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Research Article

Egg Quality of Laying Hens Fed Different Diets Supplemented with Purslane (*Portulaca oleracea* L.) Meal Rich in Alpha-linolenic Acid (ALA)

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Abstract: The research aim was to determine the impacts of including alpha-linolenic acid, omega-3 polyunsaturated fatty acid, from plant sources in the laying hen diets on chemical and physical characteristics of the eggs. As many as 125 laying birds from Hy-Line Brown aged 54 weeks were housed in cages individually and treated to five experimental diets. The treatment of diets was prepared by adding a basal diet supplemented with purslane meal of 0, 2, 4, 6, and 8%. All layers were treated with diets for 4 weeks after a 7-days adaptation period, and ration and water were provided ad libitum. On day 28, a total of 25 eggs (n = five eggs for each diet) were taken to evaluate its chemical and physical quality. ANOVA was used for data evaluation, and further tests with Duncan's New Multiple Range Test were used to analyze the differences among the mean of treatments. Results indicated that the chemical composition of laying eggs was not affected by adding diets with ALA. Then, the inclusion of purslane powder in the rations did not change the physical quality of laying eggs, including an index of Haugh Unit, egg index, and the index of yolk and albumen. Diets containing purslane meal improved the weight of yolk and albumen and yolk color intensity. It is concluded that brown laying hens which were fed diets added with purslane meal rich in ALA enhanced the physical qualities without affecting the egg chemical composition.

Keywords: Alpha-linolenic acid, Egg quality, *Portulaca oleracea* L.

1. INTRODUCTION

Fatty acid profiles of egg especially omega-3 long-chain polyunsaturated fatty acid (n-3 LCPUFA) from fish meal or fish oil (marine sources) into diets on the egg fatty acid composition has been explored by several studies [1, 2]. However, in several sensory evaluations, there was a negative impact on egg flavor [3] which is likely to reduce consumer acceptance or consumer preference. Hence, another strategy to produce eggs enriched n-3 PUFA that can maintain both the physical, chemical and sensory quality of eggs is needed. An alternative to increase levels of alpha-linolenic acid (n-3 PUFA, ALA) and n-3 LCPUFA can be carried out by dietary inclusion of plants rich in a high level of n-3 PUFA, ALA [4]. A previous study conducted by Kartikasari et al. [5] revealed that laying hens fed by linseed oil rich in ALA can produce eggs containing fatty acids of omega-3 and have good characteristics of egg sensory.

Portulaca oleraceae (purslane) is an herbaceous weed and tropical plant, which contains an abundance of nutrients and active compounds that are important for biological functions, such as alpha-tocopherol, ascorbic acid, and β-carotene. It is also rich in high n-3 PUFA levels. Fatty acid source from plants, ALA, is fundamental for growth, disease prevention, and development of good health [6]. Plant sources such as seeds or oils containing a high level of ALA can be added to diets to produce n-3 enriched eggs. The feeding strategy relies on the laying hen ability in converting ALA to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA, n-3 LCPUFA). Some investigators reported that there were increased egg n-3 fatty acid levels by including n-3 PUFA source plants, such

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as flaxseed [7] or [8] chia seed. For example, the diet of layers containing 10% flaxseed can produce higher levels of n-3 fats compared to the control ration [9, 7]. Additionally, the rations of layers containing flaxseed oil improved n-3 LCPUFA level such as DHA and EPA without affecting production parameters as described by Kartikasari et al. [5].

Whilst many researchers have investigated the influence of including n-3 fat-rich plant or vegetable oils on the levels of egg n-3 fats, there is little information about using plant sources to increase production performance and egg quality. Some experts in laying hen report that a decrease in performance parameters is due to the high supplementation of flaxseed (up to a level of 10%), for example, feed intake reduction [7] and the low color intensity of yolk [10]. However, there were no changes in albumen weight, yolk weight, egg weight, Haugh Unit, and shell weight. Although, other researchers found that purslane meal supplementation (2%) increases the weight and production of eggs [11]. Furthermore, the goal of this ongoing application was to evaluate the impact of diets containing purslane meal rich in ALA on the physical and chemical qualities of brown laying hen eggs.

