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EVALUATION OF SPAWNING IN ASIAN REDTAIL CATFISH *(Mystus Nemurus)* BROODSTOCK FED WITH GOLDEN APPLE SNAIL *(Pomacea Canaliculata)*

Evaluasi Pemijahan Induk Ikan Baung (*Mystus nemurus*) Yang Diberi Pakan Keong Mas (*Pomacea canaliculata*)

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ABSTRACT

This study aimed to evaluate the impact of feeding golden apple snails (Pomacea canaliculata) on the growth and development of gonad in Asian Redtail Catfish (Mystus nemurus) broodstock. The background of this research is the declining of Asian Redtail Catfish fish population in the wild due to over-exploitation, thus there is a need for an effective culture strategy, especially from the aspect of nutrition of the broodstock. Golden apple snails were chosen as alternative feed because of their high nutrient content as well as their abundance and economic. The research was done experimentally with two treatments: the first group was fed golden apple snails, and the second group was as a control, given pellet. The parameters observed were egg diameter, fecundity, fertilization rate (FR), hatching (HR), larval survival (SR), and water quality during three months of maintenance. The result indicated that snail food significantly increased reproductive performance. The snail group has average fecundity higher (130,678 eggs) than the control (91,025 eggs), with values of FR (92%), HR (87%), and SR (79%) better than the pellet group. The egg diameter was also bigger (2.01 ± 0.14 mm vs. 1.61 ± 0.04 mm), which means that the eggs were of better quality. It is concluded that the snail is an effective alternative feed for Asian Redtail Catfish reproduction, which is supported by the protein, fat, and essential amino acids content. This research recommends the use of snail in Asian Redtail Catfish broodstock culture, and moreover, further study is needed to decide the dose and the best feeding strategy.

Key words: Egg Diameter, Fecundity, Asian Redtail Catfish, Golden Apple Snail, and Survival Rate.

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi dampak pemberian makan keong mas (*Pomacea canaliculata*) terhadap pertumbuhan dan perkembangan gonad pada calon induk ikan baung (*Mystus nemurus*). Latar belakang penelitian ini adalah menurunnya populasi ikan baung di alam liar akibat eksploitasi yang berlebihan, sehingga perlu adanya strategi budidaya yang efektif, terutama dari aspek nutrisi induk. Keong mas dipilih sebagai pakan alternatif karena kandungan nutrisinya yang tinggi serta kelimpahan dan ekonomisnya. Penelitian dilakukan secara eksperimental dengan dua perlakuan: kelompok pertama diberi makan keong mas, dan kelompok kedua sebagai kontrol, diberi pelet. Parameter yang diamati adalah diameter telur, fekunditas, laju pembuahan (FR), penetasan (HR), kelangsungan hidup larva (SR), dan kualitas air selama tiga bulan pemeliharaan. Hasilnya menunjukkan bahwa pemberian keong mas secara signifikan meningkatkan kinerja reproduksi. Kelompok keong mas memiliki fekunditas rata-rata lebih tinggi (130.678 butir) dibandingkan kontrol (91.025 butir), dengan nilai FR (92%), HR (87%), dan SR (79%) lebih baik daripada kelompok pelet. Diameter telur juga lebih besar (2,01 ± 0,14 mm vs. 1,61 ± 0,04 mm), mencerminkan kualitas telur yang lebih baik. Disimpulkan bahwa keong mas adalah pakan alternatif yang efektif untuk reproduksi ikan baung, yang didukung oleh kandungan protein, lemak, dan asam amino esensial. Penelitian ini merekomendasikan keong mas dalam budidaya induk ikan baung, serta perlunya studi lanjutan untuk menentukan dosis dan strategi pemberian pakan yang optimal.

Kata Kunci: Diameter Telur, Fekunditas, Ikan Baung, Keong Mas, dan Sintasan.

INTRODUCTION

The catfish (*Mystus nemerus*) is a freshwater fish species with high economic value. It can be found in flowing waters such as rivers, swamps, and reservoirs. Although found in various regions of Indonesia, catfish consumption is highest in Sumatra.

The increasing demand for catfish seeds, both in quality and quantity, can be met by increasing the productivity of broodstock gonads. Efforts to produce superior broodstock include broodstock selection, proper maintenance, and regular health monitoring. External factors such as water quality, feed availability, and disease also affect fish survival (Heriyati *et al*., 2023). Increasing protein in feed can increase gonad productivity (Rasyidi *et al*., 2023).

