POLISH JOURNAL OF NATURAL SCIENCES
Abbrev.: Pol. J. Natur. Sc., Vol 37(1): 115–123, Y. 2022

DOI: 10.31648/pjns.7394

EFFECTS OF FEEDING FREQUENCY ON SILVER RASBORA (*RASBORA ARGYROTAENIA*) FRY GROWTH

***Vindhya Shinta Bela*[1], *Agustono Agustono*[2], *Asep Permana*[3], *Darmawan Setia Budi*[4]**

[2] ORCID: 0000-0002-1145-0686
[3] ORCID: 0000-0001-8983-7779
[4] ORCID: 0000-0001-9508-1437
[1,4] Study Program of Aquaculture, School of Health and Life Sciences
[2,4] Department of Aquaculture, Faculty of Fisheries and Marine
Universitas Airlangga, Indonesia
[3] Research Institute for Ornamental Fish Culture
Ministry of Marine Affairs and Fisheries, Indonesia

Key words: aquaculture, domestication, fish feeding, basic breeding parameters, production.

Abstract

As a newly domesticated fish species, silver rasbora (*Rasbora argyrotaenia*) farming needs more basic knowledge about culture procedures. Feeding management is basic crucial information in the farming system of many species. This study purposes to evaluate the growth and feed efficiency of silver rasbora fry reared under different feeding frequencies. The feeding treatments of fish were divided into 4 different feeding frequency treatments (1, 2, 3, and 4 times daily), each treatment consisted of 5 replicates with 20 fish. Fish were fed ad satiation. The effects of feeding frequency on growth were determined by calculating the parameters namely body weight gain, biomass gain, specific growth rate, and feed conversion ratio. Based on the results, different feeding frequency has a significant effect ($P < 0.05$) on all parameters. The growth was higher with increasing feeding frequency; the highest growth was occurred on the most frequently feeding. The best growth was observed in 4 times daily feeding (final body weight: 0.45 ± 0.01 g/fish, bodyweight gain: 0.19 ± 0.00 g/fish, biomass gain: 5.58 ± 0.09 g, specific growth rate: 1.34 ± 0.06 %/day); meanwhile, feed conversion ratio decrease and showed the lowest value on 4 times daily feeding frequency treatment (1.56 ± 0.04). Referring to the growth parameters and the lowest feed conversion ratio was obtained for fish fed 4 times daily. It can be concluded that feeding 4 times daily as optimum feeding frequency in the present study resulted in better growth and feed conversion ratio during the rearing of silver rasbora.

Address: Darmawan Setia Budi, Wijaya Kusuma Street No. 113, Banyuwangi 68425, East Java, Indonesia, e-mail: darmawansetiabudi@fpk.unair.ac.id

Introduction

Silver rasbora (*Rasbora argyrotaenia*); belong to the family Danionidae (Cypriniformes order) with maximum length 12 cm; naturally distributed in Philippines, Malaysia, Cambodia, Thailand, and Indonesia (ARYANI 2015, KUSUMA et al. 2017, CAPULI and BAILLY 2022). As newly domesticated species in Indonesia, silver rasbora has economic values for consumption and ornamental fish (ADAWIYAH et al. 2019, HERAWATI et al. 2018). Silver rasbora wild captures still become the main fulfillment of the market demands because aquaculture is limited (BUDI et al. 2020, ROSADI et al. 2014). Silver rasbora as under development aquaculture species needs more basic information about its farming procedures to overcome overfishing in the wild (SZMYT et al. 2013, BUDI et al. 2020, SALMATIN et al. 2021).

Feeding management is basic crucial information in the farming of many species (BEN et al. 2016, TIAMIYU et al. 2018). A good feeding practice involves providing an efficient feedstuff at the right time, amounts, and form for the optimal fish growth (OKOMODA et al. 2019). Overfeeding and underfeeding lead to inefficient production. Overfeeding cause a significant reduction in water quality (decreasing dissolved oxygen and increasing ammonia content), reducing feed growth and utilization, and increased susceptibility to infection because of stress due to poor water quality (DWYER et al. 2002, NG et al. 2000, SCHNAITTACHER et al. 2005). On the other hand, underfeeding has a direct impact on the production period because growth slows down due to the fish population are partially starved (BOOTH et al. 2008, KÜÇÜK et al. 2014, MIHELAKAKIS et al. 2002, OH and MARAN 2015).

