GROWTH AND REPRODUCTIVE PERFORMANCES OF RAMIREZI (*Mikrogeophagus ramirezi*) FED WITH DIFFERENT FEED TYPES

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ABSTRACT

The Ramirezi (*Mikrogeophagus ramirezi*) is an ornamental fish in high demand with significant economic value. The high demand for this commodity has yet to be met by the quantity of fry production generated by farmers. It is due to the Ramirezi's long maturation time and slow growth, which are influenced by factors such as the feed used. This study aimed to evaluate the effect of feeding with different feed types on the growth and development of the gonads of prospective Ramirezi broodstocks. The research design employed a completely randomized design (RAL) with four treatments and three replications, using a combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2, for 45 days of culture. The results showed that a combination of artificial feed and bloodworm in a 1:2 ratio increased the absolute body growth of Ramirezi by 1.267 g, with a positive allometric growth pattern. This ratio also affected the egg diameter, leading to a higher percentage of broodstock maturing more quickly and improving reproductive performance, as seen in the parameters of the number of eggs produced (ranging from 80-200 eggs), a 96.83% fertilization rate, and a 91.80% hatching rate. Therefore, researchers and farmers can combine artificial feed and bloodworms in a 1:2 ratio in Ramirezi cultivation activities.

KEYWORDS: artificial feed; bloodworm; growth; maturation; ramirezi

ABSTRAK: Performa Pertumbuhan dan Reproduksi Ramirezi (*Mikrogeophagus ramirezi****) yang Diberi Jenis Pakan Berbeda***

*Ramirezi (**Mikrogeophagus ramirezi**) adalah salah satu ikan hias yang banyak diminati dengan nilai ekonomis tinggi. Tingginya permintaan terhadap komoditas ini belum diimbangi dengan jumlah produksi benih yang dihasilkan oleh pembudidaya. Hal tersebut karena secara biologis ramirezi memiliki waktu maturasi yang cukup lama dan pertumbuhan yang lambat. Salah satu factor, yang dipengaruhi oleh beberapa faktor seperti pakan yang digunakan. Penelitian ini bertujuan untuk mengevaluasi pengaruh pemberian pakan dengan jenis pakan berbeda terhadap pertumbuhan dan perkembangan gonad calon induk ramirezi. Rancangan penelitian yang digunakan yaitu rancangan acak lengkap (RAL) dengan empat perlakuan dan tiga ulangan, menggunakan rasio kombinasi pakan buatan dengan cacing sutra (**Chironomus** sp.): (A) 3:0, (B) 0:3, (C) 2:1, dan (D) 1:2, selama 45 hari pemeliharaan. Hasil penelitian menunjukkan bahwa pemberian kombinasi pakan buatan dan cacing sutra dengan*

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rasio 1:2 mampu meningkatkan pertumbuhan bobot mutlak ramirezi sebesar 1,267 g, dengan pola pertumbuhan alometrik positif. Rasio ini memberikan pengaruh terhadap diameter telur, menghasilkan persentase induk yang lebih cepat matang gonad serta meningkatkan performa reproduksi, terlihat dari parameter jumlah telur yang dihasilkan (berkisar 80-200 butir), derajat pembuahan 96,83%, dan derajat penetasan sebesar 91,80%. Oleh karena itu, peneliti dan pembudidaya dapat mengombinasikan pakan buatan dan cacing sutra dengan rasio 1:2 pada kegiatan budidaya ramirezi.

KATA KUNCI: *cacing sutra; maturasi; pakan buatan; pertumbuhan; ramirezi*

INTRODUCTION

Ramirezi (*Mikrogeophagus ramirezi*) is an ornamental fish in great demand, with high economic value, and is widely cultivated by ornamental fish enthusiasts in Indonesia. Morphologically, male fish are much in demand compared to female fish because they have a more beautiful color and fin shape. The price is around IDR 5,000-45,000 per fish in the local market, while in the international market, it can reach 12-36 fold the price compared to the local market. Furthermore, the production of this fish experienced an average increase in total production of more than 50% from 2018 to 2019 (KKP, 2019). Therefore, an annual production increase must be accompanied by a sustainable number of seeds.

