*Indonesian Journal of Agricultural Research Vol. 02, No. 02, 2019 | 50 – 65*

talenta PUBLISHER

**InJAR**
Indonesian Journal of Agricultural Research

# Free Choice Feeding on the Quality of Quail Eggs (*Coturnix coturnix-japonica*)

***Eva Morani Silaban, Ma'ruf Tafsin, and Nevy Diana Hanafi****

*Animal Husbandry Study Program, Faculty of Agriculture, University North Sumatra, Indonesia*

**Abstract**. Quail is one of the potential sources of animal protein from poultry as egg producers. An egg contains complete nutrients, namely protein, fat, vitamins, and minerals. As food, eggs must be maintained both physically and chemically to be safe for consumption. This study aimeds to examine the effect of selective feeding on the quality of quail eggs. This research was carried out at Percut Sei Tuan Subdistrict, Deli Serdang Regency, North Sumatra, which had been implemented from August to November in 2018. The study used a completely randomized design with 4 treatments and 5 plots. The study used egg samples from quail aged five (5) months. The treatment consists of Commercial feed ($T_0$), 2 energy source feed (rice bran, corn) with 2 ($T_1$), 3 ($T_2$), 4 ($T_3$) protein source feeds (fish meal, soybean meal, coconut meal, Poultry Meat Meal). The results showed that the treatment gave a significant effect ($P<0.05$) on egg weight, albumen, and eggshell weight, commercial feed showed eggs weight higher than free choice feeding treatments, while among free choice feeding treatment did not show significant effect. The free choice feeding treatment has a significant effect on the yolk weight, where $T_2$ has the lowest yield. Percentage of yolk, albumen, quail eggshell and egg index, egg yolk index, albumen index, haugh unit and quail yolk color did not show significantly different ($P>0.05$) among treatment. It can be concluded that the commercial feed showed higher egg weight but had no significant effect ($P>0.05$) on the proportion of eggs and the interior quality of quail eggs, while among free choicee feeding treatment has no effect.

**Keywords:** coturnix coturnix japonica, free choice feeding, quail eggs, quality of eggs

Received 27 July 2019 | Revised 26 August 2019 | Accepted 11 September 2019

## 1. Introduction

Quail eggs have good quality because they contain protein around 13% per 100 grams, where as chicken egs only comprise of 12% protein per 100 gram eggs. Therefore, the increase of both production and quality of the quail-consuming eggs is necessity to be done to support the needs and supply of animal protein from livestock and be affordable to the community [1].

In general, quail breeders provided a complete feed from feed companies or make their own rations while the breeders have a limited knowledge on the type of feed material that are suitable for the quails. This problem causes livestock have no chance to choose proper feed

*Corresponding author at: Animal Husbandry Study Program, Faculty of Agriculture, Universitas Sumatera Utara, Jl. Prof. Sofyan No. 3, Medan 20155, Indonesia

E-mail address: nevydiana@yahoo.co.id


Journal Homepage: https://talenta.usu.ac.id/InJAR DOI 10.32734/injar.v2i2.1154

ingredients which results in the time to start laying eggs become too late. Therefore,, we need to reevaluate quail nutritional standards by examining the *free choice feeding* pattern.

The free choice feeding system is feeding with various types of feed which aimed to provide quails with greater opportunities to choose the preferred type of feed, especially related to nutrient fulfillment based on their physiological needs. Based on the ability of quails to choose these foods will provide a more detailed picture of the nutritional needs of quails, especially the energy and protein ratio at each stage of growth in the intensive maintenance system.

So far, free choice feeding of quails (*Coturnix coturnix japonica*) has not been widely studied, therefore research needs to be done to determine the actual preferences and needs of quails and how the influence of free choice feeding on the quality of the interior and exterior of the eggs produced.

## 2. Methodology

### 2.1. Materials and Equipment

The study was conducted at Jalan Pendidikan I, Gang Sugeng, Sei Rotan Village, Hamlet X, Pasar XI RT 3, Percut Sei Tuan Subdistrict, Deli Serdang Regency, North Sumatra. The quails were raised for 4 months starting from August to November in 2018. Research using eggs taken at the peak of production of quail. The raised quail animals was given selective feed for 4 months, with 7 (seven) various feed ingredients: complete feed, bran, corn, fish meal, soybean meal, coconut meal, and *Poultry Meat Meal* (PMM). The equipments in this research were *battery* cage*,* food container, drink container, lighting, electric scales, electric thermometer ($^0$C), *Yolk color fan,* petri dish, stationery and others.

### 2.2. Methodology

The method used was a non-factorial completely randomized design (CRD) with one factor namely feed energy source which consists of 4 levels:

T0 = Commercial feed ration (control)

T1 = 2 types of energy sources (bran, corn) + 2 types of protein sources (fish meal, soybean meal);

T2 = 2 types of energy sources (bran, corn) + 3 types of protein sources (fish meal, soybean meal, coconut meal);

T3 = 2 types of energy sources (bran, corn) + 4 types of protein sources (fish meal, soybean meal, coconut meal, Poultry Meat Meal (PMM).

This study used 240 female quails which were kept in 20 cage units for 20 weeks, in which each unit was filled with 12 quails. The sample used is all eggs obtained in a day from every treatment that is available and taken on the same day.

