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Effect of probiotic supplementation in the diet on the production and physical quality of eggs in laying hens

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Abstract

Probiotics are beneficial microorganisms that are used as feed supplements whose activity in the host's digestive tract produces organic acids so that the intestinal microflora is always in a balanced state and nutrient absorption can be optimal. This study aims to examine the effect of probiotic (Pro-B10) supplementation in the diet on egg characteristics and performance of laying hens. A total of 120 hens aged 60 weeks were randomly divided into 4 treatment groups, namely: the group of laying hens fed a diet supplemented with 0.5% Pro-B10 (P1); 1% Pro-B10 (P2); and 1.5% Pro-B10 (P3). The control group of chickens was fed without Pro-B10 (P0). Each treatment with 5 repetitions with 30 hens per repetition. The results showed that the hens in the P3 group had the highest egg production and feed efficiency ($P<0.05$) compared to the P0, P1 and P2 hen groups. Pro-B10 supplementation in the diet had a significant ($P<0.05$) effect on egg characteristics.It can be concluded that supplementation of 1.5% probiotic Pro-B10 in feed for Lohmann Brown laying hens from 60-68 weeks of age, can increase egg production and feed efficiency, as well as increase the weight and color of eggshells which are preferred by consumers.

Keywords: Egg production; Feed efficiency; Hens; Probiotics

1. Introduction

Productivity and egg quality in laying hens will decrease if it has passed its peak production period. A decrease in egg production is usually followed by a decrease in egg quality, so efforts are needed to maintain egg production and quality, one of which is by using antibiotics. Antibiotics have been banned for use in feed because they can trigger resistance to pathogenic microorganisms and residues in livestock products such as meat, milk and eggs [1]. Therefore, other efforts are sought to increase the production and quality of chicken eggs and one of them is with probiotics, as reported by [2] that antibiotics can be replaced with probiotics.

Probiotics are beneficial microorganisms that are used as feed additives that work to produce organic acids so that the intestinal microflora is always in a balanced state, so that nutrient absorption can be properly absorbed in the digestive tract. Priastoto et al. [3] stated that good absorption of nutrients in the digestive tract can affect productivity in laying hens. Microorganisms that are often used as probiotics are strains of *Lactobacillus*, *Bifidobacterium, Bacillus, Pediococcus* and *Yeast* [4]. The use of probiotics in feed can lead to increased production performance, increase feed digestibility, feed efficiency and egg production [5,6,7]. *Bifidobacterium bifidum* is a natural microflora found in the digestive tract that functions as a probiotic bacteria in inhibiting the growth of pathogenic bacteria such as *Escherichia coli, Salmonella* and *Clostridium* bacteria [8].

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The role of probiotics in increasing egg production in discarded laying hens has been proven by [9] that commercial probiotic supplementation containing *Lactobacillus, Lactococcus, Bifidobacterium* and *Streptococcus* bacteria, can improve production, egg yolk color, and reduce egg cholesterol content. The same thing was reported by [10] that probiotic supplementation in laying hens that are 64 weeks old can increase egg weight, albumen weight, and yolk weight.

This study aims to examine the effect of probiotic supplementation (Pro-B_{10}) in feed on production performance and egg quality of laying hens aged 60 weeks.

2. Material and methods

2.1. Material

This research was carried out in a laying hen house located in the Village of Tempatan, Sebawi District, Sambas Regency, West Kalimantan, Indonesia and sample analysis was carried out at the Quality Analysis Laboratory of the State Polytechnic, Sambas and the Animal Feed Laboratory at the Animal Husbandry Office of the Province of West Kalimantan, Indonesia.

The materials used in this study were 60 weeks old Lohmann Brown layers with homogeneous body weight. The probiotic used was commercial **Pro-B_{10}** produced by CV. Paradipta Paramita which contains bacteria: *Bacillus cereus, Bacillus amyloliquefaciens, Bifidobacterium bifidum, Bifidobacterium longum, and Lactobacillus bulgaricus*. The ration used consisted of 801 laying hens concentrate produced by PT. Gold Coin Indonesia, corn and rice bran. Rations were prepared according to the needs of laying hens. The tools used are: digital scales, caliper, egg yolk color fan, eggshell color fan, egg tray, plastic, battery cage, PVC pipe, nipple, and label paper.