The high market demand for this commodity has yet to be matched by the number of products farmers produce. One of the main limiting factors in the development of ramirezi cultivation is the low frequency of spawning broodstock and the limited quality and quantity of gonadally mature broodstock so the seeds produced are not sustainable. Biologically, ramirezi has a long maturation time, generally 5-6 months, and in some species, such as Bolivian ram (*Microgeophagus altispinosa*), it has been reached after 8-10 months of age (Burres, 2017). The maturation time of gonads in most of ornamental fish generally ranges from 5-8 months (Akhsan *et al.*, 2020; Thomas *et al.*, 2020). Moreover, another marine ornamental fish, clownfish, requires an extended period of 9-18 months old (Anikuttan *et al.*, 2020). These conditions impact on the supply of seeds in the market in quantity and time. The long maturation process of broodstock is caused by several factors, such as environmental conditions, nutrition, and genetics (Khalil *et al*., 2019). Efforts that can be made to increase the frequency of spawning and increase the quality and quantity of ramirezi broodstock with continuously maturing gonads can be made in various ways, one of which is by improving the nutrition of the broodstock feed. Delays in gonadal development due to lack of quality or nutritious broodstock, such as the content of protein, vitamins, essential amino acids, minerals, and essential fatty acids in broodstock feed being inappropriate, causing nutrient imbalances in the hormonal action pathway system in one phase of the reproductive process. Feed is an essential factor affecting fish growth, gonad development, reproductive performance, fecundity, hatchability, and survival (Ibrahim *et al*., 2020).

Fish feed is divided into two types: natural and artificial. Both feeds have their advantages and disadvantages. The natural feed has a high nutritional content, is easy to digest, and the feed's movement attracts the fish's attention. However, the availability of natural feed is heavily dependent on nature and requires care because it is administered to fish in the living form. Meanwhile, the availability of artificial feed is not limited and does not require maintenance. However, some artificial feeds are complex for fish to digest and can cause a decrease in water quality in culture containers (Sinjal *et al*., 2014).

The current ramirezi feeding method used by farmers is using natural feed in the form of bloodworms (Budianto *et al*., 2019). However, in

the preparation phase of ramirezi broodstock, there has yet to be a scientific study on the best feed used by farmers to maximize the growth and maturation potential of ramirezi broodstock. Therefore, conducting a feeding experiment with different feeds is necessary to achieve optimal ramirezi broodstock production. This study evaluates the growth performance and gonadal development of ramirezi fed with different feed types.

MATERIALS AND METHODS

Preliminary Test

Thirty 5-month-old electric blue ramirezi broodstock with an average weight of 2.63 ± 0.63 g and an average length of 10.83 ± 1.83 cm were selected. The testing involves 3-4 pairs of ramirezi in the same container measuring 40x30x30 cm^3. Then, the ramirezi female broodstock will choose the male broodstock naturally. It is done to minimize the number of fish that do not mate. Ramirezi broodstocks, selected with a male-to-female ratio of 1:1, are then moved into a spawning container in the form of an aquarium measuring 40x30x30 cm^3 with a working volume of 25 L that has been previously prepared and equipped with the PVC pipe shelter as a medium for laying eggs. The type of feed given in the rearing of ramirezi broodstock is frozen bloodworm (*Chironomus* sp.). The feeding frequency is three times daily at 08:00, 12:00, and 15:00 local time. Feeding is done ad satiation. The results of this preliminary test were used as a reference for the subsequent test.

Experimental Design

The experimental design used was a completely randomized design (CRD). Determining the treatment used refers to the study by Anggraini (2014), with four treatments and three replications. The treatment given was a combination of artificial feed: bloodworms at various ratios: (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2. In treatment A, fish were given 100% commercial feed three times a day, while in treatment B was fed 100% bloodworms three times a day. In treatment C, natural bloodworms were combined with commercial feed with a feeding system where commercial feed was administered at 08:00 and 12:00, and then feeding using bloodworms at 17:00. In contrast, in treatment D was fed bloodworms at 08:00 and 12:00, and then feeding using commercial feed at 17:00.

