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Effect of Processed Rumen Digesta with Probiotics on Eggs Quality Characteristics of Khaki Campbell Ducks (Anas Platyrhynchos Domesticus)

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Abstract
Khaki Campbell is a duck with a dual purpose, as a producer of meat and egg, although its role as laying is more prominent. The aim of the present study is to examine feed ingredients for ducks (poultry) originating from abattoir waste that does not compete with humans. Feed is the largest component that affects poultry production since feed expenses occupy at least 60 - 70% of the production cost. The examined feed ingredient was the rumen digesta of the cow that was collected from the slaughterhouse and it is recommended to participate at 10 - 15% in rations, so as not to cause adverse side effects. The method of addition of probiotics to the feed of processed cow rumen serves to improve the growth rate, feed conversion efficiency, egg production, and livestock health. Measurements in the form of the amount of raw feed balance with processed rumen digesta substitution feed on the productivity of duck eggs. The conclusion of this study that the partial replacement of processed rumen content feeds up to 15% in Khaki Campbell ducks, did not give a noticeable difference (p>0.05) on egg weight, egg shape index, egg white index, yolk index, Haugh Unit, and egg yolk color. The main finding is that processed beef rumen content at the level of 10-15% can be used as a diet ingredient for ducks without affecting egg quality characteristics.

Keywords: *Khaki Campbell ducks, probiotics, productivity, rumen digesta of cows.*

INTRODUCTION

Ducks are one of the poultry species known as producers of both meat and eggs. Duck’s egg contains higher protein, calories and fat levels than hen eggs (Gerzilov et al., 2018). Egg is a product that covers a great part of human needs, especially for protein (Yuan et al., 2013). Egg production of the Campbell breed can exceed that of the most efficient laying hens, with an average egg production of 300 eggs per year. When provided with environmental conditions that favour its development, ducks lay eggs of improved quality. The unique nature of this duck is that it does not incubate its egg, but human intervention is needed to hatch its eggs (Hasan et al., 2017).

Feed is the highest expense that affects poultry production because it accounts for at least 60-70% of the production cost. Feed is used as a determinant of production efficiency and quality of livestock products (Swain, 2016). Meeting the nutritional needs of livestock both in terms of feed quality and quantity also affects its performance. The use of imported feed ingredients resulted in high feed prices, so many farmers that cannot purchase them suffer severe losses (Lokapirnasari et al., 2015).

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The rumen digesta of the cow's is a waste of slaughterhouses that can still be used as non-ruminant animal feed, since it contains nutrients of high nutritional value such as coarse fiber, protein, fat, vitamins, minerals, digestive enzymes and some types of digestive aid microbiota. Utilization of the contents of cow rumen in addition to reducing environmental pollution, the feed material does not compete with human needs. The contents of the rumen itself is one of the livestock wastes that is widely disposed of and has not been widely used (Restiadi, 2022; Moningkey, et al., 2020). The nutritional content is still quite high, due to the unabsorbed food substances, and the food substances contained are not far different from the substances derived from the raw materials (Hudha et al., 2020). Dietary substances contained in rumen include protein at 8.86%, fat at 2.60%, coarse fiber at 28.78%, phosphorus at 0.55%, ash at 18.54% and water at 10.92% (Basri, 2016). Utilization of processed cow rumen digesta feed at the level of 10% in duck diets can increase weight/productivity (Restiadi and Widiyatno, 2018).

In addition to protein, vitamins and minerals, the contents of rumen also contain high coarse fiber. High coarse fiber is a limiting factor of rumen digesta application as animal feed material, but this problem can be overcome by its processing (Esonu et al., 2006). Rumen fluid contains bacteria and protozoa with a concentration of about 109/cc and 105-106/cc, respectively. Bacteria/microbes contained in the contents of the rumen are categorized as: (a) lipolitic bacteria (2.1 x 1010 cells/gram) and fungi (1.7 x 103 cells/gram), (b) acid-forming bacteria (5.6 x 109 cells/grams), (c) amylolytic bacteria (4.9 x 109 cells/gram), (d) cellulolytic bacteria (8.1 x 104 cells/grams), (e) proteolytic bacteria (2.5 x 109 cells/gram) (Liu et al., 2019; Calsamiglia et al., 2008).

Probiotics are living microorganisms that can improve the health of humans or livestock by balancing microflora in the digestive tract if consumed in sufficient quantities (Kusumawati et al., 2003). These microbes can be mass-produced, remain stable and viable for long periods of time in storage conditions and in the field, can survive inside the digestive tract, and have a beneficial impact on the host (Salminen and Wright, 1998).