Protein Protein and fat are the dominant nutrients that significantly influence the gonad maturity of Sangkuriang catfish (*Clarias gariepinus*) broodstock, with the supporting role of vitamin E as an antioxidant and minerals as enzymatic cofactors in reproduction (Rasyidi *et al*., 2023). Gonad maturity is a specific phase in gonad development before and after spawning, including two stages: gonad development from hatching to adulthood and gonad maturation.

Golden apple snails, as a pest of rice plants, apparently have high nutritional value so they can be used as an alternative fish feed. The nutritional content of golden apple snails is known to contain omega 3, omega 6 and omega 9 acids, so their use is very good for feed for freshwater fish such as tilapia (Edo *et al*., 2019). Snails are rich in protein, but low in fat so they can be used as an alternative feed for tilapia (Yuga *et al*., 2023). The use of golden apple snails as fish feed is not only beneficial in terms of nutrition, but can also help control the population of golden apple snail pests in waters. In research (Miptah *et al*., 2024) golden apple snails have the potential to be a raw material for making fish feed because they have a protein content of 26-54%. The purpose of this study was to determine the egg diameter, fecundity, Fertilization Rate (FR), Hatching Rate (HR), Survival Rate (SR).

RESEARCH METHODS

Time and Place

This research was conducted at Mujiono Farm, a catfish hatchery located on Jl. Letjend Soeprapto, Mulyojati, Metro Barat District, Metro City, Lampung. The research was conducted from September to December 2024.

Tools and materials

The tools used in this study include: female broodstock maintenance pond, male broodstock maintenance pond, paranet, skopnet, pH meter, thermometer, test kit, aerator, scales, spawning pond, syringe needle, kakaban, aquarium. While the materials used are: female and male catfish, commercial floating feed with 31% protein content, ovulation hormone (ovagold), golden snails.

Research Procedures

Treatment and Experimental Design

This study used two treatments and three replications. The female broodstock were fed with golden apple snails and pellets during the rearing period. This research expanded on a previous study on the effect of fresh golden apple snails on gonad productivity in Sangkuriang catfish (Rasyidi *et al*., 2023), which was then applied to catfish. The male broodstock were fed with pellets. Fish spawning was carried out semi-artificially for three cycles.

1. Treatment A: feeding the female parent using golden apple snails
2. Treatment B: feeding the female parent using pellets

Preparation of the Maintenance Container for Prospective Broodstock

The maintenance media for prospective broodstock in this study used an outdoor system consisting of two ponds for maintaining prospective female broodstock measuring 4 × 4 × 0.8 meters (each as a treatment and control) and one pond for maintaining prospective male broodstock measuring 6 × 3 × 2 meters.

Selection and Maintenance of Prospective Parents

The catfish (*Mystus nemurus*) broodstock used in this study were selected based on specific physiological criteria: a minimum age of 1.5 years for females and 1 year for males, in good physical condition, with a proportional body, no defects, and exhibiting good motor activity. The prospective broodstock were obtained from the Sukabumi Center for Freshwater Aquaculture (BBPBAT) and reared semi-intensively for 90 days until they reached optimal gonad maturity.

Males are characterized by a relatively longer and slender body shape, especially in the abdomen when viewed from above, as well as elongated genitalia and aggressive movements. Meanwhile, females can be identified by the presence of a clear urogenital opening, a bulging abdomen when viewed from above, and the ability to release eggs during gentle stripping, indicating physiological readiness for spawning.

Water quality management involves changing the pond water once a week and measuring water quality parameters twice daily, in the morning and evening. Monitored parameters include temperature, pH, and ammonia levels, to ensure environmental conditions remain supportive of the development and health of the broodstock throughout the rearing period.

Feeding

During the rearing period, the male broodstock were fed 300 grams of commercial pellets per day. Meanwhile, the female broodstock were fed *ad libitum* twice a day, in the morning and evening. The difference between the amount of feed given and the remaining feed was calculated to determine the total feed consumed during the rearing period of the female broodstock.

Preparation of Spawning Container

The spawning media used were two 2 x 2 meter concrete pools with a water level of 50 cm. The bottom of the pools was filled with spawning substrate, akaban, arranged evenly to stimulate the fish's natural spawning behavior. The spawning pools were aerated to maintain oxygen levels 24/7.

