Effect of energy-protein ratio in diets on Balinese duck (Anas sp) performance and feed digestibility

I Dewa Gede Alit Udayana, IG Mahardika, IK Sumadi, K Budaarsa and IGNG Bidura

Abstract

The present study was conducted to determine the effects of energy-protein ratio in diets on Balinese duck performance and feed digestibility. A total of 120, 1-d-old healthy male Bali duck (Anas sp) were randomly divided into four treatment groups: i) The ration contains metabolic energy (ME) 3150 kcal/kg with 22% crude protein as a control (A); the ration contains 3000 kcal/kg of metabolic energy with 20% protein (B); ration contains 2850 kcal/kg of metabolic energy with 18% (C) protein; and ration contains 2700 kcal/kg of metabolic energy with protein 16% (D), respectively. There were six replications per treatment, resulting in 24 pens, which contained 5 birds each. The results showed that there was no significant difference ($P>0.05$) in feed intake, dry matter digestibility and protein digestibility between all treatments. Final body weight and live weight gains, the highest ($P<0.05$) obtained in ducks fed ration A, conversely, the lowest was found in treatment D. Likewise, the lowest feed efficiency ($P<0.05$) was found in ducks that were treated D. It was concluded that the decrease in metabolic energy and protein in the ration significantly decreased the performance of male Bali ducks in the starter phase and did not affect the digestibility of dry matter and protein ration.