Container Preparation

The containers used were 12 aquariums measuring 40 x 30 x 30 cm^3. Before use, the aquariums were cleaned of adhering dirt using a sponge and clean water. After cleaning, the aquarium was dried for 24 hours. Then, each aquarium was filled with water with 25 L of water. After the water was filled, a bio-foam filter unit was placed in the middle of the aquarium, complete with an aeration installation.

Test Fish Preparation and Acclimatization

The fish used were the electric blue variety of ramirezi, which were 3 months old and had never spawned. The fish used came from ornamental fish cultivators in the Bogor area. Before being given treatment, the fish must be adapted to the new environmental conditions. Adaptation was done by keeping the fish for seven days in an aquarium container measuring 40x30x30 cm^3 with a working volume of 25 L. One hundred twenty fish were used, with 10 fish in each aquarium. The average weight of the test fish used was 0.503 ± 0.140 g and an average length of 3.3 ± 0.1 cm.

Rearing of Test Fish

The feeding frequency was three times daily during the rearing period of the test fish at 08.00, 12:00, and 17:00 local time. The feed given was in the form of test feed according to each treatment with the ad satiation feeding method. The test feed used was commercial feed in the form of pellets (Tetrabits) containing 47.5% protein and natural feed (frozen bloodworms). Every day at 10:00 local time, siphoning of the aquarium is carried out only to suck up fish waste to maintain the water quality of the maintenance container.

Spawning

After 45 days of rearing, the broodstock selection process is carried out to pair the healthy broodstocks for spawning. The broodstock selection process was carried out using ramirezi broodstocks with an average length of 3.9 ± 0.1 cm and an average weight of 1.65 ± 0.49 g. The selected broodstocks were put together in a spawning container, an aquarium measuring 40 x 30 x 30 cm^3 with a working volume of 25 L. The parent spawning ratio is 1:1. Spawning was done naturally in the aquarium by placing a shelter as a pipe. The substrate was placed in the corner of the aquarium.

Experimental Parameters

The parameters observed in this study were absolute length growth, absolute weight growth, length-weight relationship, survival rate, percentage of mature gonads, egg diameter, number of eggs produced, degree of fertilization, and degree of hatching. The zootechnical variables, weight gain (Δw) was measured or calculated at the beginning and end of the experiment by subtracting the initial weight from the final weight. Furthermore, the analysis of the length-weight relationship of fish aimed to determine the growth pattern using length and weight parameters. The equation used to analyze the relationship between length and weight was the constant multiplied by the length raised to the power of the constant. The SR was the percentage of the number of fish that survived at the end of the rearing period compared to the initial stocking number. The percentage of mature gonads referred to the ratio of mature fish with gametes to the total number of fish. The calculation of egg diameter was carried out twice by taking 10 eggs per treatment, which were observed and measured under a microscope equipped with 40x magnification using a micrometer. The total number of eggs produced in ramirezi spawning was calculated based on the number of eggs attached to the spawning substrate. The fertilization rate was determined by the ratio of the number of fertilized eggs to the total number of eggs produced. The hatching rate was determined by the ratio of the number of hatched eggs to the number of fertilized eggs.

Data Analysis

Quantitative parameter data observed in the form of absolute weight growth, absolute length growth, survival rate, percentage of mature gonads, and egg diameter were tabulated using Microsoft Excel 2016 and analyzed statistically with analysis of variance (ANOVA). A regression function statistically analyzed the relationship between fish length and weight. If it was significantly different, further testing was conducted using Duncan's test with a 95% confidence level and it was used for multiple comparisons among treatments if the assumptions were met (Levene's and Shapiro-Wilk tests). If the assumptions weren't met (Levene's and Shapiro-Wilk tests), so used normalization by substansial positive skewness. Furthermore, the qualitative parameter data in the form of the number of eggs produced, the degree of fertilization, and the degree of hatching were analyzed descriptively.