2.2. Methods

A total of 120 hens aged 60 weeks were randomly divided into 4 treatment groups, namely: the group of laying hens fed a diet supplemented with 0.5% Pro-B_{10} (P1); 1% Pro-B_{10} (P2); and 1.5% Pro-B_{10} (P3), respectively. The control group of chickens was fed without Pro-B_{10} (P0). Each treatment with 5 repetitions with 30 hens per repetition.

All chickens were kept in battery cages measuring 30 cm long, 30 cm wide and 35 cm high which were made of iron wire, and each battery was filled with 2 hens. Each cage is equipped with a feed container made of paralon pipes and drinking water using a nipple, and under the feed container a plastic is placed to collect excreta.

2.2.1. Variable measurement

Feed consumption (FI) is the amount of feed consumed in a certain period of time, and was calculated every day in units of g/head/day [11]. Feed Conversion Ratio was obtained from calculating the amount of feed spent divided by the weight of the eggs produced. The lower the ration conversion value, the better the laying hen business. This means that laying hens were reared more efficiently in consuming feed. The weight of the eggs produced during the study was weighed and recorded every day so that the weight of the chicken eggs was obtained. Egg production is expressed by the size of hen-day production (HD), which is one measure of the productivity of laying hens which was obtained by dividing the number of eggs by the number of chickens in the population.

The egg index was obtained from the results of measuring the diameter of the width of the egg with the length of the egg (width/length×100%) which was measured using a caliper. The color of egg yolk varies from pale yellow to dark reddish orange. To determine the color score of the yolk using the egg yolk color fan which consists of 15 color series [12]. Haugh unit (HU) was related to egg weight and egg white height. The higher the haugh unit value indicates the higher the quality of the egg [13]. Albumin weight or egg white weight was obtained by separating the yolk from the egg white and then weighing it in g/egg. Yolk weight or egg yolk weight was obtained by separating the yolk from the egg white and then weighing it in g/egg. The weight of the eggshell was obtained by breaking the egg and separating the egg white, yolk and eggshell, then the eggshell was weighed in g/egg. The color of the eggshell varies from off-white to dark brown. To determine the color score using the Egg Shell Color Fan which consists of 15 color series.

2.3. Data analysis

The data obtained were analyzed with one-way analysis of variance. If there were significantly different results between the treatments ($P<0.05$), the analysis was continued with Duncan's multiple range test.

3. Results and discussion

3.1. Egg production performance.

The results of the research on the production performance of laying hens fed probiotics (Pro-B_{10}) in rations from 60-68 weeks of age on feed consumption, feed conversion, egg weight and egg production can be seen in Table 1.

Table 1 Production performance of Lohmann Brown laying hens aged 60-68 weeks fed with Pro-B_{10} probiotic supplementation

Variable	Pro-B10 level in Feed (%)				SEM
	0	0.5	1.0	1.5	
FI (g/head/day)	112.25b	113.50a	113.93a	112.43b	0.410
Feed conversion ratio	2.43a	2.33ab	2.09ab	1.98b	0.101
Egg weight (g/egg)	61.74	61.59	61.73	60.95	0.428
HD (%)	76.25b	80.30ab	89.35ab	93.51a	3.970

Note: The mean with superscript (^{a,b}) was significantly different (P≤0.05); SEM= Stadard error of the treatment means

Feed consumption in group P0 was lower than in groups P1 and P3, but statistically it was not significantly different (P>0.05) and when compared to group P2 it was 1.47% significantly different (P<0.05) higher than the control laying hen group. The mean FCR values in the P0 group were higher, namely: 4.11% and 13.99% compared to the P1 and P2 groups, but statistically they were not significantly different (P>0.05) and 18.52% (P<0.05) higher than the P3 layer chicken group. The mean egg weight between groups P1, P2 and P3 was not significantly different (P>0.05). More detail is presented in Table 1.

Egg production in groups P2 and P1 was higher, namely: 14.66% and 5.04%, compared to group P0 (control), but statistically not significantly different (P>0.05). Egg production in the P3 group was 18.46% significantly (P<0.05) higher than the control layer group (P0).

