Five different foods in initial development of Siamese fighting fish (*Betta splendens*)

[1]Marcelo D. Matielo, [2]Lucas P. Gonçalves Jr., [3]Samuel L. Pereira, [4]Paula D. C. Selvatici, [5]Pedro P. Mendonça, [5]Carina A. Troina

[1] Programa de Pós-Graduação em Aquicultura, Universidade Nilton Lins/Instituto Nacional de Pesquisas da Amazônia, Av. Professor Nilton Lins, 3259, Parque das Laranjeiras – Manaus/AM, Brazil; [2] Universidade Federal de Minas Gerais, Belo Horizonte-MG, Brazil; [3] Universidade Estadual do Norte Fluminense Darcy Ribeiro, UENF, Rio de Janeiro-RJ, Brazil; [4] Centro de Ciências Agrárias - Universidade Federal do Espírito Santo, Alegre-ES, Brazil; [5] Instituto Federal do Espírito Santo IFES, Alegre-ES, Brazil; [6] Universidade Federal Fluminense, Niterói-RJ, Brazil. Corresponding author: M. D. Matielo, matielomd@gmail.com

Abstract. The aim of this study was to test the use of five different foods for the initial growth of the *Betta splendens*. The experiment was performed in randomized design with five treatments and five replications, 125 animals with average initial weight of 0.0013±0.0003 g and length averaging 0.56±0.04 cm. The treatments were: T1 - *Artemia* nauplii, T2 - egg yolk, T3 - feed powder, T4 - *Daphnia* and T5 - plankton, provided for 30 days. At the end, we measured the standard length, total length, height, weight, specific growth rate, specific development rate and survival. Statistical difference was observed at 5% for survival and the level of 5% for other variables by the Tukey test, being the *Artemia* nauplii the food with best results for all variables, following then the egg yolk and feed powder that did not differ statistically.

Key Words: *Artemia, Daphnia,* plankton, feed.

Introduction. The siamese fighting fish (*Betta splendens*) is a fish that stands out in the ornamental market by its beauty, variety of colors and aggressiveness, which makes it known in Brazil as "fighting fish" and in the United States as "Siamese fighting fish" (Chapman et al 1997). Originally from Southeast Asia, more precisely from Cambodia, Vietnam, Thailand and Malaysia, endures temperatures up to 36°C and can be raised in small aquariums, with low oxygenation thanks to an alternate breathing mechanism, the labyrinth, used to withdraw oxygen from the atmosphere (Faria et al 2006).

Siamese fighting fish is a carnivore which possesses a small digestive tract, indicating that it accomplishes a quick digestion. Thus, since the exposure period of the digest to the intestinal mucosa is small, it becomes convenient to feed them several times a day, always in small portions. To this end, there is on the market a gamma of industrial "Pet" feed, and also can be used a series of foods, for example: bovine heart, raw shrimp, heart with spinach pate, live or frozen saline *Artemia*, chopped garden annelids, white worms, *Drosofila melanogaster* larvae (fruit fly's), mosquito larvae, *Daphnia*, among others (Faria et al 2006).

The diet preparation for the Siamese fighting fish can vary due to the digestion of products of animal and vegetal origin. Testing the digestibility of these ingredients for adult Siamese fighting fish, Zuanon et al (2007) found greater digestibility of crude soy protein in feed; however the energy digestibility was inversed, being greater in the feed. Still, the post-larvae feeding should ensure the color and mobility of the food, to attract and elevate consumption of the animals, whether it is on the surface or slightly sinking (Monvises et al 2009).

Due to the facts cited above about the Siamese fighting fish (*B. splendens*) such as nourishment, digestion, food used, and the way to work in the farming of this species related to food management, the present study has the objective to evaluate the efficiency of utilizing five different foods (*Artemia*, feed, egg yolk, *Daphnia* and plankton) in the zootecnical development of Siamese fighting fish post-larvae.

Material and Method

Description of the study sites. The present study was conducted at the Instituto Federal do Espírito Santo - Campus de Alegre, Brazil, at the Laboratório de Nutrição e Produção de Espécies Ornamentais (LNPEO), during 1 to 30 of June of 2011. 125 post-larvae were used, from only one spawning at the laboratory, pre fed for 15 days with *Artemia* nauplii in a 20 liters plastic tray. During a period of 15 days it was daily observed if there was predation of young daphnias and plankton, being the last day the confirmation that the animals could receive the treatments.

