Sensory quality of mayonnaise formulated with eggs produced by laying hens fed diet enriched with purslane meal (*Portulaca oleracea*)

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Abstract. The objective of the study was to assess the sensory quality of mayonnaise formulated by egg yolks produced by hens fed purslane meal as a source of omega-3 (n-3) fats, alpha-linolenic acid. Eggs used were produced by Hy-Line Brown hens (38 weeks old) fed five diets suplemented with 0, 2, 4, 6 and 8% purslane meal. A total of 40 eggs of day 29 (n = 8 eggs for each treatment) were collected to formulate mayonnaise. The ingredient composition of mayonnaise was 14% egg yolks, 9% vinegar, 74% corn oil, 1% salt, 1% sugar, and 1% mustard. The parameters included colour, emulsion stability, texture, homogeneity, aroma, taste and flavour of mayonnaise. The findings of sensory evaluation by quantitative descriptive analysis showed that the use of egg yolk from hens fed dietary purslane meal up to 8% resulted in a significant effect on the yellow color of mayonnaise, but did not significantly affect emulsion stability, texture, homogeneity, aroma, taste, and flavour. Based on consumer preference, consumers did not detect any differences in the sensory characteristics between mayonnaise prepared from control eggs and those formulated with eggs produced from dietary treatment. Apparently, there was an increase in colour liking by inclusion of purslane meal. In conclusion, eggs from laying hens fed diets supplemented with purslane meal improved the colour intensity of mayonnaise. Mayonnaise formulation using eggs from diets added with *Portulaca oleracea* meal up to a level of 8% can be applied without influencing mayonnaise sensory characteristics and consumer acceptance.

Keywords: Egg yolks, laying hens, mayonnaise, purslane meal, sensory characteristics

1. Introduction
As animal food products, eggs are considered a high-profile ingredient. Beside eggs provide high nutritional value, eggs have multifunctional properties, including foaming, coagulation, mulsification, and flavor.[1]. Feeding laying hens is one of efforts to improve the nutrition and quality of chicken eggs. A number of investigators have conducted research to investigate the influence of diets enriched with omega-3 polyunsaturated fatty acids (n-3 PUFA) sources on the sensory characteristic of boiled eggs. The n-3 PUFA sources from plants include chia, camelina, canola or flax [2, 3, 4]. A previous study found that the egg n-3 fatty acid levels resulted in from hens fed dietary inclusion of flaxseed rich in n-3 PUFA (alpha-linolenic acid, ALA) increased egg n-3 PUFA without adversely influencing the sensory characteristics of the final products.
*Portulaca oleracea* (purslane) contains alpha-tocopherol, \( \beta \)-carotene, and ascorbic acid, which are biologically active compounds, and is a source of many nutrients. Purslane also contains high n-3 PUFA level, ALA which is important for disease prevention, health promotion, and normal human growth.[6]. Providing diets added with purslane meal to laying hens enhanced the colour intensity of egg yolks [7]. Yolk of eggs is an excellent emulsifier for food processing. Therefore, in the production of many food emulsions, such as mayonnaise, egg yolks are key ingredients. Feeding laying hens with purslane meal will provide higher egg yolk quality and increase the sensory quality of food products including mayonnaise. The aim of this research was to evaluate sensory quality of mayonnaise formulated with egg yolks produced by laying hens fed diets enriched with purslane meal as a source of alpha-linolenic acid up to a level of 8%.

2. Materials and Methods

2.1. Research Materials

A total of 25 eggs obtained from *Hy-Line Brown hens* aged 54 weeks fed diets supplemented with purslane meal were used in this research. Other ingredients used to produce the mayonnaise, such as corn oil, vinegar, sugar, mustard, and salt were purchased from a local grocery store.

2.2. Research Methods

One-way classification design was used for this study. The variable factor was mayonnaise formulated with eggs from laying hens fed diets containing 0 (T0), 2 (T1), 4 (T2), 6 (T3) and 8% (T4) purslane meal (w/w). Fat content of the diets was kept constant at ~ 3.5%. Birds were housed at individual cages and assigned to five experimental diets. The corn-soybean based diet, which contains energy 2,925 kcal/kg and crude protein 17% was used to prepare the diets. The composition of ingredient and nutrient value of experimental diets were shown in Table 1. At day 28, 25 egg samples in total, n = 5 egg for each treatment, were collected and processed for mayonnaise. The ingredients used in all mayonnaise formulation consisted of 14% egg yolks, 9% vinegar, 74% corn oil, 1% salt, 1% sugar, and 1% mustard.

