Effects of Essential Amino Acid Supplementation and Ration Type on Feed Efficiency and Performance of Alabio Ducks Aged 9–20 Weeks

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Abstract. Determining the nutritional requirements of rations, particularly essential amino acids (EAAs), and selecting the appropriate feed form remain important in duck farming. This study evaluated the effects of different EAA levels and feed forms on feed efficiency and performance of Alabio ducks. A total of 360 female ducks aged 9 to 20 weeks were randomly allocated into 36 pens (3×2 m²) and assigned to six treatments with six replications (10 ducks per replicate) in a completely randomized 3×2 factorial design. The first factor was EAA levels (0, 10, and 20%), and the second factor was feed form (mash and pellet). Observed variables included feed consumption (FC), body weight gain (BWG), feed conversion ratio (FCR), and live body weight (LBW). EAAs supplementation at different levels significantly affected ($P<0.05$) duck performance. Although FC, BWG, and LBW were not significantly different ($P>0.05$) among treatments, FCR was significantly improved ($P<0.05$) by EAAs addition. The best performance was observed in ducks receiving 10% EAAs with pelleted feed (T5). It is concluded that supplementing 10% EAAs in pelleted rations from 9 to 20 weeks of age improved feed efficiency and overall performance of Alabio ducks.

Keywords: Alabio, ducks, efficiency, nutrition, ration

1 Introduction

Duck eggs and meat are recognized for their high nutritional value, offering essential proteins, lipids, vitamins, and minerals that contribute to human health and food security. Despite their potential, the productivity and quality of ducks particularly local breeds such as the Alabio duck in Indonesia remain below optimal levels and fail to meet consumer expectations. This underperformance is largely attributed to limitations in feed quality,

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breeding stock, and management practices, with feed being the most critical determinant of both production efficiency and product quality [1].

Locally available feed ingredients in Indonesia present promising alternatives for poultry nutrition due to their accessibility and cost-effectiveness. However, their nutritional composition must be rigorously analyzed to formulate balanced rations that meet the physiological needs of ducks. Laboratory testing is essential to identify nutrient deficiencies or excesses, which directly influence growth, immunity, and reproductive performance [2].

The nutritional requirements of ducks, particularly regarding essential amino acids (EAAs), are not well established for local breeds. Current recommendations are primarily based on the NRC guidelines [3], which focus on the Pekin duck a breed with significantly higher body weight and different metabolic demands than indigenous Indonesian ducks. This discrepancy has led to suboptimal feeding strategies and inconsistent production outcomes. Similar challenges have been reported internationally, including in Korea and other regions, where data on local duck nutrition remain scarce [4]

EAAs such as lysine, methionine, threonine, arginine, and tryptophan are indispensable for ducks, as they cannot be synthesized endogenously and must be supplied through feed. These amino acids play pivotal roles in protein synthesis, metabolic regulation, immune function, and reproductive development. Deficiencies in EAAs can result in impaired growth, reduced feed efficiency, weakened immunity, and poor carcass and egg quality [1].

