International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

I J F B S International Journal of Fauna And Biological Studies

ISSN 2347-2677
IJFBS 2020; 7(1): 41-46
Received: 28-11-2019
Accepted: 30-12-2019

# 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**

**I Dewa Gede Alit Udayana**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

**IG Mahardika**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

**IK Sumadi**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

**K Budaarsa**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

**IGNG Bidura**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

**Corresponding Author:**
**I Dewa Gede Alit Udayana**
Doctor Program Faculty of Animal Science, Udayana University, Jalan PB Soedirman, Denpasar, Bali, Indonesia

## 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 energi, protein, digestibility, performans, 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) [5]. 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, 37].

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) [34, 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) [24]. 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, 32].

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 pens. 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 1:** Chemical compositions of experimental diets in duck ration aged 0-8 weeks

| Chemical compositions* | ME-CP ratio in Diets | | | |
|---|---|---|---|---|
| | **A** | **B** | **C** | **D** |
| Metabolic energi (Kcal/kg) | 3150 | 3000 | 2850 | 2700 |
| Crude protein (%) | 22 | 20 | 18 | 16 |
| ME:CP ratio (%) | 143 | 150 | 158 | 169 |
| Crude fibre (%) | 4.10 | 5.24 | 6.08 | 7.15 |
| Ether Extract (%) | 3.51 | 4.17 | 4.71 | 4.90 |
| Calcium (%) | 1.42 | 1.28 | 1.24 | 1.19 |
| Phosphor (%) | 0.65 | 0.62 | 0.59 | 0.57 |

*): Based on calculation according to NRC (1994) [28]

**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 Assocciation of Official Analytical Chemists (2005) [2]. 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 withDuncan'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

| Variables | Groups[1] | | | | SEM[2] |
|---|---|---|---|---|---|
| | A | B | C | D | |
| Initial body weight (g) | 45.44a | 44.36a | 44.46a | 45.74a | 0.641 |
| Final body weight (g) | 1267.90a | 1233.17b | 1082.32c | 850.26d | 5.570 |
| Body weight gains (g/bird/days) | 20.31a | 19.83a | 17.30b | 13.41c | 0.290 |
| Feed consumption (g/bird/days) | 67.23a | 65.84a | 65.91a | 65.57a | 1.805 |
| Feed conversion ratio (feed consumption: body weight gain) | 3.31a | 3.32a | 3.81a | 4.89b | 0.17 |
| Dry matter digestibility (%) | 76.54a | 73.07a | 71.61a | 75.38a | 0.751 |
| Crude protein digestibility (%) | 91.96a | 91.32a | 90.13a | 91.41a | 1.640 |

**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) [33] 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 K. cal/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) [30]. 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) [4], 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 passage 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) [23] 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.


## Acknowledgements

The authors would like to thank to the Rector of Udayana University and Dean of Faculty Animal Science, Udayana University for their support during this study. Thanks to the staff of the Animal Nutrition Chemistry Laboratory, Faculty of Animal Husbandry, Udayana University for their assistance during sample analysis.


## References


1. Adeola O. Review of research in duck nutrient utilization. International J Poult. Sci. 2006; 5:201-218.
2. AOAC. Official Methods of Analysis of AOAC International (18th ed.). Association of Official Analytical Chemists, Arlington, USA, 2005.
3. Ariesta AH, Mahardika IG, Dewi GAMK. Pengaruh Level Energi Dan Protein Ransum Terhadap Penampilan