Application of optimal feeding regimes can optimize the production period, maximize utilization of feed, improve the rearing media (water qualities), and increase the uniformity of fish size until harvest (DWYER et al. 2002, OH et al. 2013, OH and MARAN 2015, SILVA et al. 2007, ZHOU et al. 2003). These regimes vary for different species, size/age/stadia, the composition of feed, and rearing media (CHO et al. 2003, LEE et al. 2000, WANG et al. 1998, XIE et al. 2011). Previous study about feeding frequencies have shown effect on growth, survival, and social interactions on fry and juvenile of some species namely African catfish (*Clarias gariepinus*) (OKOMODA et al. 2019), Korean rockfish (*Sebastes schlegeli*) (LEE et al. 2000), gibel carp (*Carassius auratus gibelio*) (ZHOU et al. 2003), yellowtail flounder (*Limanda ferruginea*) (DWYER et al. 2002), gilthead sea bream (*Sparus aurata*) (MIHELAKAKIS et al. 2002), and rock bream (*Oplegnatus* *faciatus*) (OH and MARAN 2015). Meanwhile, studies on the effect of feeding frequency on silver rasbora have never been conducted.

This study aims to evaluate the growth and feeding efficiency of silver rasbora fry reared under different feeding frequencies.

Materials and Methods

Origin of fish and acclimation

This study was conducted from February to March 2019 in the laboratory and aquaculture facilities of Airlangga University, Banyuwangi Campus (East Java, Indonesia). This research was conducted under the oversight and approved by Marine Sciences Faculty of Airlangga University (based on assignment letter from Dean of Marine Sciences Faculty of Airlangga University, 1851/UN3.1.16/PPd/2018).

The fry were obtained from silver rasbora breeding program in aquaculture facilities of Airlangga University, Banyuwangi Campus. All fish were transferred to 20 glass aquaria (volume 60 l; 30 fish/aquaria) and acclimated for 1 week. Fish were fed on commercial dry pellets (PF-1000, Prima Feed™, Indonesia; size 1.3-1.7 mm; crude protein 39-41%; crude lipid 5%; moisture 6%; ash 15%; water 15%) during acclimation twice daily on ad satiation.

The parameters of water quality were monitored daily during experiment including temperature (25–28 °C), pH (7.6–8), dissolved oxygen (6.0–6.7 mg/l), total dissolved solid (143–203 mg/l), and total ammonia nitrogen (0.033–0.058 mg/l).

Experimental design

The feeding trials of fish were divided into 4 different feeding frequency treatments consisted 5 replicates with 20 fish (initial body weight can see in Table 1). Feeding frequency trials were carried out are 1 (T1), 2 (T2), 3 (T3), and 4 (T4) times daily. Fish were fed ad satiation. Schedule of feeding time can be seen in Table 2. All feeding frequency trial groups were used commercial dry pellets (same as the diet in the acclimation period) on ad satiation, no excess of feed in all aquariums. Experiments were carried out for 40 days. Every 10 days, fish body weight was measured.

Table 1

The initial average body weight (BW_i, mean ± SD, n = 5) of silver rasbora (*Rasbora argyrotaenia*) fry

Parameters	Treatment			
	T1	T2	T3	T4
BW_i (g/fish)	0.26 ± 0.01	0.26 ± 0.01	0.27 ± 0.02	0.26 ± 0.01

Tabel 2

Feeding time of silver rasbora (*Rasbora argyrotaenia*) fry with different feeding frequency treatments

Treatment	Feeding schedule			
T1	08.00-09.00	–	–	–
T2	08.00-09.00	17.00-18.00	–	–
T3	08.00-09.00	12.30-13.30	17.00-18.00	–
T4	08.00-09.00	11.00-12.00	14.00-13.00	17.00-18.00

T1, T2, T3, and T4 are 1, 2, 3, and 4 times daily feeding frequency treatment.