Keywords: Metabolic energy, protein, digestibility, performers, Balinese duck

Introduction

Bali duck (Anas sp) is a germplasm native to Indonesia, which is widely developed in the Province of Bali, and this duck is a dual-function livestock, namely for broilers and laying (Bidura, 2019) [1]. In the province of Bali, these ducks are widely used to support traditional ceremonies, laying and as a provider of animal protein which is increasingly favored by foreign tourists. The colors of Bali duck feathers are diverse, there are white, sumi (light brown), black and so on (Fig.1). As a result, various studies have been carried out to better understand the nutritional needs of Bali ducks (Bidura, 2019; Bidura et al., 2012; Bidura et al., 2019) [5, 8, 7]. Nutritionally, the source of protein in the food of all livestock species is very important. It is estimated that 70-80% of input costs in poultry farming are related to feeding. Protein from duck meat has played an indispensable role in requirements the needs of quality animal protein for human populations in developing countries (Adeola, 2006) [1]. Duck meat is becoming increasingly popular throughout the world because of its appetizing taste, nutritional value, and specific taste (Liao et al., 2010) [22]. In recent years, there has been an increase in consumption of duck meat to obtain certain nutritional properties. In the actual process of duck production, it turns out that ducks have a strong resistance to the environment and a variety of fibrous feed ingredients (Bidura, 2019; Wang et al., 2017) [5, 7]. Demand for animal protein continues to increase to meet the nutritional needs of the growing human population (Joshi et al., 2014) [20]. Ducks are the second largest source of eggs and there are around 23 million ducks in India. Egg ducks are preferred over chicken eggs in certain countries and regions, because of economic and nutritional interests. Compared to ducks, chicken farms require less complicated cages. They are stronger, easier to maintain and more resistant to general avian diseases. Considering the importance and scope of raising ducks, further research can be carried out by introducing good feed formulations and nutritional management to address the growing demand for animal protein (Mohanty et al., 2015) [27]. Feed is an important and critical input for the poultry industry because it accounts for 60-70% of production costs (Singh et al., 2015) [31]. Maximum productive and reproductive efficiency can be obtained by providing a balanced diet according to their needs, which varies according to age and production level of ducks. A balanced duck ration is to meet the needs of...
energy and protein to support growth and proforman production. The nutritional value of proteins from various feed ingredients directly depends on the availability of critical amino acids. Therefore, the correct protein level of high biological value in the ration is very important for optimal livestock performance (Bidura et al., 2010) [6]. Feeding livestock must refer to the nutrients needed by livestock. The content and balance between energy and protein in the diet greatly affects the performance of ducks. Fat supplementation and increased concentration of nutrients in the diet have been reported to increase weight gain and feed efficiency (Song et al., 2003; Hastad et al., 2005) [18, 17]. Wahyu (1992) [36] found that growing animals fed diets with high energy densities had greater growth and feed efficiency, associated with increased feed intake and digestibility, compared to animals fed with low energy densities. Increased nutrient density, such as protein and energy, is expected to increase nutrient intake and weight gain. Protein balance includes consumption of protein, lost protein in stool, digestible protein and protein that is retained in the body. Increased dietary protein content causes an increase in the amount of protein consumed by chickens (Mahardika et al., 2013) [29]. In addition, dietary adjustments are aimed at maximizing production performance without regard to excess supply of nutrients, namely proteins and amino acids (Lee et al., 2001) [21]. However, several studies have found that energy levels in the diet do not affect growth performance in weaned piglets (Tokach et al., 1995; Smith et al., 1999) [35, 52]. Decreased protein consumption causes decreased protein retention thereby reducing growth. This is due to the lack of protein that will be used to arrange the chicken body components. In addition, the increase in protein retention is also supported by an increase in the ration of the metabolic energy (Mahardika et al., 2013) [24]. Bidura et al. (2010) [6] reported that the level of protein retention is influenced by the consumption of protein and the metabolic energy of the ration. Furthermore Lloyd et al. (1978) [23] states that the amount of protein that is retained will determine the level of production or growth of chickens. Decreased energy and protein content will cause lower protein digestibility and decreased protein retention so that it will reduce growth (Mahardika et al., 2013) [24]. The ration with high energy and protein tended to accelerate growth and improve feed conversion. From the manufacturer’s point of view, the most feasible solution in terms of nutrition without reducing product quality, is the most desirable. Until now the standard of duck nutrition used in Indonesia is based on the recommendation of NRC (1994) [28]. According to NRC (1994) [28], the metabolic energy requirements for 0-8 week ducks between 2900 kcal/kg and protein 16-22%, whereas according to Farell (1995) [15], the need for metabolic energy is 2900 kcal/kg and 18% protein. The standard is actually for ducks in sub-tropical regions, while the energy and protein requirements for ducks raised in the tropics have not been established. Therefore, energy and protein requirements for ducks in Indonesia in general and Bali ducks in particular, need to be examined. Cerrate and Corzo (2019) [12] suggest different energy levels and amino acids are used in different regions, although it is not known how much these food nutrients can affect feed costs or biological nutritional requirements and the performance of poultry. The purpose of this experiment was to determine the effect of the balance between crude protein (CP) and metabolic energy (ME) in the diet on the growth performance and digestibility of dry matter in growing Bali ducks (Anas sp).

Material and Methods

Animal treatments and experimental design. The birds were randomly allocated to four treatments with four replicate cages of five birds per pen. The dietary treatments consisted of A): The ration contains metabolic energy (ME) 3150 kcal/kg with 22% crude protein as a control; B): the ration contains 3000 kcal/kg of metabolic energy with 20% protein; C): ration contains 2850 kcal/kg of metabolic energy with 18% protein (C); and D): ration contains 2700 kcal/kg of metabolic energy with protein 16%, respectively. The bird were fed their diets ad libitum, and had free access to clean fresh water. There were 24 pens, each having a floor area of 100x50x50 cm (length×width×height) with 5 ducklings in each pen. The individual body weight of ducklings was recorded up to 1g sensitivity with electric scales. They were weighed once weekly on the same day for the duration of the trial, and their live weights were recorded to determine ADG. The diets were formulated to meet the nutrient requirements for poultry (NRC., 1994) [28] for eight weeks of experiment. The chemical compositions of experimental diets are shown in Table 1. Each experimental diet was in mash form and the birds had free access to feed and water throughout the experiment.