RESULTS AND DISCUSSION

Based on the preliminary test conducted using a total of 30 fish, the response of the test fish to the feed given was less responsive. It is suspected that ramirezi does not like this feed, so looking for other feed to support ramirezi growth and reproduction is necessary. Then, the results of observations of ramirezi spawning found that the 5-month-old ramirezi broodstock could spawn. In this spawning activity, it is known that the female parent had mature gonads, which the female parent has been able to lay eggs, and the male parent did not have matured gonads, indicated by unfertilized eggs. It is presumably due to spawning, which is done naturally, where sometimes the male and female parents do not have the same gonadal maturity.

Table 1 presents the results of observations of ramirezi growth in length, absolute weight, and survival rate. The highest absolute length growth was observed in treatment D, 0.67 ± 0.15 cm, followed by treatment B, 0.57 ± 0.15 cm, treatment A, 0.53 ± 0.35 cm, and treatment C, 0.57 ± 0.10 cm. The analysis of variance (ANOVA) showed that different feeding treatments had no significant effect on the absolute length growth of prospective ramirezi broodstock ($P>0.05$).

The absolute length growth shown in this growth study differs from the results of previous studies. According to Budianto *et al*. (2019) ramirezi could result in a length growth of 13.78%. This difference is because the ramirezi reared in this study were generally ramirezi already in the brood-to-parent phase, so the increase in length did not appear specific compared to ramirezi in the larval phase. Apart from that, the management of feeding is different, and in general, fish growth is influenced by internal and external factors (Arditya *et al*., 2019).

The highest absolute weight growth value of ramirezi was found in treatment D of 1.27 ± 0.08 g, followed by treatment C of 1.26 ± 0.09 g, treatment B of 1.11 ± 0.03 g, and treatment A of 0.95±0.22 g. The analysis of variance (ANOVA) showed that different feeding treatments significantly affected the absolute weight growth of prospective ramirezi broodstock ($P<0.05$). Treatment A was significantly different ($P<0.05$) from treatments B, C and D, while treatment C was not significantly different ($P>0.05$) from treatment D but significantly different ($P<0.05$) from treatment A and treatment B.

The results showed that the ratio of the combination of artificial feed and bloodworms (1:2) could produce higher absolute weight growth than fish only given bloodworms. It can be concluded that fish only given bloodworms twice a day can increase their weight growth. Reducing the frequency of administration of bloodworms is efficient. In addition, fish can use this feed combination properly, and there is no leftover feed in the rearing container. The effect of a combination of natural feed and artificial feed was reinforced by the study performed by Subandiyah & Satyani (2003), which stated that the combination of natural feed and artificial feed had a significant effect on absolute weight, growth rate, and survival of red lurik tilan ornamental fish (*Mastacembelus erythrotaenia*). The experiment conducted by Amriawati (2020) also showed that giving a combination of artificial and natural feed can increase the growth and survival of gourami.

The absolute weight growth value of ramirezi, which was only given artificial feed, was the lowest compared to other treatments. This can be seen directly during the study when the ramirezi were only given artificial feed; much leftover feed that was not eaten. It was allegedly because the fish did not like the feed. The low level of feed consumption is also suspected because the feed is only used for the needs of fish life, which results in a low growth rate of fish.

The highest survival value was found in treatment D, which was 90 ± 17.32%. Then, followed by treatment B and treatment C, namely 87 ± 15.28% and 87 ± 11.55%, and the lowest was in treatment A (80 ± 10.00%). The analysis of variance (ANOVA) showed that different feeding treatments had no significant effect on the survival of prospective ramirezi broodstock ($P>0.05$). High production results are obtained from the percentage of fish survival obtained. The survival value obtained from all the different feed combination treatments showed a high survival potential of around 80-90%. It is because the study used a low stocking density so that there were not many fish in the aquarium which could reduce competition for space to get the feed given. In addition, water conditions during the rearing period were also good in supporting the survival of ramirezi because siphoning was carried out daily to reduce high ammonia levels caused by uneaten feed and feces.