Panellists who were willing to consume mayonnaise and had no allergies to eggs or products containing egg were recruited from students at the Faculty of Agriculture, Universitas Sebelas Maret, Surakarta. Thirty (n = 30) panellists participated in the evaluation. After investigators explained the details of the experiment, each panellist was asked to return a signed written consent form. The panellists were blinded to the experimental diets. On the days of final descriptive analysis (DA), samples of mayonnaise were prepared and each panellist assessed aroma, colour, taste, and flavour of mayonnaise samples from five different treatment groups. To evaluate the sensory characteristics of mayonnaise samples, unstructured 15-cm line scales, which were anchored at both ends (at 10 and 90%) with intensity extremes of each attributes, were used and panellists were asked to score their perception of each attribute tested. [8]. Consumer acceptance of mayonnaise was also evaluated by hedonic test using 9-point hedonic scale. Mayonnaise samples were placed in closed plastic containers, which were coded with a randomly generated three-digit number, and were presented to each panellist, along with filtered water and unsalted crackers as palate cleansers. Between every two samples, panellists were instructed to rinse their palate and had a forced 1 minute break. Samples were presented to the panellists in groups of five samples.
2.3. Data Analysis

The data in this research were sensory attributes of mayonnaise. The collected data were analysed using analysis of variance (ANOVA). When there were significant differences between treatment means, the analysis was followed by Tukey test, with significance level of P<0.05.

Table 1. Ingredient composition and nutrient value of dietary treatments

| Dietary Treatments | T0  | T1  | T2  | T3  | T4  |
|--------------------|-----|-----|-----|-----|-----|
| Ingredient         | %   |     |     |     |     |
| Soybean meal       | 24.90 | 24.50 | 23.71 | 23.30 | 23.00 |
| Yellow corn        | 53.00 | 53.00 | 53.00 | 53.00 | 53.00 |
| Rice polish        | 7.53  | 6.57  | 6.15  | 4.85  | 2.20  |
| Di-calcium Phosphate | 1.30 | 1.34  | 1.34  | 1.34  | 1.34  |
| CaCO₃              | 2.15  | 1.90  | 1.70  | 1.46  | 1.21  |
| DL-Metionin        | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  |
| L-Lysin            | 0.10  | 0.10  | 0.10  | 0.10  | 0.10  |
| Copra meal         | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| Purselane meal     | 0.00  | 2.00  | 4.00  | 6.00  | 8.00  |
| Limestone          | 4.90  | 4.90  | 4.88  | 4.88  | 4.88  |
| Palm oil           | 3.00  | 3.07  | 3.00  | 3.20  | 4.65  |
| Vitamin E          | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  |
| Filler             | 1.50  | 1.00  | 0.50  | 0.25  | 0.00  |
| Salt               | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  |
| Premix             | 0.30  | 0.30  | 0.30  | 0.30  | 0.30  |
| Total              | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Nutrient value     |     |     |     |     |     |
| DM                 | 79.60 | 80.05 | 80.64 | 80.96 | 79.73 |
| Ash                | 2.99  | 2.93  | 2.90  | 2.83  | 2.64  |
| 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  |
| Nitrogen free extract | 59.96 | 59.22 | 58.64 | 57.86 | 55.99 |
| ME                 | 2925.40 | 2925.09 | 2919.68 | 2922.87 | 2852.17 |
| Phosphorus         | 0.65  | 0.65  | 0.65  | 0.63  | 0.60  |
| Available phosphorus | 0.37 | 0.37  | 0.37  | 0.37  | 0.35  |
| Calcium            | 3.10  | 3.10  | 3.10  | 3.10  | 3.10  |
| Methionine         | 0.43  | 0.42  | 0.42  | 0.41  | 0.40  |
| Lysine             | 0.96  | 0.94  | 0.92  | 0.90  | 0.88  |

3. Results and Discussion

The descriptive analysis of mayonnaise samples showed that there were no significant differences in the sensory characteristics including emulsion stability, texture, homogeneity, aroma, taste, flavour, or off-odour of the mayonnaise formulated with eggs from birds fed experimental diets. The average attribute scores are presented in Table 2. This indicates that there were no negative effects of eggs
produced by supplementing purslane meal rich in ALA on the sensory quality of the mayonnaise. The emulsion stability of mayonnaise was not different between control mayonnaise and mayonnaise formulated with eggs from dietary treatments. This could be due to the percentage of egg yolks used to prepare mayonnaise was same. Egg yolk contains lecithin which is an emulsifier and the increase in the concentration of egg yolk improved emulsifying activity [9]. Interestingly, it appears that mayonnaise formulated with eggs from laying hens fed diets enriched with purslane meal was generally considered to elicit a higher perception of colour compared to mayonnaise control. The highest intensity of mayonnaise colour (average of intensity score of 10.98 on a scale from 0 to 15; $P < 0.05$) was reached when eggs from hens were fed diets added with the highest purslane meal level. This could be due to eggs produced from diets containing high levels of purslane meal have higher xanthophyll and carotene levels than eggs from control diet. Portulaca oleracea is an omega-3 source plant containing many nutrients, including β-carotene and xanthophyll [10]. A previous study carried out Krawczyk et al. [11] found that xanthophyll and carotene content of the diets influenced yolk colour of eggs. In addition, as reported by Kartikasari et al. [7], diets enriched with purslane meal up to 8% increased the colour quality of yolks. A higher yolk colour intensity of eggs from hens fed diets containing purslane meal probably resulted from the fact that purslane consumed by the laying hens was a source of xanthophylls and β-carotene [10] for yolks. Therefore, the yolks produced by hens fed dietary purslane meal have a higher amount of xanthophylls and vitamin A and this resulted in the increase in the yellow colour intensity of mayonnaise.

