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The effect of different energy-protein ratio in diets on feed digestibility and performance of native chickens in the starter phase

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Abstract

The present study was conducted to determine the effects of different energy-protein ratio in diets on feed digestibility and performance of native chickens in the starter phase. A total of 128, 1-d-old healthy male native chickens were randomly divided into four treatment diet groups: A) diets containing metabolic energy (ME) 3100 kcal/kg with crude protein (CP) 22%; B): diet containing 3000 kcal/kg ME with CP 20%; C): diets containing ME 2900 kcal/kg with 18% CP (C); and D): diet containing ME 2800 kcal/kg with 16% CP, respectively. There were four replications, resulting in 16 pens, which contained 8 birds each. The results showed that there was no significant difference ($P>0.05$) in feed consumption and feed digestibility between group treatments. Final body weight and live weight gains, the highest ($P<0.05$) obtained in birds Group A and B, conversely, the lowest was found in Group C and D. FCR between treatments showed significant differences ($P<0.05$). The highest feed efficiency was found in Groups A and B, on the contrary, the lowest was found in Groups C and D. It can be concluded the decrease of metabolic energy content and protein content in the ration resulted in higher performance of native chickens, but did not affect feed digestibility.

Keywords: Metabolizable energy, protein, feed efficiency, chickens

Introduction

The development of native chicken farms lately is increasingly being cultivated, both in rural and urban areas. This aims to increase the need for animal protein and increase family income in rural areas, because native chickens are easily maintained and can be sold at any time for urgent needs (Mardiningsih *et al*., 2004) [16]. As reported by Joshi *et al*. (2014) [12] that demand for animal protein, continues to increase to meet the increasing needs of human animal protein. Efforts to maintain native chicken among rural communities are generally still carried out traditionally, so that the results obtained are still relatively low, so in an effort to develop native chicken farms with intensive maintenance patterns have agribusiness-oriented business prospects (Dinata *et al*., 2019) [8]. Generally, the component cost of feed ranges from: 60-70% of the total production cost (Singh *et al.*, 2015) [22].

Increasing the productivity of broilers is continuously being improved, because chicken meat is becoming increasingly important in meeting global demand to meet the growing human population. However, a sustainable poultry business is faced with an increase in the cost of feed ingredients. Reducing the protein content in diets, has been shown to suppress nitrogen excretion and has the potential to reduce feed costs (Yin *et al*., 2019) [28]. Considering the cost of feed is the largest cost of total production costs, research on ration formulations that are in line with the needs of native chickens needs to be done to address the increasing demand for animal protein (Mohanty *et al.*, 2015) [19]. Maximum production efficiency can be obtained by providing a balanced diet according to poultry needs, which varies according to the age and level of poultry production (Udayana *et al.*, 2020) [24]. A balanced ration formulation between energy and protein, as well as perfect is to meet the energy and protein needs of the body of poultry, to support optimal poultry growth.

The biological value of proteins from various feed ingredients, directly depends on the availability of essential amino acids and the metabolic energy content in diets (Bidura *et al.*, 2010) [3]. Therefore, the correct protein level of high biological value in the ration is very important for optimal animal performance. In addition, giving poultry rations must refer to the nutrients needed by poultry.

The balance between energy and protein in diets has a very important role in the preparation of diets for native chickens. If it is not balanced, it can cause excess or lack of energy and protein intake in the body (Bidura *et al.*, 2010) [3], so that the growth of chickens becomes inhibited. Until now, the standard formulation of diets for native chickens still refers to the recommendations of Scott *et al.* (1982) [21] and NRC (1994) [20]. According to Scott *et al.* (1982) [21], the ME requirements for mild-type chickens aged 2-8 weeks between: 2600-3100 kcal/kg and CP between: 18-21.4% with the ME and CP ratio being: 144-144.86. NRC (1994) [20] recommends that ME and CP requirements are: 2900 ME kcal/kg and 18% CP, with an ME and CP ratio of 161. Energy content and balance between ME and CP in the ration, greatly affect the performance of poultry. Fat supplementation and increased concentration of nutrients in the diet are reported to significantly increase body weight and feed efficiency (Song *et al.*, 2003; Hastad *et al.*, 2005) [23, 11].

