

Evaluation of the digestive organs of laying quails fed diets containing golden apple snail (*Pomacea canaliculata*) and *Azolla pinnata* meal

Evaluasi organ pencernaan puyuh petelur yang diberi pakan mengandung tepung Keong mas (*Pomacea canaliculate*) dan *Azolla pinata*

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Abstract. The objective of this study was to evaluate the effects of feed containing Golden Apple Snail (*Pomacea canaliculata*) meal and *Azolla pinnata* meal on the digestive organs of laying quails to determine the safety of using these two feed ingredients. The experiment used a Completely Randomized Design (CRD) with four treatments and five replications, each replication consisting of four laying quails, and from each replication one bird was randomly selected for digestive-organ observation. The treatments were: P0, control feed without Golden Apple Snail or *Azolla pinnata* meal; P1, feed containing 10% *Azolla pinnata* meal; P2, feed containing 10% Golden Apple Snail meal; and P3, feed containing 10% *Azolla pinnata* meal and 10% Golden Apple Snail meal. Data were analyzed using a one-way CRD, and when significant differences were found, Duncan's Multiple Range Test (DMRT) was applied. The results showed that inclusion of 10% Golden Apple Snail meal, 10% *Azolla pinnata* meal, or their combination in the diet of laying quails had no significant effect on the percentage weight of the ventriculus, liver, heart, or intestinal length, and all internal organs appeared normal. These findings indicate that Golden Apple Snail and *Azolla pinnata* are safe to use as alternative protein sources in quail feed.

Keywords: laying quails, golden apple snail, *Azolla pinata*

Abstrak. Tujuan dari penelitian ini adalah mengevaluasi pemberian pakan yang mengandung tepung Keong mas (*Pomacea canaliculate*) dan *Azolla pinata* terhadap organ pencernaan puyuh petelur guna mengetahui tingkat keamanan penggunaan kedua bahan pakan tersebut. Penelitian ini menggunakan metode Rancangan Acak Lengkap (RAL) 4 perlakuan dan 5 ulangan dengan 4 ekor puyuh petelur disetiap ulangan. Setiap ulangan diambil satu ekor secara acak untuk dilakukan pengamatan organ pencernaannya. Perlakuan yang digunakan dalam penelitian ini yaitu: P0 = Pakan Kontrol (tanpa kandungan Keong mas dan *Azolla pinnata*), P1 = Pakan yang mengandung tepung *Azolla pinnata* 10%, P2 = Pakan yang mengandung tepung Keong mas 10%, dan P3 = Pakan yang mengandung tepung *Azolla pinnata* 10% dan Keong mas 10%. Data yang di peroleh dianalisis dengan menggunakan Rancangan Acak Lengkap (RAL) pola searah. Jika didapatkan hasil analisis yang berbeda nyata maka dilakukan uji lanjut *Duncan Multiple Range Test* (DMRT). Berdasarkan hasil penelitian disimpulkan bahwa pemberian tepung Keong mas 10%, *Azolla pinnata* 10% dan kombinasi antara keduanya dalam pakan puyuh petelur tidak memberikan pengaruh yang nyata terhadap persentase bobot organ ventrikulus, hati, jantung dan panjang

usus. Kondisi organ dalam semua perlakuan normal. Hal ini menunjukkan bahwa Keong mas dan *Azolla pinnata* aman untuk digunakan sebagai bahan pakan sumber protein.

Kata kunci: Puyuh petelur, Keong mas, *Azolla pinata*

INTRODUCTION

Providing high-quality animal feed can help increase livestock numbers and boost the production of meat and eggs. Therefore, it is important to explore and use alternative feed ingredients that are affordable, nutritious, and easy to find or produce.

The Golden Apple Snail (*Pomacea canaliculata* L.) is a pest that reproduces very quickly and can cause population outbreaks in a short time. However, it can also be used as an alternative feed because it contains high levels of nutrients: 54% crude protein, 30% carbohydrates, 4–5% fat, and several minerals such as phosphorus, iron, calcium, magnesium, and iodine (Lutfi et al., 2025). *Azolla pinnata* is often thought of as an aquatic weed, but it actually has potential as a feed ingredient for birds such as quail because of its relatively high nutrient content: 23.49% protein, 14.7% crude fiber, 3.7% ether extract, 24.26% total ash, 7.94% acid-insoluble ash, 2.58% calcium, and 0.26% phosphorus (Miranda, 2014).

Both Golden Apple Snail and *Azolla pinnata* contain carotene. According to Dansou et al., (2023), carotene is a type of provitamin A that can deepen the yellow color of egg yolks, which improves consumer appeal and overall egg quality. Carotene reaches the yolk by traveling with lipids that are sent from the liver and then incorporated into the yolk.