Table 2. Descriptive analysis of mayonnaise formulated with eggs from laying hens fed dietary treatments enriched with Portulaca oleracea meal.

| Parameters       | Dietary treatments | P value | Significance |
|------------------|--------------------|---------|--------------|
|                  | T0 | T1 | T2 | T3 | T4 |
| Colour           | 7.35<sup>b</sup> | 6.64<sup>b</sup> | 5.90<sup>b</sup> | 7.01<sup>b</sup> | 10.98<sup>a</sup> | 0.00<sup>**</sup> | ** |
| Emulsion stability | 9.47 | 9.41 | 9.09 | 9.20 | 9.60 | 0.97 | NS |
| Texture          | 8.41 | 7.83 | 8.30 | 8.60 | 9.21 | 0.26 | NS |
| Homogeneity      | 7.92 | 8.02 | 7.85 | 8.08 | 9.30 | 0.20 | NS |
| Aroma            | 8.13 | 7.87 | 7.95 | 7.62 | 8.47 | 0.75 | NS |
| Off-odour        | 4.79 | 4.19 | 4.64 | 4.00 | 3.74 | 0.69 | NS |
| Taste            | 7.25 | 7.18 | 7.24 | 7.08 | 7.96 | 0.64 | NS |
| After Taste      | 6.31 | 5.53 | 7.01 | 6.84 | 6.50 | 0.33 | NS |
| Flavour          | 7.32 | 6.63 | 6.95 | 7.08 | 8.09 | 0.16 | NS |
| Overall acceptance | 7.32 | 6.94 | 6.95 | 7.11 | 7.93 | 0.44 | NS |

<sup>1</sup>Mayonnaise formulated with eggs from hens fed 0 (T0), 2 (T1), 4 (T2), 6 (T3), and 8% (T4) purslane meal diet. ** ($P<0.01$); NS= not significant

Importantly, the consumer acceptance test conducted on mayonnaise showed that eggs produced from diets containing purslane meal did not change the consumer liking of the mayonnaise including aroma and creamy compared with mayonnaise from control eggs (Table 3). In addition, consumers did not have different liking on taste and flavour between mayonnaise prepared from control eggs and those formulated with eggs produced from dietary treatments. However, mayonnaise texture prepared with eggs from hens fed up to 6% purslane meal tended to be liked more than all other mayonnaise (average of liking score of 6.07; a 9-point hedonic scale). Based on the data, a significant difference was observed in sensory panel scores for the degree of liking of mayonnaise colour, with the highest score achieved for mayonnaise formulated with eggs from 8% dietary purslane meal (average of liking score of 6.03; a 9-point hedonic scale).
Table 3. Consumer acceptance of mayonnaise formulated with eggs from laying hens fed dietary treatments enriched with *Portulaca oleracea* meal.

| Parameters            | Dietary treatments¹ | P Value | Significance |
|-----------------------|---------------------|---------|--------------|
|                       | T0  | T1  | T2  | T3  | T4  |        |
| Colour                | 5.633<sup>a</sup>b | 5.300<sup>a</sup>  | 4.967<sup>b</sup>  | 5.467<sup>a</sup>b | 6.033<sup>a</sup>  | 0.05  | *  |
| Aroma                 | 5.300  | 4.967  | 5.100  | 5.467  | 5.667  | 0.19  | NS  |
| Texture               | 5.367  | 5.300  | 5.200  | 5.433  | 6.067  | 0.11  | NS  |
| Creamy                | 5.300  | 5.467  | 5.600  | 5.767  | 6.100  | 0.16  | NS  |
| Taste                 | 5.300  | 5.300  | 5.200  | 6.067  | 5.733  | 0.09  | NS  |
| Flavour               | 5.400  | 5.367  | 5.467  | 5.900  | 5.900  | 0.32  | NS  |
| Overall acceptance    | 5.600  | 5.400  | 5.567  | 5.867  | 6.100  | 0.23  | NS  |

¹Mayonnaise formulated with eggs from hens fed 0 (T0), 2 (T1), 4 (T2), 6 (T3), and 8% (T4) purslane meal diet, * significant (P<0.05); NS= not significant

4. Conclusions

It was concluded that eggs from laying hens fed experimental diets containing *Portulaca oleracea* (purslane) meal increased the colour intensity of mayonnaise and the consumer liking for the mayonnaise colour. The use of eggs from laying hens fed diets added with *Portulaca oleracea* meal up to a level of 8% can be applied to formulate mayonnaise, without influencing the sensory characteristics and consumer acceptance of the mayonnaise.

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