Ayam Kampung Umur 0-10 Minggu. Majalah Ilmiah Peternakan. 2015; 18(3):89-94
4. Behera NK, Babu LK, Sahoo SK, Giri SC, Pati PK, Panigrahi B *et al*. Effect of feeding different levels of protein on mortality, carcass characteristics, biochemical parameter, time motion study and economics of desi ducks under intensive system of rearing. Asian Journal of Animal Sciences. 2016; 10(1):106-112
5. Bidura IGNG. Sumber Daya Genetik Ternak. Plasma Nutfah Provinsi Bali. Penerbit Suwasta Nulus, Denpasar, Bali, Indonesia, 2019.
6. Bidura IGNG, Candrawati DPMA, Warmadewi DA. Pakan Unggas, Konvensional dan Inkonvensional. Udayana University Press, Denpasar, Bali, Indonesia, 2010.
7. Bidura IGNG, Siti NW, Partama IBG. Effect of probiotics, *Saccharomyces* spp. Kb-5 and Kb-8, in diets on growth performance and cholesterol levels in ducks. South African Journal of Animal Science. 2019; 49(2):219-226
8. Bidura IGNG, Suyadnya IP, Mahardika IG, Partama IBG, Oka IGL, Aryani IGAI. The implementation of *Saccharomyces spp.n-2* isolate culture (isolation from traditional yeast culture) for improving feed quality and performance of male Bali duckling. Agricultural Science Research Journal. 2012; 2(9):486-492
9. Brand TS, Viviers SF, van der Merwe J, Hoffman LC. Effect of varying levels of protein concentration on production traits of ostriches (*Struthio camelus* var. *domesticus*). SAJAS 2019; 49(4):684-696 http://dx.doi.org/10.4314/sajas.v49i4.10
10. Candrawati DPMA. Pendugaan Kebutuhan Energi dan Protein Ayam Kampung Umur 0-8 Minggu. Tesis. Institut Pertanian Bogor, 1999.
11. Carstens PD. Studies to develop a mathematical optimisation model to describe the effect of nutrition on the growth of ostriches (*Struthio camelus* var. *domesticus*). MSc (Agric) thesis, University of Stellenbosch, South Africa, 2013.
12. Cerrate S, Corzo A. Lysine and energy trends in feeding modern commercial broilers. Int. J Poult. Sci. 2019; 18:28-38.
13. Danisman R, Gous RM. Effect of dietary protein on the allometric relationships between some carcass portions and body protein in three broiler strains. S. Afr. J Anim. Sci., 2013; 41:194-208.
14. Dewi GAMK. Effect of balance energy-protein ration for performance of Kampung chickens. Proc. Bioscience and Biotechnology Conference. Universitas Udayana, Bali. 2011, 23-24.
15. Farrell DJ. Table Egg Laying Ducks: Nutritional Requirements and Husbandry Systems in Asia. Poult and Avian Biol. Rev. 1995; 6(1):55-69.
16. Gandini GC, Burroughs RE, Ebedes H. Preliminary investigation into the nutrition of ostrich chicks (*Struthio camelus*) under intensive conditions. J. S. Afr. Vet. Assoc. 1986; 57:39-42.
17. Hastad CW, Tokach MD, Nelssen JL, Dritz SS, Goodband RD, DeRouchey JM *et al*. Effect of sorting and added fat level performance on grow-finish pigs reared in a commercial facility. J Anim. Sci. 2005; 83(2):80
18. He LW, Meng QX, L DY, Zhang YW, Ren LP. Meat quality, oxidative stability and blood parameters from Graylag geese offered alternative fiber sources in growing period. Poult. Sci. 2015; 94:750-757.
19. Henn JD, Bockor L, Ribeiro AML, Coldebella A, Kessler ADM. Growth and deposition of body components of intermediate and high performance broilers. Rev. Bras. Cienc. Avic. 2014; 16:319-328.
20. Joshi SK, Sahoo SK, Babu LK. Effects of feeding different levels of proteins on the mortality in khaki Campbell ducks during starter stage. Int. J Sci. Res., 2014; 3:142-144.
21. Lee JH, Kim JH, Kim JD, Kim SW, Han IK. Effects of low crude protein diets supplemented with synthetic amino acids on performance, nutrient utilization and carcass characteristics in finishing pigs reared using a phase feeding regimen. Asian Australasian J Anim. Sci. 2001; 14(5):655-667.
22. Liao GZ, Wang GY, Xu XL, Zhou GH. Effect of cooking methods on the formation of heterocyclic aromatic amines in chicken and duck breast. Meat Sci. 2010; 85:149-154.
23. Lloyd LE, Mc.Donald BE, Crampton EW. Fundamental of Nutrition. 2nd Ed. W.H. Freeman and Co., San Fransisco, 1978.
24. Mahardika IG, Kristina Dewi GAM, Sumadi IK, dan Suasta IM. Kebutuhan Energi dan Protein Untuk Hidup Pokok dan Pertumbuhan Pada Ayam Kampung Umur 10-20 Minggu. Majalah Ilmiah Peternakan. 2013; 16(1):6-11
25. Mateos GG, Jiménez-Moreno E, Serrano MP, Lázaro R. Poultry response to high levels of dietary fiber sources varying in physical and chemical characteristics. J. Appl. Poult. Res. 2012; 21:156-174.
26. Mead GC, Griffiths NM, Impey CS, Cople-Stone JC. Influence of diet on the intestinal microflora and meat flavour of intensively-reared broiler chickens. Br. J Nutr. 1983; 24:261-272.
27. Mohanty SR, Sahoo SK, Babu LK, Pradhan CR, Panigrahi B, Joshi SK. Effect of feeding different levels of proteins on egg weight, egg quality, fertility, hatchability and fatty acid profile of eggs in Khaki Campbell duck during laying period. Indian Vet. J. 2015; 92:25-30.
28. National Research Council. Nutrient requirements of poultry. 9th Ed. National Academy Press, Washington, DC, 1994.
29. Pym RAE, Leclercq B, Tomas FM, Tesseraud S. Protein utilisation and turnover in lines of chickens selected for different aspects of body composition. Br. Poult. Sci. 2004; 45:775-786.
30. Rosa PS, Faria Filho DE, Dahlke F, Vieira BS, Macari M, Furlan RL. Effect of energy intake on performance and carcass composition of broiler chickens from two different genetic groups. Revista Brasileira Ciencia Avicola. 2007; 9:117-122.
31. Singh MK, Singh SK, Sharma RK, Singh B, Kumar S *et al*., Performance and carcass characteristics of guinea fowl fed on dietary Neem (*Azadirachta indica*) leaf powder as a growth promoter. Iran. J Vet. Res. 2015; 16:78-82.
32. Smith JW, Tokach MD, Nelssen JL, Goodband RD. Effects of lysine:calorie ratio on growth performance of 10-to 25-kilogram pigs. J Anim. Sci. 1999; 77:3000-3006.

