

## A Review of the Potential of Golden Apple Snail (*Pomacea Canaliculata*) as a Raw Material for Aquaculture Feed

Yuli Andriani<sup>1\*</sup>, Rusky I. Pratama<sup>2</sup>, Iis Rostini<sup>3</sup>

Fisheries Department, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran

**Corresponding Author:** Yuli Andriani [yuliyusep@yahoo.com](mailto:yuliyusep@yahoo.com)

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### ARTICLE INFO

*Keywords:* Aquaculture,  
Golden Apple Snail,  
Nutrition, *Pomacea*  
*Canaliculata*

*Received :* 17 May

*Revised :* 18 June

*Accepted:* 20 July

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### ABSTRACT

This review offers a overview of the golden apple snail (*Pomacea canaliculata*) as a potential raw material for aquaculture feed. The taxonomy, anatomy, habitat, life cycle, nutritional composition, and utilization prospects of this freshwater snail species are discussed. The golden apple snail's features, including its conical shell, distinct coloration, and unique respiratory system comprising gills and a lung, contribute to its adaptability and mobility in diverse environments. Its life cycle encompasses egg deposition, hatching, and subsequent growth stages, with reproductive maturity and lifespan influenced by environmental factors. With its significant calcium content and variable protein levels, the golden apple snail holds nutritional value. Consequently, it has gained attention as a promising ingredient for aquaculture feed due to its protein-rich meat

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## INTRODUCTION

The Pomacea genus encompasses around 50 snail species, but their identification has posed challenges, leading to multiple revisions, especially involving biochemical genetic techniques. Approximately 15 of these species, including *Pomacea canaliculata*, exhibit channeled shells. However, *P. canaliculata* is frequently associated with the introduction of Pomacea snails in the Americas and the Indo-Pacific region, although other species might also have played a role (Howells & Smith, 2003). In Indonesia, *Pomacea canaliculata* is known as the golden apple snail, while in English, it is referred to as the "keong mas" or golden apple snail. It is a freshwater snail with a voracious appetite for aquatic vegetation, such as lotus and rice. The golden apple snail was introduced from its native South America to Taiwan in the 1980s, primarily as a food source for people and for commercial purposes (Cowie, 2005).

Until 1990, two prevailing beliefs existed regarding the golden apple snail. One view considered it a nuisance to rice crops, while another recognized its potential as an export item. Nevertheless, golden apple snails have been commonly found on the islands of Java and Sumatra (Suharto, 2003). Farmers often plant rice when the conditions are muddy or water outflow is low, as young golden apple snails are less likely to thrive in such environments (Hamzah, 2003). The golden snail avoids planting areas with messy conditions. If farmers implement an irrigation system that creates stagnant water, the golden snail will seek out these areas. To facilitate their collection and destruction, farmers can construct ditches on the edge of the rice planting area as gathering spots for the golden snail (Suhada, 2019).

## LITERATURE REVIEW

This study employed a literature review as the research method, which involves the examination of academic articles, books, and other relevant materials pertaining to a specific subject, field of study, or theory. The purpose of the literature review was to describe, summarize, and critically evaluate these works. A diverse range of sources, including articles, organizational and government websites, published surveys, reports, and papers, were analyzed to assess the information regarding golden apple snail potential. The search process involved structured keyword searches in multiple databases, such as PubMed, Google Scholar, and various university repositories, covering the period from 1995 to 2022. Source selection criteria focused on scientific research, research articles, theses, and publications in both Indonesian and English to ensure relevance. The findings were subsequently grouped into different categories, including anatomy, habitat, life cycle, nutritional composition of the golden apple snail and its utilization in feed.

## METHODOLOGY

### **Anatomy of Golden Apple Snail**

The golden apple snail is characterized by its conical shell, which typically has 5 to 6 threads and a large, oval to spherical aperture. The body of the snail can display a range of colors, from yellow to a darker brown. Its shell is light brown, while the flesh varies from milky white to reddish-gold or orange. The

size of golden apple snails can be influenced by food availability. Males of this species possess a convex operculum, whereas females possess a concave operculum. The snail's body is connected to the shell through columellar muscles, allowing it to burrow inside for protection. Notably, the golden apple snail exhibits a unique adaptation featuring a set of respiratory organs resembling fish gills, along with a lung positioned along the left side of the snail's body. The latter mentioned unique respiratory system allows the snail to go further in its attempt to look for food. Additionally, the presence of a tubular siphon on the snail's left side aids in breathing while submerged, reducing its vulnerability to predation by birds (Nurrohmah, Wahyuni & Lestari, 2008; Hymann, 1967; Pennak, 1989).