The feed given to poultry can also affect their internal organs and digestive system. These organs develop in line with the diet provided, and problems are usually marked by specific changes such as differences in color or size (Kholifah et al., 2025). Measuring internal organs is necessary to determine whether the alternative feed given does not contain toxins and does not inhibit the function of the quail's organs.

Healthy internal organs allow quail to absorb and use nutrients efficiently, which supports good egg production and weight gain. Based on this, the present study was carried out to evaluate the effects of feed containing Golden Apple Snail (*Pomacea canaliculata*) meal and *Azolla pinnata* meal on the digestive organs of laying quails, in order to assess the safety of using these two ingredients.

MATERIALS AND METHODS

Material

This study used 80 laying quails that were seven weeks old. The birds were given the experimental feed for four weeks, with a one-week adaptation period beforehand. Golden Apple Snail and *Azolla pinnata* were processed into meal and mixed with other ingredients—layer concentrate Hi-pro-vite (124P) from PT Charoen Pokphand Indonesia Tbk., oil, premix, rice bran, and corn—until evenly blended. The final feed contained 19% crude protein (CP) and 2,900 kcal/kg metabolizable energy (ME).

Method

The experiment followed a Completely Randomized Design (CRD) with four treatments and five replications, using four laying quails in each replication. From each replication, one bird was randomly selected for observation of its internal organs and digestive tract. The treatments were:

P0 = control feed without Golden Apple Snail or *Azolla pinnata* meal

P1 = feed containing 10% *Azolla pinnata* meal

P2 = feed containing 10% Golden Apple Snail meal

P3 = feed containing 10% *Azolla pinnata* meal and 10% (Tarigan & Manalu, 2019) and Golden Apple Snail meal (Rondonuwu et al., 2018)

To check whether the alternative feed caused no toxicity or harm to the quails' organs, the ventriculus, liver, and heart were weighed using an analytical scale. The percentage of each digestive organ was calculated relative to the bird's live body weight (Khoerudin, 2019). The length of the small intestine was measured with a measuring tape after its contents were removed (Saprinanda, 2021). Before slaughter, the quails were fasted overnight.

Data Analysis

Data collected during the study were analyzed using a one-way CRD, since the experiment involved a single factor with several levels. An Analysis of Variance (ANOVA) was performed, and when significant differences were found, Duncan's Multiple Range Test (DMRT) was used to identify which treatments differed or were similar.

RESULTS AND DISCUSSION

Percentage of Ventriculus

The ventriculus (gizzard) is the organ that grinds the feed, a process assisted by grit. Observations of the percentage of ventriculus weight in quails for each treatment are shown in Table 1.

Table 1. Percentage of ventriculus weight

Treatment	Replication					Average ^{ns}
	1	2	3	4	5	
P0	1.18	1.79	1.97	1.93	2.32	1.83
P1	2.14	2.35	2.67	1.98	1.83	2.19
P2	1.76	2.05	1.77	2.31	1.52	1.88
P3	1.77	1.70	1.82	1.84	2.03	1.83

Note: Superscripts in the table columns indicate no significant difference ($P > 0.05$).

Based on the results of the study, the use of Golden Apple Snail meal and *Azolla pinnata* meal had no significant effect ($P > 0.05$) on the percentage of ventriculus weight. This shows that the crude fiber content of golden snail flour of 0.08% (Suci et al., 2019) and *Azolla pinnata* flour of 14.7% (Miranda, 2014) in the ration did not increase the workload of the ventricle, as indicated by the absence of an increase in its weight. The average percentage of ventriculus weight in this study ranged from 1.83% to 2.19%. This average is lower than that reported by Halim et al. (2018), which was 2.48%–2.63%. Pradikdo, (2016) stated that the normal percentage of ventriculus weight in quails is about 1.6%–2.3% of live body weight. A smaller ventriculus weight than the standard is usually caused by feed that is ground too finely, so the ventriculus does not have to work as hard to grind food. This matches the conditions of the present study, in which all ingredients were finely ground, likely reducing the workload of the ventriculus.

Percentage of Liver Weight

The liver is part of the giblet and functions to detoxify toxins. Differences in liver weight and size are influenced by how much work the liver performs in the bird's body. Observations of the percentage of liver weight in quails for each treatment are shown in Table 2.

Table 2. Percentage of liver weight

Treatment	Replication					Average ^{ns}
	1	2	3	4	5	
P0	3.10	2.92	2.40	2.62	2.67	2.74
P1	1.77	3.06	3.27	1.79	2.26	2.43
P2	3.71	3.55	2.69	2.59	3.10	3.13
P3	2.84	2.08	2.74	2.14	3.49	2.66

Note: Superscripts in the table columns indicate no significant difference ($P > 0.05$).

