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MORALITY BEFORE KNOWLEDGE

The use of Babadotan leaves (*Ageratum conyzoides* l) flour in ration on quail ration (*Cortunix-cortunix Japonica*) energy metabolism

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ABSTRACT
Background: Quails are livestock whose main products are eggs and meat. This plant is often referred to as a weed because its clinical benefits are not yet widely known to the public. The purpose of this study was to determine the effect of adding babadotan (*Ageratum conyzoides* L.) leaf meal on the metabolizable energy of quails (*Cortunix-cortunix Japonica*). The research was conducted at the Quail House, Arkan Quail Farm (Jl. Bebengket, Cihideung Village, Ciampea District, Bogor Regency, 16620). **Methods:** The study used a Completely Randomized Design (CRD) with four treatments: P0 = commercial feed without babadotan leaf meal (control), P1 = commercial feed with 1% babadotan leaf meal, P2 = commercial feed with 3% babadotan leaf meal, and P3 = commercial feed with 5% babadotan leaf meal. The observed variables included Apparent Metabolizable Energy (AME), Nitrogen-Corrected Apparent Metabolizable Energy (AMEn), total metabolizable energy consumption, and the AMEn/GE ratio. **Findings:** The results of this study showed that the addition of babadotan leaf meal (*Ageratum conyzoides* L.) in the diet significantly (P<0.05) affected the values of apparent metabolizable energy (AME) and nitrogen-corrected apparent metabolizable energy (AMEn), with a decrease observed in treatment R3 (diet containing 5% babadotan leaf meal). However, the results for metabolizable energy intake and the AMEn/GE ratio in quails (*Cortunix-cortunix Japonica*) were not significantly different or did not show a significant effect. **Conclusion:** The inclusion of babadotan leaf meal at a level of 5% in the diet can reduce the values of AME and AMEn. However, it did not significantly affect metabolizable energy intake or the AMEn/GE ratio. **Novelty/Originality of this article:** Therefore, the use of babadotan leaf meal in the diet is recommended only up to a concentration of 3%.

KEYWORDS: quail; *Ageratum conyzoides*; energy metabolism; feed additive; poultry nutrition.

1. Introduction

The advantages of the quail farming business include its relatively easy maintenance, primarily because quails have a small body size and a relatively fast production cycle. The quail population in Indonesia reached 15,222,580 head in 2020 and increased to 16,014,879 head in 2021, marking a population increase of 2.23% (Ditjen PKH, 2023). In quail farming, feed and labor are important factors influencing production results. Quality feed provided in controlled amounts is the main key to supporting productivity. It is not surprising that 60–70% of the total quail production cost originates from the feed component (Anggitasari et al., 2016). The ability to maintain stable body temperature

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through mechanisms of radiation, conduction, and convection is possessed by poultry. One way poultry stabilizes its temperature is by releasing heat during heat stress, which causes the fowl to utilize significant amounts of energy (Komalasari et al., 2014). Energy is diverted to stabilize body temperature, which subsequently leads to reduced physical activity and increased rest for the poultry.

The feed consumed by livestock has a significant effect on animal productivity and body weight, which correlates with the effectiveness of the livestock business. Furthermore, environmental factors, animal health, housing conditions, feed container, nutrient content in the feed, and the stress experienced by quails also influence feed consumption (Widodo, 2000). The difference between gross energy and the energy present in excreta constitutes metabolizable energy. Generally, the measurement of gross energy, digestible energy, metabolizable energy, and net energy serves to explain the energy level. Basal metabolic energy covers requirements such as fat, feathers, tissues, activity, body temperature regulation, and egg production. The largest source of energy is derived from nutrients absorbed through the digestive tract (Tillman et al., 1998). Excess metabolizable energy will be stored in the form of fat, and too much fat can disrupt productivity (Rasyaf, 2008). Amrullah (2004) stated that low energy results from diets containing high crude fiber, which is bulky. The level of metabolizable energy, besides external factors, can also be influenced by the varying ability of individual livestock to digest the diet (Dianti, 2012). It is stated that if livestock are given a diet with nutrient content that meets their needs, the animals will consume it in an amount proportional to their physiological requirements. In places such as roadsides, yards, and open fields, babadotan (*Ageratum conyzoides*) grows wildly.

The babadotan plant (*Ageratum conyzoides* L.) is often referred to as a weed because the general public is not fully aware of its clinical benefits. However, babadotan contains active compounds such as flavonoids, saponins, and polyphenols, which are known to have antibacterial properties and can help inhibit the growth of pathogenic germs (Magdalena et al., 2013). Protein quality in poultry can be determined through its digestibility level. A high level of digestibility indicates an increased amount of feed substances absorbed by the body.Babadotan leaves contain secondary metabolite compounds such as precocene I and II, phenolic compounds, and essential oils that are toxic to insect pests. These compounds function as antifeedants, repellents, and growth inhibitors for pests. These components are also known to potentially interfere with the insect endocrine system and inhibit the development of eggs and larvae. However, it should be noted that babadotan also has a relatively high crude fiber content, which can reduce energy digestibility if given in excessive amounts. Crude fiber tends to accelerate the passage rate of feed through the digestive tract, shortening the contact time with digestive enzymes, which ultimately lowers energy utilization (Wahju, 2004). Research by Pramesty & Salbiah (2023) indicated that giving a limited amount of babadotan leaf meal did not significantly disrupt poultry performance and even had the potential to increase feed efficiency when combined with high-quality feed ingredients. Therefore, it is important to pay attention to the appropriate dosage to avoid lowering the overall ME value.