Observed parameters

The effects of feeding frequency on growth were determined by calculating the parameters namely body weight gain (BWG), biomass gain (BG), specific growth rate (SGR), and feed conversion ratio (FCR) with the following formula:

$$\text{BWG [g/fish]} = (BW_f - BW_i)$$
$$\text{BG [g]} = (N_f\,BW_f - Ni\,BW_i)$$
$$\text{SGR [\%/day]} = (\ln BW_f - \ln BW_i) / t)$$
$$\text{FCR} = FC/(N_f\,BW_f - Ni\,BW_i)$$

where:

BW_i and BW_f – the initial average body weight [g] and the final average body weight [g]
N_i and N_f – the initial number and the final number of larvae
t – the experiment duration in days
FC – amount of feed consumption during experiment.

A total 20 grams of feed was weighed at the beginning of the study and the remaining feed was weighed at the end of the study, the FC value was the difference between the weight of the initial feed and the rest of the feed.

Data analysis

The distribution and homogeneity of data were analyzed; all data have normal distribution and homogeneity of variances. Then, data were analyzed statistically by analysis of variances (ANOVA) test at 95% confidence level and continued with Duncan Multiple Range Test (DMRT) using SPSS 17.0 software.

Results

The growth of silver rasbora fry reared with different feeding frequency showed in Table 3. Based on the data, different feeding frequency has significant effect ($P < 0.05$) on all parameters. At the end of study, the average of final body weight (BW_f), body weight gain (BWG), biomass gain (BG), specific growth rate (SGR), and feed consumption (FC) showed a similar tendency between treatments; increase sequentially from treatment T1 to T4. Feed consumption (FC) not significantly different on treatment T1, T2, and T3 ($P > 0.05$); meanwhile, feed conversion ratio (FCR) decrease and showed lowest value on T4 (1.56 ± 0.04).

The growth was higher with increasing of feeding frequency; the highest growth was occurred on the most frequently feeding. The best growth was observed in T4 (Bw_f: 0.45 ± 0.01 g/fish, BWG: 0.19 ± 0.00 g/fish, BG: 5.58 ± 0.09 g, SGR: 1.34 ± 0.06 %/day).

Table 3

The final average body weight (BW_f), body weight gain (BWG), biomass gain (BG), specific growth rate (SGR), feed consumption (FC), feed conversion ratio (FCR), and survival rate (SR) of silver rasbora (*Rasbora argyrotaenia*) fry reared with different feeding frequency for 40 days

Parameters	Treatment			
	T1	T2	T3	T4
BWG [g/fish]	$0.06^c \pm 0.01$	$0.12^b \pm 0.02$	$0.13^b \pm 0.03$	$0.19^a \pm 0.00$
BG [g]	$1.86^c \pm 0.23$	$3.54^b \pm 0.68$	$3.90^b \pm 0.76$	$5.58^a \pm 0.09$
SGR [% /day]	$0.53^c \pm 0.08$	$0.92^b \pm 0.18$	$1.00^b \pm 0.22$	$1.34^a \pm 0.06$
FC [g]	$4.42^c \pm 0.53$	$7.68^b \pm 0.41$	$8.08^{ab} \pm 0.55$	$8.76^a \pm 0.21$
FCR	$2.41^a \pm 0.42$	$2.23^a \pm 0.39$	$2.11^a \pm 0.26$	$1.56^b \pm 0.04$
SR [%]	100	100	100	100

Values (mean ± SD, $n = 5$) with different superscripts in the same row are significantly different ($P < 0.05$). T1, T2, T3, and T4 are 1, 2, 3, and 4 times dialy feeding frequency treatment.

Discussion

The increased growth and improvement feeding efficiency of fish due to increased feeding frequency were demonstrated by several previous studies (Oh and Maran 2015, Okomoda et al. 2019, Wang et al. 2007). In the current study, we were able to reveal that the growth (showed by value of BWG, BG, and SGR; Table 2) and FCR of silver rasbora fry significantly decreased until four meals per day.