Injection Preparation

The spawning of catfish was carried out in 3 spawning cycles using a semi-artificial method, the dosage of female parent was 0.6 ml/Kg and male 0.5 ml/Kg Rasyad *et.al*., (2023). The hormone used for artificial spawning of catfish parent Salmon *Gonadotropin Releasing Hormone* (SGnRHa) or which has the trademark Ovagold.

$$\frac{\text{Fish weight}}{1.000} \times 0{,}6 \text{ (female) atau } 0{,}5 \text{ (male)}$$

Ovagold hormone induction was injected intramuscularly into the dorsal region. A 1:1 male:female spawning ratio was placed in a 2x1x1 m^3 spawning tank. The spawning process took place naturally, with eggs observed until they hatched after 24 hours at a water temperature of 28±1°C. Evaluation was carried out by reweighing the female parent after spawning to calculate fecundity.

Egg Maintenance

The hatching media used 20 aquariums (100 × 40 × 35 cm) equipped with a substrate in the form of kakaban, installed 10 cm below the water surface. Catfish eggs were hatched intensively in a controlled aquarium with aeration and dim lighting. Monitoring was carried out every 6 hours until hatching (24–36 hours), with analysis of egg mortality and larval abnormalities as indicators of success. Larvae were maintained in an aquarium (100 × 40 × 35 cm) with a density of ±35 individuals/L. Feeding in the form of fine *Tubifex sp*. (5–10% biomass/day) began on the 3rd day. Monitoring of larval development was carried out every 6 hours.

Female Parent Recovery

After spawning, the catfish broodstock enter a recovery phase, which aims to restore the broodstock's physiological condition after reproduction. This phase not only serves as a recovery period but also plays a crucial role in stimulating the growth and maturation of gonads, both egg and sperm, to prepare the broodstock for the next reproductive cycle. This phase is maintained in semi-intensive ponds, with a maintenance period of one month after spawning.

Observation

Egg Diameter

Egg diameter was observed using the cannulation method on female broodstock by taking samples using a catheter to obtain eggs without damaging the gonads. The diameter of

the obtained egg samples was measured using a paper block to determine the 1 mm interval scale and measured using the ImageJ application. Measurements were repeated three times for each sample to minimize errors. Measurements were carried out randomly on three eggs from each individual fish to obtain representative data.

Fecundity

Fekunditas The fecundity of catfish can be calculated using the formula, according to (Cahyanurani *et al*., 2023) as follows:

$$F=\left(\frac{G}{Q}\right) x\ X$$

F = total fecundity (eggs)
X = Number of eggs in gonad sub-sample (grain)
Q = Gonad subsample weight (g)
G = Gonad weight (g)

Fertilization Rate (FR)

The degree of fertilization (FR) is calculated 4 hours after fertilization. The degree of fertilization is calculated using the formula according to (Cahyanurani *et al*., 2023).

$$FR\ (\%) = \frac{\text{Number of fertilized eggs}}{\text{Total number of eggs}} \times 100$$

Information:
FR = Egg hatchability (%)

Hatching Rate (HR)

The hatching rate (HR) is observed for 30 hours from fertilization or until the estimated temperature stops showing any more eggs hatching. The number of hatched eggs is then calculated using the formula (Cahyanurani *et al*., 2023):

$$\text{Egg hatchability}\ (\%) = \frac{\text{Number of eggs hatched}}{\text{Number of fertilized eggs}} \times 100$$

Information:
HR = Egg hatchability (%)

Survival Rate (SR)

The SR survival rate refers to the percentage of individuals that survive to the end of the rearing period. The calculation is based on the formula proposed by (Cahyanurani *et al*., 2023), as follows:

$$SR\ (\%) = \frac{Nt}{No} \times 100$$

Information:
SR = Life sustainability (SR)
Nt = Number of fish larvae surviving at the end of maintenance (tail)
No = Number of fish larvae alive at the start of maintenance (tail)

Water Quality

Water quality is one of the factors influencing the successful rearing of potential catfish broodstock. The main parameters that must be monitored include temperature, pH, and ammonia. Water temperature is measured using a thermometer, immersed for 1 minute, until a stable reading is obtained. To measure pH, a digital pH meter is dipped directly into the rearing medium and then read on the digital display. Ammonia levels are measured using a TAN test kit.