The following are the results of Kiha et al. (2012) study regarding the relationship between papaya leaf extract and broiler chicken energy metabolism in the treatment diet. The study used four treatments: T0 (control), T1 (control + 30% papaya leaf extract 300 ml/kg), T2 (control + 30% papaya leaf extract 600 ml/kg), and T3 (control + 30% papaya leaf extract 900 ml/kg). The parameters measured included feed consumption, body weight gain, fat consumption, and corrected metabolizable energy. The results showed a significant effect ($p<0.05$) on feed consumption, body weight, and metabolizable energy, but no significant effect ($p>0.05$) on fat digestibility. Therefore, the administration of 30% papaya leaf extract in the diet did not affect fat digestibility but could increase corrected metabolizable energy at the 900 ml/kg diet level. According to Widodo (2000), compared to good quality protein, low quality protein will contain more nitrogen. Amino acids from high-quality protein tend to undergo deamination, where nitrogen is broken down into uric acid in poultry, while its carbon chain is converted into fat, carbohydrates, or directly used as an energy source. This may be the cause of the increase in metabolizable energy in the T3 treatment (3112.05 kcal/kg), due to the large amount of carbon resulting from deamination being utilized as an energy source. Therefore, it is important to conduct research to determine the extent of babadotan leaf meal use in the diet to potentially increase metabolizable energy without causing negative side effects on the performance of quails.

1.1 Classification and characteristics of the Japanese quail (Coturnix coturnix japonica)

One type of poultry with the potential for development and increased production is the quail. Quail serves as a source of animal protein through their meat and eggs. In the quail farming sector, there are currently no operations on an industrial scale; they remain at the community level. According to Listiyowati (2009), quails are taxonomically classified into the class Aves and the order Galliformes. They belong to the suborder *Phasianoidea* and the genus Coturnix. The specific species covered by this classification is *Coturnix coturnix japonica.*

Fig. 1. Japanese quail (*Coturnix coturnix japonica*)

Quail farming is a business with significant potential, but its management is not yet as intensive as that of broiler chicken farming. Additionally, quails are small terrestrial birds that feed on grains and insects. The most commonly farmed quail species is the Japanese quail (Coturnix coturnix japonica), which reaches maturity at around 42 days of age. Some of the superior traits of quail parents are their ability to produce eggs quickly and efficiently (Listiyowati, 2009).

1.2 Classification and characteristics of the Bandotan (Ageratum conyzoides)

Ageratum conyzoides L., or bandotan, is known as a traditional medicinal plant used in Indonesia and several other countries. This plant grows easily in various soil conditions and has a rapid growth rate. Its phytochemical constituents, such as terpenoids, alkaloids, essential oils, saponins, and phenols, have been shown to possess antibacterial activity, supporting its use as a traditional medicine.

Fig. 2. Babadotan Plant

Babadotan (*Ageratum conyzoides* L.) is an annual herb that grows to a height of 30–90 cm (Riyati et al., 2010). Babadotan possesses antibacterial properties that can inhibit the growth of Staphylococcus aureus and acts as an anti-inflammatory agent. Some of the active compounds it contains include flavonoids and saponins (Mahpudin et al., 2016). Babadotan leaves contain bioactive compounds such as saponins, flavonoids, polyphenols, and essential oils. The phenolic content can be utilized as a surface disinfectant while also inhibiting and eliminating disease-causing microorganisms (Astuti, 2015). As a botanical insecticide, metabolites found in babadotan leaves—such as alkaloids, flavonoids, coumarins, saponins, polyphenols, and essential oils—also possess various biological properties (Lumowa, 2011). Although ruminant livestock are still widely used in research, babadotan leaves are generally used to induce wounds in laboratory experimental animals.

1.3 Feed quality and factors affecting quail feed intake

A continuously increasing feed energy content can indicate high-quality feed intake, whereas a decreasing feed energy content can also indicate high-quality feed intake. However, if this does not occur, it indicates that the ration quality is low (Setyono et al., 2013). Feed quality, along with husbandry management, is a major factor influencing feed intake. In addition, environmental conditions, the health status of livestock, housing design, type of feeders, nutrient composition, and stress in poultry also impact feed utilization efficiency (Widodo, 2000).