Furthermore, from the length and weight parameters, fish growth patterns can be identified by analyzing the relationship between length and weight. The length-weight relationship of fish aims to determine growth

Table 1. Growth and survival rate of ramirezi (*Microgeophagus ramirezi*) at four treatments using a combined ratio of artificial feed to bloodworms for 45 days.

Treatments	Length (cm) (Mean ± SD)	Weight (g) (Mean ± SD)	Survival rate (%) (Mean ± SD)
A (3:0)	$0.53 \pm 0{,}35^{a}$	$0.95 \pm 0{,}22^{a}$	80 ± 10.00^{a}
B (0:3)	$0.57 \pm 0{,}15^{a}$	$1.11 \pm 0{,}03^{b}$	86 ± 15.28^{a}
C (2:1)	$0.50 \pm 0{,}10^{a}$	$1.26 \pm 0{,}10^{c}$	86 ± 11.55^{a}
D (1:2)	$0.67 \pm 0{,}15^{a}$	$1.27 \pm 0{,}08^{c}$	90 ± 17.32^{a}

Note: Four treatments using a combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2. Different superscripts in the same column indicate significantly differences at a confidence level of 95% ($P<0.05$).

patterns using length and weight parameters. The relationship between the length and weight of ramirezi is presented in Table 2. Based on the analysis of the relationship between the length and weight of ramirezi, it shows a positive allometric growth pattern ($b>3$). The weight gain of ramirezi in each treatment was higher than the increase in length which indicated the condition of the fish being fatter (rounded body posture). Allometric growth is temporary, for example, due to changes related to gonadal maturity. The growth of fish expressed from the b value can be caused by several factors, such as differences in age, gonadal development, sex, habitat conditions, stomach fullness, food availability, water quality in the rearing environment, and the ability of fish to swim actively or passively (Ogunola *et al*., 2018).

The growth of ramirezi at the end of rearing is accompanied by ramirezi that begin to show the characteristics of mature gonads. Observations of gonadally mature broodstock based on morphological characteristics can be shown in Figure 1. Observations of gonadally mature broodstock were made by observing the body morphology of ramirezi every 15 days. This observation was done by observing body morphology and the color of the fins and urogenital. At the beginning of the study, ramirezi did not show the characteristics of mature gonads and could not be distinguished between males and females. On the day 30 of the rearing period, the male began to show characteristics of mature gonads, such as the color of the front dorsal fin becoming elongated and black, the color of the body, and the abdomen turning bluer. In female parents, the abdomen was pink and the urogenital protrudes and was yellow, indicating that the fish was starting to mature gonads.

Figure 2 shows that the best percentage of gonadal mature broodstock was shown by treatment D; gonad maturation occurred on day 30 with a percentage of 40% and on day 45 with a percentage of 40%. In treatment B, the gonads also started to mature on day 30 as much as 30% and on day 45 as much as 40%. Treatment C of gonad maturity also started to occur on day 30 as much as 20% and on day 45 as much as 20%. In treatment A, there were no gonadal mature parents until the end of the study. The analysis of variance (ANOVA) showed that different feeding treatments had no significant effect on the percentage of gonad maturity in prospective ramirezi broodstock ($P>0.05$).

Based on the study results, treatment D stimulated more gonad maturity than treatments A, B, and C from day 30 to day 45. It is presumably due to the time of administration and the high nutritional content of the feed given in sufficient quantities and nutrients for the maturation of ramirezi gonads. According to Pantoni *et al*. (2022), the high nutritional content of bloodworms causes the gonads to mature faster in fish. Several studies had shown that tubifex worms also contained high amounts of fatty acids along with their protein content. Fatty acids are needed for the

Table 2. The length-weight relationship and growth pattern of ramirezi (*Mikrogeophagus ramirezi*) at four treatments using a combined ratio of artificial feed to bloodworms for 45 days

Treatments	Equation $W = aL^b$	a	b	R	Growth pattern
A (3:0)	$W = 0.0056L^{4,1907}$	0.0056	4.1907	0.6575	Positive allometric
B (0:3)	$W = 0.002L^{4,9805}$	0.0020	4.9805	0.6517	Positive allometric
C (2:1)	$W = 0.0013L^{5,3332}$	0.0013	5.3332	0.6113	Positive allometric
D (1:2)	$W = 0.0023L^{4,8094}$	0.0023	4.8094	0.7300	Positive allometric

Note: Four treatments using a combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2. a: constanta, b: coefficient of regression, R: coefficient of determination.