Data analysis

Observational data were analyzed using analysis of variance (ANOVA) with a 95% confidence level. If there was a significant difference between treatments ($P<0.05$), further analysis was performed using the Tukey test.

RESULTS

Egg Diameter

The results of measuring the diameter of catfish eggs can be seen in Figure 1 below.

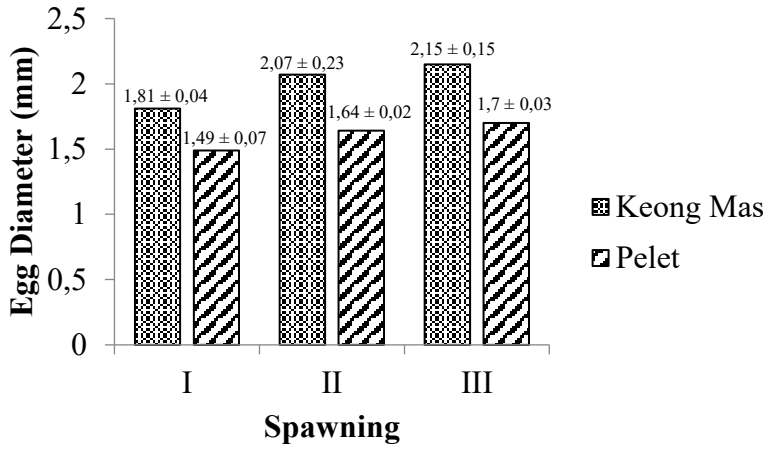

Figure 1. Diameter of catfish eggs

The results of this study showed that the average diameter of broodstock eggs fed with golden snails was 2.01 ± 0.14 mm, while the treatment using pellets was 1.61 ± 0.04 mm, which was higher than the findings (Rasyidi *et al*., 2023) in catfish fed with golden snails (1.45 mm) and the results (Suhenda *et al*., 2016) in catfish without treatment (1.75 mm).

Fecundity

Samples taken during three spawning cycles showed that feeding the golden apple snails significantly increased the number of eggs. The average number of eggs obtained per gram of sample was around 586.

Table 1. Fecundity of catfish eggs

Spawning	Female Parent Weight (grams)				Gonad Weight (grams)		Total Eggs (pieces)	
	Pellets		Golden snail		Pellets	Golden snail	Pellets	Golden snail
	Beginning	End	Beginning	End				
I	959	811	1.040	819	148	221	86.728	129.506
II	967	810	1.079	841	157	238	92.002	139.468
III	1.019	858	1.070	860	161	210	94.346	123.060

These results indicate that feeding golden apple snails as feed has a positive effect on gonad development and fecundity of catfish compared to commercial pellets. Based on data analysis, golden apple snail-based feed significantly increased fecundity.

Fertilization Rate (FR)

Based on the results, it was found that the broodstock fed with golden snails produced 113,535-129,886 fertilized eggs, from an average total of eggs, while the broodstock fed with commercial pellets only produced 77,014-82,166 eggs. These results are seen in the percentage in the figure, indicating that the provision of golden snail-based feed has a better effect on the success of egg fertilization compared to commercial pellet feed.

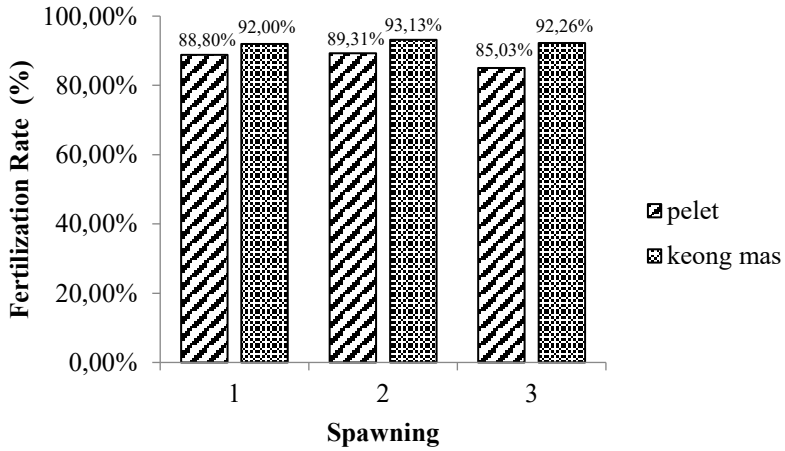

Figure 2. Fertilization of catfish

Broodstock fed golden apple snails had a higher fertilization rate than broodstock fed commercial pellets. These results indicate that feeding golden apple snails has a positive effect on the fertilization rate of catfish eggs.