Factors that affect the physical quality of eggs are: feed, age, ambient temperature, and productive system, as well as genetic factors. Egg quality parameters consisted of egg weight, albumen weight, yolk weight, shell weight, yolk color score, shape index, Haugh unit and shell thickness (Nugraha et al., 2013; Tan et al., 2012). The quality of duck eggs can be evaluated in two ways, namely by candling and measurement of the parameters of the Egg White Index (EWI), Egg Yolk Index (EYI), and Haugh Unit (HU) (Abd El-Hack et al., 2019; Hashemzadeh and Farajzadeh, 2016).

Egg White Index is a parameter that indicates a comparison between the height of albumin with the average diameter of the length and width of the viscous albumin. According to Buckle et al. (2010), freshly ground chicken eggs have EWI values ranging from 0.050 - 0.174. Generally, under normal circumstances, it ranges from 0.090 - 0.120. EWI may decrease during storage, as an effect of ovomucin breakdown. The decrease in EWI is strongly influenced by the storage temperature, the lower the storage temperature, the smaller the decrease.

The Egg Yolk Index is a comparison between the height of the yolk and its diameter after the yolk is separated from the egg white. Fresh eggs have an EYI of 0.33-0.50 with an average value of EYI of 0.42. With the age of the eggs, the EYI will decrease due to the increase in the size of the yolk due to water transfer (Buckle et al., 2010).

The Haugh Unit as a measure of egg albumen quality between the height of the egg white and the weight of the egg. The higher the HU the better the quality of the egg. The newly laid egg has a HU value of 100 (Buckle et al. 2010). Egg with adequate quality has a HU value of 75 while damaged eggs below 50. Eggs stored at inadequate conditions undergo HU changes very quickly; at low temperatures or cooling a change in HU from 80 to 68 is recorded after 19 days, while without cooling an average decrease of 1.51 units per day is observed (de Menezes et al., 2012; Novita et al., 2021).

The brightness of the yolk is an indicator that determines the internal quality of the egg. The color quality of the yolk is determined by comparing the standard color of the "Roche yolk color fan" in the form of a fan sheet of standard color with a score of 1-15 from pale to dark orange or concentrated (Kurtini et al., 2011). This egg yolk color measurement uses a yolk color fan. The higher the yolk color score, the better the egg quality (Vuilletjmier, 1968; Muharlien, 2010; Kaewtapee and Supratak, 2021).

MATERIALS AND METHODS

This research was carried out from December 2020 until February 2021 at a Khaki Campbell duck farm in Sawahan Village, Turen District, Malang Regency. Proximate analysis of feed ingredients was conducted at the Animal Feed Laboratory, and the egg quality assessment was conducted at the Veterinary Public Health Laboratory of the Faculty of Veterinary Medicine, Airlangga University of Surabaya.

A total of 40 Khaki Campbell ducks at the age of 24 weeks, placed on a battery cage (individual) with the following dimensions: length 40cm, width 35 cm, front height 55 cm, and rear height 50 cm. Ducks were randomly allocated into 4 treatments provided with the following diets: P0; 100% commercial feed, P1; 95% commercial feed and 5% processed rumen digesta, P2; 90% commercial feed and 10% processed rumen digesta, P3; 85% commercial feed and 15% processed rumen digesta. Adaptation period has a duration of a week, while the main experiment lasted for 4 weeks. Feed was provided in the form of commercial feed (manufactured by animal feed factory). The processed cow rumen digesta was prepared by drying the contents of wet rumen from the slaughterhouse for about 7 days below sunlight, further smoothed by grinding. Probiotics were then added for 2-3 days and the mixture was wrapped in plastic bag.

The data obtained in this study were analyzed using the statistical method of Analysis of Variants (ANOVA) when they followed a normal distribution to determine whether or not there was a significant difference. If there was a significant difference among treatments, Duncan's Double Distance Test followed with the significance rate set at 5%. If the data obtained was not normally distributed, Kruskal Wallis test was applied (Kusriningrum, 2012). Data analysis was performed using SPSS 20 for Windows computer devices.

Eggs were cleaned from dirt using a cleaning cloth. They were then weighed using digital scale with an accuracy of 0.01 g. Measurement of egg diameter (long and wide) followed using the caliper to measure the length and width of eggs with a precision level of 0.01 mm.