Lysine is particularly important for muscle development and feed conversion efficiency. Studies have shown that lysine requirements vary significantly with age and breed. For example, Pekin ducks require 0.90% lysine at 0–2 weeks and 0.65% at 2–7 weeks [5], while white-feathered Pekin ducks may require up to 1.06% during early growth stages [6]. Korean local ducks exhibit lysine needs ranging from 0.70% to 1.01% post-hatching [7]. Methionine, often the first limiting amino acid in poultry diets, supports feather growth, protein synthesis, and immune response. Its requirements also vary by strain, sex, and environmental conditions. Restricted methionine intake has been linked to reduced egg weight and altered lipid metabolism in ducks [5]. Optimal methionine levels have been shown to improve egg mass and feed conversion ratio (FCR) in Longyan laying ducks [8]. Arginine enhances gut health, immune function, and reproductive performance. It serves as a precursor for nitric oxide and creatine, compounds essential for muscle development and metabolic regulation. Supplementation of arginine has been associated with improved body weight, growth rate, and FCR, particularly in young birds [8]. Threonine is the third limiting amino acid in corn-soybean-based diets and is crucial for intestinal integrity, immune organ development, and nitrogen metabolism. Azzam *et al.* reported that a dietary threonine level of 0.28% resulted in the highest post-hatch body weight in ducklings, with a total threonine content of 0.66% being optimal for breeder performance [9]. Supplementation of threonine has been shown to improve growth performance, feed efficiency, and immune responses in ducks. Tryptophan, a precursor to serotonin and melatonin, influences behavior, stress response, and reproductive function. Supplementation of tryptophan has been shown to enhance feed intake, reduce aggressive behaviors, and improve egg production and quality. Zhang *et al.* found that dietary tryptophan levels between 2.9 and 3.1 g/kg were optimal for laying performance in Longyan duck breeders [10].

The Alabio duck, a native Indonesian breed with high genetic potential for egg production, continues to exhibit suboptimal performance due to inadequate EAAs content in its diet. Research aimed at optimizing EAAs supplementation during the grower phase (9–20 weeks) is essential to improve feed efficiency, growth, and reproductive outcomes. Establishing precise amino acid requirements tailored to local duck breeds will support sustainable poultry production and enhance the economic viability of duck farming in Indonesia.

2 Materials and Methods

This paper is a continuation of a previously published study on the effects of adding essential amino acids (EAAs) to two types of rations (mash and pellet) during the starter period (1–8 weeks of age), whereas the present study focuses specifically on the grower period (9–20 weeks of age). All ducks were kept in accordance with the Agricultural Research and Development Agency's operational standards. The ingredients, formulation, composition, and nutritional content of the experimental rations are presented in Table 1.

Table 1. Ingredients, formulation, and nutritional composition of the treatment rations from 9 to 20 weeks of age

Ingredient	Treatmen ration					
	T1 (0)	T2 (10%)	T3 (20%)	T4 (0%)	T5 (10%)	T6 (20%)
Pollards (%)	30.000	30.000	30.000	30.000	30.000	30.000
Corn (%)	28.000	30.000	26.000	28.000	30.000	26.000
Soybean meal (%)	7.000	7.000	5.100	7.000	7.000	5.100
Palm kernel cake (%)	25.000	22.000	26.000	25.000	22.000	26.000
BR1(201) (%)	3.000	3.100	2.800	3.000	3.100	2.800
Meat Bone Meal (%)	2.500	3.000	4.000	2.500	3.000	4.000
Lysine (%)	0.220	0.310	0.390	0.220	0.310	0.390
Methionine (%)	0.040	0.080	0.100	0.040	0.080	0.100
Arginine (%)	0.000	0.450	0.770	0.000	0.450	0.770
Threonine (%)	0.030	0.083	0.160	0.030	0.083	0.160
Tryptophan (%)	0.000	0.000	0.000	0.000	0.000	0.000
Premix (%)	0.560	0.577	0.225	0.560	0.577	0.225
CPO (%)	2.800	2.550	3.605	2.800	2.550	3.605
Dicalcium phosphate (%)	0.600	0.600	0.600	0.600	0.600	0.600
CaCo3 (%)	0.150	0.150	0.150	0.150	0.150	0.150
Salt (%)	0.100	0.100	0.100	0.100	0.100	0.100
Total (%)	100	100	100	100	100	100
Nutritional content (Calculation result)						
Protein (%)	16	16	16	16	16	16

