Exterior and interior physical quality of egg of laying hens fed diets containing different dietary purslane levels

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Abstract. Purslane is considered a rich vegetable source of alpha-linolenic acid, beta-carotene and various antioxidants. The objective of the study was to investigate the effect of different dietary levels of purslane meal (\textit{Portulaca oleracea}) in the diets of laying hens on physical quality of eggs. A total of 125 Hy-Line Brown hens (54 weeks old) were placed at individual cages and assigned to five dietary treatments. The diets were supplemented with 0, 2, 4, 6 and 8\% purslane meal. Laying hens were fed for 5 weeks after a typical period of adaptation (7 days). Water and feed were provided \textit{ad libitum}. A total of 25 egg samples of day 28 and day 35 (n = 5 egg yolks for each treatment) were collected to analyse exterior and interior physical quality of eggs. The data were analysed using ANOVA. Differences between treatment means were further analysed using Duncan’s New Multiple Range Test. Results showed that feeding different purslane meal levels in the diets improved egg weight, yolk weight, albumen weight and yolk colour. The highest intensity of yolk colour was obtained with the diet containing 8\% purslane meal. However, dietary treatments did not affect egg index, albumen index, yolk index, shell weight, shell thickness and Haugh Unit. It is concluded that including purslane meal to laying hen diets increases the physical qualities of the eggs.

1. Introduction
A number of studies have investigated the effect of dietary omega-3 long chain polyunsaturated fatty acids (n-3 LCPUFA) from marine sources, such as fish meal or fish oil on the fatty acid composition of eggs [1,2]. However, the presence of an off-flavour (fishy off-flavour) in these eggs has been noted in a number of sensory assessments [3,4] and this causes a decrease in consumer acceptability. Therefore, another dietary strategy is needed to provide eggs rich in n-3 PUFA without any off-flavour. A study conducted by Kartikasari et al. [5] showed that n-3 fatty acid content of eggs produced by laying hens fed diets supplemented with n-3 PUFA, alpha-linolenic acid (ALA, 18:3n-3) enhanced without negatively affecting the sensory qualities of the eggs.

Purslane is a green plant that is a source of many nutrients and contains many biologically active compounds, such as β-carotene, alpha-tocopherol, and ascorbic acid. Purslane is one of an herbaceous weed containing high level of n-3 PUFA (ALA), which is essential for normal human growth, health promotion, and disease prevention [6]. Feeding laying hens with plant seeds or oils, rich in the n-3 PUFA, can be one of dietary approach to increase n-3 fat content in eggs. ALA is the n-3 precursor for n-3 LCPUFA. Therefore, the dietary strategy by including ALA-rich plant sources rests on the ability of laying hens to convert ALA to docosahexaenoic acid (DHA). Some researchers reported that the level of n-3 fatty acid of eggs improved by adding plant sources of ALA, such as flaxseed [7] or
The observed data in this research were egg weight, yolk colour, yolk weight, albumen weight, egg index, albumen index, yolk index, shell thickness, shell weight and Haugh Unit. The obtained data were analysed using analysis of variance (ANOVA). Differences between treatment means were further analysed using Duncan’s New Multiple Range Test (DMRT) with significance level of \( p<0.05 \).
Table 1. Ingredient composition and nutrient content of experimental diets.

| Ingredient                  | Treatment | R0     | R1     | R2     | R3     | R4     |
|-----------------------------|----------|--------|--------|--------|--------|--------|
| Yellow corn                 |          | 53.00  | 53.00  | 53.00  | 53.00  | 53.00  |
| Rice polish                 |          | 7.53   | 6.57   | 6.15   | 4.85   | 2.20   |
| Soybean meal                |          | 24.90  | 24.50  | 23.71  | 23.30  | 23.00  |
| CaCO$_3$                    |          | 2.15   | 1.90   | 1.70   | 1.46   | 1.21   |
| Di-calcium Phosphate        |          | 1.30   | 1.34   | 1.34   | 1.34   | 1.34   |
| L-Lysin                     |          | 0.10   | 0.10   | 0.10   | 0.10   | 0.10   |
| DL-Metionin                 |          | 0.15   | 0.15   | 0.15   | 0.15   | 0.15   |
| Premix                      |          | 0.30   | 0.30   | 0.30   | 0.30   | 0.30   |
| Salt                        |          | 0.15   | 0.15   | 0.15   | 0.15   | 0.15   |
| Limestone                   |          | 4.90   | 4.90   | 4.88   | 4.88   | 4.88   |
| Purslane meal               |          | 0.00   | 2.00   | 4.00   | 6.00   | 8.00   |
| Palm oil                    |          | 3.00   | 3.07   | 3.00   | 3.20   | 4.65   |
| Copra meal                  |          | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |
| Filler                      |          | 1.50   | 1.00   | 0.50   | 0.25   | 0.00   |
| Vitamin E                   |          | 0.02   | 0.02   | 0.02   | 0.02   | 0.02   |
| **Total**                   |          | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