Egg white index is calculated by breaking duck eggs, held on a flat plane glass, measured albumin height and albumin diameter (the longest and shortest diameter) using a spherometer and caliper. Egg white index are calculated using the following formula:

$$\mathbf{EWI} = \frac{\mathbf{H}}{\mathbf{0{,}5\,(D_1 + D_2)}}$$

Description; EWI = egg white index, H = albumin height, and D1, D2 = albumin diameter (longest and shortest)

Measurement of the Egg Yellow Index by breaking duck eggs, poured on flat plane glass. Measurements can be made on egg yolks that have been or have not been separated from the egg white, measured the height and diameter of the yolk (two sides) with a spherometer and hollow term. Egg yolk index can be calculated using the following formula:

$$\mathbf{EYI} = \frac{\mathbf{h}}{\mathbf{0.5\ (d_1 + d_2)}}$$

Description; EYI = egg yolk index, h = egg yolk height, and d1, d2 = egg yolk diameter

Haugh Unit measurement is to weigh the egg first and then the egg fell is broken down and measured the height of the egg white, using the following formula:

$$\mathbf{H = 100\ log\ (h+7.57-1{,}7.\ W^{0{,}37})}$$

Description; H= Haugh unit, h = egg white height, and W= egg weight

Measurement of Egg Yolk Color by breaking the egg aquae, placed on flat glass and then matched the color with yolk color fan.

RESULTS AND DISCUSSION

Khaki Campbell Duck Egg Weight

Egg weight data was daily recorded in the last 7 days of the study. The average egg weight of each treatment is shown in Table 1.

Table 1. Average and Standard Deviation (SD) Egg Weight of Khaki Campbell Ducks

Treatment	Average and Standard Deviation (X±SD)
P0	$59.087^{a} \pm 1.595$
P1	$60.134^{a} \pm 2.140$
P2	$61.470^{a} \pm 1.802$
P3	$57.235^{a} \pm 2.701$

Description: The same superscript in the same column shows no noticeable difference ($p>0.05$).

Figure 1. Egg weight measurement

Based on the results of the analysis of egg weight data written in Table 1. Using one-way ANOVA (Analysis of Variance) it can be known that the fermentation of flour containing processed rumen as a substitution, does not show a noticeable difference ($p>0.05$).

Factors affecting egg weight are feed consumption, genetics and age, medications, diseases and nutritional content of rations, environmental temperature, and weight (Bell and Weaver Jr., 2002; Travel et al., 2010; Ledvinka et al., 2012). The most important factor in the feed that affects egg weight is protein, since about 50% of the egg's dry matter is protein, hence the provision of amino acids for protein synthesis is essential for egg production (Leeson and Summers, 2008). The use of protein in rations of less than 17% can reduce egg weight, so it is best to use protein above 17% (Zurmiati et al., 2017). An amino acid that greatly affects the weight or size of eggs is the amino acid methionine. Egg weight is an indicator of the physical quality of eggs whose value is influenced by the nutritional content in the ration given, especially the protein and Ca content (Leeson and Summers, 2008).

In general, duck eggs are large and the color of the macaque is white to bluish-green. The average weight of duck eggs is 60-75 g (Idahor et al., 2015). According to SNI (2008) that the classification of consumption eggs based on their weight is three, namely small (less than 50 g), medium (50-60 g), and large (more than 60 g). The average egg weight in this study belongs to the weight of eggs that fall into the medium category for P0 and P2, while P1 and P3 fall into the large category.

Eggs are composed of three main parts, namely egg whites, yolks, and eggshells. All three have a role in the overall egg weight and are also influenced by the weight of livestock (Wolc et al., 2012; Belitz et al., 2014; Kusum et al., 2018).

Khaki Campbell Duck Egg Shape Index

The egg shape index is the quality of the outer egg is calculated based on dividing the average width of the egg (the outer diameter of the egg hole) and the average length of the egg (the height of the egg's outer egg. The average value obtained from the calculation of the Egg Shape Index can be seen in Table 2. Next:

Table 2. Average and Standard Deviation (SD) Khaki Campbell Duck Egg Shape Index

Treatment	Average and Standard Deviation (X±SD)
P0	$82.15^{ab} \pm 2.924$
P1	$81.82^{a} \pm 3.180$
P2	$82.70^{ab} \pm 2.603$
P3	$82.53^{ab} \pm 2.048$

Description: The same superscript in the same column shows no noticeable difference (p>0.05).