2. MATERIALS AND METHODS

2.1 Research Materials

This treatment used as many as 125 laying hens (Hy-Line Brown) aged 54 weeks. These hens were housed in cages individually. Laying hens were treated to five experimental diets based on corn-soybean with crude protein level of 17% and energy of 2,925 kcal kg^{-1}.

2.2 Research Methods

The one-way classification was applied in the treatment design of this study. The experimental diets were those purslane meals in different levels consisting of n-3 PUFA. The number of five treatments consisted of a control diet containing 0% (D0) purslane meal, as well as the four experimental diets enriched with 2% (D1), 4% (D2), 6% (D3), and 8% (D4) purslane meal (w/w). The composition of ingredients and diet nutrient content is showed in Table 1. On placement day l, the weight of the birds was immediately recorded and allocated one per cage. The dimensions of each cage were 50 cm wide × 55 cm deep × 50 cm high. Each experimental diet consisted of five replications with five laying hens for each replication. The treatment was implemented for 4 weeks after the adaptation period (7 days), and the addition of feed and water were provided ad libitum for the treatment period. The laying hens were checked and observed at frequent intervals during the first few days, ensuring their comfort with the cage and environmental conditions and the hens had adequate feed and water.

Production performance data were measured throughout the 4th week of the experimental period. Thus, data of feed consumption of hens were taken weekly and the final experimental period and the feed conversion ratio (FCR) was also measured (kg feed kg^{-1} egg). Each hen was weighed individually both at the beginning and at the end of the trial. During the experiment, the eggs produced were recorded every day and counted as hen day egg production. The eggs collected are then classified as perfect, defective, or broken. Eggs produced by each hens before the study started and for the last 3 days during the 28 day rearing period were weighed individually and stored for evaluation.

The measurement of external and internal characteristics followed the procedures of Rath et al. [12] with some modification in the measurement of shell weight. The egg length and breadth were measured and the shape index was determined. Using a digital balance, eggs were weighed individually and then cracked. The inner shell membrane in the eggshell was removed. Then, the weight of eggshells was measured by heating the eggshells in the oven and those were controlled for 12 h and all the dried materials were estimated using a digital balance. Haugh unit (H.U.) score was measured by using the formula $H.U.=100 \log (H+7.57-1.7W^{37})$. The height of the albumen (H) was measurement (in millimeters) and W is egg weight (in grams). Albumen weight was determined as egg weight - (yolk weight + shell weight). The average value of the physical quality measurement of eggs in the last 3 days during the 28 days of the study was used as statistical analysis data. A number of 25 yolk eggs aged 28 days (n = 5 egg yolks for each dietary treatment) were stored at -20°C to analyze the chemical composition of the yolks.

Tabel 1. The ingredient and nutrient content of laying hen diets

Treatment	D0	D1	D2	D3	D4
Ingredient			**Percentage (%)**		
Yellow corn	53.00	53.00	53.00	53.00	53.00
Soybean meal	24.90	24.50	23.71	23.30	23.00
Rice polish	7.53	6.57	6.15	4.85	2.20
Copra meal	1.00	1.00	1.00	1.00	1.00
Dicalcium Phosphate	1.30	1.34	1.34	1.34	1.34
Purslane meal	0.00	2.00	4.00	6.00	8.00
Palm oil	3.00	3.07	3.00	3.20	4.65
Vitamin E	0.02	0.02	0.02	0.02	0.02
L-Lysine	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.15	0.15	0.15	0.15	0.15
Limestone	7.05	6.80	6.58	6.34	6.09
Premix	0.30	0.30	0.30	0.30	0.30
Salt	0.15	0.15	0.15	0.15	0.15
Filler	1.50	1.00	0.50	0.25	0.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Nutrient content					
DM (%)	79.60	80.05	80.64	80.96	79.73
ME (kcal kg^{-1})	2 925.40	2 925.09	2 919.68	2 922.87	2 852.17
Ether extract (%)	3.37	3.36	3.42	3.37	3.13
Crude protein (%)	17.04	17.11	17.06	17.13	17.02
Crude fiber (%)	3.34	3.66	4.00	4.33	4.48
Calcium (%)	3.10	3.10	3.10	3.10	3.10
Phosphorus (%)	0.65	0.65	0.65	0.63	0.60
Available phosphorus (%)	0.37	0.37	0.37	0.37	0.35
Lysine (%)	0.96	0.94	0.92	0.90	0.88
Methionine (%)	0.43	0.42	0.42	0.41	0.40

2.3 Data Analysis

The parameter data included the weight of egg, albumen, and yolk, index of albumen and yolk, yolk color, Haugh Unit, thickness, and weight of eggshell. Data analysis used analysis of variance (ANOVA). The further analysis used was Duncan's New Multiple Range with a significance level of $p < 0.05$ if there were differences between means of treatments.