### 2.3. Preparation of the Cage

The cage used in the study was a battery enclosure. Before using the cage, it was cleaned by sanitizing the cage, which washed with clean water and sprayed with disinfectant. Quail placed in a battery enclosure measuring of 120 x 50 x 40 $cm^3$ consists of 20 units. Each unit consists of 12 quails. The cage was made with a combination of ram wire and wood which completed with a feed and drink container, feces container, and a pedestal that was made slanted so that the eggs laid the quail would roll out and collected in one place.

Feed container placed in the cage. Each feed ingredient was placed in one place so that each quail could access all six types of feed ingredients easily. Maintenance was carried out for 16 weeks. Quail were cared and fed once a day in the afternoon. Drinking water was given in *ad libitum*.

### 2.4. Feeding the Quails

Feed used for maintaining that would be carried out, namely some feed ingredients, namely, commercial feed, bran, milled corn, fish flour, soybean meal, coconut meal, and *Poultry Meat Meal* (PMM). Feed ingredients were given in *ad libitum*. Each type of feed ingredients would be given every day at 15:00 WIB until finished and placed in different feed container and placed in each cage according to the order of treatment used at the time of the study.

### 2.5. Collection of Quail Eggs

Collection of quail eggs was done every afternoon at 18:30 WIB after feeding.

### 2.6. Determination of Quail Eggs Quality

#### a. Egg weight [2]

The eggs were weighed using a digital scale and recorded.

#### b. Egg index *(Shape Index)* [3]

The egg index was measured by determining the weight, length and width of the egg. Measurement of length and width using a Caliper and weight with digital scale. The values obtained were calculated using formulas according to [4] as follows:

$$\text{Egg shape index} = \frac{\text{Egg width (mm)}}{\text{Egg height (mm)}} x100\%$$

**c. Yolk Index [5**

The index value of yolks was obtained by breaking all quails eggs obtained as samples from each experimental unit. The calculation of the yolk index was determined by measuring the height and diameter of the yolk using a tool, namely, calipers. Then the values obtained are calculated using formulas according to [6] as follows:

$$Yolk\ Index = \frac{High\ of\ Yolk\ (mm)}{(D1 + D2)\ (mm)}$$

where:

D1 : long diameter of yolk.

D2 : short diameter of yolk

**d. Albumen Index [7]**

The albumen index is the ratio of the height of the thick albumen to the longest and shortest of diameter average of albumen. The albumen is divided into two parts, namely: albumen 1 thick in form close to the egg yolk and albumen 2 in the outermost position and very runny. The method of measuring albumen is done by breaking the egg and placing it on a flat glass, then measuring the albumen height, long diameter of albumen 1 and short diameter of albumen 1 using a caliper (calipers), then the values obtained are calculated using formulas according to [6] as follows:

$$Yolk\ Index = \frac{High\ of\ Albumen\ (mm)}{(D1 + D2)\ (mm)}$$

Where:

D1: long diameter of albumen.

D2: short diameter of albumen

**e. Haugh *Unit* (HU) Value [8]**

HU value was a measurement of albumen height and egg length. Eggs already weighed using digital scales, than broken down, the egg fragments were placed on a flat glass then the albumen height was measured using a caliper. Calculation of the value of Haught Unit (HU) quail eggs using formulas according to [9] as follows:

$$HU = 100 \log (H + 7.57 - 1.7\ W\ 0.37)$$

Where:

HU = Haugh Unit

H = Albumen Height

W = Egg Weight

**f. Percentage of albumen weight [10]**

Albumen weight (g) was obtained from the difference between egg weight and the sum of yolk weight (g) and eggshell weight (g). Albumen weight percentage was calculated using the formula:

$$\%\,albumen\,weight = \frac{Egg\ white\ weight\ (g)}{Whole\ egg\ weight\ (g)} x100\%$$

**g. Percentage of yolk weight [10]**

The weight of the yolk (g) was obtained by weighing the yolk that has been separated from the egg white. The percentage of egg yolk weight was calculated using the formula:

$$\%\,yolk\ weight = \frac{Egg\ yolk\ weight\ (g)}{Whole\ egg\ weight\ (g)} x100\%$$

**h. The color of yolk [11]**

Color measurement was done by comparing the yolk color with *Egg Yolk Color Fan* which has a color scale standard of 1-15.

**i. Eggshell weight percentage [10]**

Eggshell weight (g) was obtained by weighing the eggshells after being separated from the contents of the egg. The percentage of eggshell weight is calculated using the formula:

$$\%\ eggshell\ weight = \frac{Eggshell\ weight\ (g)}{Whole\ egg\ weight\ (g)} x100\%$$

**j. Shell thickness (mm) [10]**

Shell thickness was obtained by measuring shell thickness by using a *micrometer/*calipers and measuring the blunt, middle, and pointed ends of the egg and then being averaged.

**2.7. Data Analysis**

This study used a completely randomized design (CRD) method consisting of 4 treatments and 5 plots. Each experimental unit consists of 12 quails. The mathematical model used is as follows:

$$Yij = \mu + \tau i + \varepsilon ij$$

Information:

Yij = Feed energy source treatment to-i and replicaton to-j

M = General average

τi = Effect of the treatment to-i

εij = Error treatment to-i replication to-j

Data were analyzed using the SPSS program for analyzing of variance (ANOVA). If the results are significantly different, it is further tested by the Duncan test [12].