Figure 2. Egg shape index measurement

Based on the results of the analysis of egg shape index data written in table 2. using oneway ANOVA (Analysis of Variance) that the provision of processed rumen content flour as a substitution does not show a noticeable difference (p>0.05).

The egg shape index is the value that determines the ideal or absence of egg shape and is influenced by the processes that occur during egg formation (Dirgahayu et al., 2016). Obtained from the measurement of the length and width of the egg (width/length x

100%). The measurement results (Roesdiyanto, 2002) index of egg form obtained is 76.50 ± 2.90 with an average range of 73.79 - 81.37. (Suselowati et al., 2019) stated that the measurement results against the index of egg form obtained had an average of 80.56 – 81.42. The high value of the egg index indicates that the eggs tend to be round in shape. Factors that determine the shape of eggs are very diverse, including age, breeds, species, and genetics (Idahor et al., 2015). The egg shape may have important functions during incubation and hatching (Salamon and Kent, 2017). In this study, the egg index belongs to the good category.

Khaki Campbell Duck Egg White Index

The egg white index is the quality of egg whites calculated based on the quotient between the average height of the egg white and the average width of the egg white. The average value obtained from the calculation of the egg white index can be seen in table 3. next:

Table 3. Average and Standard Deviation (SD) Khaki Campbell Duck Egg White Index

Treatment	Average and Standard Deviation (X±SD)
P0	$0.096^{c} \pm 0.007$
P1	$0.085^{bc} \pm 0.014$
P2	$0.068^{a} \pm 0.016$
P3	$0.071^{ab} \pm 0.009$

Description: The same superscript in the same column shows no noticeable difference (p>0.05).

Based on the results of the analysis of egg white index data in table 3. using oneway Anova (Analysis of Variance) it can be known that the provision of processed rumen content flour as a substitution, highest at P0, followed by P1, P3, and P2 respectively. In P0, P1 shows no real difference (p>0.05), P1, P3 shows no real difference (p>0.05), and in P2 and P3 it does not differ markedly (p>0.05).

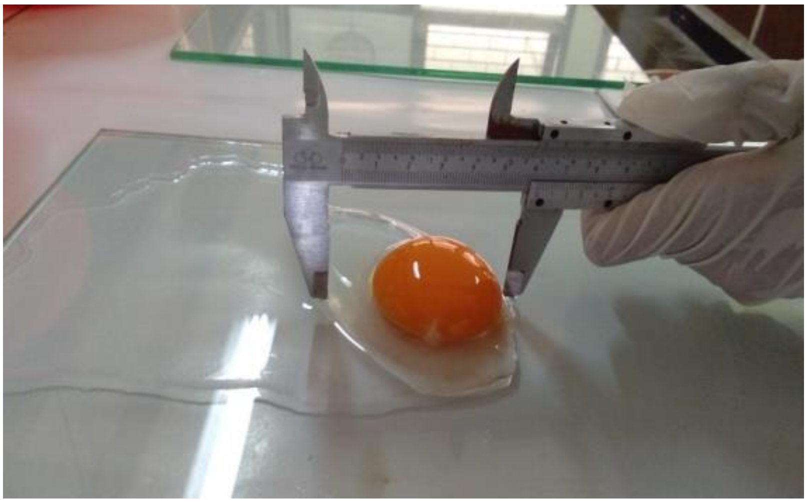

Figure 3. Egg white index measurement

Egg quality can be influenced by genetic properties, including the texture and thickness of egg aquae, the number of pores of the egg number, the presence of blood stains, the viscosity of egg whites and the chemical composition of eggs (Abd El-Hack et al., 2019). Changes in egg whites are caused by the exchange of gas between the outside air and the contents of the egg through the pores of the wall. Thin egg droppings are relatively porous and large, accelerating the decline in egg quality that occurs due to evaporation (Abd El-Hack et al., 2019; Widyantara et al., 2017). According to (Musadiq et al., 2017) that at the beginning of storage, evaporation of water and CO_2 gases takes place faster because the amount of liquid in the egg is more abundant.

A significant difference in each treatment is due to the timing of non-simultaneous duck egg laying and egg examination is carried out after the eggs have collected all in the morning. Research Novita et al. (2021) did not show a noticeable difference in the egg white index, since testing was carried out shortly after the hens' laid eggs. Another factor is the protein content present in the feed. The results of the proximate analysis showed that the rough protein in each treatment was still above normal (SNI, 2008) where the need for coarse protein in duck rations was at least 15%. The protein content that is in the minimum standard range allows it to affect the index value of egg whites to be lower.