33. Soeharsono. Respon broiler terhadap berbagai kondisi lingkungan. *Disertasi.* Program Pascasarjana, Universitas Pajajaran Bandung, 1976.
34. Song GL, Li DF, Piao XS, Chi F, Yang WJ. Apparent ileal digestibility of amino acids and the digestible and metabolizableenergy content of high-oil corn varieties and its effects on growth performance of pigs. Arch. Anim. Nutr. 2003; 57(4):297-306
35. Tokach MD, Pettigrew JE, Johnston LJ, Overland M, Rust JW, Cornelius SG. Effect of adding fat and (or) milk products to the weanling pig diet on performance in the nursery and subsequent grow-finish stages. J Anim. Sci. 1995; 73(11):3358-3368.
36. Wahyu J. Ilmu Nutrisi Unggas. Gadjah Mada University. Press. Yogyakarta, 1992.
37. Wang SP, Wang WJ, Yang DS, Zhao XL, Luo DM, Guo YB. Growth, carcass, and physiological traits of growing male China Micro-ducks fed various levels of dietary crude fibre. Czech J Anim. Sci. 2017; 62:347-356.
38. Washburn KW, Guill RA, Edwards Jr HM. Influence of genetic differences in feed efficiency on carcass composition of young chickens. J Nutr. 1975; 105:1311-1317.
39. Wen C, Jiang X, Ding L, Wang T, Zhou Y. Effects of dietary methionine on breast muscle growth, myogenic gene expression and IGF-I signaling in fast- and slow-growing broilers. Scient. Rep. 2017, 7. 10.1038/s41598-017-02142-z 3.