Mensuration. After the pre feeding period, a sample population of 30 animals was used of initial biometrics before random distribution of the animals in the experimental units. The animals were weighed on an analytical scale (Model: FA-2104N, Bioprecisa) with a 0.001 g precision and measured with a stereoscopic microscope (Modelo: ZTX-T, Nova Optical Systems) and micrometric lens. The initial weight was 0.0013±0.0003 g and the initial length of 0.56±0.04 cm.

Delineation and data. The experimental design was entirely random, with five treatments: recently hatched *Artemia* nauplii (T1), cooked egg yolk (T2), powder feed (T3), *Daphnia* (T4) and plankton (T5), with five repetitions each. The 25 experimental units were built in experimental aquariums, with a useful volume of three liters, constant aeration and five animals each.

Daily, 30% of the water of all experimental units was siphoned to remove faeces and spare food. The water used to restore the volume removed of each experimental unit during siphoning was from the laboratory's own reservoir which contained stable water. The quality parameters of the water were kept up with daily; and the temperature with a mercury thermometer; conductivity, with a conductivemeter (Model: CD-4301, Lutron); dissolved oxygen (DO) with an oxymeter (Model: DO 5519, Lutron); and the pH and total ammonia by the methodology of Verdouw et al (1978).

The feeding was done three times a day (07:00, 12:00 and 17:00), being each food item was provided willingly, so there would be spare food, so the animals could satiate their needs independent from which food was provided. The *Artemia* nauplii were hatched in saline water with 35 ppm of iodide salt (kitchen salt) for 24 hours; the egg was cooked daily in the morning and kept in the refrigerator for the three nourishments and the plankton and the *Daphinia* were harvested in the nursery and the cultivation boxes with the help of a fine mesh, respectively every day during the three hours of the post larvae feed.

The parameters analyzed were: final length pattern (LP), total final length (LT), final height (H), final weight (W), specific growth rate (SGR), specific development rate (SDR) and survival (S).

The growth rates (SGR) and development rates (SGD), were calculated according to the formulas:

$$SGR = [(\log \text{final weight} - \log \text{initial weight})/n°\text{experimental days})] \times 100$$

$$SGD = [(\log \text{final LT} - \log \text{initial LT})/n° \text{ experimental days})] \times 100$$

Statistical analysis. The study was conducted in a completely randomized design with five treatments and five repetitions. To analyze data it was used *one-way* ANOVA for the whole data and average comparison by the Tukey test at 5% variance for the survival percentage and 1% for the others evaluated variables. It was used the SAEG 9.0 program.

Results and Discussion

Water quality results. The water quality parameters: oxygen, temperature, conductivity, pH and ammonia were maintained within the comfort zones for the species, with values on Table 1. For the Siamese fighting fish larvae, according to Halperin et al (1992), a great temperature zone for production is between 25 and 28°C. The average value of dissolved oxygen in egg yolk treatment was smaller than in other treatments, with 3.8 mg L^{-1}, although in others the variable maintained stable at 5.2±0.2 mg L^{-1}.

Table 1

Mean values of water quality variables observed in the use of five different feed for *Betta splendens* larvae

Variable	*Treatment*					
	Artemia	*Egg*	*Feed*	*Daphnia*	*Plankton*	Unit
Oxygen	5.0	3.8	5.0	5.2	5.4	mg L^{-1}
Conductivity	0.17	0.17	0.17	0.18	0.18	ms
Temperature	26.29	26.22	26.28	26.35	26.29	°C
pH	7.12	6.94	7.02	7.27	7.36	-
Ammonia	0.63	0.51	0.29	0.31	0.43	ppm

No significant differences were found for One-way ANOVA at 5% significance.

The easy decomposition of soluble solids in water, by using egg yolk contributed to higher oxygen consumption in treatment 2. However, the Siamese fighting fish has the possibility to endure low levels of dissolved oxygen using the labyrinth (alternate breathing mechanism), with which it can breathe atmospheric air (Faria et al 2006).

The highest ammonia values were found in treatment 1, treatment 2 and treatment 5 with values of 0.63, 0.51, and 0.43 ppm respectively. This compost can reduce animals growth affecting its metabolism, with reduction of immunity at levels above 0.20 ppm and lethal above 0.70 ppm for most fish species (Cavero et al 2004; Pereira & Mercante 2005).