The protein content in the feed will affect the ovomucin which serves as the formation of the egg structure. Ovomucin is a membrane-shaped egg-white protein that is insoluble in water. Ovomucin is four times thicker in thick egg whites than in diluted egg whites. Thick egg whites will affect the index value of egg whites to be higher and higher to maintain the quality of egg whites during their storage period (Sudaryani, 2003; Guhaa et al., 2018; Kusum et al., 2018).

Khaki Campbell Duck Egg Yolk Index

The yolk index is the quality of the yolk which is calculated based on the quotient between the average height of the yolk and the average width of the yolk. The average value obtained from the calculation of the yolk index can be seen in table 4. next:

Table 4. Average and Standard Deviation (SD) Khaki Campbell Duck Yolk Index

Treatment	Average and Standard Deviation (X±SD)
P0	$0{,}348^{c} \pm 0{,}013$
P1	$0{,}329^{abc} \pm 0{,}037$
P2	$0.316^{ab} \pm 0.011$
P3	$0.304^{a} \pm 0.022$

Description: The same superscript in the same column shows no noticeable difference (p>0.05).

Based on the results of the analysis of egg yolk index data in table 4. using oneway Anova (Analysis of Variance) can be known that the provision of flour processed rumen contents as substitution, highest at P0, followed by P1, P2, and P3 respectively. In P0, P1 shows no real difference (p>0.05), P1, P2 does not show any real difference (p>0.05), and in P1 and P2 it does not differ markedly (p>0.05).

Figure 4. Egg yolk index measurement

Research by Alfiyah et al. (2015) on the egg yolk reported that the observed variability are a result of differences in nutrients in the feed provided. The decrease in the value of the yolk index is likely caused by a decrease in feed quality especially the crude protein in feed (Rahayu et al., 2020). Protein is one of the main sources of egg formation. The yolk index is influenced by the content of proteins that can stimulate the formation of vitelline membranes. The vitelline membrane is an integral part of egg yolk, separating it from egg white (albumen). By surrounding slurry yolk, it gives a spherical shape. The structure of vitelline membrane integrity is of high biological importance. It protects the inner part of yolk against pathogens and allows the proper course of embryogenesis. The thinner the vitelline membrane, the osmotic pressure of the yolk becomes greater than the egg white so that the water from the egg white moves towards the yolk. The transfer of water causes the yolk to become diluted and relatively flat in shape, so that the value of the yolk index becomes low (Marzec et al., 2016; Purdiyanto and Riyadi. 2018; Gao et al., 2022).

The high value of the yolk index is influenced by the protein and fat content in the feed that serves as a mediator in the egg formation process (Gerzilov et al., 2018). Function from protein and fat maintains the viscosity of the egg, especially in the khalaza which helps the condition of the yolk remain in the middle and also forms a vitelin membrane or strong egg yolk wrapper (Atik, 2010). The fat content in egg yolks can be influenced by the fat content in feed (Yamamoto et al., 2018), while the fat requirement in ducks is a maximum of 7% (SNI, 2006).

Haugh Unit Khaki Campbell Duck Eggs

Based on the results of the analysis of Haugh Unit (HU) data on Khaki Campbell's duck eggs with the provision of flour the contents of processed rumen on feed as a substitution of each treatment seen from table below:

Table 5. Average and Standard Deviation (SD) Haugh Unit Khaki Campbell Duck Eggs

Treatment	Average and Standard Deviation (X±SD)
P0	$77.310^{c} \pm 3.896$
P1	$74.100^{bc} \pm 6.166$
P2	$64.630^{a} \pm 9.547$
P3	$68.050^{ab} \pm 4.738$

Description: The same superscript in the same column shows no noticeable difference ($p>0.05$).

Based on the results of the analysis of Haugh Unit egg data in table 5. using oneway Anova (Analysis of Variance) it can be known that the provision of flour is processed rumen content as a substitution, the highest number at P0, followed by P1, P3, and P2 respectively. In P1, P3 shows no real difference ($p>0.05$), and in P2 and P3 it does not differ markedly ($p>0.05$).