## 3. Results and Discussion

The results of the observed weight and egg composition (egg weight, yolk weight, albumen weight, eggshell weight, yolk percentage, albumen percentage, eggshell percentage) are presented in Table 1.

**Table 1.** Average Results of Egg Weight and Composition of Quail Eggs

| Average $\pm$ Sd | Treatment | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Weight and physical composition of egg weight quail eggs (g/grain) | $10.36^{c}\pm0.45$ | $9.47^{ab}\pm0.40$ | $8.91^{a}\pm0.66$ | $9,47^{b}\pm0,80$ |
| Weight of yolk (g/grain) | $3.69^{b}\pm0.13$ | $3.67^{b}\pm0.08$ | $3.32^{a}\pm0.15$ | $3.78^{b}\pm0.44$ |
| Weight of albumen (g/item) | $5.76^{b}\pm0.39$ | $5.08^{a}\pm0.26$ | $4.86^{a}\pm0.53$ | $4.91^{a}\pm0.62$ |
| Weight egg shell (g/grain) | $0.90^{b}\pm0.03$ | $0.78^{a}\pm0.07$ | $0.71^{a}\pm0.06$ | $0.77^{a}\pm0.13$ |
| Percentage of quail yolk (%) $^{ns}$ | $35.72\pm1.61$ | $38.43\pm0.78$ | $37.22\pm2.42$ | $40.27\pm4.27$ |
| Percentage of quail albumen(%)$^{ns}$ | $55.27\pm1.61$ | $53.33\pm1.49$ | $54.70\pm2.53$ | $51.66\pm3.92$ |
| Percentage of shells eggs (%) $^{ns}$ | $8.74\pm0.24$ | $8.23\pm0.82$ | $8.08\pm0.34$ | $8.07\pm1.27$ |

Note: $T_0$ = Commercial feed ration (control); $T_1$ = 2 types of energy sources (bran, corn) + 2 types of protein sources (fish meal, soybean meal); $T_2$ = 2 types of energy sources (bran, milled corn) + 3 types of protein sources (fish meal, soybean meal, coconut meal); $T_3$ = 2 types of energy sources (bran, milled corn) + 4 types of protein sources (fish meal, soybean meal, coconut meal, *Poultry Meat Meal* (PMM)
$^{ns}$ = Not Significant (P>0.05) | (Percentage of quail yolk, albumen, shells eggs).

### 3.1. Weight and Physical Egg Composition

#### a. Weight of quail egg

The results of the study with average feed and protein consumption for each treatment $T_0$, $T_1$, $T_2$, $T_3$, which is 23.05; 17.39; 15.50; 21.19 g/head/day and 4.05; 3.40; 3.11; 3.75 g/head/day (Appendix 1.). The data show that the highest consumption was found in $T_0$ treatment. Where the highest average value of quail protein consumption was also found in the $T_0$ treatment, which was 4.05 g/head/day with the use of commercial feed. $T_3$ with the use of four (4) sources of the most protein that has the most average amount of protein consumption of 3.75 g/head/day, which is not sufficient to be able to equalize the egg weight produced in the $T_0$ treatment, which is commercial feed ration. [13] in his study stated that protein consumption of 3.49 grams/head/day has been sufficient to fullfill basic life, growth and egg production. From the statement it can be seen that all treatments are sufficient to fullfill quail protein needs, but cannot be compensate for the weight of the eggs produced by treatment $T_0$.

According to [14] quail eggs weigh around 10 g/grain (about 8% of the parent body weight) up to 11.91 g/grain [15]. However, the egg weight of in this study was below the average, in which the $T_1$, $T_2$, produced eggs with weight of 9.47, 8.91, and 9.47 g/grain, respectively. $T_0$ contains the highest protein consumption, therefore, the lower daily protein consumption of treated quail in the *free choice feeding* treatment was also in line with the weight of the resulted eggs.

The source of crude protein in this study was obtained from 32.78% fish meal, soybean meal 45.44%, coconut meal 16.75%, *Poultry Meat Meal* (PMM) 14% along with commercial feed 19.56%. We can know that the crude protein contained in feed ingredients used as a source of protein has non-significant effect (Appendix 1.), because the crude protein content of all feed ingredients used is not less than 11% and the quantity of feed consumed by quails also affects on egg weight. This is in accordance with previous study [16] stating that 13 – 17% protein does not significantly affect egg weight. The amount of more than 17% can increase egg weight [17]. Meanwhile, rhe decrease in the weight of eggs occurs if the protein content in the feed is less than 11%. This is in line with previous study [18] which states that quail egg weight is not only influenced by the quantity of rations consumed, but also the quality of rations, especially the protein content. Protein deficiency will result in a decrease in the both size and number of albumen of the egg [19].

**b. Yolk weight**

The average value of yolk weight at the *free choice feeding* ($T_3$) was 3.78 g/grain, which was higher than egg with commercial feed treatment (3.69 g/grain). The weight of normal yolk is 2.4 – 3.3 g/grain [16] However, the yolk weight obtained in this study was different. There are many factors could affect the size of the yolk: weight, age, quality, and quantityof feed, disease and environmental conditions include the housing system, and enviromental temperature [20]. Additionally, it was strongly influenced by the development of the ovary that produces ovum. In this study, quail used was the quail with the same age and species. Therefore, the same poultry strain should have similar physiological ability in the formation of yolk [21]. As the quantity of feed, especially protein consumption, also greatly affects the size of yolk, the daily feed consumption of each treatment in sequence (23.05; 17.39; 15.50; 21.19 g/head/day), would be in line with the change in average yolk weight.