| Nutrient value              |          | DM     | Crude protein | Ether extract | Crude fiber | ME           | Calcium | Phosphorus | Available phosphorus | Lysine | Methionine |
|-----------------------------|----------|--------|---------------|---------------|-------------|--------------|----------|-------------|----------------------|--------|------------|
| **Total**                   |          | 79.60  | 17.04         | 3.37          | 3.34        | 2925.40      | 3.10    | 0.65        | 0.37                 | 0.96   | 0.43       |
| **Nutrient value**          |          | 80.05  | 17.11         | 3.36          | 3.66        | 2925.09      | 3.10    | 0.65        | 0.37                 | 0.94   | 0.42       |
| **Nutrient value**          |          | 80.64  | 17.06         | 3.42          | 4.00        | 2919.68      | 3.10    | 0.65        | 0.37                 | 0.92   | 0.42       |
| **Nutrient value**          |          | 80.96  | 17.13         | 3.37          | 4.33        | 2922.87      | 3.10    | 0.63        | 0.37                 | 0.90   | 0.41       |
| **Nutrient value**          |          | 79.73  | 17.02         | 3.13          | 4.48        | 2852.17      | 3.10    | 0.60        | 0.35                 | 0.88   | 0.40       |

3. Results and discussion
Adding *Portulaca oleracea* (purslane) meal up to 8% into the diets did not adversely influence egg physical qualities of brown hens including yolk index, albumin index, shell thickness, shell weight and HU (table 2 and 3). Feeding diets enriched with purslane meal for 28 days significantly increased ($p<0.05$) egg weight, albumen weight and yolk weight. Yolk weight of eggs produced by hens at day 35 were consistent with those produced at day 28, which was diets containing purslane meal resulted in heavier yolk compare to those produced from hens fed control diet. However, we observed that egg and yolk weights produced by laying hens at day 35 were relatively similar among the dietary treatments.
Table 2. Interior and exterior physical quality of egg of laying hens fed diets supplemented with *Portulaca oleracea* meal at day 28.

| Parameters          | R0     | R1     | R2     | R3     | R4     | p Value |
|---------------------|--------|--------|--------|--------|--------|---------|
| **Interior**        |        |        |        |        |        |         |
| Yolk colour         | 8.07^b | 8.93^b | 8.73^b | 9.27^ab| 10.47^a| **      |
| Albumen index       | 0.073  | 0.067  | 0.061  | 0.067  | 0.074  | NS      |
| Yolk index          | 0.381  | 0.388  | 0.382  | 0.385  | 0.390  | NS      |
| Albumen weight      | 32.93^c| 33.55^bc| 35.03^bc| 36.76^ab| 38.65^a| **      |
| Yolk weight         | 13.88^b| 14.58^ab| 14.86^ab| 15.68^a| 15.55^a| *       |
| Haugh Unit          | 76.79  | 73.52  | 67.80  | 70.23  | 77.07  | NS      |
| Albumen pH          | 8.750  | 8.740  | 8.757  | 8.760  | 8.660  | NS      |
| Yolk pH             | 6.437^ab| 6.490^a| 6.373^b| 6.407^ab| 6.363^b| **      |
| **Exterior**        |        |        |        |        |        |         |
| Egg weight          | 55.89^c| 57.98^bc| 59.19^abc| 62.36^ab| 64.27^a| **      |
| Egg index           | 0.678^b| 0.693^a| 0.661^ab| 0.657^ab| 0.651^b| *       |
| Shell weight        | 5.71   | 5.86   | 5.66   | 5.03   | 5.90   | NS      |
| Shell thickness     | 0.360  | 0.359  | 0.342  | 0.346  | 0.349  | NS      |
| Specific gravity    | 1.328  | 1.284  | 1.314  | 1.314  | 1.327  | NS      |

**R0:** Basal diet + 0% purslane meal, **R1:** basal diet + 2% purslane meal, **R2:** basal diet + 4% purslane meal, **R3:** basal diet + 6% purslane meal and **R4:** basal diet + 8% purslane meal.

* significant (p<0.05); ** (p<0.01); NS= not significant.