Hatching Rate (HR)

Broodfish fed with golden apple snails produced 97,072 - 110,532 larvae from an average of fertilized eggs, while broodfish fed with commercial pellets produced an average of 62,381 - 68,444 larvae. This data can be seen in Figure 3, showing the variation in the number of fertilized eggs and hatched eggs in both ponds fed with golden apple snails and ponds fed with commercial pellets.

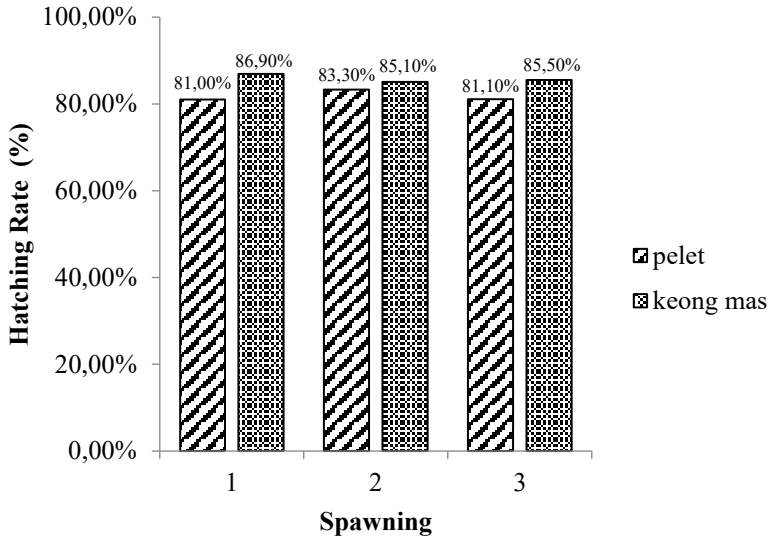

Figure 3. Hatchling rate of catfish

Based on data analysis, broodstock fed golden apple snails significantly increased egg hatching rates, with the essential nutrient composition of the golden apple snails suspected to be a determining factor in the increased egg quantity. These results indicate that feeding golden apple snails has the potential to positively impact the hatching rate of catfish eggs.

Survival Rate (SR)

The broodstock fed with golden snails produced 72,736-89,088 hatched eggs, while the broodstock fed with commercial pellets produced 47,846-52,770 eggs. These data show variations in the number of live larvae in both the ponds fed with golden snails and the pond fed with commercial pellets. The results of SR measurements in the broodstock fed with golden snails and commercial pellets based on observations of the spawning cycle can be seen in Figure 4.

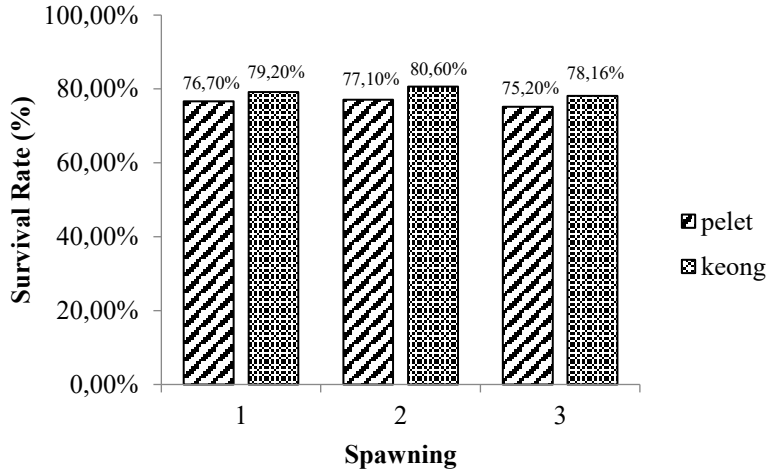

Figure 4. Survival of catfish larvae

The percentage of broodstock fed with golden snails was 78.16 - 80.60% of the average total larvae that hatched. Broodstock fed with commercial pellets had a larval survival rate of

75.20 - 77.10%. These data show variations in larval survival rates in both groups, with broodstock fed with golden snails having a higher larval survival rate.