Increased protein content in rations causes an increase in the amount of protein consumed by chickens. In addition, ration adjustments are intended to maximize production performance without regard to excess supply of nutrients, namely protein and amino acids (Lee *et al*., 2001; Mahardika *et al*., 2013) [13, 15]. Reducing protein concentration in diets will reduce feed costs; Therefore, the diet is formulated with standard or relatively low protein levels. This approach is indispensable for developing ration formulations with low protein content, and if successful, will lead to more efficient and sustainable chicken meat production (Yin *et al.*, 2019) [28].

Rations containing high energy and high protein can accelerate growth and improve feed efficiency. Therefore, this study aims to determine the effect of the balance between metabolizable energy (ME) and crude protein (CP) in diets on the digestibility of dry matter and the performance of native chickens in the starter phase.

Materials and Methods

Experimental design, animals, housing, and diets

All male native chickens were randomly allocated to four treatments with four replications, and the cage used ten chickens per unit of cage. Feed treatment consisted of A): diets containing metabolizable energy (ME) 3100 kcal/kg with crude protein (CP) 22%; B): diet containing 3000 kcal/kg ME with CP 20%; C): diets containing ME 2900 kcal/kg with 18% CP (C); and D): diet containing ME 2800 kcal/kg with 16% CP. All treatment chickens were fed *ad libitum*, and had free access to clean drinking water. There were 16 battery colony cages, with a cage size: 80x50x50 cm (length×width×height) with 8 chickens in each cages. The chickens used were one day old chickens (DOC) with a homogeneous average body weight (26.8 $\pm$ 2.13 g). Chicken weighing was done once on the same day during the trial period (age 0-8 weeks), and their weight was recorded to determine daily weight gain (ADG).

Retention and excretion of nutrients

To determine the digestibility of dry matter from the ration, which is the total collection method for three days. The number of rations given to chickens is as much as 30 g/bird, this amount is based on preliminary tests with the consumption of native chickens rations. All chickens are not fed for 24 hours to ensure that their digestive tract is empty of leftovers. They were then given a diet with a certain amount of diet (all treatments for three days). Drinking water is available *ad libitum* during the trial period. Total excreta for three days was collected in a plastic tray. Stool samples were frozen, allowed to reach equilibrium with atmospheric humidity, weighed, and pounded through a 1 mm sieve. Excreta and diet samples, analyzed to determine dry matter (DM). Dry matter (DM) is carried out according to AOAC (2005) [1]. All analyzes were carried out in triplicate.

The diet was formulated to meet nutritional requirements for poultry (NRC., 1994) [20] for an eight-week trial. The Feed ingredients and nutrient composition of experiment diets was shown in Table 1. Each experimental diet in the form of mash and chickens has free access to eat and drink water during the experiment.

Table 1: Feed ingredients and nutrient composition of experiment diets

Ingredients (%)		ME-CP ratio in Diets			
		A	**B**	**C**	**D**
Yellow corn		60.5	57.4	55.8	57.6
Rice bran		2.9	8.3	15.2	17.2
Coconut oil		1.7	2.0	1.8	0.9
Coconut meal		5.2	7.2	7.0	9.0
Fish meal		20.0	15.0	11.0	6.0
Soybean		9.4	9.8	8.9	9.0
NaCl		0.3	0.3	0.3	0.3
Total		100	100	100	100
Chemical compositions*					
Gross energy	(Kcal/kg)	3783	3611	3525	3352
Metabolizable energi	(Kcal/kg)	3165	2934	2836	2823
Crude protein (%)	(%)	21.58	20.85	17.30	15.33
Crude fibre (%)	(%)	4.26	4.77	4.14	6.54
Ether extract (%)	(%)	4.93	6.46	5,78	3.53
Calcium (%)	(%)	1.48	1.22	0.92	0.84
Phosphor (%)	(%)	0.93	0.88	0.74	0.7

Note:

1. Calculations based on the recommendations of Scott *et al.* (1982) [21]
2. The diets containing metabolic energy (ME) 3100 kcal/kg with crude protein (CP) 22%; B): diet containing 3000 kcal/kg ME with CP 20%; C): diets containing ME 2900 kcal/kg with 18% CP (C); and D): diet containing ME 2800 kcal/kg with 16% CP, respectively.

Live performance

Continuous lighting and access to food and drinking water were provided during the trial period. Body weight, weight gain, feed consumption, and feed conversion ratio (feed consumption: body weight gain) for chickens, recorded separately from week 1 to week 8. Feed consumption (grams per head) is recorded every week at each replication by weighing the rest of the ration. Total feed consumption for each test was measured during the trial period. Feed conversion ratio (FCR) is calculated as grams of feed consumed per gram of body weight gained. The physical picture of native chickens in Bali Province, Indonesia, is presented in Figure 1.