<table>
<thead>
<tr>
<th>Chemical compositions*</th>
<th>ME-CP ratio in Diets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Metabolic energy (Kcal/kg)</td>
<td>3150</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>22</td>
</tr>
<tr>
<td>ME:CP ratio (%)</td>
<td>143</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td>4.10</td>
</tr>
<tr>
<td>Ether Extract (%)</td>
<td>3.51</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.42</td>
</tr>
<tr>
<td>Phosphor (%)</td>
<td>0.65</td>
</tr>
</tbody>
</table>

*: Based on calculation according to NRC (1994) [24]

Live performance. Continuous lighting and access to feed and water was provided throughout the experiment. Body weight, weight gain, feed intake and feed conversion ratio for birds were recorded separately from week 1 until week 8. Feed consumption (gram per bird) was recorded weekly at each replication by weighing the remaining diet. The total feed intake for each replicate was measured during the test experiment period. The FCR was calculated as gram of feed consumed of per gram body weight gained.

Fig 1: Physical body shape and color of feathers on Bali ducks (Anas sp)

At the end of the feeding experiment, birds were weighed and feed consumption was recorded by replicate to calculate
average daily gain (ADG), average daily feed intake (ADFI) on the basis of DM, and feed conversion ratio (FCR, feed DM intake/weight gain). Birds were deprived from feed for 12 h (water was provided) before weighing to ensure the emptying of the digestive tract of the bird (Wang et al., 2017) [37]. Mortality was recorded on a daily basis as it occurred. Any bird that died or was removed was weighed and used to correct FCR.

Retention and excretion of nutrients. To determine the digestibility of nutrients (dry matter and protein digestibility) from the ration: The amount of ration used is 100 g, this amount is based on preliminary tests with the consumption of local duck rations. All birds are not fed for 24 hours to ensure that their digestive tract is empty of leftovers. They are then fed with a certain amount of diet (all treatments) using a 40 cm plastic tubing funnel used in forced feeding techniques (Bidura et al., 2012). Water is available ad libitum during the trial period. Total excreta collected in a plastic tray. The excreta sample is cleaned, then frozen, and allowed to reach equilibrium with atmospheric humidity, weighed, and pounded through a 1 mm sieve. The excreta and diet samples were carried out with appropriate analyzes to determine the dry matter (DM) and crude protein (CP), respectively. Dry matter (DM) and CP, as well as ash determinations were done according to the Association of Official Analytical Chemists (2005) [21]. All assays were conducted in triplicate.

Statistical analysis. All data were analyzed with ANOVA to determine the differences among treatments. If differences were found, then further analysis was performed with Duncan’s multiple range test.

Results
Final body weight, daily weight gain, feed conversion ratio (feed consumption: body weight gains), dry matter digestibility, and protein digestibility are presented in Table 2. The results showed that the difference in the ratio of energy to protein in the ration did not show any significant difference (P>0.05) in ration consumption, dry matter digestibility and protein digestibility. The average final body weight between treatments showed a significant difference (P<0.05). The final duck body weight in Group A was 1267.90 g/head (Table 2). Final weight of Group B, C and D ducks was: 2.74%; 14.64%; and 32.94% were significantly lower compared to The average live weight gains in Group A ducks was 20.31 g/birds/day. The average live weight gains of Group B, C and D of ducks, decreased significantly (P<0.05), namely: 2.36%; 14.82%; and 33.97% were lower than Group A. The highest average weight gain was found in Group A and the lowest was found in Group D.

Table 2: Effect of energy-protein ratio in diets on duck performance and feed digestibility

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups&lt;sup&gt;1&lt;/sup&gt;</th>
<th>SEM&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Initial body weight (g)</td>
<td>45.44a</td>
<td>44.36a</td>
</tr>
<tr>
<td>Final body weight (g)</td>
<td>1267.90a</td>
<td>1233.17b</td>
</tr>
<tr>
<td>Body weight gains (g/bird/days)</td>
<td>20.31a</td>
<td>19.83a</td>
</tr>
<tr>
<td>Feed consumption (g/bird/days)</td>
<td>67.23a</td>
<td>65.84a</td>
</tr>
<tr>
<td>Feed conversion ratio (feed consumption: body weight gain)</td>
<td>3.31a</td>
<td>3.32a</td>
</tr>
<tr>
<td>Dry matter digestibility (%)</td>
<td>76.54a</td>
<td>73.07a</td>
</tr>
<tr>
<td>Crude protein digestibility (%)</td>
<td>91.96a</td>
<td>91.32a</td>
</tr>
</tbody>
</table>