3. RESULTS

The evaluations of the physical and chemical aspects of laying hen eggs by feeding diets containing *P. oleracea* (purslane) meal were studied. External physical quality traits (weight of egg and eggshell, index of egg shape, and shell thickness) and internal physical quality traits (albumen and yolk weight, index of albumen and yolk, Haugh Unit, and also the color of yolk) were measured in eggs of the experimental Hy-Line Brown hens. Results showed that there were no negative effects of feeding dietary treatments containing purslane meal equal to 8% on albumen and yolk index, shell weight, shell thickness, and Haugh Unit value (Table 2). The average Haugh Unit score of layer eggs fed by diets incorporating 8% of purslane meal is 77.88 suggesting that the eggs are considered to be grade AA (72 or more) as reported by the United States Department of Agriculture (USDA) [13]. Importantly, egg weight

and albumen weight of layers fed diets composed of purslane meal increased significantly ($p < 0.05$) as shown in Fig. 1. In contrast, the weight of yolks for the layers given diets enriched with purslane meal are not significantly different ($p > 0.05$) compared to those produced by layers fed the basal diet, except for the 6% purslane meal diet, which produced significantly heavier egg yolk (Fig. 1). Interestingly, the intensity of yolk color increased by dietary inclusion of purslane meal to the diets of laying hens (Fig. 2). The inclusion of purslane meal (up to 8%) into the diets does not affect the chemical quality of egg including water, protein, fat, and ash content (Table 3)

Table 2. The diets enriched with the different meal of *P. oleracea* on the physical quality of egg of laying hens

Parameters	D0	D1	D2	D3	D4	P-Value
Egg index	0.687^{a}	0.674^{ab}	0.651^{b}	0.648^{b}	0.652^{b}	**
Yolk index	0.378	0.388	0.384	0.384	0.383	NS
Albumen index	0.075	0.069	0.064	0.066	0.075	NS
Haugh Unit	77.07	74.22	70.06	69.79	77.88	NS
Shell weight (g)	5.71	5.91	5.82	5.02	5.87	NS
Shell thickness (mm)	0.356	0.359	0.347	0.342	0.351	NS

D0: 0% purslane meal+ basal diet, D1: 2% purslane meal + basal diet, D2: 4% purslane meal + basal diet, D3: 6% purslane meal + basal diet and D4: 8% purslane meal + basal diet; NS = not significant

Table 3. The different diets enriched with the different meal of *P. oleracea* on chemical aspects of eggs of laying hens

Parameters (%)	D0	D1	D2	D3	D4	P-Value
Water	46.42	44.602	46.15	46.26	46.44	NS
Protein	18.89	18.13	17.48	18.07	18.93	NS
Fat	30.38	30.61	31.52	31.66	30.21	NS
Ash	1.99	2.156	1.94	1.866	1.69	NS

D0: 0% purslane meal + basal diet, D1: 2% purslane meal + basal diet, D2: 4% purslane meal + basal diet, D3: 6% purslane meal + basal diet and D4: 8% purslane meal + basal diet; NS = not significant