Production results. The observed results showed a significant difference between the foods used in the diet of the Siamese fighting fishs as a growth enhancer (Table 2). The *Artemia* nauplii newly hatched were superior to the other treatments, followed by the egg yolk and commercial feed. The less satisfactory results were observed with the *Daphnia* and plankton treatments.

Table 2

Final variables averages, related to the development and survival of de *Betta splendens* post larvae. GP (growth pattern), LT (total lenght), H (height), W (weight), SGR (specific growth rate), SDR (specific development rate), S (survival percentage)

Variable	*Treatment*				
	Artemia	*Egg*	*Feed*	*Daphnia*	*Plankton*
GP (cm)	1.83±0.16^{a}	1.09±0.23^{b}	0.89±0.24^{bc}	0.82±0.20^{cd}	0.63±0.06^{d}
LT (cm)	2.33±0.18^{a}	1.38±0.30^{b}	1.15±0.28^{bc}	1.08±0.25^{cd}	0.83±0.09^{d}
H (cm)	0.55±0.05^{a}	0.33±0.08^{b}	0.27±0.08^{bc}	0.24±0.06^{cd}	0.18±0.03^{d}
W (g)	0.158±0.039^{a}	0.046±0.041^{b}	0.023±0.018^{bc}	0.023±0.016^{bc}	0.008±0.004^{c}
SGR	15.98±0.63^{a}	11.75±0.77^{b}	9.49±0.50^{c}	9.62±0.49^{bc}	5.96±0.12^{d}
SDR	4.74± 0.12^{a}	2.97±0.29^{b}	2.38±0.29^{bc}	2.17±0.21^{c}	1.27±0.04^{d}
S (%)*	100±0.0^{a}	87±13.0^{ab}	76±24.0^{ab}	80±20.0^{ab}	72±28^{b}

Averages followed by the same letter in the same column do not differ between each other by the Tukey test at the significance of 1%; * Averages followed by the same letter in the same column do not differ between each other, by the Tukey test at 5% significance.

However, survival was different from the variables observed in the water quality, where the best response was observed using *Artemia*, and worst using plankton, by the Tukey test at 5% probability. In other resorch, Jomori et al (2003) also found better results, for the pacu (*Piaractus mesopotamicus*), using *Artemia*. However, despite this treatment elevate the ammonia in the present paper, presented lower mortality than the others.

The use of *Artemia* in treatment 1, presented better results of development productiveness in all variables evaluated. However, the survival in this study shows no statistical difference, comparing the use of egg yolk, feed and *Daphnia*, confirming the nutritional efficiency of *Artemia* and difficulty in using native plankton. The animals fed with artemia did not present mortality, differentiating itself statistically from the use of plankton, demonstrating a superior result.

Evaluating the use of *Artemia* nauplii, Tesser & Portela (2006) showed the importance of the same in food transition as a chemical and visual stimulant to the consumption and change of food for the pacu larvae. However, Takahashi et al (2010) found, for the angel fish with 151.3 mg, better growth with the supply of commercial feed powder, and the absence of statistical difference between the feed flakes and *Artemia* nauplii. As for the mandi (*Pimelodus britskii*), Diemer et al (2010) found better growth in mandi larvae with the supply of powder feed + *Artemia* comparing when provided *Artemia* and feed separately.

The different results found by Tesser & Portela (2006), Takahashi et al (2010), Diemer et al (2010) and the present study are influenced by eating habits, the animals morphology and nourishment availability. Luna-Figueirosa et al (2010), for angel fish larvae and juvenile, found that the larvae growth was larger with the supply of *Artemia franciscana* nauplii, however, for juvenile of the same species, the best result was observed with the supply of *Moina wierzejski*. Corroborating the results of the present study indicating that not just the nourishment can influence the animals development but also the stage development that they found themselves in.

The lambari, *Brycon americus* aff. *iheringii*, studied by Borges et al (2010), presented different stomach contents related to the larvae growth stage and harvest period, demonstrating that nutrition should be adapted to development, animal growth and between different species, mainly in the larval stages and other critical stages that demand special care. Siamese fighting fish six-week-old mosquito larvae fed different storage conditions (frozen and freeze-dried) had shown equal growth in research on Thongprajukaew et al (2019), because the production of digestive enzymes is more developed.