Table 1. Nutrient requirements for each life stage

No	Nutrient Requirements	Starter	Grower	Layer
1.	Metabolic Energy (kcal/kg)	2800	2600	2700
2.	Minimum Crude Protein (%)	190	17.0	17.0
3.	Minimum Crude Fat (%)	7.0	7.0	7.0
4.	Minimum Crude Fiber (%)	6.5	7.0	7.0
5.	Calcium (Ca) (%)	0.90 – 1.20	0.90 – 1.20	2.50 – 3.50
6.	Calcium (Ca) (%)	0.60 – 1.00	0.60 – 1.00	0.60 – 1.00
7.	Amino Acids:			
	Minimum Lysine (%)	1.10	0.80	0.90
	Minimum Methionine (%)	0.40	0.35	0,40

Quality requires feed for daily survival and egg production, which is related to their feed intake levels. Feed intake in livestock depends on several factors, including the animal's age, feed acceptance, health status, livestock type, and physical activity. Factors that can cause stress in quail include an unsuitable housing environment, which has the potential to reduce feed intake, egg weight, and feed conversion. As quails age, the amount of feed they consume also increases. Feed intake also varies among individual birds.

1.4 Gross energy (GE) and digestible energy (DE)

Gross Energy (GE) is the total chemical energy content of feed measured using a bomb calorimeter. GE includes all energy from carbohydrates, proteins, and fats, without accounting for their availability to livestock (National Research Council (NRC), 1994). Gross Energy (GE) indicates the potential energy content in feed, but this form cannot be directly utilized by the body. To become usable energy, a lengthy process through the digestive system, nutrient absorption, and metabolism is required. Gross Energy serves as an initial parameter for evaluating feed energy efficiency. Although GE does not directly indicate the energy available to the body, this data is crucial for calculating digestive and metabolic efficiency, particularly in monogastric animals such as quails. The greater the difference between the GE of the feed and the GE of excreta, the more efficiently the body digests and utilizes the feed (McDonald et al., 2011).

DE (Digestible Energy) is generally measured through controlled feeding trials, where the energy content of the feed is analyzed. Digestible energy (DE) is defined as the energy obtained after subtracting the energy lost in feces from the total energy consumed. Furthermore, not all the DE is utilized by the body; some is excreted or released in urine, referred to as urine energy (UE). Research has shown that the DE values of various poultry by-products can range from 3,281 to 4,567 kcal/kg, depending on the specific material and its composition. Digestibility coefficients for various nutrients, such as dry matter and crude protein, can vary significantly between young and adult poultry, which ultimately affects the overall DE value.

1.5 Metabolic energy expenditure (kcal)

Metabolic energy intake is one of the key parameters in evaluating the nutritional requirements of poultry, including quail. Metabolic energy intake is calculated by multiplying the amount of feed consumed by the metabolic energy content of the diet. Metabolic energy itself can be measured as Net Metabolic Energy, which is the energy absorbed by the body after subtracting the energy lost through feces and urine. In poultry research, such as that on quail, metabolic energy is one of the most important parameters for measuring feed utilization efficiency (Kleyn, 2013). Metabolic energy values are expressed in kilocalories per kilogram of feed (kcal/kg).

Quails adjust their feed intake in response to the energy density of the diet (higher Metabolic Energy leads to a tendency for feed intake to decrease), so metabolic energy intake remains relatively stable around physiological requirements. This phenomenon is well-established in layer poultry and is relevant for quails. Poultry, including quails, possess physiological mechanisms to adjust feed intake based on the energy density of the diet. When the apparent metabolizable energy content in the diet increases, physical feed intake tends to decrease. Conversely, when energy density is low, poultry will increase feed intake. Nevertheless, metabolizable energy intake remains relatively stable because birds regulate energy intake to meet maintenance, growth, and egg production requirements (NRC, 1994).

This has long been identified in laying hens, and its relevance has also been demonstrated in quails. Research results from (Ashour et al., 2024) show that increasing the energy density of the diet in laying quails reduces feed intake but does not significantly affect metabolic energy consumption. This confirms that physiological energy requirements are the primary factor in feed intake. In short, an understanding of metabolic energy and apparent metabolic energy consumption aids in designing efficient diets. Feed formulations must balance energy density and other nutrients to achieve optimal production performance without feed wastage.

2. Methods

The experimental design used was a Completely Randomized Design (CRD) with four types of treatments, each replicated five times. This study utilized 20 cage units, with each cage containing 10 female quails, resulting in a total of 200 birds. The mathematical model used in this study is as follows in Equation 1. This study used four different feed treatments to examine the effect of babadotan leaf flour on the study subjects. The treatments began with P0 as the control, which consisted of commercial feed without added babadotan leaf flour. Subsequently, babadotan leaf flour was administered in increasing doses in the following treatments: 1% in P1, 3% in P2, and 5% in P3. The mathematical model used in this study is as follows:

$$Yij = \mu + \alpha i + \epsilon ij \quad \text{(Eq. 1)}$$

The mathematical model used in this study consists of several components, where *Yij* represents the observed value for the i-th treatment and the j-th replicate. This value is influenced by the overall mean (μ), the effect of the i-th treatment (αi), and the experimental error for the i-th treatment and j-th replicate (ϵij). All data obtained were then analyzed using Analysis of Variance (ANOVA). If the analysis results indicate a significant difference ($P<0.05$), the testing is continued using Duncan's Multiple Range Test (DMRT) to determine the differences between treatments.