The shell of most Ampullariidae snails is round and cylindrical, having the shell opening on its right side (dextral). The snail's exterior has a variety of forms and curving sutures. The umbilicus, the deep space in the heart of the shell, and the columella, the shell's central axis, are critical for the snail's connection to its exterior. The columellar muscles serve the control of pulling the snail inside the body for protection. This amphibian creature breathes with branched respiratory structures comparable to fish gills and a lung on its left side (Pennak, 1989).

The golden apple snail exhibits unique characteristics and adaptations. Its shell color is determined by pigments in the periostracum layer, and its texture can vary based on growth rate. The snail's operculum serves as a protective door for the shell. The snail uses its sense of scent to discover food and distinguish other snails, thanks to coupled antennae termed latrial palps with receptive tentacles. The eyes detect light direction, while chemical receptors and osphradia in front of the lungs aid in detecting chemicals in water. The snail's mucus secretion facilitates movement by lubricating its foot (Hymann, 1967; Pennak 1989).

The golden apple snail's size can reach up to 10 cm, although aquarium-bred species are typically smaller. Shell coloration ranges from brownish to greenish, often displaying spiral bands. Captive-bred snails have bright golden yellow variants. The body color of the snail can range from black to pale beige. A distinguishing feature is the presence of vibrant pink egg clutches deposited above the water's surface. With these adaptations, the golden apple snail thrives in various environments, utilizing its sensory organs and mucus secretion for movement and survival (Cowie, 2005).

#### **Habitat and Life Cycle**

The golden apple snail is native to Argentina and the Amazon River, and it has been imported to several Asian countries, notably Japan, Indonesia, Vietnam, Taiwan and the Philippines. It can also be found in some parts of America, the Dominican Republic, Papua New Guinea, Hawaii and Guam (Cowie, 2005). The golden apple snail loves clean waters with a muddy surface and many aquatic plants in its natural habitat (Estebenet & Martin, 2002). It flourishes in regions with slow water flow, poor drainage, and water that does not dry rapidly. Because significant amounts of calcium and an alkaline environment are required for shell production, fluids that have elevated carbonate content and pH levels that are alkaline are beneficial to the snail (Pennak, 1989). It can tolerate a pH

range of 5 to 8 and has a temperature tolerance between 14°C and 28°C. However, temperatures above 32°C can have a detrimental effect on the snails, leading to a high mortality rate (Sulistiono, 2007).

The golden apple snail's activity and growth are influenced by temperature. At higher temperatures, the snail exhibits increased eating, movement, and growth rates. Conversely, at lower temperatures, the snails become inactive and sink into the mud. Temperature plays a crucial role in various aspects of the snail's biology, and its growth is highly dependent on temperature conditions (Estebenet & Martin, 2002; Sulistiono, 2007). It is important to note as the golden apple snail may survive in dry soil for up to 6 months, demonstrating its adaptability to many environmental circumstances. Overall, the golden apple snail prefers stable water conditions with suitable temperatures, alkaline pH levels, and sufficient calcium availability for its shell formation (Estebenet & Martin, 2002; Pennak, 1989).

The golden apple snail has a lifespan of up to 4 years, and its reproductive maturity is typically reached between 3 months to 2 years, depending on the environmental temperature (Cowie, 2005). The adult golden apple snail lays eggs on plants, banks, twigs, and occasionally in the water during the early stages of its life cycle. The eggs hatch after 7-14 days, and the recently hatched snails, averaging 1.7-2.2 mm, exit their eggshells and entering the water. Over the next few days, their shells harden, and the young snails, measuring 2-5 mm, start feeding on algae and soft plant parts. The initial growth phase lasts approximately 15-25 days, and by the age of 26-59 days, the golden apple snails exhibit high feeding activity. After 60 days, they become sexually mature and are ready for reproduction, which usually takes place in areas with a constant water supply. Adult golden apple snails have shells with a diameter of about 4 centimeters and weigh between 10-20 grams. The availability of calcium as a shell-forming component influences the formation of their shells, and a nutrient-rich environment promotes the creation of larger, thicker, and stronger shells (Nurrohmah, Wahyuni & Lestari, 2008).