**c. Weight of albumen**

The normal quail albumen wieght is 4.1 – 6 g/grain [16]. It can be seen from Tabel 1 that the average albumen weight of the treatment with commercial feed ration and *free choice feeding* ($T_3$) was 5.76 g/grain and 4.91 g/grain, respectively. The constituent components of albumen according to [22] are water (88%), protein (9.7 - 10.6%), fat (0.03%), carbohydrates (0.4 - 0.6%), and ash (0.5 - 0.6%). Therefore, the largest component of albumen is water and followed by protein. Protein cannot directly control the changes in albumen weight. If consumption of protein is low, small yolk will form [23]. The percentage of albumen is inversely proportional to the yolkweight.

**d. Weight of Quail Egg Shell**

Based on Table 1 it can be seen that the average eggshell weight with commercial feed ration treatment was 0.90 g/egg and *free choice feeding* ($T_3$) treatment decreased 0.77 g/grain. All eggshell weight in this study were corresponded to the normal weight of the quail egg shell which is around 0.56 - 0.9 g/egg. [33] stated that the main nutritional factors associated with eggshell quality are calcium, phosphorus, and vitamin D. However Ca and phospor basal of calcium is the most important nutrient in the formation of the shell. Eggshell occurs during the dark phase when inactive poultry eat and the source of calcium became a food reserve in the digestive tract and cartilage that affects eggshell formation and is supported by [19] several factors that can cause eggshell quality problems they are genetic, age of poultry, high environmental temperature, food and disease. The age of poultry is influenced by the formation of eggshell.

**e. Percentage of quail *yolk***

The weight percentage of yolk is normally 30 – 33% [16]. Quail yolk in this stufy seemed to be higher than the normal weight: 35.72 with treatment of commercial ration and 40.27% if being fed with *free choice feeding* ($T_3$). The larger quali yolk occurs because the most important factor in the ration that affects the weight of the egg is protein. Approximately 50% of the yolk weight is protein, therefore, the weight and size of the yolk in eggs are also influenced by the consumption of protein in the ration. Protein consumption in the treatment with commercial feed ration is more than that of in the *free choice feeding*. This is in accordance with the statement by [23] which stated that low protein consumption will form a small yolk.

**f. Percentage of albumen**

The average of albumen weight with commercial feed ration treatment was 55.27% and with the *free choice feeding* was 53.23%. This values are in accordance with the normal albumen, amounting 52% - 60% [16]. The percentage of quail albumen weight was not significantly different in this study. The similar value is related to the same strains, age, and quail health, so the percentage of albumen weight did not differ amongst the treatment. The percentage of albumen weight will decrease with increasing of yolk weight. Thus, there is also no significant difference in the average percentage of yolk [20]. Storage can also affect the percentage weight of quail eggs, in which the weight of the egg will be lower with strorage time. It is according to the statement [25] stating that every addition of one day of storage will be followed by shrinking egg weight about 0.17%.

**g. Percentage of Quail Egg Shells**

The average value of quail eggshell weight percentage with a commercial feed ration treatment and *free choice feeding* ($T_3$) treatment were 8.74% and t of 8.07%, respectively. The treatment have No. Significant effect on the eggshell, which was in the range 8 - 9 %. Eggshel normally account for 7% - 9% of egg weight [16]. Eggshell weight is influenced by the thickness of the eggshell and egg membrane. Moreover, eggshell thickness is influenced by the type of quail, age, feed given, feed consumption, and lighting use. [26] Eggshell quality is also influenced by the age, and consumption of quail feed.

Table 2. Average Results of Research on the Interior Quality of Quail Eggs

| Average±Sd | Treatment | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| Interior Quality of Eggs<br>Thickness of Eggshell (g/grain) ns | 0.15±0.03 | 0.11±0.01 | 0.15±0.04 | 0.12±0.02 |
| Eggs Index (Shape Index) ns | 78.99±0.04 | 77.49±0.01 | 77.63±0.02 | 77.27±0.01 |
| Yolk Index ns | 0.37±0.01 | 0.37±0.02 | 0.37±0.02 | 0.37±0.01 |
| Albumen Index ns | 0.04±0.003 | 0.04±0,0009 | 0.04±0.009 | 0.05±0,009 |
| Haught Unit (HU) Quail Eggs ns | 86.72±1.47 | 86.45±0.45 | 86.71±2.49 | 88.19±2.06 |
| Yolk Color ns | 5.55±0.45 | 5.78±0.66 | 5.11±0.85 | 6.17±0.66 |

Note: $T_0$ = Commercial feed ration (control); $T_1$ = 2 types of energy sources (bran, corn) + 2 types of protein sources (fish meal, soybean meal); $T_2$ = 2 types of energy sources (bran, milled corn) + 3 types of protein sources (fish meal, soybean meal, coconut meal); $T_3$ = 2 types of energy sources (bran, milled corn) + 4 types of protein sources (fish meal, soybean meal, coconut meal, *Poultry Meat Meal* (PMM)
ns = Not Significant (P > 0.05) |

### 3.2. Interior Quality of Eggs

#### a. The thickness of quail eggshell

The average thickness of shellfish were not affected by feeding treatment. The shell tickness werenot very specific due to the same type of quail and quail age in this study. The thickness of the quail egg shell ranges from 0.11 to 0.15 mm with an average of 0.13 mm. The results were smaller compared to the normal quail eggshell, which is normally around 0.22 mm [1].