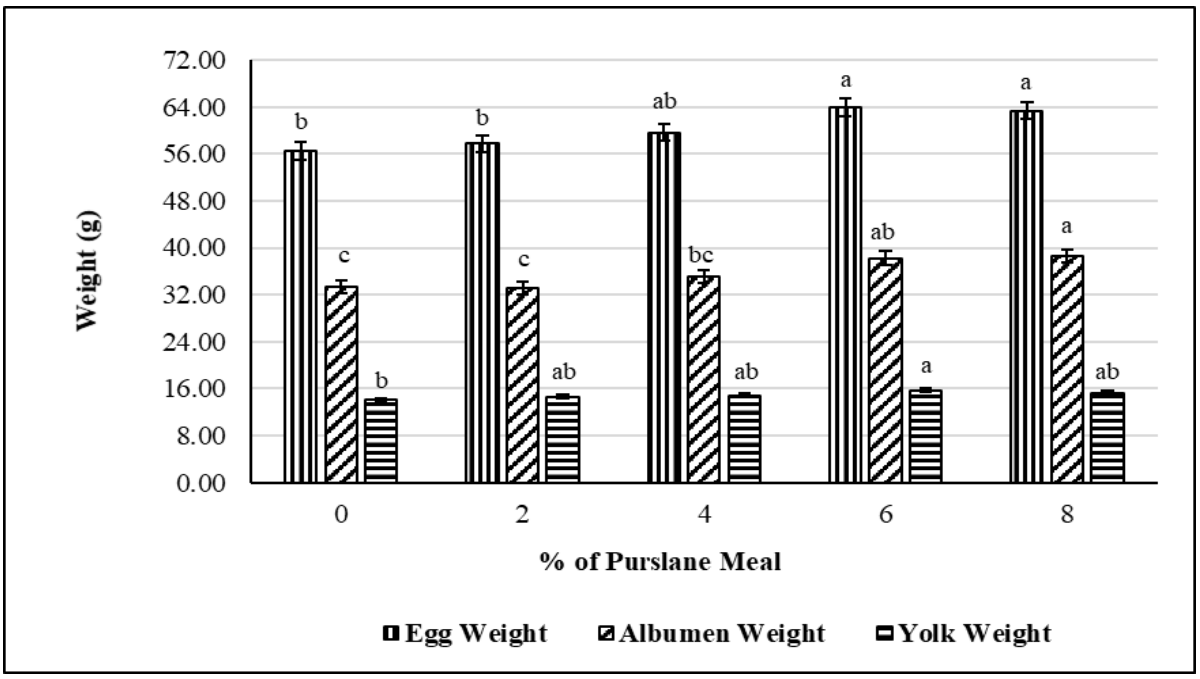

Fig.1. Egg weight, albumen weight, and yolk weight of eggs produced by laying hens fed diets enriched with the different meal of *P. oleracea*

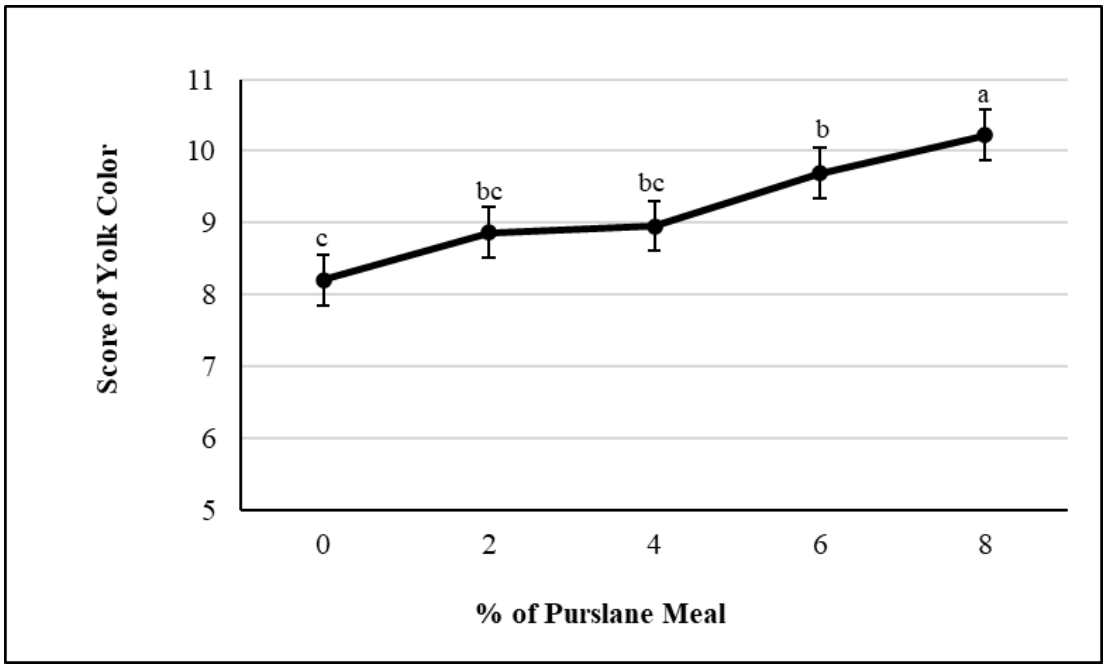

Fig. 2. Yolk color of eggs produced by laying hens fed diets enriched with the different meal of *P. oleracea*