Water Quality

The data in Table 2 shows the results of water quality measurements in the catfish maintenance pond with two different types of feed (pellets and snails), which were carried out at 09:00 and 16:00.

Table 2. Water quality of the pond for rearing catfish broodstock

Pool	Temperature (°C)		pH		NH3 (mg/L)	
	09:00	16:00	09:00	16:00	09:00	16:00
Pellets	27–28,5	28–29	7–7,5	7–7,4	< 0,1	< 0,1
Snail	27–28,5	27–30	7,1–7,4	7–7,3	< 0,1	< 0,1
Literatur	24 - 30°C		6.0 – 7.5		< 0.5 mg/L	

The water quality in both broodstock rearing ponds is within optimal limits. Stable water conditions can reduce stress on the broodstock, thereby increasing fecundity and egg quality.

DISCUSSION

Berdasarkan Based on the results of the chemical composition analysis of golden apple snails by (Ghosh *et al*., 2018), it is known that the proportion of essential amino acids reaches 39.7%, while non-essential amino acids make up 60.3% of the total amino acid content. The fatty acid composition shows a dominance of unsaturated fatty acids at 60.5%, exceeding saturated fatty acids which are only 39.5%. In the unsaturated fatty acid fraction, polyunsaturated fatty acids (PUFA) dominate with a higher proportion than monounsaturated fatty acids (MUFA). Meanwhile, the proximate content of boiled golden apple snails includes crude protein (13.67%), fat (0.4%), carbohydrates (4.43%), ash (4.1%), and water content (77.4%) (Pratama *et al*., 2023).

Induk Catfish broodstock require balanced nutrition for reproductive health and gonad development. Protein serves as the primary energy source, tissue builder, and metabolic regulator through enzymes and hormones (Manik & Arleston, 2021). Essential fatty acids (n-6 and n-3) are crucial as raw materials for reproductive hormones and cell membrane formation, with optimal levels of 12-15% to improve gonad quality (Utomo et al., 2006; Utiah *et al*., 2023). Minerals (Ca, Mg, P) and vitamins (C, E) are also required, albeit in small amounts (2-5%), to support metabolism, gonad maturation, and protect cells from oxidative stress (Kingsbury, 1962). Vitamin C, in particular, plays a role in steroid hormone synthesis, and its deficiency can reduce egg quality and fertilization rates (Utiah *et al*., 2007).

Pakan High-fat feeds have been shown to produce larger-diameter eggs in catfish (Suhenda *et al*., 2016). The mechanism involves the high energy availability of fat, which stimulates GnRH secretion in the hypothalamus, thereby triggering the pituitary gland to release gonadotropins for vitellogenesis (Suhenda *et al*., 2016). This process leads to the accumulation of yolk in the oocytes, which increases egg diameter (Utiah *et al*., 2007).

Peningkatan The increase in egg diameter in fish is closely related to the nutritional content of golden apple snail-based feed, which is rich in protein and fat. Unsaturated fatty acids (n-3 and n-6) are essential components that play a role in egg development, cell membrane formation, and the synthesis of bioactive compounds such as eicosanoids, which regulate cell growth and differentiation during embryogenesis (Utomo *et al*., 2006).

Research (Rasyidi *et al*., 2023) shows that golden apple snails can increase gonad productivity in Sangkuriang catfish. Their protein content supports reproductive hormone synthesis and vitellogenesis, while fat serves as an energy source for gonad maturation and egg cell membrane formation. Golden apple snails are also rich in essential fatty acids, vitamin E (an antioxidant), and minerals such as phosphorus and calcium, which are important for fecundity and embryo development (Aryani, 2015). With a balanced feed formulation, fish reproductive success can be significantly improved.

Compared to this study, the fecundity of catfish fed with golden snails was higher. Furthermore, (Cahyanurani *et al*., 2023) reported an average catfish egg production of 89,250 eggs per broodstock weighing 750 grams during semi-natural spawning. This result is still lower than the fecundity of catfish fed with snails. This is in line with several previous studies showing that golden snails can improve fish reproductive quality. Based on research conducted by (Rasyidi *et al*., 2023), data obtained showed that Sangkuriang catfish weighing 400-500 grams produced 41,144 eggs.