[27] repored that rations containing fiber will cause changes in the size of the digestive tract, making it heavier, longer, and thicker. The thickness of the eggshell is also influenced by the age of the livestock, environmental temperature, level of egg production, disease, genetic and energy and protein ration balances. Eggshell thickness can be determined by several factors, such asthe ability of egg absorption and mobilizing calcium and phosphorus [28]. Most of the constituent elements of the eggshell are calcium, magnesium, sodium, and carbon. The thicker the eggshell means the higher the Ca-stem.\

High temperatures will reduce the strength and thickness of the eggshell [29]. The eggshell quality will be optimal if the ambient temperature is between 16 - 21°C. The increased in environmental temperature will reduce egg weight and eggshell solidity. However, environmental temperature does not have a direct effect on the eggshell as the increase in environmental temperature will reduce feed consumption and calcium consumption, which then would affect the acid base balance in poultry blood [16]. To produce quality eggshells, the provision of protein in feed must be balanced with the provision of energy and minerals. In addition to the factors mentioned abouve, high environmental temperatures, especially above 29ºC, can also affect the physical quality of eggs. Eggshell quality decreases with increasing age [20].

**b. Egg index *(shape index)***

It can be seen from Table 2 that the average shape index was greater than 77, which indicating that an egg has a round shape, due to the type of quail used in this study. Eggs with relatively long and narrow (oval) at various sizes have a low egg index and short and wide (almost rounded) eggs show a high egg index. [30] reported that, the average value of the shape index with a round shape is above 77, the oval egg has a value of 69 - 77 and tapering below 69.

Quail egg shape is more rounded than the race chicken egg, the good quail hatched egg shape index is 79.2 [31]. Variations in the egg index result from egg rotation in the reproductive organs because of the rhythm of the reproductive tract pressure or are determined by the lumen diameter of the reproductive tract [16]. According to [32], the higher the egg index, the better egg quality with its round shape. Egg shape is one of the genetic elements derived from the mother to her child. The protein content of diet does not affect the egg shape, because it is most influenced by genetics. Each quail produces a typical egg index because the egg index is inherited [33].

**c. Yolk index**

Tabel 2 presents the average value of the Yolk Index. The eggs obtained showed that the eggs studied were fresh because the yolk index of 0.37, indicating that the eggs used in this study were in fresh condition, because the eggs used are eggs produced from the same day. This is in accordance with previous statement in which the fresh eggs have Yolk Index 0.33 - 0.50 with an average value of Yolk Index 0.42 [34]. The yolk index is a freshness quality index measured by the height and diameter of the yolk [35]. Yolk index value is also affected by temperature and egg storage time. The yolk index did not show a significant difference indicating that the application of the treatment does not affect the yolk index.

**d. Albumen index**

Table 2 shows that the average index of albumen was aruond 0.005, and treatment of *free choice feeding* has no effect on the albumen index. According to [36], the index of fresh albumen ranges from 0.050 - 0.174, indicating that the eggs used in this study were all in fresh condition. The diameter of the albumen of older eggs will be wider so that the index of albumen will be smaller [37].

[38] states that albumen is a picture of feed protein, as the protein ration affects the viscosity of the eggs which describes the quality of the egg's interior. The higher the protein ration, the albumen will be thicker. Ticker eggs are narrower in diameter of the albumen, which is resulted

in higher albumen index. In this study, the various protein concentration consumed by quail does not affect the albumen index. Protein consumption in each treatment is different where the amount of protein consumption is sequential, 4.05; 3.40; 3.11; 3.75 g/head/day. While metabolic energy consumption in each treatment differs sequentially, namely 56.15; 41.10; 37.32; 51.04 kcal/g/head/day (Appendix 1). From the results of the study [13], it can be seen that protein consumption and metabolic energy for quails during the production period of 3.49 grams/head/day and 50.55 kcal/head/day were sufficient to meet basic life needs.

So according to the statement above the average protein consumed by quail is sufficient for quail's daily energy needs but is not sufficient in $T_2$. While the average metabolic energy (EM) consumed by quail in addition to the treatment of free choice feeding $T_1$ and $T_2$ is sufficient for the daily needs of quail. High protein consumption can lead to less efficient consumption of protein and is considered as less effective. Metabolism of proteins to form energy also requires a lot of energy, which is supported by high temperatures resulting in the production becomes less efficient. It is before that maximun enery use for production purposes can be achieved if the ratian contains balanced amino acids and other subtances [39]. Furthermore, [13] stated that the low energy consumption in poultry in the production phase could result in a decrease in production.

Storage can support the increase in the albumen index value. The albumen index decrease is due to $CO_2$ gas in the egg experiences continuously evaporate so that egg quality decreases. The process of $CO_2$ gas evaporation through the skin pores of the albumen causes physical and chemical changes, so that the albumen becomes runny (watery). More dilute egg white cause the albumen, lower in the height, which the indication of decrease of eggs [27].