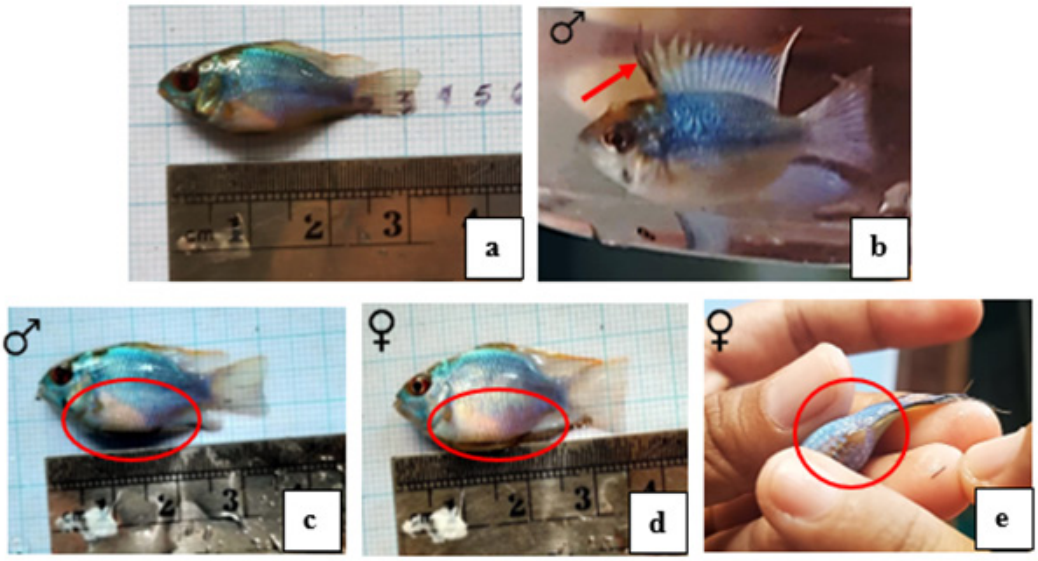

Figure 1. Visual observations of gonad matured ramirezi broodstock: (a) research start (b) ramirezi male at the end of the research with a black elongated front dorsal fin (c) ramirezi male with a bluer body and belly (d) ramirezi female with a pink belly (e) prominent and yellow urogenital.

reproductive process, both for the formation of the gonads and the maturation of the gonads. During the reproductive process, some energy is used to develop gonads. It was known from this study that to accelerate the maturation of ramirezi gonads, it was not enough to only give bloodworms. There is a need for additional feed for ramirezi for the process of maturation of the gonads. The selected feed must meet several requirements: easy to obtain, cheap price, and good nutritional content, the feed can be used is artificial feed. The high protein and fatty acids in bloodworms and the complete nutritional content of artificial feed can add to the complete nutritional content of the feed. Bloodworms' energy source is protein and fatty acids, whereas artificial feed is obtained from processed products containing high levels of protein and fat.