Haugh Unit values are influenced by genetics, age, season, conditions of storage of eggs and feed (Bovšková et al., 2014). The crude protein content in this study varies among treatment, the more the addition of processed rumen digesta to the feed ration shows a decrease in the crude protein content. Digestibility to protein will be lower when the content of coarse fiber is high. While the need for coarse fiber in ducks is a maximum of 8% (SNI, 2006). Proteins in the feed affect the formation of albumin which leads to an increase in egg weight. Egg weight gain can affect the value of Haugh Unit (Purdiyanto, and Riyadi, 2018; Gao et al., 2022).

The newly ground egg has a Haugh Unit value of 100. The exchange of gas between the outside air and the contents of the egg through the pores of the egg's eggshell causes changes in the egg white. Water loss can occur due to evaporation due to the length of time the egg is stored. The longer the storage time, the higher the evaporation of CO2 and H2O so that the egg white decreases viscosity and affects the value of Haugh Unit (Novita et al., 2021).

Khaki Campbell Duck Egg Yolk Color

Egg Yolk Color is measured using the tool "Roche yolk color fan" Based on the results of data analysis using oneway Anova (Analysis of Variance) it can be known that color yellow egg duck Khaki Campbell by giving flour filled with processed rumen on ducks feed. The average value of the yolk color of each treatment can be seen in table 5.6 below:

Table 6. Average and Standard Deviation (SD) Khaki Campbell Duck Egg Yolk Color

Treatment	Average and Standard Deviation (X±SD)
P0	12.860[a] ± 0.844
P1	12.480[a] ± 0.884
P2	12.640[a] ± 0.770
P3	13.180[a] ± 0.481

Description: The same superscript in the same column shows no noticeable difference (p>0.05).

Based on the results of the analysis of egg yolk color data in table 6. using oneway Anova (Analysis of Variance) it can be known that the provision of processed rumen digesta flour, in all treatments (P0, P1, P2, and P3) does not show a noticeable difference (p>0.05).

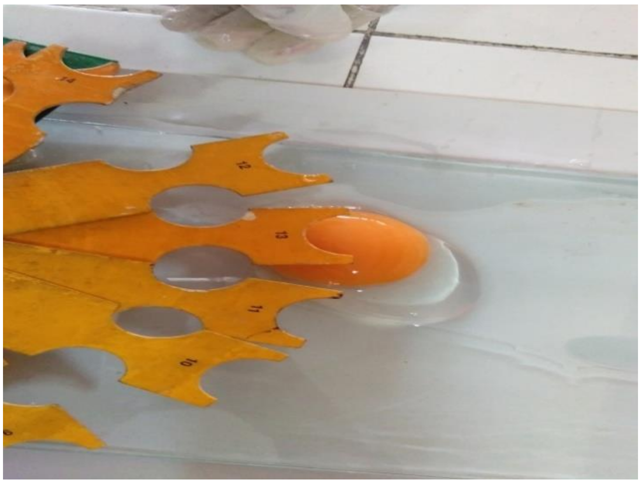

Figure 6. Egg yolk color measurement

The quality of the color of the yolk was chosen as a parameter in this study because it is one of the important factors that can determine the quality of egg from the many factors that can determine the quality of egg. Egg with good quality will produce a high selling price so that it can increase revenue with increasing consumer demand (Kaewtapee and Supratak, 2021).

As high as the color of the yolk, it can be identified that more amount of vitamin A in the form of carotenoids is consumed or contained in feed substances. The content of vitamin A contained in the fermentation of processed rumen-filled flour can increase the color of egg yolks (Bovšková et al., 2014; Kanyinji and Moonga, 2014). Carotenoid metabolism processes also differ between animals including carotenoids that are absorbed in the digestive system. Pigment deposits in the body of livestock are strongly influenced by fat content because carotenoids are fat soluble. The digestive system of fat in the body is helped by the presence of bile salts produced by the liver. Bile salts combine with fat to form complex micelles that dissolve in water so that fat is more easily absorbed (Ashok et al., 2004; Suharja, 2010). Fat accumulation in feed will affect the structure of the yolk, which has an impact on the increase in the yolk index (Purdiyanto and Riyadi, 2018; Gao et al., 2022). β-carotene will be more efficiently used by the body in small amounts of food, therefore the absorption of carotene varies (Sahara (2011; Grune et al., 2010).

Conflict of Interest

"The authors declare that there are no conflicts of interest."

CONCLUSION

Partial replacement of commercial diet with processed rumen digesta till the level of 15% in Khaki Campbell ducks, does not affect egg weight, egg shape index, egg white index, yolk index, yolk index, Haugh Unit, and egg yolk color.

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