**e. Haught Unit (HU) quail eggs**

Average *Haught Unit* (HU) for each treatment of $T_0$, $T_1$, $T_2$, and $T_3$ were 86.72; 86.45; 86.71 and 88.19, respectively and had no significant different from one another. This is because the eggs used and the data taken in the study were carried out on the same day so that the haught unit values of each egg were similar. In previous study, it was reported that AAA quality eggs have a HU value of more than 79, AA quality, 55-78 quality A, 60-72, quality B 31 - 54, and quality C is less than 30 [40]. Based on the HU in Tabel 2, it can be concluded that all eggs in this study have AAA quality. Longer storage time increases the HU because the evaporation of water and gas such as $CO_2$ causes thick albumen to dilute [41]. Therefore, the treatment of free choice feeding did not affect the HU value of the quail eggs.

**f. The color of yolk**

The yolk egg color with free treatment choice feeding in this study were ranging from 5.11 and 6.17 (Table 2). The yolk color value of 4 – 6 is stated as bright yellow (4 – 6) in Yolk Color Fan (6 scales of egg yolk) can be stated as bright yellow (4 - 6) in Yolk Color Fan [42]. Eggs produced both using commercial feed rations and free choice feeding treatments gave no significant diffrence and were not included in the category of good quality eggs. In addition, if the color of the yolk reaches a score of 7 – 8, the egg will be classified into good quality. [19] Yolk color score is influenced by the content of nutrients in the feed, for example beta-caroteneand xanthophyll contained in feed. Beta-carotene is a carotenoid class compound that is unstable because it is easily oxidized to xanthophyll which functions as a dye for egg yolk.

The color of the yolk for each treatment was not significantly different. From the results of the study it was found that in the treatment of free choice feeding, corn was the most consumed feed ingredient (Appendix 1). Pigments carrying yolks are usually owned by yellow feed ingredients such as yellow corn [43]. Therefore, the increase in corn consumption raises the xanthophyll content which eventually affecting the yellow color of the yolk produced. The pigment giving the yolk color in the ration is physiologically absorbed by the digestive organs of the small intestine and circulated to the target organs that need it.

Egg pigments are carotene and riboflavin which are classified as lipochrome, namely xanthophyill, the color of the yolk is increasingly reddish orange [44]. Higher the carotene content causes the color of the yolk to get dark. Another factor that affects the color of the yolk is the length of storage. The color of the yolk changes more and more light along with storage. Long stored eggs will change the yolk color to fade. Long storage cause the dilution of the albumen, which is absorbed water from the albumen into the egg yolk so that the yolk becomes light and pale.

## 4. Conclusion and Suggestions

The treatment for feeding free choice feeding will reduce weight but does not affect the composition and interior quality of quail eggs. The free choice feeding treatment with 4 feed protein sources can offset the weight of the yolk treatment for commercial feed ration. Commercial feed is better than optionally feeding (Feeding Free Choice) which are 2 feed energy source mixed with 2, 3, or 4 feed protein sources. The application of free choice feeding to quails should use more feed ingredients as a source of protein favored by quails in order to compensate for the egg quality of the treatment of commercial feed rations.

## REFERENCES

[1] D. Sudrajat, D. Kardaya, E Dihansih, S. F. S. Puteri, "Performa produksi telur burung puyuh yang diberi ransum mengandung kromium organik," *Jurnal Ilmu Ternak dan Veteriner*, vol. 19, no. 4, pp. 257-262, 2014.

[2] I. Alawiyah, E. Sujana, and W. Tanwiriah, "Kualitas eksterior telur puyuh (*Coturnix-coturnix japonica*) turunan hasil persilangan warna bulu coklat dan hitam di pusat pembibitan puyuh Universitas Padjadjaran," Fakultas Peternakan, Universitas Padjadjaran, Sumedang, 2016.

[3] H. D. Arifin, Zulfanita, and J. M. W. Wibawati, "Berat telur, indeks dan volume telur puyuh (*Coturnix - coturnix Japonica*) pengaruh konsentrasi sari markisa (*Passion fruit)* dan lama simpan di suhu ruang," Studi Peternakan, Fakultas Pertanian, Universitas Muhammadiyah Purworejo, 2016.

[4] A. P. Heriyanto, "Pengaruh penambahan probiotik lactobacillus plus balam bentuk tepung sebagai aditif pakan terhadap kualitas telur burung puyuh (*Coturnix coturnix japonica*), Jurusan nutrisi dan makanan ternak," Jurusan Nutrisi dan Makanan Ternak, Fakultas Peternakan, Universitas Brawijaya, 2015.

[5] I. Joni, " Kualitas fisik telur puyuh yang direndam dalam larutan gelatin tulang kaki ayam dengan lama penyimpanan yang berbeda," Program Studi Peternakan,Fakultas Pertanian dan Peternakan Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, 2015.

[6] B. P. Kumari, B. R. Gupta, M. G. Prakash, and A. R. Reddy, "A study on egg quality traits in Japanese quails (*Coturnix coturnix Japonica*)," *Journal Veterinary and Animal Science*, vol. 4, no. 6, pp. 227-231, 2008.

[7] I. G. Indrawan, I. M. Sukada, and I. K. Suada, "Kualitas telur dan pengetahuan masyarakat tentang penanganan telur di tingkat rumah tangga," Journal Indonesia Medicus Veterinus vol. 1, no. 5, pp. 607-620, 2012.

[8] D. Purwati, M. A. Djaelani, and E. Y. W. Yuniwarti, "Indeks Kuning Telur (IKT), *Haugh Unit* (HU) dan Bobot Telur pada Berbagai Itik Lokal di Jawa Tengah", Laboratorium Biologi Struktur dan Fungsi Hewan, Jurusan Biologi, Fakultas Sains dan Matematika, Universitas Diponegoro, Jawa Tengah, 2015.