Note:
1. A): The ration contains metabolic energy (ME) 3150 kcal/kg with 22% crude protein as a control; B): the ration contains 3000 kcal/kg of metabolic energy with 20% protein; C): ration contains 2850 kcal/kg of metabolic energy with 18% (C) protein; and D): ration contains 2700 kcal/kg of metabolic energy with protein 16%, respectively. 
2. SEM: Standard Error of Treatment Means.
3. Means with different superscripts within raw values are significantly different (P<0.05)

The average FCR value for eight weeks observed in treatment A was 3.31/bird. The average FCR values in treatment ducks A, B, and C, were not significantly different (P>0.05). However, the mean FCR values in treatment D ducks were significantly different (P<0.05) lower than those in treatments A, B and C (Table 2). Differences in energy balance: protein (ME/CP ratio) in the ration did not show a significant effect (P>0.05) on the digestibility of dry matter and protein digestibility.

Discussion
The provision of rations with different energy and protein (ME/CP ratios), apparently affects the final body weight and live weight gains of the Bali duck. Duck weight loss is very visible due to a decrease in energy and protein content in the ration (Groups B, C and D). The more decreased ME and CP content in the ration, causing a significant decrease in final body weight and weight gain. This is due to the decrease in protein intake which is a major component for the synthesis of tendon.

Decreased energy and protein content will cause lower protein digestibility and decreased protein retention so that it will reduce growth (Mahardika et al., 2013) [24]. Soeharsono (1976) [53] found that rations with high energy and protein tended to accelerate growth and improve feed conversion. The results of the study were supported by the research of Dewi et al. (2011) [14] that native chickens fed rations containing higher energy and protein balance produced significantly higher body weight compared to rations containing lower energy and protein balance at 8 weeks of age. This final weight loss in Grup B, C, and D were caused by reducing the consumption of nutrients (energy and protein) which were caused by decreasing energy content and protein ration. Energy and protein are the main nutrients that influence chicken growth. Decreased consumption of these nutrients will cause a decrease in chicken growth (Mahardika et al., 2013) [24]. Candrawati (1999) [10] found that native chickens given rations with an energy content of 3100 Kcal/kg and crude protein 22% of their body weight for 8 weeks were 542 g/head whereas those who received rations
with 2823 K.cal/kg energy and 15.33% crude protein was 391 g/head. Ariesta et al. (2015) [3] stated that growth from native chickens that received higher protein energy was better than native chickens that received lower energy and protein rations. The increase in the amount of energy and protein ration causes an increase in the amount of energy which was retained by chickens. This shows that chickens that get food with higher energy and protein content will have better growth (Mahardika et al., 2013) [24]. Gandini et al. (1986) [16] reported that superior growth occurs in the pre-starter phase, if proteins ranging from 160 g/kg to 180 g/kg of feed, are present in food. However, a recent study by Carstens (2013) [11] found no difference in live weight gains for the three treatment groups (168 g protein/kg of feed, 202.8 g of protein/kg of feed and 234.8 g of protein/kg of feed) used in pre-starter stage.

Energy requirements for growth are the amount of energy retained in the body that is corrected with partial efficiency. The total energy needs of chickens that are growing are energy for basic life plus energy to grow (Mahardika et al., 2013) [24]. Protein requirements for growth are calculated from the amount of protein retained in the body which is corrected by protein digestibility data and the biological value of the protein. According Soeharsono (1976) [33] found that rations with high energy and protein tended to accelerate growth and improve feed conversion. Protein for basic life is calculated from making a regression between protein consumption and protein retention which is then extrapolated to retention equal to zero (Mahardika et al., 2013) [24].