Catfish broodstock fed with golden apple snails showed higher FR compared to commercial pellet feed. Snails are rich in essential amino acids such as arginine, leucine, and lysine, which play a role in the synthesis of reproductive hormones (such as GnRH and vitellogenin) and gonad maturation (Suhenda *et al*., 2016). Golden apple snails contain essential fatty acids (n-3 and n-6), prostaglandin compounds in golden apple snails play a role in regulating the process of interaction between sperm cells and egg cells, so that fertilization and early embryo development can take place optimally (Utomo *et al*., 2006). The level of essential fats in golden apple snails plays an important role in the process of embryogenesis, if a lack of fatty acids will be hampered or even fail (cell division 16, 32 and organogenesis) and will result in low fertilization (Utomo *et al*., 2006).

Based on a study (Aryani, 2015) such as essential fatty acids (EPA and DHA), vitamin E, amino acid tryptophan, minerals (zinc and selenium), significantly affect the success of fertilization in fish. Essential fatty acids play a role in maintaining the integrity of sperm and egg cell membranes, vitamin E. As comparative data, research conducted by (Cahyanurani *et al*., 2023) reported the number of fertilized eggs as many as 80,652 eggs from a total of 89,250 eggs with a FR percentage of 90%.

According to (Suhenda *et al*., 2016), the fatty acids contained in eggs influence the early stages of embryogenesis and ultimately affect the degree of egg hatching. Golden apple snails contain high protein (12.16%) and essential fatty acids, including omega-3 (EPA and DHA), which are crucial for the formation of embryonic cell membranes and larval survival in fish. Furthermore, golden apple snails are rich in powerful antioxidants that protect embryos from oxidative stress during development.

According to a study (Aryani, 2015), fish embryo development is significantly influenced by the nutritional quality of eggs, particularly the content of essential fatty acids (EPA and DHA), which play a role in cell membrane formation and energy sources during embryogenesis. Research conducted by (Cahyanurani *et al*., 2023) reported an egg hatch rate of 84%.

Based on research (Utomo *et al*., 2006), fat and fatty acid content have a significant influence on the reproductive success and survival of fish larvae. This can be attributed to the role of essential fatty acids (EPA) such as linoleic acid and linolenic acid, which cannot be synthesized by fish independently, so they must be met through feed. Research (Utomo *et al*., 2006) is in line with the literature stating that feed quality, especially EPA content, is a critical factor in increasing larval SR. Thus, the use of golden apple snails as a source of fat in catfish larval feed can be a strategy to increase survival up to DOC-14. Essential fatty acids (EPA, DHA, and ARA) in golden apple snails are one of the factors that determine the success of

larval survival, because the fatty acids contained in eggs affect the early stages of embryonesis (Suhenda *et al*., 2016).

Based on research (Aryani, 2015), larval quality is significantly determined by the nutritional composition of the egg yolk and initial feed. Essential fatty acids, particularly DHA and EPA, play a crucial role in the development of the nervous system and larval stress resistance. Research conducted by (Cahyanurani *et al*., 2023) reported that the number of larvae after 14 days of rearing was 51,974 from a total of 80,652 hatched eggs, with a survival rate of 76%.

Based on data obtained from measurements of temperature, pH, and ammonia levels in two types of ponds with different media measuring 4x4x0.5 m3, it can be seen that the environmental conditions of both ponds are still within the range in accordance with the literature. Both temperature ranges are still within the optimal limits according to the referenced literature (Yudha *et al*., 2018), although the snail pond experiences higher temperature fluctuations in the afternoon.

CONCLUSION

The results showed that feeding golden apple snails (*Pomacea canaliculata*) significantly improved the reproductive quality of potential catfish (*Mystus nemurus*) broodstock compared to commercial pellet feed. The group fed golden apple snails produced higher fecundity (an average of 130,678 eggs), Fertilization Rate (FR) of 92%, Hatching Rate (HR) of 87%, and Survival Rate (SR) of 79%. Meanwhile, the control treatment fed with pellets showed a fecundity of 91,025 eggs, FR of 89%, HR of 81%, and SR of 76%. In addition, the egg diameter in the treatment fed with golden apple snails was larger (2.01 ± 0.14 mm) than the pellets (1.61 ± 0.04 mm), indicating better egg quality. Water quality parameters (temperature, pH, ammonia) remained stable and optimal during maintenance. This study proves that golden apple snails are an effective alternative feed in improving the reproductive performance of catfish broodstock.

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