The results showed that the optimum feeding frequency for silver rasbora fry was occurred in higher feeding frequency treatment (4 time/day) – Table 2, because at this treatment the fish had higher value of BWG, BG, and SGR; but lower FCR compared with other less feeding frequency treatment. The optimal feeding frequency for growth of fish varies widely depending on species and size (OH and MARAN 2015). For example, Korean rockfish (*Sebastes schlegelii*) juveniles (initial weight 5.7 g) with feeding frequency 1 time/day grew faster and converted feed more efficient than 1 time/2 days of feeding (LEE et al. 2000). On the other hands, the optimal feeding frequency of juvenile yellowtail flounder (Limanda ferruginea) with 6.8 g initial weight had 2 times/day (DWYER et al. 2002), juvenile hybrid sunfish (male *Lepomis macrochirus* × female *Lepomis cyanellus*) with 7.4 g initial weight had 3 times/day (WANG et al. 1988), post-larvae ayu (*Plecoglossus altivelis*) with 0.15 g initial weight had 4 times/day (CHO et al. 2003), and juvenile gibel carp (*Carassius auratus gibelio*) with 3.0 g initial weight had 24 times/day (ZHOU et al. 2003).

Fish fed more frequently eat a larger amount of food than those fed at lower frequencies, but the individual feed consumption size was smaller (DWYER et al. 2002). Fish achieve this by improving their stomach volume and becoming hyperphagic (ROUHONEN et al. 1998). The digestibility ratio is related to the frequency of meals depending on the volume of the stomach (GRAYTON and BEAMISH 1977, JOBLING 1983, ROUHONEN et al. 1998), the interval of meals (BISWAS et al . 2010, LIU 1999), and the rate of gastric emptying (LEE et al. 2000). Data regarding daily feed intake patterns will provide important information regarding the timing of feeding and the amount of feed provided at each feed to increase the growth of silver rasbora.

In present study, FCR was affected by feeding frequency is similar with other previous research of Asian sea bass (*Lates calcarifer*) (SALAMA 2008), *Clarias gariepinus* (ADEROLU et al. 2021, JAMABO et al. 2015), and Black Sea trout (*salmo trutta labrax*) (BAŞÇINAR et al. 2007). In line with growth parameters, best FCR was occurred in most of frequently feeding (4 times/day feeding frequency). Similar tendency of relation between FCR and growth that affected by feeding frequency was also occurred in previous study in some species, for example Asian sea bass (*Lates calcarifer*) (SALAMA 2008), hybrid sunfish (male *Lepomis macrochirus* × female *Lepomis cyanellus*) (WANG et al. 1988), Australian snapper (*Pagrus auratus*) (TUCKER et al. 2006).

Referring to the growth parameters and the lowest FCR were obtained for fish fed 4 times daily, although further studies should be conducted to investigate the effect of more frequent feeding. It can be concluded that feeding 4 times daily as optimum feeding frequency in the present study resulted in better growth and FCR during the rearing of silver rasbora.

Acknowledgements

This research was conducted independently and there was no agency that supported research funding. We thank all colleagues who supported this research.

Accepted for print 24.05.2022

Refferences

Adawiyah L.A., Sulmartiwi L., Bodur T., Budi D.S. 2019. *Induction of spermiation using ovaprim^{TM} with topical gill method in the silver rasbora (Rasbora argyrotaenia).* Theriogenology., 126: 172–176.

Aderolu A.Z., Seriki B.M., Apatira A.L., Ajaegbo C.U. 2010. *Effects of feeding frequency on growth, feed efficiency and economic viability of rearing African Catfish (Clarias Gariepinus, Burchell 1822) Fingerlings and Juveniles*. African J. Food Sci., 4(5): 286–90.

Aryani N. 2015. *Native species in Kampar Kanan River, Riau Province Indonesia*. Int. J. Fish. Aquat. Sci., 2(5): 213–216.

Başçinar N., Çakmak, E. Çavdar Y., Aksungur N. 2007. *The effect of feeding frequency on growth performance and feed conversion rate of black sea trout (Salmo trutta labrax Pallas, 1811).* Turkish J. Fish. Aquat. Sci., 17: 13–17.