2.1 Research time and location

This study was conducted from April to May 2025 at the Quail House, Arkan Quail Farm (Jl. Bebengket, Cihideung Village, Ciampea District, Bogor Regency, 16620). The average environmental temperature in the quail house during the day reached 30.55C with a humidity level of 64.46%. The research location is situated at an altitude of 1,088 meters above sea level (masl). The gross energy and moisture content analyses were performed at the Feed Quality Testing and Certification Center Laboratory/*Balai Pengujian Mutu dan Sertifikasi Pakan (BPMSP)* in Bekasi.

2.2 Research material

The materials used in this study were 200 quails aged 24 weeks with an average body weight of 140±2,56 g/quails, babadotan leaf meal, drinking water, and disinfectant. The feed utilized was SP-22, produced by PT. Shinta Prima Feedmill, with the nutrient composition detailed in Table 3.

Table 1. Nutrient content of the feed

BK (%)	Nutrient					
Commercial Feed	BK (%)	PK (%)	SK (%)	LK (%)	Abu (%)	BETN (%)
Ageratum conyzoides Leaf Meal	90.73	20.48	6.07	9.11	16.07	39.41

(IPB Feed Science and Technology Laboratory, 2023)

This study utilized a diet formulated using the trial-and-error method. This tables based on the nutritional requirements of laying quails. The composition of the different treatment diets is presented in Table 2.

Table 2. Nutrient content of each treatment

Nutrient	R0	R1	R2	R3
BK (%)	90.73	90.70	90.64	90.59
PK (%)	22.48	22.51	22.56	22.61
SK (%)	6.07	6.14	6.27	6.40
LK (%)	6.70	6.68	6.64	6.60
Abu (%)	16.07	16.03	15.96	15.90
BETN (%)	39.41	39.34	39.21	39.09
GE (Kkal/kg)	4,012.49	4,014.77	4,019.33	4,023.89

Note, the results of the trial-and-error calculation using Microsoft Excel (2024) established the treatments as follows: (P0) a diet containing 0% babadotan leaf meal; (P1) a diet containing 1% babadotan leaf meal; (P2) a diet containing 3% babadotan leaf meal; and (P3) a diet containing 5% babadotan leaf meal.

2.3 Equipment

During the study, the equipment used in the field included two units of five-tier cage systems, with each unit measuring 1,8 m x 60 cm x 3 m. Each level of the cage was provided with a plywood sheet, measuring 35 cm x 60 cm x 26 cm, to serve as a manure collector. Each compartment housed 10 female quails aged 24 weeks. The cage floor was made of wire mesh with a size of 1,5 x 1,5 cm. Feeders and drinkers were provided outside each cage. Illumination was provided by 4-watt incandescent lamps. Research equipment consisted of a digital scale, a power strip, markers, buckets, plastic bags, stationery, a blender, and a heating oven. Equipment used during sample collection included a 0.5 mm PVC plastic sheet, measuring 1,5 m x 55 cm per cage, used as an excreta mat, a sprayer, a blender, an incubator, and another blender. A depiction of the quail cage is shown in Fig. 3.

Fig. 3. Quail cage

2.4 Research variables

2.4.1 Apparent metabolizable energy (AME) (Kcal/kg)

AME measurement can be performed using the direct method through excreta collection over a specific period (usually 3–5 days), along with the measurement of feed intake and energy content using a bomb calorimeter. Several studies also use a nitrogen correction approach to obtain the nitrogen-corrected AME (AMEn) value, which more accurately represents the net available energy. According to Rusydy et al. (2022), AME measurement is important for evaluating the efficiency of energy utilization from feed materials, especially under extreme environmental conditions such as high temperatures. According to Sibbald & Wolynetz (1985), Apparent Metabolizable Energy (AME) can be calculated using the following formula:

$$AME = \frac{EI - EE}{FI} \quad \text{(Eq. 2)}$$

In the calculations performed, the variables used included EI (Energy Intake), which represents energy intake in kilocalories (kcal), and EE (Excreta Energy), which indicates the energy content of excreta in kilocalories (kcal). In addition, the variable FI (Feed Intake) was used to measure the amount of feed consumed, expressed in grams (g).

2.4.2 Nitrogen-corrected apparent metabolizable energy (AMEn) (Kcal/kg)

Nitrogen-Corrected Apparent Metabolizable Energy (AMEn) is the energy value available to the animal's body from the feed after subtracting the energy lost through excreta, but without being corrected for endogenous nitrogen losses. AMEn measurement is important for determining the amount of energy from the feed that is truly available for bodily metabolic processes such as growth, maintenance, and egg production (McDonald et al., 2011).

$$AMEn = \frac{(EI - EE) - (RN \times 8.22)}{FI} \quad \text{(Eq. 3)}$$

The components used in this calculation include EI (Energy Intake) as total energy intake and EE (Excreta Energy) as energy in excreta, both expressed in kcal. Additionally, there are the variables FI (Feed Intake) to measure feed consumption in grams (g) and RN (Nitrogen Retention) to indicate nitrogen retention in grams (g). This calculation also involves a constant of 8.22, which represents the energy value released per gram of nitrogen not stored in the body in kcal/g N.