After the initial exogenous feeding, the larvae present nutritional demands, characterized by elevated growth rates and protein synthesis. Thus, the larvae feeding are one of the critical factors in this stage, and natural food exercises influence in its development (Soares et al 2000). This influence can be related to larger protein levels, of 57.26% observed in *A. fransciscana* by Luna-Figueirosa et al (2010), and for *M. wierzejski*, *Panagrellus redivivus* and commercial feed for ornamental fish, respectively of 50, 44.22 and 47.5% of protein.

The performance results for final weight, final length and survival reflect on the specific growth rate and specific development rate, reinforcing the superiority of the use of *Artemia* nauplii. The *Artemia* used treatment had better SGR and SDR being a food rich in protein and, possibly, of better digestibility.

The digestibility of nourishments affect the absorption and protein use (Luna-Figueirosa et al 2010), however, according to Sales & Janssens (2003), it is difficult to obtain larvae digestibility data, due to their size. The digestibility and food quality is generally obtained with zootechnical development.

For the length pattern, total length, height and weight there was no statistical difference between egg yolk and feed, however the specific growth rate demonstrated better statistical results with the use of egg yolk comparing to the use of feed. In both these treatments, the mortality observed was probably occasioned by the lack of mobility and visual stimuli of the food provided to the Siamese fighting fish post larvae, which may have led it to not feed properly. Assessing the performance and survival of Siamese fighting fish larvae, Kaseguer et al (2019) also observed no difference between a zooplacton (*Alona* sp.), boiled egg yolk and commercial feed, among the treatments, being the live food the most indicated.

Tesser & Portela (2006) affirmed that pacu larvae (*P. mesopotamicus*) need chemical and visual stimuli to feed more efficiently. Tesser & Portela (2006) also stated that pacu larvae (*P. mesopotamicus*) use chemical and visual stimuli to feed more efficiently because they increase consumption and helps in the transition from live food to inert food, reducing mortality during the transition. The stimuli found by Tesser & Portela (2006) corroborate the better results found in treatment 1 (*Artemia* nauplii) in the study, that after offered as food to Siamese fighting fish post larvae in freshwater, continued swimming and consequently, visually stimulated predation.

According to Cardoso et al (2004), the egg yolk is used as an ingredient in the elaboration of diets for the jundiá (*Rhamdia quelen*), a fish of carnivore habit. However, the authors cite the use of this ingredient, only cooked and dissolved in water, as being inadequate as the only form of nourishment, being able to cause mortality. Contrary results are encountered by Siamese fighting fish larvae by Kim (2007), that affirms that until the eighth day of life, the use of egg yolk was better than the use of feed and food deprivation. Corroborating the greater efficiency in the use of *Artemia* for Siamese fighting fish, however, with attention to water quality due to increased ammonia concentration.

The plankton and *Daphnia* did not present good results before other nourishments evaluated, possibly because of the capture and ingestion difficulty of them both. This difficulty related to the capture may have led the animals to less development and consequently to a low survival rate. All treatments presented high subrevival values when compared to the research by Wullur et al (2018), who used different zooplankton in the feeding of angelfish (*Centropyge ferrugata*). In the same research, *Daphnias* and wild zooplankton could not escape, thus angelfish larvae can easily eat these foods.

Corroborating the low *Daphnia* productivity for the post larvae in the present study, Samara et al (2003) studied encounters, lunges, seizure and ingestion for the angel fish *Pterophyllum scalare*, *Astyanax fasciatus* (Characidae) and black tetra *Gymnocorymbus ternetzi*, fed with four live foods: two rotifers *Brachionus calyciflorus* and *Brachionus patulus*, and two cladocerans *Moina macrocopa* and *Daphnia pulex*. And found high quantity of encounters and lunges of the three species of fish studied however the results of seizures and ingestion were low, mainly for those fed with daphnia (*D. pulex*), because they were very large.

Treatment 5 presented inferior results of development and smaller survival, compared to other treatments, due to variety of organisms and the risk of introducing pathogens from the natural ambient. The Siamese fighting fish, four-day-old, fed captive zooplankton (*Alona* sp.), had better survival compared to boiled egg and feed, however from the 3rd week the mortality increased because of parasites (Kaseger et al 2019).

All in all, Luna-Figueirosa et al (2010), found similar data to the present study, observing superior results with *Artemia* to *P. scalare*, comparing the use of *M. wierzejski*, *P. redivirus* and industrial feed.