4. DISCUSSION

Yolk weights produced by the hens do not differ among dietary treatments, except for the diet containing 6% purslane meal. The similar content of fat of diets enriched with purslane meal and the control diet might cause these results. This is supported by Ayersa and Coates [8] findings, which report that the higher fat level of the chia diets in comparison to the basal ration may cause the enhance in egg weight and egg yolk from hens fed chia diets. Some experts report that yolk weight, albumen weight, and egg weight does not change due to the inclusion of dietary flaxseed up to a level of 10% in the laying hens' ration [7, 10]. However, when high dietary flaxseed levels (15%) were added, a reduction in the qualities of eggs such as yolk index, yolk color, and egg weight was observed [9]. Interestingly, in this current study dietary supplementation rich in ALA content from purslane meal improved yolk weight, albumen weight, and egg weight. These findings suggest that ALA source from purslane meal up to a level 8% in the diet can be used without adversely impact egg quality. Additionally, there was no effect on egg qualities, such as yolk weight and egg weight by feeding diets containing purslane meal up to 200g kg^{-1} as reported by Evaris et al. [14] The idea that using high ALA diets can increase egg weight is supported by Aydin and Dogan [11]. Their study found that egg weights were able to be increased significantly ($p < 0.05$) by adding purslane dried at the level of 10g kg^{-1} or 20g kg^{-1} in the laying ration compared to a basal ration. Hence, a study was carried out by Ayersa and Coates [8] stated that supplementation of chia rich in omega-3 equal to a level of 280g kg^{-1} (28 %) in brown laying hen up to day 90 was able to produce heavier eggs than those fed the basal diet. Thus, chia diets given to brown layers at a level of 70g kg^{-1} (7%) were able to produce egg yolks significantly heavier than those fed the basal diet. Meanwhile, this study focused on white laying birds does not accept any considerable changes in egg weight for an exception for 58 days producing a significantly lighter egg as well as the weight of yolk between white laying hens fed diets enriched with chia and those fed the basal diet for up to 90 days. These results suggest that there was an impact of strain on the egg due to the dietary inclusion of *omega-3* fat-rich plants. These findings also suggest that there may have been a correlation between diet and age and that differences in reproductive maturity may have caused a different response to the dietary

alpha-linolenic acid on yolk weight and egg weight. Results also show that the intensity of yolk color is increased by feeding purslane meal to the laying hens. High purslane powder level (8%) in the layer diet given to laying birds can increase yolk color intensity (10.53). The color of egg yolk depends on the carotene and xanthophyll levels of the diet [15]. Purslane is a plant rich in nutrients containing xanthophylls and β-carotene [16, 6]. The intensity of yolk color produced from layers fed diets added with purslane meal likely results from the fact that purslane powder fed to these layers are a point of supply of β-carotene and xanthophylls [16, 15]. Hence, the increased concentration of purslane meal in the rations can improve the concentration of xanthophylls and vitamin A content in the egg yolks, which increases the intensity of egg yolk color.

An absence of change in the fat content of egg yolk may be due to the similar fat content of dietary treatments, although the level of alpha-linolenic acid is increased. This effect is alike to previous studies carried out by Cherian and Quezada [10]. Diets supplemented with 10% full-fat camelina or 10% flaxseed did not alter the fat content of egg yolks compared to those fed the basal diet.

5. CONCLUSION

To sum up, that feeding laying hens with the diets composing Portulaca oleracea (purslane powder) can improve the egg qualities of brown layers including the weight of yolk, albumen, egg, and intensity of yolk color. The dietary inclusion of purslane meals of up to 8% can be enforced without influencing the physical and chemical quality of the eggs.

6. ACKNOWLEDGEMENTS

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