[9] M. D. Stojcic, N. Milosevic, and L. Peric, "Determining some exterior and interior quality traits of Japanese quail eggs (*Cotunix japonica*)," *Agro-knowledge Journal*, vol. 13, no. 4, pp. 667-672, 2012.

[10] S. Kul and I. Seker, "Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (*Coturnix coturnix japonica*)," *International Journal of Poultry Science*, vol. 3, no. 6, pp. 400-405, 2004.

[11] T. Aisjah, R. Wiradimadja, and Abun, "Suplementasi metionin dalam ransum berbasis lokal terhadap imbangan efisiensi protein pada ayam pedaging," Artikel Ilmiah, Fakultas Peternakan, Universitas Padjajaran, 2007.

[12] R. G. D. Steel and J. H. Torrie, "Prinsip dan prosedur statistika: suatu pendekatan biometric", Jakarta, ID: PT. Gramedia Pustaka Utama, 1993.

[13] T. Widjastuti and R. Kartasudjana, "Pengaruh pembatasan ransum dan implikasinya terhadap performa puyuh petelur pada fase produksi pertama*," Journal Indoesia Tropical Animal Agriculture*, vol. 31, no. 3, pp. 162-166, 2006.

[14] A. R. Woodard, H. Abplanalp, W. O. Wilson, "Japanese quail husbandry in the Laboratory (*Coturnix coturnix japónica*)", California, USA: University of California, California, 1973.

[15] B. Parizadian, Y. J. Ahangari, M. S. Shargh, and A. Sardarzadeh, "Effects of different levels of L-Carnitine supplementation on egg quality and blood parameters of laying Japanese Quail," *International Journal of Poultry Science*, vol. 10, no. 8, pp. 621-625, 2011.

[16] T. Yuwanta, "Telur dan kualitas telur", Yogyakarta: Gadjah Mada University Press, Yogyakarta, 2010.

[17] J. C. Protais, Lahellec et Y. Michel," Etude de la Contamination Bacterrience des Oeufs en Coquille", Bul. D'Anf. Station Exp. D'Aviculture de Ploufragon 29: 31-32, 1989.

[18] S. Mozin, " Kualitas fisik telur puyuh yang mendapatkan campuran tepung bekicot dan tepung darah sebagai substitusi tepung ikan," *Jurnal Agrisains*, vol. 7, no. 3, pp. 183-191, 2006.

[19] Amrullah, "Nutrisi ayam petelur," Lembaga Satu Gunung Budi, Bogor, 2003.

[20] A. L. Romanoff and A. J. Romanoff, *The Avian Egg*. New York: John Wiley and Sons, 1963.

[21] B. Ismawati, "Bobot, komposisi fisik dan kualitas interior telur puyuh (*Coturnix coturnix japonica)* yang diberi suplemen omega-3", [Skripsi]. Departemen Ilmu Produksi dan Teknologi Peternakan, Fakultas Peternakan, IPB, Bogor, 2011.

[22] W. J. Stadelman and O. J. Cotterill, *Egg Science and Technology*. 4th ed. Westport, Connecticut: The Avy Publishing, Inc., 1995.

[23] M. C. Nesheim, R. E. Austic, and L. E. Card, *Poultry Production*. 3rd ed. Philadelphia: Lea and Febiger, 1972.

[24] M. Sezer, "Heritability of exterior egg quality traits in Japanese Quail", Department of Animal Science, Faculty of Agriculture, Gaziosmanpasa University2007, 2007. Accessed on: December 1, 2014. [Online]. Available: http://www.nobel.gen.tr/Makaleler/JABSIssue%201-19-2011.pdf

[25] Samsudin, "Hubungan antara lama penyimpanan dengan penyusutan bobot, *haugh unit,* daya dan kestabilan buih putih telur ayam ras pada suhu ruang", Bogor: IPB, 1972.

[26] W. J. Stadelman and O. J. Cotterill, *Egg Science and Technology*. Westport, Connecticut: The Avy Publishing, Inc., 1995.

[27] A. C. C. Alleoni and A. J. Antunes, "Albumen foam stability and S-ovalbumin contents in Eggs Coated with whey protein concentrate," Universidade do Norte do Parana, UNOPAR, Londrina, 2004.

[28] R. Wells and C. G. Belyavin, "Egg quality-current problems and recent advances," Butterworth, London, 1987.

[29] A. Fance, "Efek penggunaan tepung cangkang keong mas (*Pomacea Canaliculata Lamarck*) dalam ransum terhadap tebal dan berat cangkang telur puyuh," Universitas Negeri Gorontalo", Gorontalo, 2014.

[30] P. K. Sharma and P. Vohra, "Relationship between egg weight, shape index, and fertility and hatchtability of japanese quail (*Coturnix coturnix japonica*) Eggs", *Indian Journal of Poultry Science*, vol. 15, pp. 5-10, 1980.

[31] E. Syamsir, "Studi komparatif sifat mutu dan fungsional telur puyuh dan telur ayam ras," Fakultas Pertanian, Institut Pertanian Bogor, Bogor,1993.

[32] Tiara, "Laporan praktikum ilmu pemuliaan ternak dan reproduksi ternak", UNDIP, Semarang, 2017.