Supplementation of 0.5-1% Pro-B10 in the diet significantly increases FI. This increase was caused by increased digestive activity caused by probiotics [14]. The same thing was reported by [15] that laying hens consumed more rations with probiotics. Even though the mean FI and egg weight were relatively the same, the high average egg production in the P3 treatment caused the feed conversion value to be lower or to be more efficient. The average ration conversion value in this study indicated that probiotic supplementation in the diet tended to improve ration conversion values. Jannah et al. [16] reported that improving the conversion value of the ration in chickens given the probiotic *Bacillus sp.* enabled the digestibility of feed ingredients to be more perfect.

Egg weight is influenced by several factors, namely the age of the chicken, ambient temperature, strain, nutritional content of the feed, body weight of the chicken, and the time the eggs are produced [17]. The chickens used in this study were 60 weeks old, where this age had entered phase II of production. According to [18], laying hens with phase II production at the age of 42-72 weeks, the average production is 72% and the egg weight is 60g. Kompiang [19] reported that chickens that were given probiotics in feed and drinking water also had egg weight that did not have a significant effect, which ranged from 59.99-60.71 g. Tugiyanti et al. [20] stated that egg weight is affected by the protein content in the feed. High feed protein levels affect albumin and egg yolk protein synthesis, while albumin and egg yolk are the largest components in the formation of egg weight [21,22,23]. The value of egg weight in the treatment given probiotics tended to decrease, presumably because the nutritional value of the rations, especially metabolic energy and protein, had a complex relationship. This statement is supported by [24] which states that if the ration has little energy, the lack of energy will convert protein carbon into energy.

Statistical results showed that there was a difference in egg production between feeds given probiotics and feeds without probiotics (control). Bidura et al. [25] reported the results of their study on Lohmann Brown laying hens supplemented with probiotics in feed could increase egg production, namely feed given probiotics was able to achieve production from 85.64% to 86.64%, whereas without probiotics it was only 82.02%. Priastoto et al. [3] reported the results of his study that probiotic-treated feed increased egg production from 76.50% to 82.17%, while egg production without probiotics was only 75.97%.

3.1.1. External quality of eggs.

The results of the study on the egg quality of laying hens fed probiotic Pro-B_{10} in feed on egg index, yolk color, haugh unit (HU), albumin weight, yolk weight, shell weight, and eggshell color are presented in Table 2.

Table 2 Effect of Pro-B_{10} probiotic supplementation in the diet of Lohmann Brown laying hens from 60-68 weeks of age on the external quality of eggs

Variable	**Pro-B_{10} level in Feed (%)**				**SEM**
	0	**0.5**	**1.0**	**1.5**	
Egg index	74.51^{b}	76.87^{a}	75.99^{ab}	75.26^{ab}	0.50
Egg yolk color (1-15)	9.17	9.25	9.08	9.46	0.81
Haugh Unit (HU)	79.35	78.93	78.44	78.73	1.27
Albumin weight (g/egg)	36.37^{b}	39.43^{ab}	38,20^{ab}	40,99^{a}	0.98
Yolk weight (g/egg)	16.76	16.91	16.22	16.87	0.20
Shell weight (g/egg)	7.75^{b}	8.09^{ab}	8.22^{a}	8.33^{a}	0.13
Eggshell color (1-15)	12.02^{b}	12.32^{b}	13.53^{ab}	14.23^{a}	0.52

Note: The mean with superscript (^{a,b}) was significantly different (P≤0.05); SEM= Stadard error of the treatment means

Supplementation of 0.5% probiotics in the diet significantly (<0.05) increased the egg shape index, which was 3.07% higher than the control. The inclusion of probiotics in the diet did not have a significant effect (P>0.05) on the weight and color of the yolk. Likewise, the average haugh unit (HU) score between groups did not show a significant difference (P>0.05).

The mean egg albumin weight in the P3 group was 11.27% significantly (P<0.05) higher than the control group (P0). Likewise, the eggshell weight in group P3 was 6.96% significantly higher (P<0.05) than group P0. The average eggshell weight in the P3 group was 1.32% (P>0.05) higher than that in the P2 group. Supplementation of Pro-B10 at the level of 1.5% in feed significantly (P<0.05) increased eggshell color, namely: 15.53% higher than the P0 group (control). Meanwhile, shell color between groups P0, P1, and P2, did not show a significant difference (P>0.05).