Female golden apple snails tend to grow larger than their male counterparts, and they may also have a higher growth rate. Male and female snails attain the same size at the commencement of reproductive activity in laboratory trials, but male growth stops whereas female snails continued to grow all through their lives. Male snails had a greater survival rate than females, suggesting that the larger stature of females in naturally occurring populations is attributable to their quicker growth rate rather than a superior survival rate. These biomass discrepancies underscore the fact that female snails were larger compared to males of the identical size (Estebenet & Martin, 2002).

## **RESULT AND DISCUSSION**

### **Nutritional Composition**

The golden apple snail has a high calcium content but low phosphorus content, as reported by Sja'bani (2004). These snails are also known to contain omega-3, omega-6, and omega-9 fatty acids, and their protein content ranges from 16 to 50 percent, according to the proximate test conducted by Sulistiono (2007). In addition, Susanto (1995) states that 100 grams of golden apple snail meat provides

approximately 64 kcal of energy, 12 grams of protein, 1 gram of fat, and 2 grams of carbohydrates. The meat also contains various minerals such as phosphorus, iron, and calcium. Table 1 showed a detailed breakdown of the nutritional composition of golden apple snails.

Table 1. Nutritional Content of the Golden Apple Snail Per 100 Grams

<b>Nutrients</b>	<b>Content</b>
Energy	83 cal
Protein	12.2 g
Fat	0.4 g
Carbohydrate	6.6 g
Ash	3.2 g
Phosphor	61 mg
Sodium	40 mg
Potassium	17 mg
Riboflavin	12 mg
Niacin	1.8 mg
Others: Vitamin C, Zn, Cu, Mn and Iodine	trace

### Golden Apple Snail as Feed

The edible golden apple snail meat constitutes only about 18% of the entire weight of live snails. This flesh, having a protein level of about 54% (dry weight), is able to be fed to fish directly or treated into concentrate, comparable to fish meal and related products. When the essential amino acids of golden apple snail meat were compared to those of shrimp flesh, it was discovered that the essential amino acid index (EAAI) of golden apple snail meat is around 0.84, as shown by (Bombeo-Tuburan, Fukumoto, & Rodriguez, 1995). The efficacy of aquaculture feed is dependent on the amino acid profile meeting that of the intended type of fish (Sulistiono 2007).

Golden apple snails can be obtained in large quantities and continuously to meet various needs such as animal feed, fish feed, food ingredients, and medicines. They may flourish in a variety of public waters, have quick growth and reproduction, and are relatively easy to maintain, including in aquaculture ponds (Sulistiono 2007). The use of minced golden apple snail meat as a cost-effective source of protein and calcium has been applied in the development of ducks. Feeding ducks a 10% golden apple snail mixture encourages healthy growth throughout egg-laying time in South Sumatra, Indonesia, and has been proven to boost egg output in ducks by up to 80% in Pasaman, Indonesia. Golden apple snails can also be made into flour for animal feed, which benefits broiler poultry, ruminants, quails, and domesticated fowl. Furthermore, golden apple snails are frequently used as a feed source in the farming of a variety of species of fish, such as *Anguilla* eel, tiger shrimp, crab, carp, snakehead fish, catfish, lobster, and tilapia. (Sulistiono 2007). Table 2 contains a selection of research that have been done to investigate the possible use of the golden apple snail as a good raw material for fish feed.