2.4.3 Metabolizable Energy Consumption (Kcal)

In poultry research, such as on quails, metabolizable energy is one of the most important parameters for measuring feed utilization efficiency (Kleyn, 2013). The metabolizable energy value is expressed in kilocalories per kilogram of feed (Kcal/kg). To obtain the total metabolizable energy consumption value, the following formula is used:

$$\text{Metabolizable Energy Consumption} = \text{Feed Intake} \times \text{AME} \qquad \text{(Eq. 4)}$$

2.4.4 AMEn/GE Ratio

In diet formulation, the AMEn/GE ratio is used to compare the potential of raw feed materials. Knowing this ratio facilitates the adjustment of the formulation so that the available energy meets the physiological needs of quails, whether for growth (starter-grower) or egg production (layer). It can be calculated based on the following formula (Ramadhani et al., 2021):

$$AMEn\ /\ GE\ Ratio\ = \frac{AMEn}{GE} \qquad \text{(Eq. 5)}$$

In this analysis, the GE (Gross Energy) variable was also used, which indicates the total gross energy in the feed, expressed in kcal/kg. Additionally, the AMEn (Nitrogen-Corrected Apparent Metabolizable Energy) variable was used, which represents the apparent metabolizable energy value corrected for nitrogen, also expressed in kcal/kg.

Cage preparation was conducted one week before the cages were utilized. The cage area was washed by spraying disinfectants, particularly the floor and the cage system to be used. Cleaning was also performed on the feeders, drinkers, and egg trays. The quails used for the research had to be in healthy and normal condition. The first step was to select quails and separate those with small body weight, poor health, or suboptimal performance, as these would not be used as research subjects.

In the process of making babadotan leaf meal, the leaves were first separated from the stems, petioles, and flowers. Once collected, the leaves were roasted using an oven at a temperature of 60C for 24 hours. The next step involved grinding the dried babadotan leaves using a blender until they became meals. The diet provided utilized SP-22 and was substituted with babadotan leaf meal according to the given treatments: R0 (without babadotan meal), R1 (babadotan meal 1%), R2 (babadotan meal 3%), and R3 (babadotan meal 5%). Feeding was done in the morning and evening, totaling 22g/head/day, and drinking water was provided ad libitum.

2.5.5 Excreta collection

Data collection was performed during the last four days of the study using the total excreta collection method. Excreta was collected over 24 hours starting at 9:00 AM WIB, along with the collection of residual feed data. The excreta was then weighed to determine the wet weight before being sprayed with H_2SO_4 (sulfuric acid) to prevent the protein in the excreta from volatilizing. The excreta was first air-dried and then placed into an incubator for complete drying. The dry excreta samples were subsequently weighed to determine the sun-dried dry matter content. The excreta was then ground, and samples were taken for gross energy content analysis.

3. Results and Discussion

Metabolizable energy is one of the indicators used to evaluate the effectiveness of the feed in achieving good productivity results. The results of the study on the effect of incorporating babadotan leaf meal into the diet on the metabolizable energy of quails can be seen in Table 3.

Table 3. Results of the study on AME, AMEn, Energy Consumption, and AMEn/GE Ratio

Variables	Treatment			
	P0	P1	P2	P3
AME (Kcal/kg)	3,399.9±123.7^{b}	3,335.2±100.2^{ab}	3,267.7±129.2^{ab}	3,169.1±123.2^{a}
AMEn (Kcal/kg)	3,395.9±123.7^{b}	3,331.1±100.2^{ab}	3,263.7±123.2^{ab}	3,165.2±123.2^{a}
Energy Consumption (Kcal)	74.3±12.7	65.8±10.4	68.8±9.2	59.2±12.5
AMEn/GE Ratio	0.79±0.02	0.78±0.02	0.76±0.03	0.74±0.02

Notes: (P0) Diet containing 0% babadotan leaf meal. (P1) Diet contains 1% babadotan leaf meal. (P2) Diet containing 3% babadotan leaf meal. (P3) Diet containing 5% babadotan leaf meal. Values with different superscripts in the same row indicate a significant difference (P<0.05).

3.1 Apparent metabolizable energy (AME)

Apparent Metabolizable Energy (AME) is one of the parameters used to assess the energy quality of a feed material in poultry. AME is defined as the amount of gross energy in the feed that can truly be utilized by the animal's body after subtracting the energy lost through excretion in the form of feces and urine, without considering the energy originating from endogenous metabolism or excretory products of body tissue metabolism (McDonald et al., 2011). In poultry, AME measurement is more practical to use than other forms of energy measurement because poultry possesses a digestive tract that excretes feces and urine simultaneously as excreta, making the accurate separation of the two difficult.