Energy (kkal/kg)	2700	2700	2700	2700	2700	2700
Crude fiber (%)	7.41	6.94	7.55	7.41	6.94	7.55
CaCo3 (%)	1.46	1.46	1.46	1.46	1.46	1.46
Posphor (%)	0.80	0.80	0.85	0.80	0.80	0.85
Lysine (%)	0.65	0.72	0.78	0.65	0.72	0.78
Methionine (%)	0.30	0.33	0.36	0.30	0.33	0.46
Arginine (%)	0.85	0.87	1.04	0.85	0.87	1.04
Threonine (%)	0.50	0.55	0.60	0.50	0.55	0.60
Thryptophan (%)	0.12	0.14	0.16	0.12	0.14	0.16

Notes: MBM=Meat bone meal; CPO = Crude palm oil; DCP=Dicalcium posphat

The materials used in this study were local ducks. namely Alabio ducks. A total of 360 of ducks were reared for 10 weeks and allocated to 6 treatments with 6 replications, each replication consisting of 10 ducks. The experiment was arranged in a completely randomized design (CRD) with a 3×2 factorial pattern. The first factor was 3 levels of essential amino acids (0/control, 10, and 20%), and the second factor was 2 types of feed (mash and pellets). The levels of essential amino acids (lysine, methionine, threonine, arginine, and tryptophan) in the control diet followed the recommendations of the Indonesian National Standard for Animal Feed (SNI) [11].

The feed ingredients used included corn, pollard, palm kernel cake, soybean meal, crude palm oil (CPO), commercial duck feed, meat and bone meal, salt, premix, and limestone. The essential amino acids supplemented in the diet were lysine, methionine, threonine, arginine, and tryptophan. The experimental diets were formulated to be iso-protein and iso-energy, and drinking water was provided ad libitum.

Ducks were weighed weekly to record feed consumption (FC), body weight gain (BWG), feed conversion ratio (FCR), and live body weight (LBW). The data obtained were analyzed using the General Linear Model (GLM) procedure with the Statistical Analysis System (SAS) program [12].

3 Results & Discussion

3.1 Feed consumption

Feed consumption (FC) of 20-week-old Alabio ducks fed diets containing 0, 10, and 20% of essential amino acids (EAAs) in two ration forms (mash and pellet) is presented in Table 2. The average FC for rations with 0, 10, and 20% EAAs were 9135, 8871, and 8982 g/duck, respectively, while the average FC of ducks fed mash and pellet rations were 9400 and 8593 g/duck, respectively. Statistical analysis indicated that different EAA levels and ration forms (mash and pellet) had a significant effect ($P<0.05$) on the FC of 20-week-old ducks. However, analysis of variance showed no significant interaction between EAA level and ration form.
As shown in Table 2, the FC of ducks fed mash-form rations did not differ significantly ($P>0.05$) among treatments, whereas pellet-form rations had a significant effect ($P<0.05$). These results indicate that EAAs supplementation in pellet-form rations produced better

outcomes than in mash-form rations. Furthermore, Table 2 shows that the two ration types (mash and pellet) resulted in significantly different FC values (P<0.05). Statistical analysis confirmed that pellet-form rations produced significantly lower FC values (P<0.05) compared with mash-form rations. However, further analysis revealed that the addition of EAAs to both ration types at 20 weeks of age did not significantly affect duck FC. The best treatment for achieving optimal FC in 20-week-old (grower) ducks was the T5 ration (20% EAAs in pellet form), which resulted in an average FC of 8337 g/duck.

Table 2. The average feed consumption (FC) of Alabio ducks with supplementation of various levels of EAAs in two types of ration from 9 to 20 weeks of age (g/duck)

Types of feed	Esential amino acids levels			Average±SE
	0% ± SE	10% ± SE	20% ± SE	
Mash (g/duck)	9562±11.48^{a}	9403±11.48^{a}	9232±11.56^{a}	9400±64.49^{a}
Pellet (g/duck)	8708±11.48^{b}	8337±11.48^{c}	8733±11.48^{b}	8593±62.44^{b}
Average (g/duck)	9135±12.42^{a}	8871±12.42^{b}	8982±12.42^{ab}	

Note: Different superscript letters in each row and column shows a significant difference (P<0,05); SE (Standard error).