[33] R. Ardiansyah H, Sujana, and W. Tanwiriah, "Pengaruh pemberian tingkat protein dalam ransum terhadap kualitas telur puyuh (*Coturnix coturnix japonica*) quail eggs", Fakultas Peternakan, Universitas Padjadjaran, 2016.

[34] Hardini, "Pengaruh suhu dan lama penyimpanan telur konsumsi dan telur biologis terhadap kualitas interior telur ayam kampung", FMIPA Universitas Terbuka, 2000.

[35] T. Sudaryani, *Kualitass Telur*. Jakarta: Penebar Swadaya, 2006.

[36] BSN (National Standardization Agency), "Telur ayam konsumsi standar nasional Indonesia," Jakarta, SNI - 013926 – 2008, 2008.

[37] T. Purnomo, "Pengaruh pemberian tomat (*Solanum lycopersicum*) dalam air minum terhadap kualitas telur puyuh (*Coturnix-coturnix japonica*)," Universitas Jambi, 2017.

[38] L. B. Argo, Tristiarti and I. Mangisah, "Kualitas fisik telur ayam arab petelur fase I dengan berbagai level Azolla microphylla", *Animal Agricultural Journal,* vol. 2, no. 1, pp. 445-457, 2013.

[39] J. Wahju, *Ilmu Nutrisi Unggas*. Yogyakarta: Gadjah Mada University Press, 2004.

[40] United Stated Department of Agriculture (USDA), "Agricultural marketing service," Agricultural handbook. Number 75. Egg grading Manual. National Supervisor, Shell Eggs Grading Branch, Poultry Programs USDA - AMS - STOP 0258 1400 Independence

Avenue, SW Washington, DC 20250-0258, 2004.

[41] N. Jazil, A. Hintono, and S. Mulyani, "Penurunan kualitas telur ayam ras dengan intensitas warna coklat kerabang berbeda selama penyimpanan," *Jurnal Aplikasi Teknologi Pangan*, vol. 2, no. 1, pp. 43-47, 2012.

[42] P. O. A. Harmayanda, D. Rosyidi and O. Sjofjan, "Evaluasi kualitas telur dari hasil pemberian beberapa jenis pakan komersil ayam petelur," Fakultas Peternakan, Universitas Brawijaya Malang, Malang, 2016.

[43] A. Mampioper, S. D. Rumetor, and F. Pattiselanno, "Kualitas telur ayam petelur yang mendapat ransum perlakuan substitusi jagung dengan tepung singkong," Program Studi Produksi Ternak FPPK UNIPA dan Program Studi Nutrisi dan Makanan Ternak FPPK UNIPA. Universitas Negeri Papua. Papua, 2008.

[44] T. Yamamoto, L. R. Juneja, H. Hatta and M. Kim, *Hen Eggs: Basic and Applied Science*. University of Alberta, Canada, 2007.

**Appendix 1.** Average palatability for 16 weeks of research, Feed Consumption (g/head/day), Protein Consumption (g/head/day), Energy Consumption of Metabolism (EM) kcal/kg/day)

| Feed | Treatment | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Commercial Feed | 100 | - | - | - |
| Corn | - | 54,43 | 53,60 | 46,12 |
| Rice Bran | - | 6,06 | 4,31 | 2,83 |
| Soybean Meal | - | 33,82 | 27,00 | 24,39 |
| Fish Meal | - | 5,67 | 4,67 | 3,73 |
| Coconut Cake | - | - | 10,08 | 5,71 |
| PMM | - | - | - | 16,99 |
| Total | 100 | 99,98 | 99,66 | 99,97 |

Feed Consumption (g/head/day)

| Treatment | Replicaton | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | | |
| $T_0$ | 23,92 | 21,96 | 22,16 | 24,97 | 22,25 | 115,26 | 23,05 |
| $T_1$ | 17,51 | 19,26 | 17,8 | 14,9 | 17,50 | 86,97 | 17,39 |
| $T_2$ | 17,21 | 17,71 | 17,3 | 12,08 | 13,23 | 77,53 | 15,50 |
| $T_3$ | 19,62 | 21,84 | 21,58 | 20,63 | 22,30 | 105,97 | 21,19 |

Protein Consumption (g/head/day)

| Treatment | Replicaton | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | | |
| $T_0$ | 4,21 | 3,86 | 3,90 | 4,39 | 3,91 | 20,27 | 4,05 |
| $T_1$ | 3,21 | 3,62 | 3,67 | 2,87 | 3,66 | 17,03 | 3,40 |
| $T_2$ | 3,40 | 3,42 | 3,44 | 2,43 | 2,86 | 15,55 | 3,11 |
| $T_3$ | 3,28 | 3,60 | 3,84 | 3,95 | 4,10 | 18,77 | 3,75 |

Energy Consumption of Metabolism (EM) ( kcal/kg/day)

| Treatment | Replicaton | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | | |
| $T_0$ | 58,27 | 53,5 | 53,99 | 60,83 | 54,2 | 280,79 | 56,158 |
| $T_1$ | 44,81 | 50,31 | 38,63 | 35,86 | 35,91 | 205,52 | 41,104 |
| $T_2$ | 42,14 | 43,24 | 40,72 | 29,34 | 31,18 | 186,62 | 37,324 |
| $T_3$ | 48,87 | 53,42 | 51,52 | 48,62 | 52,81 | 255,24 | 51,048 |