Biswas, A., Kazushige I., Takii K. 2010. *Feeding interval and photoperiod influence the growth performance of striped knifejaw, Oplegnathus fasciatus*. Aquac. Res., 41(10): 517–523.

Booth M.A., Tucker B.J., Allan G.L., Fielder D.S. 2008. *Effect of feeding regime and fish size on weight gain, feed intake and gastric evacuation in juvenile Australian snapper Pagrus auratus*. Aquaculture, 282(1–4): 104–110.

Budi D.S., Rizkyan I., Prayogo. 2020. *The effect of stocking density on the survival and growth of silver rasbora (Rasbora argyrotaenia) larvae*. Polish J. Nat. Sci., 35(1): 87–95.

Capuli E.E., Bailly N. 2022. *Rasbora argyrotaenia (Bleeker, 1849), Silver rasbora*. FishBase, https://www.fishbase.in/summary/Rasbora-argyrotaenia.html.

Cho S.H., Lim Y.S., Lee J.H., Lee J.K., Park S., Lee S.M. 2003. *Effects of feeding rate and feeding frequency on survival, growth, and body composition of ayu post-larvae plecoglossus altivelis*. J. World Aquac. Soc., 34: 85–91.

Dwyer K.S., Brown J.A., Parrish C., Lall S.P. 2002. *Feeding frequency affects food consumption, feeding pattern and growth of juvenile yellowtail flounder (Limanda ferruginea).* Aquaculture, 213: 279–292.

Grayton B.D., Beamish F.W.H. 1977. *Effects of feeding frequency on food intake, growth and body composition of rainbow trout (Salmo gairdneri).* Aquaculture, 11: 159–172.

Herawati T., Yustiati A., Nurhayati A., Mustikawati R. 2018. *Proximate composition of several fish from Jatigede Reservoir in Sumedang district, West Java*. in: IOP Conference Series: Earth and Environmental Science, pp. 1–7.

Jamabo N.A., Fubara R.I., Dienye H.E. 2015. *Feeding frequency on growth and feed conversion of Clarias Gariepinus (Burchell, 1822) Fingerlings*. Int. J. Fish. Aquat. Stud., 3: 353–356.

JOBLING M. 1983. *Effect of feeding frequency on food intake and growth of Arctic charr, Salvelinus alpinus* L. J. Fish Biol., 23: 177–185.

KÜÇÜK E., AYDIN I., POLAT H., EROLDOĞAN O.T., ŞAHIN T. 2014. *Effect of feeding frequency on growth, feed efficiency and nutrient utilization of juvenile flounder (Platichthys flesus luscus).* Aquac. Int., 22: 723–732.

KUSUMA W.E., SAMUEL P.D., WIADNYA D.G.R., HARIATI A.M., KUMAZAWA Y. 2017. *Complete mitogenome sequence of Rasbora argyrotaenia (Actinopterygii: Cyprinidae).* Mitochondrial DNA Part B Resour., 2: 373–374.

LEE S.M., HWANG U.G., CHO S.H. 2000. *Effects of feeding frequency and dietary moisture content on growth, body composition and gastric evacuation of juvenile Korean rockfish (Sebastes schlegeli).* Aquaculture, 187: 399–409.

LIU F.G. 1999. *Effect of feeding regimen on the food consumption, growth, and body composition in hybrid striped bass Morone saxatilis × M. chrysops*. Fish. Sci., 65: 513–519.

MIHELAKAKIS A., TSOLKAS C., YOSHIMATSU T. 2002. *Optimization of feeding rate for hatchery-produced juvenile gilthead sea bream Sparus aurata*. J. World Aquac. Soc., 33: 169–175.

NG W.K., LU K.S., HASHIM R., ALI A., 2000. *Effects of feeding rate on growth, feed utilization and body composition of a tropical bagrid catfish*. Aquac. Int., 8: 19–29.

OH S.Y., KIM M.S., KWON J.Y., MARAN B.A.V. 2013. *Effects of feed restriction to enhance the profitable farming of blackhead seabream Acanthopagrus schlegelii schlegelii in sea cages*. Ocean Sci. J., 48: 263–268.