Conclusions. The use of *Artemia* nauplii in the initial development of Siamese fighting fish *Betta splendens* post larvae is the best alternative to maximize growth. Although, the cooked egg yolk and the powder commercial feed can be alternative nourishment, however, with the due care with water quality of the raising system.

Acknowledgements. We are grateful for the close collaboration of *IFES-Capus de Alegre* at the conclusion of this study. The scholarship of the PIBIC program and the current Phd scholarship by the *Fundação de Amparo à Pesquisa do Estado do Amazonas - FAPEAM*. Thanks also to the Postgraduate *Programa de Pós-graduação em Aquicultura da Universidade Nilton Lins/Instituto Nacional de Pesquisas da Amazôna* INPA.

References

Borges R. Z., Assakawa L. F., Cunha A. B., Bialetzki A., Nakatani K., 2006 Morfologia do trato digestório e dieta de larvas de *Brycon americus* aff. *iheringii* (Boulenger, 1887) (Osteichthyes, Characidae). Acta Scientiarum. Biological Sciences 28(1):51-57. [in Portuguese]

Cardoso A. P., Randüns Neto J., Medeiros T. S., Knöpker A., Lazzari R., 2004 Criação de larvas de jundiá (*Rhamdia quelen*) alimentadas com rações granuladas contendo fígados ou hidrolisados. Acta Scientiarum Animal Sciences 26(4):457-462. [in Portuguese]

Cavero B. A. S., Pereira-filho M., Bordinhon A. M., Fonseca F. A. L., Ituassú D. R., Roubach R., Ono E. A., 2004 Tolerância de juvenis de pirarucu ao aumento da concentração de amônia em ambiente confinado. Pesquisa Agropecuária Brasileira 39(5):513-516. [in Portuguese]

Chapman F. A., Fitz-Coy S. A., 1997 United States of America trade in ornamental fish. Journal of the World Aquaculture Society 28:1-10.

Diemer O., Neu D. H., Sary C., Feiden A., Boscolo W. R., Signor A. A., 2010 Manejo alimentar na larvicultura do mandi-pintado (*Pimelodus britskii*). Revista Brasileira de Saúde e Produção Animal 11(3):903-908. [in Portuguese]

Faria P. M. C., Crepaldi D. V., Teixeira E. A., Ribeiro L. P., Souza A. B., Carvalho D. C., Melo D. C., Saliba E. O. S., 2006 Criação, manejo e reprodução do peixe *Betta splendens*. Revista Brasileira de Reprodução Animal 30:134-149. [in Portuguese]

Halperin J. R. P., Dunham D. W., Ye S., 1992 Social isolation increases social display after priming in *Betta splendens* but decreases aggressive readiness. Behavioural Processes 28(2):13-22.

Jomori R. K., Carneiro D. J., Martins M. I. E. G., Portella M. C., 2003 Growth and survival of pacu *Piaractus mesopotamicus* (Holmberg, 1887) juveniles reared in ponds or at different initial larviculture periods indoors. Aquaculture 243:277-287.

Kaseger M. J., Pangkey H., Kusen D. J., Manoppo H., Mingkid W. M., Bataragoa N. E., 2019 Pemanfaatan pakan alami *Alona* sp., rebusan kuning telur dan pakan komersil terhadap peningkatan kelangsungan hidup larva ikan cupang. Jurnal Ilmiah Platax 7(2):335-340.

Kim C. Y., 2007 Efeito de dietas e altura da coluna d'água na sobrevivência de larvas de *Betta splendens* o aporte de nitrogênio e fósforo. MSc Teses, Centro de Aquicultura da UNESP, Jaboticabal, SP, Brazil, 64 pp. [in Portuguese]

Luna-Figuerosa J., Vargas Z. T. J., Figueroa T. J., 2010 Alimento vivo como alternativa en la dieta de larvas y juveniles de *Pterophyllum scalare* (Lichtenstein, 1823). Avances en Investigación Agropecuaria 14(3):63-72. [in Portuguese]

Monvises A., Nuangsaeng B., Sriwattanarothai N., Panijpan B., 2009 The Siamese fighting fish: well-known generally but little-known scientifically. Science Asia 35: 8-16.