Fig 1: Native chickens in the Province of Bali

Statistical analysis

All data were analyzed by one-way ANOVA to determine the differences among treatments. Statistical differences between diets were separated by Duncan's multiple range tests difference was considered significant at *P*<0.05.

Results and Discussion

The results of the study are presented in Table 2. Consumption of ration and digestibility of dry matter between treatments did not show a significant difference (*P*>0.05). However, final body weight, daily weight gain, and FCR (feed consumption: body weight gain), showed a significant difference (*P*<0.05) between treatments.

The final body weight and body weight gain in Group B, C, and D chickens did not show significant differences (*P*>0.05). However, when compared with the final body weight of Group D chickens, it showed a significant difference (*P*<0.05). The highest final body weight and chicken weight gain were obtained by Group A chickens, and the lowest in Group D chickens. The low final weight and weight gain in Group D chickens was due to the low CP content in the feed. As reported by Fancher and Jensen (1989) [10], a decrease in CP content in the ration should be followed by an increase in amino acid supplementation to maintain the same growth performance. The balance of different amino acids in diets also affects the utilization of nitrogen and other nutrients (Zhao *et al.*, 2019) [29]. Decreased CP consumption causes a decrease in protein retention, thus inhibiting chicken growth. This is caused by the lack of CP to be used for the synthesis of chicken body components (Mahardika *et al.*, 2013) [15]. In addition, increased protein retention is also supported by an increase in the balance between metabolic energy and protein in the ration. Decreased protein consumption causes a decrease in protein retention thereby reducing growth. This is caused by the lack of protein to be used for the synthesis of chicken body components. In addition, the increase in protein retention is also supported by an increase in the ME ratio (Mahardika *et al.*, 2013) [15]. In addition, chicken growth is also influenced by the energy content in the ration. Yi *et al.* (2010) [27] reported that reducing the ME content in a diet that was low in CP, could increase carcass weight, and was no different from the group of pigs fed a normal protein content. The ME and CP balance in the ration greatly influences the growth of poultry. As reported by NRC (1994) [20], ME requirements for ducks aged 0-8 weeks were: 2900 kcal/kg and CP: 16-22%, whereas according to Farell (1995) [9], ME requirements are 2900 kcal/kg and protein 18%. Cerrate and Corzo (2019) [6] suggest different energy levels and amino acids are used in different regions, although it is not known how much of these food nutrients can affect feed costs or poultry performance. Ariesta *et al.* (2015) [2] reported that the growth of native chickens that received rations with higher protein content, was actually better than chickens that received rations with lower ME content and CP content. Increased energy and protein content can cause an increase in the amount of energy that is retained in a chicken's body. This shows, that chickens which get rations with higher ME and CP content, will have better growth (Mahardika *et al.*, 2013) [15]. Carstens (2013) [5] apparently found no difference in chicken weight gain for the three CP level treatment groups (16.8%; 20.3%; and 23.5%) in pre-starter chicken. Increased CP content in the ration, will generally be followed by an increase in amino acid content, especially methionine which can stimulate chicken growth (Wen *et al.*, 2017) [26]. Conversely, a decrease in CP concentration in feed results in a decrease in chicken performance (Brand *et al.*, 2019) [4].

Table 2: Effect of energy-protein ratio in diets on feed digestibility and performance of native chickens in the starter phase (0 to 8 weeks old)

Variables	Groups[1]				SEM[2]
	A	B	C	D	
Feed consumption (g/bird/days)	1104.99^{a}	1055.38^{a}	1029.82^{a}	977.21^{a}	46.62
Initial body weight (g)	26.82^{a}	26.79^{a}	26.85^{a}	26.83^{a}	0.001
Final body weight (g)	542.00$^{a3)}$	497.85^{ab}	437.82^{b}	391.25^{c}	20.95
Body weight gains (g/bird/56 days)	515.18^{a}	471.06^{ab}	410.97^{b}	364.42^{c}	19.02
Feed conversion ratio (feed consumption: body weight gain)	2.15^{a}	2.24^{a}	2.15^{a}	2.70^{b}	0.051
Dry matter digestibility (%)	76.61^{a}	73.00^{a}	73.16^{a}	74.90^{a}	2.07

Note:

1. Group A): The diet contains ME 3100 kcal/kg with 22% CP; B): the diet contains 3000 kcal/kg of ME with 20% CP; C): diet contains 2900 kcal/kg of ME with 18% CP (C); and D): the diet contains 2800 kcal/kg of ME with CP 16%, respectively.
2. SEM: Standard Error of Treatment Means
3. Means with different superscripts within raw values are significantly different (*P*<0.05)

FCR value is the ratio between the amount of ration consumed with weight gain in the same time unit. The lower the FCR value, means the more efficient the chicken uses the ration to produce weight gain. The mean FCR in chicken of Group B, C and D did not show a significant difference (*P*>0.05). However, compared to Group D, it showed a significant difference (*P*<0.05). The highest FCR values were obtained in Group D chickens and were significantly (*P*<0.05) higher than those in Group B, C and D. According to Lloyd *et al.* (1978) [14], the amount of CP and ME consumed by chickens will increase feed efficiency and chicken performance. The reduced ME and CP content will cause lower CP digestibility and decrease protein retention, thereby reducing feed efficiency (Mahardika *et al.*, 2013) [15]. The same thing was reported by Dewi *et al.* (2011) [7] that rations with high ME and CP content, tend to accelerate growth and increase feed conversion. In Figure 2, a graph showing the average FCR values for eight weeks of observation.

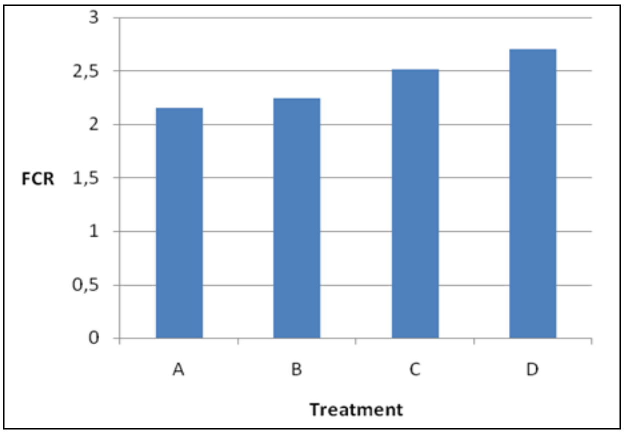

Fig 2: Effect of energy/protein ratio in the ration on FCR values in the native chickens starter phase

The balance between energy and protein in the ration did not significantly (P>0.05) affect the digestibility of dry matter (Table 2). Generally in poultry, the main factors affecting the digestibility of dry matter are the level of solubility of feed ingredients and crude fiber content (Bidura *et al.,* 2010) [3]. Poultry cannot digest crude fiber, because poultry does not have enzymes that digest fraction of crude fiber (cellulose, hemicellulose, lignocellulose). The level of crude fiber content in the digestive tract of poultry has beneficial physiological effects, as well as negative effects (Mateos *et al.*, 2012) [17]. According to Bidura *et al.* (2010) [3], crude fiber in the chicken's digestive tract can help ventricular peristalsis and be able to trap fat, so that deposition of fat into body tissue decreases. Feed fiber has an impact on chicken, such as feed intake, digestive tract rate, digestive tract development, digestive enzyme secretion, nutritional utilization, production performance, animal physiochemical status, digestive tract health, intestinal microbiota, and contribute to the distinctive taste of chicken meat (Wahyu, 1992; Mead *et al.*, 1983) [25, 26]. Similar results were reported by Ariesta *et al*. (2015) [2] that the decrease in ME content and CP content in the ration did not affect the digestibility of dry matter and digestibility. crude protein. Although there is no difference in digestibility, the amount of protein digested will increase with the increase in CP content of the feed (Dewi *et al.*, 2011) [7]. The amount of protein stored depends on the amount of protein (amino acids), the quality and quantity of protein supplied (Bidura *et al.*, 2010) [3]. Protein retention rate is influenced by CP consumption and ME of the ration. Reported by Lloyd *et al.* (1978) [14] that the amount of protein in the feed will determine the level of chicken production or growth. Reported by Udayana *et al*. (2020) [24] that a decrease in metabolic energy content and protein content (ME/CP ratio) in the ration, can reduce the performance of ducks in the growth phase, but does not significantly affect the digestibility of dry matter and protein absorption.

Conclusion
It can be concluded the decrease of metabolic energy content and protein content in the ration resulted in higher performance of native chickens in starter phase, but did not affect feed digestibility.

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