OH S.Y., MARAN B.A.V. 2015. *Feeding frequency influences growth, feed consumption and body composition of juvenile rock bream (Oplegnathus fasciatus).* Aquac. Int., 23: 175–184.

OKOMODA V.T., AMINEM W., HASSAN A., MARTINS C.O. 2019. *Effects of feeding frequency on fry and fingerlings of African catfish Clarias gariepinus*. Aquaculture, 511.

Okwuosa Obinna B., Nwachukwu V., Agha Etuu P., Enyinnaya C. 2016. *The impact of feeding frequency on the growth and survival of Clarias gariepinus fingerlings fed at different percentage body weight in four phases*. Int. J. Fish. Aquat. Stud., 4(5): 173–178.

ROSADI E., HERAWATI E.Y., SETYOHADI D., BINTORO G. 2014. *Distribution, composition, and abiotic environment of Silver Rasbora (Rasbora argyrotaenia Blkr) fish in upstream areas of Barito watershed, South Kalimantan*. J. Environ. Ecol., 5: 117–131.

RUOHONEN K., VIELMA J., GROVE D.J. 1998. *Growth and food utilisation of rainbow trout (Oncorhynchus mykiss) fed low-fat herring and dry diets enriched with fish oil*. Aquaculture, 163: 275–283.

SALAMA A.J. 2008. *Effects of different feeding frequency on the growth, survival and feed conversion ratio of the Asian sea bass Lates calcarifer juveniles reared under hypersaline seawater of the Red Sea*. Aquac. Res., 39: 561–567.

SALMATIN N., MUBARAK A.S., BUDI D.S. 2021. *Egg diameter of female silver rasbora (Rasbora argyrotaenia) at different gonadal maturity stage*. IOP Conf. Ser. Earth Environ. Sci., 718: 012066.

SCHNAITTACHER G., KING V.W., BERLINSKY D.L., 2005. *The effects of feeding frequency on growth of juvenile Atlantic halibut, Hippoglossus hippoglossus* L. Aquac. Res., 36: 370–377.

SILVA C.R., GOMES L.C., BRANDAO F.R. 2007. *Effect of feeding rate and frequency on tambaqui (Colossoma macropomum) growth, production and feeding costs during the first growth phase in cages*. Pol. J. Natur. Sc., 28: 471–483.

SZMYT M., GORYCZKO K., GRUDNIEWSKA J., LECK A.M., WIŚNIEWSKA A.M., WOZNIAK M. 2013. *Preliminary result of Europan grayling (Thymallus Thymallus* L.*) fry rearing to the autumn fingerlings stage*. Aquaculture, 264: 135–139.

TIAMIYU L.O., OKOMODA V.T., AGBO H.E. 2018. *The effect of different feeding rates and restriction on the growth performance of Clarias gariepinus*. Iran. J. Fish. Sci., 17: 840–847.

TUCKER B.J., BOOTH M.A., ALLAN G.L., BOOTH D., FIELDER D.S. 2006. *Effects of photoperiod and feeding frequency on performance of newly weaned Australian snapper Pagrus auratus*. Aquaculture, 258: 514–520.

WANG N., HAYWARD R.S., NOLTIE D.B. 1998. *Effect of feeding frequency on food consumption, growth, size variation, and feeding pattern of age-0 hybrid sunfish*. Aquaculture, 165: 261–267.

WANG Y., KONG L.J., LI K., BUREAU D.P. 2007. *Effects of feeding frequency and ration level on growth, feed utilization and nitrogen waste output of cuneate drum (Nibea miichthioides) reared in net pens*. Aquaculture, 271: 350–356.

XIE F., AI Q., MAI K., XU W., MA H. 2011. *The optimal feeding frequency of large yellow croaker (Pseudosciaena crocea, Richardson) larvae*. Aquaculture., 311: 162–167.

ZHOU Z., CUI Y., ZIE S., ZHU X., LEI W., XUE M., YANG Y. 2003. *Effect of feeding frequency on growth, feed utilization, and size variation of juvenile gibel carp (Carassius auratus gibelio)*. J. Appl. Ichthyol., 19: 244–249.