Table 2 shows that although the addition of various EAA levels to the mash ration did not have a significant effect on feed consumption (FC), a decreasing trend was observed with increasing EAA levels. The FC values were 9562, 9403, and 9232 g/duck, respectively. The FC values in treatments T2 and T3 were lower and more favorable than that in treatment T1 (control).

Several studies have reported that FC can be influenced by various factors, one of the most important being the quality of the ration, particularly its nutritional content [1, 3]. The nutritional components especially lysine and energy derived from the ration are considered sufficient to support both the growth and maintenance of ducks. Researchers have stated that increasing the energy content in the ration to an optimal level can reduce feed consumption. Conversely, if the energy content is insufficient, it can lead to increased feed intake and may even result in fat accumulation in abdominal tissues, including the carcass.

Lysine is an essential amino acid that plays a crucial role in promoting growth, reducing feed intake, and improving feed efficiency in poultry. It has been reported that diets with low nutritional content, particularly those deficient in lysine, can reduce poultry performance [13]. Similar results have also been observed in ducks [11]. However, information on the nutritional requirements of local ducks remains limited and is generally based on recommendations established for commercial breeds [13]. According to the NRC, the lysine requirement for Pekin ducks aged 2–7 weeks is 0.65%. Meanwhile, the minimum recommended levels of lysine, methionine, and methionine+cysteine according to SNI are 0.65, 0.30, and 0.50%, respectively. The minimum energy and protein requirements for grower-type laying ducks are 2,600 kcal/kg and 15% protein, respectively [11].

3.2 Body weight gain (BWG)

The body weight gain (BWG) value of ducks is calculated based on the weight of the duck obtained during weighing minus the weight of the day-old duck (DOD) which was recorded previously. Body weight gain (BWG) of the ducks was measured weekly to assess their responses to the treatment rations. The average BWG of Alabio ducks from 9 to 20 weeks of age with supplementation of various levels of essential amino acids (EAAs) in two types of feed (mash and pellet) is presented in Table 3. The results of the study showed that the addition of different levels of EAAs to two forms of rations (mash and pellet) significantly

affected body weight gain (BWG). The average BWG of ducks fed pelleted rations with varying EAA levels was not significantly different (P>0.05), whereas the mash rations showed a significant effect (P<0.05). The provision of the T2 treatment (10% EAAs) in mash form resulted in a significantly higher BWG (P<0.05) compared to the control ration (T1). Statistical analysis also indicated that the interaction between EAA levels and feed form (mash and pellet) had no significant effect (P>0.05). These results indicate that the T2 treatment (10% EAAs in mash form) produced the highest BWG in Alabio ducks during the grower period (up to 20 weeks of age).

Table 3. The average body weight gain (BWG) of Alabio ducks with supplementation of various levels of EAAS in two types of rations from 9 to 20 weeks of age

Types of feed	Esential amino acids levels			Average±SE
	0% ± SE	10% ± SE	20% ± SE	
Mash (g/duck)	1491±13.41^{a}	1577±12.24^{b}	1533±12.24^{ab}	1534±7.30^{a}
Pellet (g/duck)	1530±12.24^{a}	1503±12.24^{a}	1512±12.24^{a}	1515±7.06^{a}
Average (g/duck)	1511±9.07^{a}	1525±8.65^{a}	1522±8.65^{a}	

Note: Different superscript letters in each row and column shows a significant difference (P<0,05); SE (Standard error).

The average body weight gain (BWG) of ducks supplemented with 10% essential amino acids (EAAs) in mash-type feed was the highest (1,577 g/duck) compared to other treatments. The average BWG obtained from the treatment rations in this study was classified as normal, except for the control treatment (T1), which remained below 1,500 g. Feed quality, including its nutritional composition, is a major factor influencing body weight gain in poultry. Normal growth in ducks can be achieved when the diet provides adequate levels of energy, protein (amino acids), vitamins, and minerals [3].