Table 2. Studies on Golden Apple Snail as Aquaculture Feed

Treatments	Results	References
In Treatment A, the golden apple snail was provided as the sole feed source. Treatment B involved a combination of golden apple snails (50%) and trash fish (50%) in the diet. Treatment C consisted of 100% trash fish feed.	The results indicated that the combination of golden apple snail and trash fish diet did not significantly impact the growth performance and survival rate of mangrove crabs ( <i>Scylla</i> sp.). On the other hand, the feed comprising solely trash fish exhibited the best average growth performance and survival rate for mud crabs. In contrast, the lowest values were observed in the treatment combining trash fish and golden apple snails.	(Harisud, Bidayanti & Syarif, 2019)
In Treatment A, 25% fresh golden apple snail meat was combined with 75% commercial feed. Treatment B consisted of a 50% proportion of fresh golden apple snail meat and 50% commercial feed. Treatment C involved feeding catfish with 100% golden apple snail meat, while Treatment D served as the control with 100% commercial feed.	The highest survival rate was observed in Treatment D, where catfish were exclusively fed with commercial feed. However, the ANOVA test did not reveal any significant effects on Treatments A, B, and C. These results suggest that incorporating fresh golden apple snail meat into the diet of catfish can potentially enhance their growth and feed efficiency.	(Rinaldi & Ridha, 2021)
In Treatment A, the composition consisted of 100% fish meal and 0% golden apple snail flour. Treatment B involved 75% fish meal and 25% golden apple snail flour, while Treatment C consisted of an equal proportion of 50% fish meal and 50% golden apple snail flour. Treatment D comprised 25% fish meal and 75% golden apple snail flour, and Treatment E	The results of the study indicated that Treatment C, with a balanced ratio of 50% fish meal and 50% golden apple snail flour, yielded the best formulation. This formulation demonstrated the highest protein content among all treatments, reaching 34.26%. These findings suggest that incorporating an equal mixture of fish meal and golden apple snail flour can contribute to a higher protein content in the final product.	(Febrianti, 2019)

exclusively utilized 100% golden apple snail flour with no fish meal.	
Treatment A consisted of 0% golden apple snail flour and 100% fish meal, while Treatment B comprised 25% golden apple snail flour and 75% fish meal. Treatment C involved an equal mixture of 50% golden apple snail flour and 50% fish meal, and Treatment D consisted of 75% golden apple snail flour and 25% fish meal.	The inclusion of the golden apple snail mixture in the feed for snakehead fish resulted in favorable growth outcomes for the fish seeds. Among the treatments, Treatment C, with a 50% golden apple snail flour dose, demonstrated the highest growth rate and survival compared to the other treatments. This suggests that incorporating a balanced proportion of golden apple snail flour and fish meal in the feed formulation positively influenced the growth and survival of the snakehead fish. (Khaeriyah, Murni, & Saiful, 2019)
Treatment A consisted of 90% commercial feed and 10% golden apple snail flour, while Treatment B comprised 85% commercial feed and 15% golden apple snail flour. Treatment C involved 100% commercial feed.	According to the research data, incorporating golden apple snail flour ( <i>Pomacea canaliculata</i> ) at a 10% dosage in the diet of juvenile catfish ( <i>Clarias</i> sp.) known as Sangkuriang improved both their growth performance and survival rate. This indicates that the addition of golden apple snail flour positively influenced the growth and overall well-being of the catfish. (Tiyanto, Rahim & Rossarie 2022)

Based on the research findings presented in Table 2, it is evident that utilizing feed based on golden snail is effective for fish. This is demonstrated by the positive growth, efficiency, and survival rate values observed in the fish samples under study. The favorable growth parameters can be attributed to the high nutritional value of golden snail as a feed source. Moreover, the golden snail's entire body can be utilized as a rich source of protein and minerals (Pasambe & Nurhayu 2017). Being an economical and easily obtainable source of protein, fat, and carbohydrates, the golden snail proves to be a suitable substitute for some costly feed ingredients like fish meal (Edo, Duan & Amalo, 2019). Consequently, the golden snail shows great potential as a valuable ingredient in fish feed formulations.

## **CONCLUSIONS AND RECOMMENDATIONS**

The golden apple snail, *Pomacea canaliculata*, is a versatile freshwater snail species with notable characteristics and adaptations. Its anatomy, including the conical shell, respiratory system, and sensory organs, enables it to thrive in diverse habitats. The snail's life cycle involves egg deposition, hatching, and subsequent growth stages, with reproductive maturity reached within a few months to a few years. Environmental factors, particularly temperature, play a crucial role in its development and survival. The golden apple snail's nutritional composition, including high calcium content and protein levels, highlights its potential as a feed ingredient in aquaculture. The snail's meat, although constituting a small proportion of its total weight, can be utilized directly or processed into concentrate for feeding various fish species. Its utilization as a feed source offers economic and nutritional benefits in the aquaculture industry.

## **FURTHER STUDY**

Further research is recommended to explore the nutritional value, processing techniques, and feed formulation strategies for incorporating golden apple snail-derived products into aquaculture feed.



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