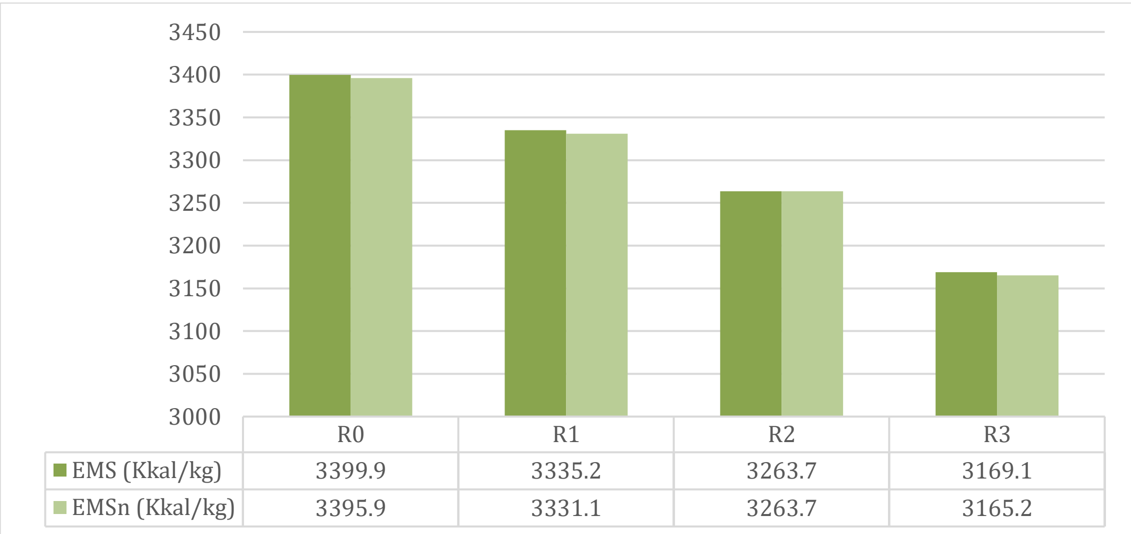

Fig. 4. Average Apparent Metabolizable Energy and Nitrogen-Corrected Apparent Metabolizable Energy

Consequently, AME measurement in poultry is generally conducted through the total excreta collection method or the indicator substance method, after which the gross energy of the feed and excreta are measured using a bomb calorimeter. The results of the analysis for apparent metabolizable energy showed that the highest mean was obtained in the P0 treatment (diet without babadotan leaf meal/control feed), which was 3,399.9±123.7 Kcal/kg. The lowest mean was obtained from the P3 treatment (diet containing 5%

babadotan leaf meal), which was 3,169.1±123.2 Kcal/kg, followed by the results of P1 (diet containing 1% babadotan leaf meal) and P2 (diet containing 3% babadotan leaf meal), which were 3,335.2±100.2 Kcal/kg and 3,263.7±123.2 Kcal/kg.

The results of the analysis of variance (ANOVA) and the Duncan's Multiple Range Test showed that the inclusion of babadotan leaf meal in the diet significantly affected the apparent metabolizable energy values of quails ($P<0.05$), as presented in Table 5. This finding contrasts with the research results of Kiha et al. (2012) regarding the effect of papaya leaf extract on fat digestibility and metabolizable energy in broiler chickens. In their study, the results indicated a significant effect of the treatment ($p<0.05$) on feed consumption, body weight gain, and the corrected metabolizable energy value of the diet, but a non-significant effect ($p>0.05$) on fat digestibility. This significant difference was demonstrated by the increase in the metabolizable energy of the broiler chickens. The highest Apparent Metabolizable Energy (AME) value in the study by Kiha et al. (2012) using papaya leaf extract was found in treatment T3 (3,112.05 Kcal/kg), and the lowest was in treatment T1 (2,390.92 Kcal/kg). Conversely, in this study utilizing babadotan leaf meal, the highest mean AME was obtained in the P0 treatment (diet without babadotan leaf meal/control feed), which was 3,399.9±123.7 Kcal/kg and the lowest mean was obtained from the P3 treatment (diet containing 5% babadotan leaf meal), which was 3,169.1±123.2 Kcal/kg.

3.2 Apparent metabolizable energy corrected for nitrogen (AMEn) (Kcal/kg)

Apparent Metabolizable Energy corrected for nitrogen (AMEn) is one of the important parameters in assessing the energy value of feed ingredients for poultry. AMEn is a form of Apparent Metabolizable Energy (AME) that has been corrected by accounting for the energy lost due to endogenous nitrogen excretion, primarily in the form of uric acid in poultry. This correction value is necessary because some of the excreted nitrogen does not originate from the consumed feed but rather from the metabolism of body protein itself. According to Sibbald & Wolynetz (1985), nitrogen correction is performed by reducing the AME value by 8.22 Kcal for every gram of nitrogen excreted, resulting in an energy value that more accurately reflects the net energy truly available for utilization by the poultry body. AMEn is widely used in research and feed formulation because it provides a more accurate representation of energy availability compared to uncorrected AME (Na'imah et al., 2017).

This is especially crucial for feed ingredients with high protein content, where the difference between AME and AMEn values can reach 10-17%. The higher the nitrogen retention, the greater the difference between AME and AMEn, because diets with good quality protein tend to increase protein metabolism and nitrogen excretion (Bregendahl et al., 2002). Thus, AMEn serves as a more appropriate reference for calculating the energy requirements of poultry across various production phases .The results of the study on nitrogen-corrected apparent metabolizable energy using babadotan leaf meal in the diet showed that the highest mean was obtained in the P0 treatment (diet without babadotan leaf meal/control feed), which was 3,395.9±123.7 Kcal/kg. The lowest mean result was found in the P3 treatment (diet containing 5% babadotan leaf meal), which was 3,165.2±123.2 Kcal/kg, followed by P1 (diet containing 1% babadotan leaf meal) at 3,331.1±100.2 Kcal/kg and P2 (diet containing 3% babadotan leaf meal) at 3,165.2±123.2 Kcal/kg. The results of the analysis of variance (ANOVA) and the Duncan's multiple range test regarding the use of babadotan leaf meal in the quail diet showed that the nitrogen-corrected apparent metabolizable energy was significantly different ($P<0.05$), as presented in Table 3.