Table 3. Interior and exterior physical quality of egg of laying hens fed diets supplemented with *Portulaca oleracea* meal at day 35.

| Parameters          | R0     | R1     | R2     | R3     | R4     | p Value |
|---------------------|--------|--------|--------|--------|--------|---------|
| **Interior**        |        |        |        |        |        |         |
| Yolk colour         | 8.467^b| 8.933^b| 8.867^b| 9.267^ab| 10.133^a| **      |
| Albumen index       | 0.066  | 0.070  | 0.073  | 0.068  | 0.066  | NS      |
| Yolk index          | 0.384  | 0.399  | 0.408  | 0.402  | 0.393  | NS      |
| Albumen weight      | 34.74  | 34.55  | 36.38  | 37.08  | 37.98  | NS      |
| Yolk weight         | 13.90^b| 15.53^ab| 15.85^a| 15.69^ab| 15.26^ab| *       |
| Haugh Unit          | 73.15  | 73.27  | 75.21  | 71.92  | 72.56  | NS      |
| Albumen pH          | 8.693  | 8.603  | 8.657  | 8.697  | 8.600  | NS      |
| Yolk pH             | 5.837  | 5.857  | 6.150  | 6.117  | 6.147  | **      |
| **Exterior**        |        |        |        |        |        |         |
| Egg weight          | 54.87  | 61.23  | 63.05  | 62.52  | 64.44  | NS      |
| Egg index           | 0.662  | 0.664  | 0.682  | 0.659  | 0.664  | NS      |
| Shell weight        | 5.967  | 5.763  | 5.995  | 5.815  | 5.729  | NS      |
| Shell thickness     | 0.357  | 0.344  | 0.346  | 0.337  | 0.338  | NS      |
| Specific gravity    | 1.342  | 1.277  | 1.315  | 1.342  | 1.318  | NS      |

**R0:** Basal diet + 0% purslane meal, **R1:** basal diet + 2% purslane meal, **R2:** basal diet + 4% purslane meal, **R3:** basal diet + 6% purslane meal and **R4:** basal diet + 8% purslane meal.

* significant (p<0.05); ** (p<0.01); NS= not significant.
This could be due to the lipid content of the purslane diets and the control diet was similar (table 1). This is supported by a study conducted by Ayersa and Coates [8], which reported that the increase in weight egg and yolk egg from hens fed chia diets might be due to the higher lipid content of the chia dies compared with the control diet. Some researcher reported that inclusion level of dietary flaxseed (10%) in laying hen diets did not change egg weight, yolk weight and albumen weight [7,10]. In addition, the inclusion of high dietary levels of flaxseed (15%) caused a decrease in egg qualities, such as egg weight, yolk index, yolk colour [9]. In this current study, egg weight, yolk weight and albumen weight, especially from day 28 improved by the supplementation of dietary ALA, suggesting that the use of 8% purslane meal as a source of ALA can be applied without negatively affecting egg quality. In addition, Evaris et al. [12] reported that diets supplemented with purslane meal up to a level of 200 g/kg did not affect egg quality, such as egg weight and yolk weight. The increase in egg weight by feeding high ALA diets is in accordance with the previous studies conducted by Aydin and Dogan [11], which reported that adding purslane dried at a level of 10 or 20 g/kg into the diet significantly (p<0.05) increased egg weight compared to the control. In addition, a study conducted by Ayersa and Coates [8] reported that brown hens fed diets enriched with chia, a plant source of omega-3, up to a level of 280 g/kg (28%), produced significantly (p<0.05) heavier eggs throughout the duration of experimental period (up to day 90) than those fed the control diet. In this case, brown hens were fed chia at a level of 70 g/kg (7%) producing egg yolks significantly heavier than those fed the control diet. However, for white hens, this study did not find any significant differences in egg weight (except for day 58 producing significantly lighter eggs) and yolk weight between white hens fed diets supplemented with chia than those given the control diet up to day 90. This suggested that there was strain effect on egg quality by inclusion plants rich in omega-3 fat. These results also suggested that there might be an interaction between the age and the diets and the differences in maturity of laying hen reproductive system may have led to different response to the dietary alpha-linolenic acid on egg weight and yolk weight.

Diet containing purslane increased yolk colour intensity of eggs. The highest intensity of yolk colour (10.53) was achieved when laying hens were fed diets containing the highest level of purslane meal. Yolk colour depends primarily on xanthophylls and carotene content of diet [13]. Purslane is a plant containing many nutrients, β-carotene and xanthophylls [14,6]. The yolk color intensity of eggs from laying hens fed purslane enriched diet probably resulted from the fact that purslane consumed by these hens were a source of xanthophylls and β-carotene [14,13] for egg yolks. Therefore, increasing the levels of purslane meal in the laying hen diets increased the amount of xanthophylls and vitamin A in the yolks, and this resulted in the increase in yolk color intensity.

4. Conclusions
It was concluded that diets enriched with Portulaca oleracea (purslane meal) increased egg weight, yolk weight, albumen weight and yolk colour. The dietary inclusion of Portulaca oleracea meal up to 8% can be applied without affecting physical quality of the eggs.

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