Similar results were not found in ramirezi that were only given artificial feed, wherein there were no gonadal mature ramirezi in the same time span. It is presumably because the feed given had insufficient nutrients for the maturation of ramirezi gonads, so the feed requirement was only used by ramirezi as a necessity of life or activity. According to Agung and Herawati (2018), the slow development of

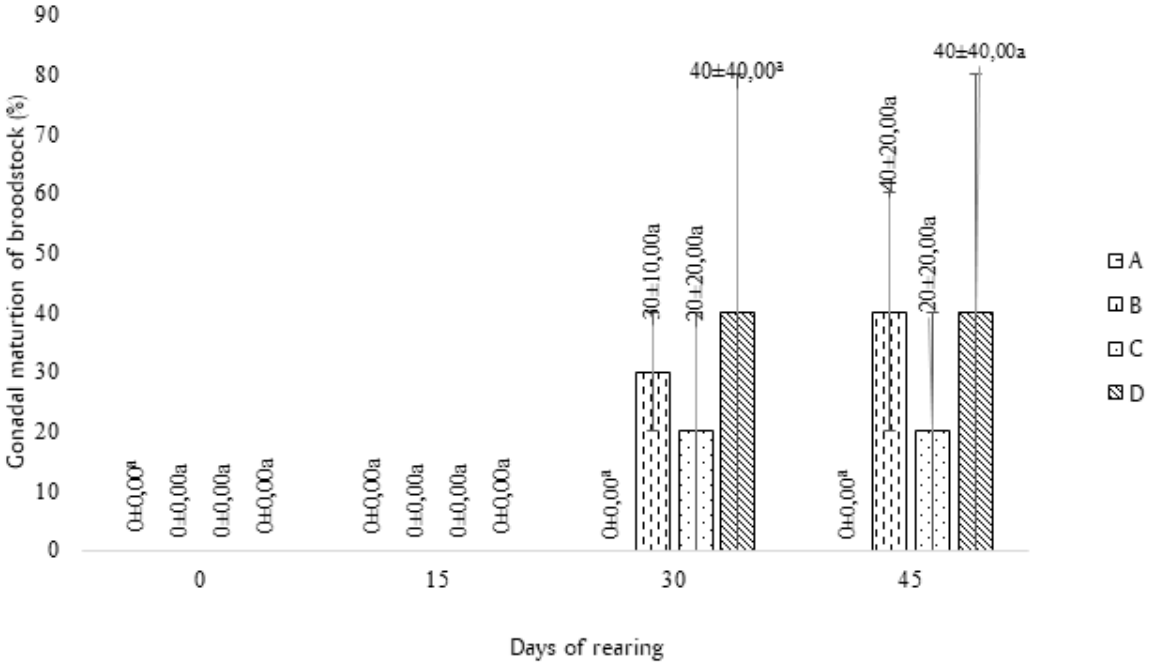

Figure 2. Accumulation percentage of gonadal mature ramirezi broodstock after treatments (combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2)) on day 0 to day 45

Note: The results presented are based on data normalization. Different superscripts in the same days of rearing indicate significantly differences at a confidence level of 95% ($P<0.05$).

the gonads is due to a lack of feed nutrients, which may cause low gonadotropin levels produced by the adenohypophysis gland, poor ovarian response or possible failure of the ovaries to produce enough estrogen.

The gonadal mature broodstocks were then evaluated for reproductive parameters, such as egg diameter, fecundity, degree of fertilization, and hatching rate (Table 3). Based on the results, treatment A did not produce eggs and the egg diameter value was 0 ± 0.00 mm. The mean value of egg diameter in treatment B was 1.73 ± 0.1319 mm, in treatment C was 1.73 ± 0.07 mm, and in treatment D was 1.73 ± 0.09 mm. The results of the ANOVA test showed that different feedinf treatments had a significant effect on ramirezi egg diameter ($P<0.05$). Treatment A differed significantly from treatments B, C, and D, while treatments B, C, and D were not significantly different from each other. According to Coleman and Galvani (1998), the diameter of ramirezi eggs ranges from 0.9-4.5 mm.

Egg diameter increases with increasing gonadal maturity level. The higher the maturity of the gonads, the larger the diameter of the egg in the ovary. Egg diameter is affected by food supply in female fish metabolism (Wicaksono *et al*., 2016).