This contrasts with the research by Mario et al. (2014) on the effect of adding red ginger, turmeric, and meniran meal to broiler feed on nutrient digestibility and metabolizable energy, where the results for Nitrogen-Corrected Apparent Metabolizable Energy (AMEn) showed no significant difference ($P>0.05$). According to Aimmah et al. (2011), the addition of a mixture of turmeric and ginger meal at a 0.6% level did not show a significant difference on protein digestibility, AME, or AMEn.The research results concerning the administration of red ginger, turmeric, and meniran meal in broiler feed showed that the lowest AMEn value was found in the P2 treatment (basal diet with a 4g/kg combination) at 2,950.91 Kcal/kg, while the highest value was obtained in the P5 treatment (basal diet with a 16 g/kg combination), which was 2,957.40 Kcal/kg. Conversely, the results of this study on the administration of babadotan leaf meal showed that the highest metabolizable energy value in the quail diet was P0 (diet without babadotan leaf meal/control feed), which was 3,395.9±123.7 Kcal/kg, and the lowest was P3 (diet containing 5% babadotan leaf meal), which was 3,165.2±123 Kcal/kg. According to Wulandari et al. (2013), indigestible crude fiber affects the absorption of other nutrients because some of the digested nutrients can be carried out with the excreta.

3.3 Metabolizable energy intake (Kcal)

Metabolizable energy intake can be defined as the total amount of metabolizable energy truly consumed by the livestock over a certain period. This value is obtained by multiplying the daily feed consumption (g/head/day) by the metabolizable energy content in the feed (kcal/kg). According to Anggorodi (1985), this calculation is crucial because energy is the component utilized first by the body for vital processes before other nutrients are used. According to the National Research Council (1994) and Sibbald & Wolynetz (1985), factors affecting ME intake in poultry include the energy content of the feed. High-energy diets typically decrease total consumption because energy requirements are quickly met, while low-energy diets encourage greater consumption. Furthermore, poor quality feed ingredients lower the ME value because some energy cannot be absorbed by the body. At high temperatures, feed consumption tends to decrease, thus reducing energy intake (Yunianto et al., 1997). Feed texture in the form of pellets increases consumption compared to mash due to higher palatability. High crude fiber content can limit consumption and reduce energy digestibility (Mateos et al., 2012).

The results of the study on the use of babadotan leaves in the quail diet showed that the highest mean metabolizable energy intake was obtained in the R0 treatment (diet without babadotan leaf meal) at 74.30 Kcal, and the lowest mean value was obtained in the R3 treatment (diet with 5% babadotan leaf meal) at 59.2 Kcal, followed by the R1 treatment (diet with 1% babadotan leaf meal) at 65.8 Kcal (Figure 3). The result of the analysis of variance (ANOVA) regarding the use of babadotan leaf meal in the quail diet on metabolizable energy intake showed no significant difference (P>0.05). This ANOVA result is consistent with the findings on energy consumption in 24-week-old Kedu chickens given diets with various levels of crude protein and crude fiber in the research by Wulandari et al. (2013), which also showed no significant difference (P>0.05) in energy consumption.