The results of this study indicate that other nutrients, such as protein and dietary energy, also play essential roles in meeting the nutritional requirements necessary to enhance body weight gain in ducks. A protein content of 16% and metabolizable energy of 2,700 kcal/kg in the ration were considered sufficient to support optimal body weight gain during the grower period. The addition of various levels of EAAs in the ration may act synergistically to facilitate metabolic processes and create a balanced nutrient profile to meet the ducks' physiological needs. The findings demonstrated that the best body weight gain during the grower period was achieved with the addition of 10% EAAs in mash-type feed.

3.3 Feed conversion ratio (FCR)

To evaluate the effect of treatment rations on the feed conversion ratio (FCR) of ducks during the grower period (9–20 weeks of age), weekly calculations were made based on feed consumption (FC) and body weight gain (BWG). The average FCR of Alabio ducks fed different levels of essential amino acids (EAAs) in two types of feed (mash and pellet) is presented in Table 4.

Table 4. The average FCR of Alabio ducks with supplementation of various levels of EAAS in two types of rations from 9 to 20 weeks of age.

Types of feed	Esential amino acids levels			Average±SE
	0% ± SE	10% ± SE	20% ± SE	
Mash (g/duck)	6.41±0.10	6.08±0.09	6.03±0.09	6.17±0.05^{a}
Pellet (g/duck)	5.69±0.09	5.54±0.09	5.77±0.09	5.67±0.05^{b}
Average (g/duck)	6.05±0.07^{a}	5.81±0.06^{b}	5.90±0.06^{ab}	

Note: Different superscript letters in each row and column shows a significant difference (P<0,05); SE (Standard error).

The average FCR of ducks was significantly affected ($p<0.05$) by the addition of various EAAs levels in the ration. Similarly, feed type (mash or pellet) had a significant effect ($p<0.05$) on duck FCR. The average FCR of ducks fed mash and pellet diets were 6.17 and 5.67, respectively, with the pellet diet showing better FCR performance than the mash diet (Table 4). The average FCR resulting from the addition of 0, 10, and 20% EAAs levels in the feed were 6.05, 5.81, and 5.90, respectively. These values indicate a decreasing trend in FCR with increasing EAAs supplementation, a pattern consistent in both ration forms (mash and pellet).

The lowest feed conversion ratio (FCR) was observed in the T5 treatment, which involved the addition of 10% essential amino acids (EAAs) in the pelleted ration. During the observation period, supplementation with 10% EAAs reduced the average FCR by 4.13% compared to the control ration (Table 4). The average FCR of ducks receiving various EAA levels in mash-type feed ranged from 6.03 to 6.41, while that in pellet-type feed ranged from 5.54 to 5.69. The average FCRs obtained from the control rations (0%), formulated according to the Indonesian National Standard for Animal Feed (SNI), were higher than those of the rations supplemented with EAAs. The SNI specifies a minimum protein content of 15% for laying duck grower rations [11].

In poultry production, including duck farming, a reduced FCR during the rearing period provides substantial benefits to producers. The results of this study showed that supplementation with various levels of EAAs in the feed had a significantly positive effected on the FCR of ducks aged 9–20 weeks (grower period). The synergistic combination of five EAAs added to the feed effectively reduced the FCR of ducks. Supplementation with different EAA levels in the ration enhanced metabolic processes and contributed to a more balanced nutrient profile, which in turn supported better nutrient utilization and lower FCR values.

The findings indicated that duck FCR decreased as the level of EAAs supplementation increased. This trend is consistent with previous findings reporting that feed efficiency in Pekin ducks improves as lysine content in the diet increases [13]. The favorable FCR values observed in this study were also influenced by other nutrient components, such as protein and energy levels, in the ration. A protein content of 16% and an energy level of 2,700 kcal/kg, combined with a 10% increase in EAAs over the control ration, resulted in a relatively low FCR. As shown in Table 4, the T5 treatment, which included a 10% increase in EAAs in the pelleted ration, was the most effective in achieving the lowest FCR during the 9–20 week grower period.