In addition to egg diameter, a related parameter is the number of eggs produced (fecundity). The value of the number of eggs during the study was known to fluctuate in number. Treatment D produced more eggs than treatments A, B, and C, as many as 189 eggs. According to Keivany and Daneshvar, 2015, the number of Iranian cichlid *Iranocichla hormuzensis* (the same family as Cichlid) eggs produced in one spawning ranges from 48-167 eggs. The high number of eggs produced in treatment D was likely due to the completeness of nutrition in treatment D. The appropriate combination of feed can influence the number of eggs produced. According to Sidhartha *et al*. (2016), the amount and quality of the

Table 3. Fecundity, egg diameter, fertilization rate, and hatching rate of ramirezi after treated combined ratio of artificial feed to bloodworms (*Chironomus* sp.) for 45 days

Treatments	Fecundity (eggs)	Egg diameter (mm)	Fertilization rate (%)	Hatching rate (%)
A (3:0)	0	$0 \pm 0{,}00^{a}$	0,00	0,00
B (0:3)	147	$1{,}73 \pm 0{,}13^{b}$	93,88	90,58
C (2:1)	87	$1{,}73 \pm 0{,}07^{b}$	90,80	81,01
D (1:2)	189	$1{,}73 \pm 0{,}09^{b}$	96,83	91,80

Note: The results presented are based on data normalization. Four treatments using a combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2. Different superscripts in the same column indicate significantly differences at a confidence level of 95% ($P<0.05$).

feed greatly influenced the number of eggs produced by the broodstock. A combination of quality and adequate feed will affect the success of gonadal maturation, spawning, egg quality improvement, and fecundity. The parent's spawning frequency also influences the number of eggs produced. Fish spawning for the first time have fewer eggs than fish spawning several times (Sarumaha *et al*., 2016). In treatment A did not produce eggs at all. It was due to the absence of gonad mature parents, where the feed requirement was used only for the necessities of life (maintenance).

The fertilization process in fish occurs due to the entry of spermatozoa into the egg through the microfil holes found in the chorion layer. From the results of the study, it was shown that treatment D had the highest degree of fertilization compared to the other treatments at 96.83%. According to Hata *et al*. (2012), the degree of fertilization in Cichlid fish ranges from 90-96%. The degree of fertilization in treatment D had a good value presumably because the combination of natural feed and artificial feed had nutrients that were important for enhancing the development of egg morphology in the formation of cell membrane structures as well as prostaglandin precursors so that the eggs were not susceptible to damage. According to the study by Burmansyah *et al*. (2013), the degree of fertilization is also influenced by egg and sperm quality factors.

The degree of hatching occurs due to the embryo's ability to continue to develop in embryogenesis until the embryos hatch or become larvae. It is known from the results that treatment D has the highest degree of hatching value compared to other treatments at 91.80%. This value had good results. It agrees with the statement of Kusrini *et al*. (2021) that the hatching rate of eggs from good parent spawning ranges from 60% - 90%. The high value of the hatching rate is influenced by the quality of the broodstock, complete feed nutrition (supporting gonad maturity), and good egg handling. This condition is consistent with the degree of fertilization because the degree of hatching is strongly influenced by the degree of fertilization unless there are environmental factors that influence it. Furthermore, the resulting larvae were then reared with their parents. However, the next day, it was used up or eaten by the parents so that that the larvae were reared separately from their parents in other treatments were successful in producing larvae. It was presumably because the ramirezi broodstocks used were the broodstocks that experienced the mature gonads or spawned for the first time so the parents were not reared with the larvae in the same place. The parents' spawning frequency also influences the parents' behavior towards the larvae. For fish spawning for the first time, the parent's behavior tends to be stressful or not used to the larvae compared to fish spawning several times (Fahmi *et al*., 2021).

CONCLUSION

The application of a combination of artificial feed and bloodworm in a 1:2 ratio can be utilized by ramirezi broodstock with the consideration of its ability to enhance absolute weight gain. It was also able to produce the percentage of broodstock that matured faster and had the highest effect on ramirezi egg diameter and reproductive performance due to the quality of the broodstock, complete feed nutrition (supporting gonad maturity), and good egg handling.

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