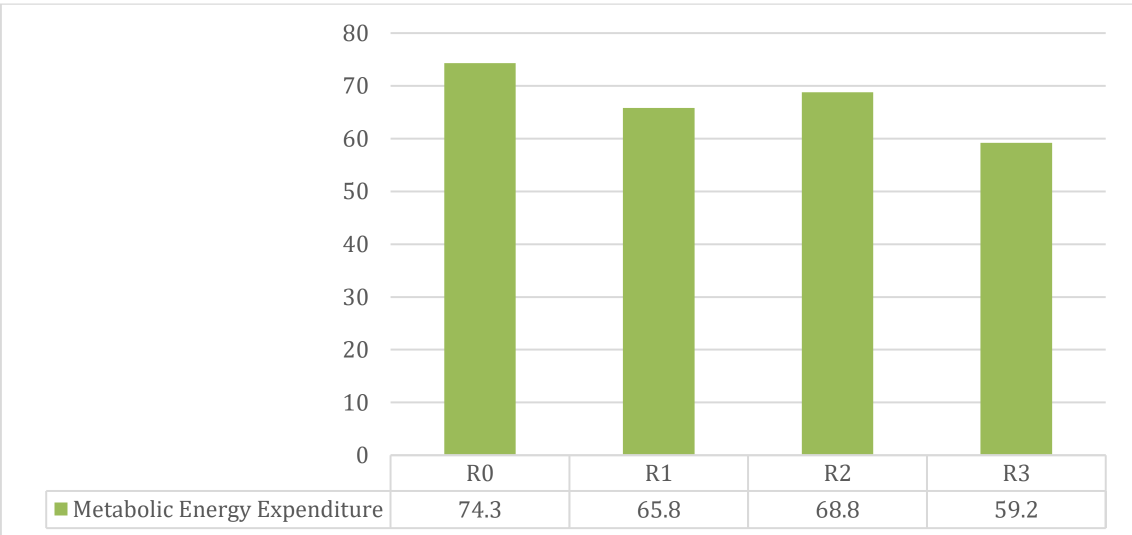

Fig. 5. Average Metabolizable Energy Consumption

3.4 AMEn/GE ratio

The AMEn/GE ratio is an important indicator for assessing the quality of feed ingredients, especially when utilizing alternative feed sources or feed supplements such as babadotan leaf meal, papaya leaf meal, or other high-fiber materials. A high ratio value signifies that the feed ingredient possesses a good level of energy digestibility, while a low ratio indicates the presence of digestibility limitations, such as high crude fiber, lignin content, or antinutritional compounds (Mateos et al., 2012). In research involving the use of babadotan leaf meal in poultry diets, the AMEn/GE ratio is a crucial parameter for determining the extent to which the bioactive compounds and fiber contained in babadotan affect energy efficiency. If the ratio decreases, it is likely attributed to an increase in the fiber fraction or antinutritional effects that inhibit digestion.

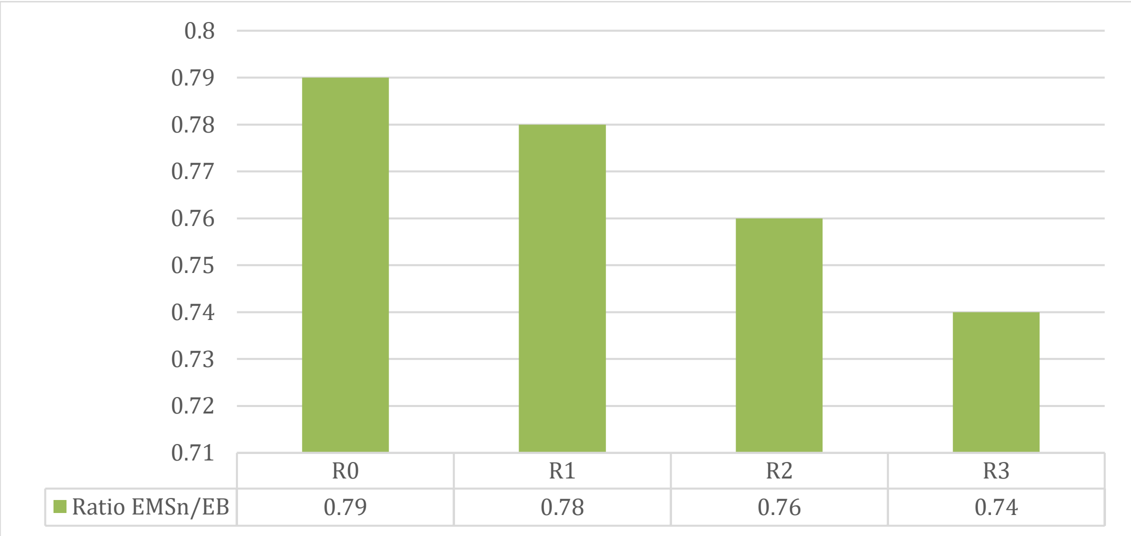

Fig. 6. Average AMEn/GE ratio

The results regarding the effect of using babadotan leaf meal in the quail diet on the AMEn/GE ratio showed that the highest mean was obtained from treatment R0 (diet without babadotan leaf meal) with a value of 0.79. The lowest mean was obtained from treatment R3 (diet containing 5% babadotan leaf meal) with a value of 0.74, followed by the results from R1 (diet containing 1% babadotan leaf meal) with a value of 0.78 and R2 (diet containing 3% babadotan leaf meal). The Analysis of Variance (ANOVA) results indicated that there was no significant difference (P>0.05) in the AMEn/GE ratio of quails when babadotan leaf meal was included in the diet. According to the (National Research Council, 1994), a good AMEn/GE ratio in poultry ranges between 0.70-0.80, signifying the proportion of gross energy that can be metabolized after nitrogen correction.

4. Conclusions

Based on the research results, it can be concluded that the use of babadotan leaf flour in quail feed has varied effects on energy parameters. The inclusion of babadotan leaf flour up to a 5% level was found to reduce the values of AME (Apparent Metabolizable Energy) and AMEn (Nitrogen-Corrected Apparent Metabolizable Energy). On the other hand, the addition of babadotan leaf flour at the same level did not significantly affect total metabolizable energy intake or the AMEn/GE ratio. Based on these findings, the use of babadotan leaf flour in quail diets is recommended only up to a 3% level to maintain energy efficiency. For future research, it is recommended to conduct a more in-depth study on the long-term effects of using babadotan leaf flour on overall quail production performance

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Author Contribution

Swasasi Sofi Makarim contributed to the conceptualization, methodology, investigation, and writing—original draft preparation. Deden Sudrajat and Dede Kardaya were involved in the supervision, validation, and writing—review & editing of the manuscript. All authors have read and agreed to the published version of the manuscript

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