, while the highest feed efficiency was found in treatment E which was 38.93 ± 1.09%, this shows that live feed in the form of *Artemia* in snakehead fish larvae provide the highest feed efficiency compared to other treatments.

Based on statistical tests (ANOVA) treatments affected the feed efficiency of snakehead fish larvae (significance value (0) < α (0.05) and α (0.01) and F_{count} (647.46) > F_{table} 5% (3.48) and 1% (5.99). LSD test results showed that all treatments were different.

Feed efficiency according to Djajasewaka & Djajadireja (1985) is the magnitude of the ratio between the weight gain of fish obtained and the amount of food consumed by fish. The greater the value of weight gain, the greater the feed efficiency. According to Kordi (2011) the value of feed efficiency is inversely proportional to feed conversion and directly proportional to the body weight gain of fish, so the higher the value of feed efficiency, the more efficient use of feed consumed for growth.

As with FCR, treatment D shows the results of less feed efficiency, this can be seen from the value of feed efficiency which is only 1.71%. This shows that the weight gain obtained in this treatment is much smaller than the amount of feed given. While the highest feed efficiency was found in treatment E, namely by providing live feed in the form of Artemia. Treatment E also showed significantly different results compared to 4 other treatments. This shows that feeding *Artemia* nauplius is considered effective in increasing the growth of snakehead fish larvae.

Water quality media of snakehead fish larvae varies among treatments for each parameter measured. The pH range of water media ranges from 7.4 to 8.3. The shortest pH range is in treatment A of 7.73-8.2 and the longest is in treatment E of 7.63-8.23. The temperature range during maintenance is between 25.18-28.12^{0}C. The shortest range was found in treatment D which was 25.21-27.53^{0}C while the longest range was in treatment B which was 25.38-28.12^{0}C.

Table 6 – Range of Water Quality of Snakehead Fish Larvae Rearing Media during the Study

Parameters	Treatments					Standard
	A	B	C	D	E	
pH	7.73-8.2	7.77-8.3	7.77-8.3	7.4-7.93	7.63-8.23	4-9[1)]
Temperature (^{0}C)	25.20-27.76	25.38-28.12	25.23-27.67	25.21-27.53	25.18-27.52	20-35[2)]
DO (mg/L)	6	6	6	2-6	6	5.3-6[3)]
Ammonia (mg/L)	0.25-2	0.25-2.5	0.25	0.25-5	0.25	0.54-1.57[4)]

[1)] KKP (2014); [2)] Wee (1982); [3)] Mollah et al., (2009); Qin et al., (1997).

Water quality of snakehead fish larvae media for DO parameters ranged from 2-6 mg/L. The largest DO fluctuation was found in treatment D which was 2-6 mg/L, while treatments A, B, C and E DO remained at 6 mg/L. Water quality for ammonia parameters ranged from 0.25-5 mg/L. The shortest range was in treatments C and E where ammonia remain at 0.25 mg/L. The longest range was in treatment D, which is 0.25-5 mg/L.

Water quality also affects the growth and survival of fish beside the factors of the species and the feed itself. Poor water quality can have an impact on the disruption of the functioning of fish organs and can cause fish to experience stress that can end to a death. Water qualities measured in this study are pH, temperature, dissolved oxygen (DO) and ammonia.

The pH range of water media for snakehead fish larvae maintenance in this study ranged from 7.4 to 8.3. According to KKP (2014), good pH for the maintenance of snakehead fish fry ranges from 4-9. The pH range of all treatments in this study is still in that range, so it can be said that the water pH of the snakehead fish larvae in this study is in a good condition for the growth and life of snakehead fish larvae. While the temperature range during the maintenance is between 25.18-28.12^{0}C. According to Wee (1982), snakehead fish can tolerate media with temperatures between 20-35^{0}C. Based on the opinion above, the pH and temperature of the media in all treatments in this study are still in the normal range and good for fish growth and life.

A good water quality of snakehead fish larvae maintenance media for DO parameters ranged from 5.3 to 6 mg/L (Mollah *et al*., 2009). The largest DO fluctuation was found in treatment D which was 2-6 mg/L, where DO decreased from the initial rate of 6 mg/L to 2 mg/L at the end of the observation. Decrease in dissolved oxygen level in treatment D can be caused by the oxidation process of fermented artificial feed which is not eaten by snakehead fish larvae in the aerobic process. while in treatments A, B, C and E the DO remain at 6 mg/L. Snakehead fish has a high tolerance level for dissolved oxygen levels due to its ability to breathe directly. According to Marimuthu & Haniffa (2007) snakehead fish larvae begin to breathe directly at the age of 10 days.

Water quality for ammonia parameters in this study ranges from 0.25-5 mg/L. the shortest range was found in treatments C and E where the ammonia remained at the rate of 0.25 mg/L while, the longest range was found in treatment D which was 0.25-5 mg/L. Ammonia fluctuation increased dramatically in treatment D where at the beginning of the measurement was 0.25 mg/L and at the end of the measurement it increased to 5 mg/L. The high ammonia in treatment D can be caused by the amount of fermented artificial feed that is wasted in addition to the decrease in dissolved oxygen levels. As Effendi (2003) argued that ammonia toxicity to aquatic organisms will increase if there is a decrease in dissolved oxygen levels, pH, and temperature. The high mortality in treatment D was also thought to be caused by high levels of ammonia. Qin *et al (*1997) stated that a good range of ammonia from 0.54 to 1.57 mg/L. Based on the statement, treatment C and E are still within the ammonia tolerance threshold.

Boyd (1982) stated that the main source of ammonia is the result of waste from the fish itself or the results of overhaul of feed that has a high enough protein value. Boyd (1982) also mentions that if the ammonia levels rise in water, the excretion of ammonia by the fish decreases and the ammonia levels in the blood and tissues increase. Fish cannot tolerate ammonia levels that are too high because it will be able to interfere with the binding process of oxygen in the blood and will eventually cause disruption of the fish's body system. Treatment D produced a lot of leftover feed which resulted in a high FCR value and low feed efficiency. This wasted food then causes ammonia in the maintenance media to increase so it disrupted the metabolism of larvae; as a result the growth and survival are low.

CONCLUSION

The results showed that the transition from live feed, *Artemia* to fermented manufactured feed significantly affected the survival and growth of snakehead fish larvae. Transitions made on snakehead fish larvae aged 20 days showed better results than the transitions made on larvae aged 10 and 15 days.

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