The mean egg albumin weight in the P3 group was 11.27% significantly (P<0.05) higher than the control group (P0). Likewise, the eggshell weight in group P3 was 6.96% significantly higher (P<0.05) than group P0. The average eggshell weight in the P3 group was 1.32% (P>0.05) higher than that in the P2 group. Supplementation of Pro-B10 at the level of 1.5% in feed significantly (P<0.05) increased eggshell color, namely: 15.53% higher than the P0 group (control). Meanwhile, shell color between groups P0, P1, and P2, did not show a significant difference (P>0.05).

The results showed that the egg index values in group P0 were not significantly different from groups P2 and P3, but there were differences from group P1. The highest index value was generated from group P1, which was 76.87%, while the lowest index value was generated from group P0, which was 74.51%. Numerically, the index value of eggs that were given probiotics in the diet increased compared to those without probiotics. The egg index value is the value that determines the ideal egg shape or not. Soekarto [26] states that the ideal egg shape has an index value of 0.80. If the index value is lower than 0.80, then the egg is oval and if it is higher than 0.80, then the egg is round. Yuwanta [11] states that the index value of eggs is in the range of 65-82% with an ideal index value of between 70-75%. Furthermore [27] reported that a proportional egg shape has an ideal egg index value of 70-75%.

The color of the yolk is an indicator in determining the quality of eggs from the consumer's point of view. Sudaryani [13] states that a good egg yolk color ranges from 9-12 on the egg yolk color fan scale. The average value of the yellow color was the highest in the P3 layer group and the lowest in the P2 group with a value of 9.08 on the egg yolk color fan scale. Giving probiotics in this study has not been able to increase the value of egg yolk color. Argo et al. [21] reported that the color of egg yolk was affected by the nutrient content in the feed, such as xanthophyll and β-carotene.

Probiotic supplementation in the diet has not been able to provide significant value to the Haugh Unit value. The haugh unit is an indicator for assessing the freshness of eggs which is calculated from the measurement results between albumin height and egg weight. Mulyadi et al. [28] stated that there was a positive correlation between the albumin value and the Haugh Unit value, that is, the higher the albumin, the higher the Haugh Unit value. Amin et al. [29] stated that factors that can affect the HU value are albumin height, nutritional value in feed, protein intake and egg weight produced. Satria et al. [30] stated that sufficient protein intake in feed affects the quality of albumin (mucin and lysozyme), thus giving good results on the Haugh Unit value.

Sahid et al.[31] reported the results of their study that the addition of the probiotic *Lactobacillus salivarius* to the diet can increase the weight of albumin in quail eggs, because probiotic bacteria can stimulate the growth of intestinal villi to get longer, so that the surface of the absorption area can absorb food and substances in the intestine [32].

Giving probiotics in the diet can increase eggshell weight compared to without probiotics. Astawa et al. [33] and [6] reported that administering probiotics can improve egg shells, due to the ability of probiotics to increase the absorption of nutrients such as protein and minerals. The positive effect of giving probiotics in the ration on shell weight is being able to reduce the number of damaged eggs, due to the sturdy shell shape. The average shell weight which tended to increase due to probiotic supplementation in the rations in this study was similar to the results of the study by [31] that administration of probiotics tends to increase the average eggshell weight.

Supplementation of 1.5% Pro-B_{10} in the diet significantly improved eggshell color. Uniform shell color intensity is very important because many consumers judge egg quality by the color of the shell [34]. Maimunah and Rokhman [35] stated that eggs with a dark brown shell color have stronger and thicker shells when compared to eggs with a lighter brown color. Furthermore [36] stated that eggs with a more brown color had the lowest quality loss compared to eggs with a lighter brown color. Yang et al. [39] reported that there was a significant correlation between eggshell color and shell strength, shell thickness and shell weight but there was no clear correlation between eggshell color and egg weight, albumin, yolk, HU, yolk color and Ca content in albumin and yolks.

4. Conclusion

It can be concluded that supplementation of 1.5% probiotic Pro-B_{10} in feed for Lohmann Brown laying hens from 60-68 weeks of age, can increase egg production and feed efficiency, as well as increase the weight and color of eggshells which are preferred by consumers.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to disclosed.

Statement of ethical approval

This research was approved by the Research Ethics Commission from the Faculty of Animal Husbandry and the Faculty of Veterinary Medicine, Udayana University, Indonesia.

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