3.4 Live body weight (LBW)

The live body weight (LBW) of the livestock studied is a crucial parameter for further evaluation. This experiment also aimed to determine the effect of supplementing different levels of essential amino acids (EAAs) in two types of rations (mash and pellet) on LBW of the ducks. The provision of treatment rations had no significant effect ($P>0.05$) on the live body weight of Alabio ducks at 20 weeks of age. Similarly, the addition of different EAA levels to the two ration forms (pellet and mash) did not significantly affect LBW. The average LBWs of ducks fed rations containing various EAA levels were 1,529, 1,543, and 1,541 g/duck, respectively, while the average LBWs of ducks fed mash and pellet rations were 1,536 and 1,540 g/duck, respectively (Table 5).

Table 5. The average live body weight (LBW) of Alabio ducks with supplementation of various levels of EAAs in two types of ration from 9 to 20 weeks of age

Types of feed	Esential amino acids levels			Average±SE
	0% ± SE	10% ± SE	20% ± SE	
Mash (g/duck)	1529±13.35	1547±12.19	1533±12.19	1536±7.26[a]
Pellet (g/duck)	1530±12.19	1540±12.19	1550±12.19	1540±7.03[a]
Average (g/duck)	1529±9.04[a]	1543±8.62[a]	1541.40±8.62[a]	

Note: Different superscript letters in each row and column shows a significant difference (P<0,05); SE (Standard error).

During the 10-week observation period, the interaction between EAA level and ration form (pellet or mash) on duck LBW was not significant effect (P>0.05). These results indicate that EAA supplementation at different levels and in different ration forms did not interact to influence LBW at 20 weeks of age, marking the end of the grower period. However, as shown in Table 5, there was a tendency for increased LBW with higher levels of EAAs supplementation in both ration forms. The increase in LBW at 20 weeks with the T2 treatment (10% EAAs, mash ration) was 1.19% higher than that of the T1 control, while the T5 treatment (20% EAAs, pellet ration) showed a 1.30% increase compared with the T4 control.

Table 5 shows that although the live body weight (LBW) values of Alabio ducks at the end of the study were not significantly affected by treatment, there was a clear trend of increasing LBW with higher levels of essential amino acid (EAAs) supplementation in both ration forms compared with the control treatments (T1 and T4). Increasing the lysine content in the ration has been reported to enhance and stimulate the growth rate of Pekin ducks reared from 7 to 21 days of age [13]. Higher live body weights in ducks have also been associated with increased total lysine levels in the diet [14]. The results of this study are consistent with these findings.

A relatively fast growth rate in Pekin ducks has also been reported in other studies [13, 15]. In addition to genetic factors, management practices and the appropriate nutrient composition of feed have been emphasized as key factors influencing duck performance [15]. The present findings demonstrate that supplementation of EAAs in the ration can increase the body weight of Alabio ducks during the grower period (9–20 weeks of age). From an efficiency perspective, the most effective EAA level for improving duck body weight was 10% above the recommendations of the Indonesian National Standard for Animal Feed (SNI) [11], particularly when provided in pelleted form. Overall, this study demonstrates that supplementation with EAAs at 10% of the SNI (2017) recommendation yields the best performance, particularly in terms of feed efficiency, in Alabio ducks aged 9–20 weeks.

4 Conclusion

Supplementation with various levels of essential amino acids (EAAs) namely lysine, methionine, threonine, arginine, and tryptophan—into two types of rations (mash and pellet) improved the performance of Alabio ducks during the grower period (9-20 weeks of age). The best treatment for increasing feed efficiency and reducing the feed conversion ratio (FCR) was supplementation with 10% EAAs in the pelleted ration.

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