Compared to slow-growing poultry, fast-growing poultry requires more amino acids or methionine (Wen et al., 2017) [39], but less food energy (Rosa et al., 2007) [38]. However, these differences cannot be extrapolated to evaluate the magnitude of changes in food nutrition in poultry today. Body protein can be accurately predicted by the amount of breast meat regardless of gender and broiler type (Danisman and Gous, 2013) [13], while body fat can be influenced by gender, type of feed, and age of livestock (Danisman and Gous, 2013; Henn et al., 2014) [13, 19]. Body fat, for example, is reduced in chickens with better feed conversion or faster growth rates compared to poultry that have worse feed conversion or slower growth rates (Washburn et al., 1975; Pym et al., 1979) [38, 29].

Brand et al. (2019) [9] states that a decrease in protein concentration results in a decrease in production performance. The positive effect of decreasing protein content in the ration is the reduction in the cost of the ration. According to Behera et al. (2016) [30], the lowest feed cost per kg of live weight gain in ducks with crude protein was 14% compared to ducks given rations containing 16 or 18% crude protein. The difference in ME/CP ratio in the ration did not significantly affect both in dry matter and protein digestibility. The main factors that influence the digestibility of dry matter and protein in ducks are the level of solubility of feed ingredients and solubility of protein, as well as the content of crude fiber ration (Bidura et al., 2010) [6]. Poultry cannot digest crude fiber, because poultry does not have enzymes that digest crude fiber fraction (cellulose, hemicellulose, lignocellulose). It is known that in poultry nutrition dietary fibre may have beneficial physiological effects, as well as negative effects (Mateos et al., 2012) [25]. Mateos et al. (2012) [25] concluded that the response to fibre supplementation depends on the source and level of dietary fibre and the characteristics of the diet as well as the physiological status and health of the bird. Dietary fibre has an impact on poultry owing to a multitude of aspects such as feed intake, digestive pass rate, gastrointestinal tract development, digestive enzyme secretion, nutrient utilisation, production performance, animal physiochemical status, body health, gut microbiota, bird behaviour and animal welfare, and contributes to the characteristic flavour of meat (Mead et al., 1983) [26]. Therefore, if the practical application of dietary fibre in poultry diets results in characteristic features in meat quality, a producer can supply specific poultry products to satisfy the requirements of consumers for meat with particular attributes pertaining to appearance, taste, texture and nutrients (He et al., 2015) [18].

Ariesta et al. (2015) [3] reported that the decrease in the metabolic energy content from 3100 k.cal/kg to 2800 k.cal/kg and protein ration from 22% to 16% has no effect on the digestibility of dry matter and the digestibility of crude protein. Although there is no difference in digestibility, the amount of protein digested will increase with increasing protein content of the feed (Dewi et al., 2011) [14].

The amount of protein retained depends on the amount of protein (amino acids), the quality and quantity of protein ration given (Bidura et al., 2010) [6]. Wahyu (1992) [36] states that the level of protein retention is influenced by protein consumption and metabolic energy of the ration. Furthermore Lloyd et al. (1978) [25] states that the amount of protein that is retained will determine the level of production or growth of chickens. When calculated the efficient use of protein for growth based on the amount of protein consumed. Protein levels below the intermediate concentration, which are used as a control or as long as the needs of ducks, result in a decrease in duck production performance, because the amount of protein and amino acids in their diet is inadequate. On the other hand, an increase in protein concentration above a control diet generally does not result in a significant increase in performance. Therefore, it can be recommended that increasing levels of protein in the diets of ducks for growth over medium diets should not be done (Brand et al., 2019) [9].

Conclusion

We conclude that the decrease in metabolic energy and protein content (ME/CP ratio) in the ration, actually decreases the performance of male Bali ducks (Anas sp) in the growth phase, but does not significantly influence the digestibility of dry matter and protein ration.

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