The results showed that the use of Golden Apple Snail meal and *Azolla pinnata* meal had no significant effect ($P > 0.05$) on the percentage of liver weight. The average liver percentage in this study ranged from 2.43% to 3.13%, which is very close to the values reported by Khoerudin, (2019), namely 2.72%–2.97%. These results are still within the normal range. This agrees with Pradikdo, (2016), who stated that the standard liver percentage in quails is around 2.31%. It is likely that the nutrient composition of all the diets was relatively similar, meeting the birds' needs and causing no negative effect on liver weight. This may also be related to feed metabolism, where the protein and crude fiber levels were not high enough to affect liver size. According to Saprinanda, (2021), poultry will increase their metabolism to digest crude fiber, which can enlarge the liver. In addition, the inclusion of Golden Apple Snail and *Azolla pinnata* meal did not affect the average liver percentage, suggesting that the beta-carotene content in these ingredients may help the liver by neutralizing toxins. Substances with toxic properties can force the liver to work harder and become heavier, but in this study the liver weight remained within normal limits. Saprinanda, (2021) also noted that one of the liver's functions is to detoxify toxins, and any liver disorder is usually indicated by shrinkage of the organ.

Percentage of Heart Weight

The heart is the organ responsible for pumping blood throughout the body. Observations of the percentage of heart weight in quails for each treatment are shown in Table 3.

Table 3. Percentage of heart weight

Treatment	Replication					Average ^{ns}
	1	2	3	4	5	
P0	0.61	0.81	0.74	0.63	0.60	0.67
P1	0.95	0.73	0.68	0.89	0.67	0.78
P2	0.78	0.59	0.71	0.71	0.66	0.69
P3	0.83	0.66	0.68	0.72	0.94	0.76

Note: Superscripts in the table columns indicate no significant difference ($P > 0.05$).

The results showed that adding Golden Apple Snail meal and *Azolla pinnata* meal had no significant effect ($P > 0.05$) on the percentage of heart weight. This is because the heart plays a crucial role in blood circulation. The average heart percentage obtained in this study ranged from 0.67% to 0.78%. The values among treatments were similar because the quails were raised under the same management system and had the same level of activity. The heart percentages in this study were lower than those reported by Farahdibah *et al.* (2018), who found values of 0.75%–1.01%, but were very close to those reported by Khoerudin, (2019), which ranged from 0.66% to 0.79%. Halim *et al.* (2018) stated that the heart weight of quails generally ranges from 0.6% to 0.9% of body weight. They further explained that heart size in quails depends on sex, age, body weight, and activity level: the larger the heart, the smoother the blood circulation.

Intestinal Length

Based on the data in Table 4, adding Golden Apple Snail meal and *Azolla pinnata* meal had no significant effect ($P > 0.05$) on intestinal length.

Table 4. Intestinal length (cm)

Treatment	Replication					Average ^{ns}
	1	2	3	4	5	
P0	55.0	66.0	74.5	65.0	80.0	68.1
P1	60.5	72.0	54.0	55.5	65.0	61.4
P2	68.0	54.0	54.8	57.6	59.0	58.7
P3	49.0	64.7	65.3	66.5	60.2	61.1

Note: Superscripts in the table columns indicate no significant difference.

This is because adding Golden Apple Snail meal and *Azolla pinnata* meal to the feed did not disrupt the activity of the small intestine in absorbing the nutrients contained in the meal. As a result, the small intestine functioned normally and absorbed nutrients efficiently. The average intestinal length in this study ranged from 58.68 to 68.1 cm, which is slightly lower than the results reported by Saprinanda, (2021), who found lengths of 63.63 to 69.75 cm. The crude-fiber content of the diet with Golden Apple Snail meal and *Azolla pinnata* meal was lower than that of commercial feed. Saprinanda, (2021) further explained that the higher the crude-fiber content of a diet, the slower the digestion and nutrient absorption, which can enlarge and lengthen the digestive tract. Therefore, the inclusion of Golden Apple Snail and *Azolla pinnata* meal in the feed produced better results than the commercial diet.

CONCLUSION

Based on the findings of this study, it can be concluded that supplementing quail feed with 10% Golden Apple Snail meal, 10% *Azolla pinnata* meal, or a combination of both had no significant effect on the percentage weight of the gizzard, liver, heart, or the length of the intestine. All internal organs remained in normal condition. This indicates that Golden Apple Snail and *Azolla pinnata* are safe to use as alternative protein sources in quail feed.

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