Pereira L. P. F., Mercante C. T. J., 2005 A amônia nos sistemas de criação de peixes e seus efeitos sobre a qualidade da água. Uma revisão. Boletim do Instituto de Pesca 31(1):81-88. [in Portuguese]

Sales J., Janssens G. P. J., 2003 Nutrient requirements of ornamental fish. Aquatic Living Resources 16(6):533-540.

Samara S. S. S., Lópes-Rómulo J. A., Nandini N., 2003 Larval feeding behaviour of blind fish *Astyanax fasciatus* (Characidae), black tetra *Gymnocorymbus ternetzi* (Characidae) and angel fish *Pterophyllum scalare* (Cichlidae) fed zooplankton. Hydrobiologia 510:207-216.

Soares C. M., Hayashi C., Gonçalves G. S., Galdioli E. M., Boscolo W. R., 2000 Plâncton, *Artemia* sp., dieta artificial e suas combinações no desenvolvimento e sobrevivência do quinguio (*Carassius auratus*) durante a larvicultura. Acta Scientiarum 22(2): 383-388. [in Portuguese]

Takahashi L. S., Silva T. V., Fernandes J. B. K., Biller J. D., Sandre L. C. G., 2010 Efeito do tipo de alimento no desempenho produtivo de juvenis de acará-bandeira (*Pterophyllum scalare*). Boletim do Instituto de Pesca 36(1):1-8. [in Portuguese]

Tesser M. B., Portella M. C., 2006 Ingestão de ração e comportamento de larvas de pacu em resposta a estímulos químicos e visuais. Revista Brasileira de Zootecnia 35(5): 1887-892. [in Portuguese]

Thongprajukaew K., Pettawee S., Muangthong S., Saekhow S., Phromkunthong W., 2019 Freeze - dried forms of mosquito larvae for feeding of Siamese fighting fish (*Betta splendens* Regan, 1910). Aquaculture Research 50:296-303.

Verdouw H., Van Echted C. J. A., Dekkers E. M. J., 1978 Ammonia determination based on indophenol formation with sodium silicylate. Water Research 12(6):397-402.
Wullur S., Kumagai S., Sakakura Y., Hagiwara A., 2018 Assessment of different minute zooplankton in the larval rearing of rusty angelfish *Centropyge ferrugata*. AACL Bioflux 11(5):1495-1501.
Zuanon J. A. S., Hisano H., Falcon D. R., Sampaio F. G., Barros M. M., Pezzato L. E., 2007 Digestibilidade de alimentos protéicos e energéticos para fêmeas de beta. Revista Brasileira de Zootecnia 36(4):987-991. [in Portuguese]

Received: 19 July 2019. Accepted: 28 September 2019. Published online: 26 October 2019 .
Authors:
Marcelo Darós Matielo, Programa de Pós-Graduação em Aquicultura, Universidade Nilton Lins/Instituto Nacional de Pesquisas da Amazônia, Av. Professor Nilton Lins, 3259, Parque das Laranjeiras – Manaus/AM, Brasil, e-mail: matielomd@gmail.com
Lucas Pedro Gonçalves Junior, Universidade Federal de Minas Gerais, PPG em Zootecnia da escola de Veterinária, Belo Horizonte, Minas Gerais, Brasil, e-mail: juniorvezula@hotmail.com
Samuel Louzada Pereira, Universidade Estadual do Norte Fluminense Darcy Ribeiro, PPG Ciência Animal, Campos dos Goytacazes, Rio de Janeiro, Brasil, e-mail: samuell_lp@hotmail.com
Paula Del Caro Selvatici, Centro de Ciências Agrárias - Universidade Federal do Espírito Santo, Programa de Pós-Graduação em Ciências Veterinárias, Alegre, Espírito Santo, Brasil, e-mail: paulaselvatici@gmail.com
Pedro Pierro Mendonça, Instituto Federal do Espírito Santo – Campus de Alegre, Membro do PPG em Ciências Veterinária do CCA-UFES, Alegre, Espírito Santo, Brasil, e-mail: ppierrom@gmail.com
Carina Andrade Troina, Universidade Federal Fluminense: Literatura Comparada, Rio de Janeiro, Brasil, e-mail: carinatroina@gmail.com

How to cite this article:
Matielo M. D., Gonçalves Jr. L. P., Pereira S. L., Selvatici P. D. C., Mendonça P. P., Troina C. A., 2019 Five different foods in initial development of Siamese fighting fish (*Betta splendens*). AACL Bioflux 12(5):1755-1761.