Evaluation of Curcumin as An Additive on Egg Yolk Pigmentation of White Laying Hens

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Abstract. The purpose of this experiment was to know the effect of curcumin on egg yolk pigmentation of white laying hens. In this experiment were used thirty-two (32) of Lohman LSL-lite white laying hens, there were reared on the bateray cages with the commercial feed and differences by the treatment with the addition of curcumin on the water. Level of the addition curcumin was divided into 4 treatments and 8 replications on each treatment. Treatments were used 0 ml (control), 1 ml, 2ml, and 3 ml of curcumin on every 100 ml water. Eggs were collected everyday, respectively. Color stability of eggs were analyzed every weeks start from 23-28 weeks. Data was analyze using GLM in a windows-based software package, SAS version 9.1 and the differences were tested by LSM. L*, a*, and b* values were used to calculate the reflectance colorimeter of fresh egg yolk. The addition of 2 ml curcumin/100 ml water (2%) has significantly effect on reflectance colorimetry consist of lightness, redness and yellowness. The addition of 3 ml curcumin/100 ml water (3 %) has significantly improved on the color stability. The conclusions of this research showed that the used curcumin as feed additive has the ability to improved reflectance colorimetry and color stability of egg.

1. Introduction
Eggs are source of nutrient containing proteins, vitamins, lipids, and mineral, and it is cheap source of food [1]. Color is the first sensation that consumer for perceives. In addition, food coloring is the first quality parameter evaluated by consumers and is critical for the acceptance of the product. Yolk color is a key criterion of consumer preferences is also consumer in most parts of the world prefer golden-yellow yolks. Consumers believe that the higher intensity of yolk colour infer to better egg quality and higher nutrition value for the egg [2]. Fresh and bright color of egg plays important role in the consumer perception. Colour of egg yolk is the important quality of the egg which is show the high quality of the egg and product made by egg. Eggs are also used in the manufacture of food product, such as bakery, pasta, sauces, etc. Consumer is not only prefers the egg yolk colour; however the nutrients component of eggs are also concern. Consumer will prefer the eggs with high quality and have beneficial effect, such as high antioxidant activity and protein [3]. Color stability can be seen with yolk color fan DSM, where in Europe the most consumer prefered scores 8,10,12, and 14. Colour and viscosity of egg yolk are the indicators to assesed the consumers to evaluate qualit of egg.
According to Krizz 1997 [4] nutrients of egg yolk consist of 35% lipids, 16% proteins and 0.2% lipophilic pigments consist of carotenoids. Plant extracts can be used to improve the appetite and digestion stimulants, for prevention and treatment of certain pathological conditions, as colorants, and antioxidants for animals [5]. An example of plant herbs is Curcuma domestica, which contains bioactive compound of curcumin. It is commonly used as flavoring, coloring, and preservative agents. The important natural substance of Curcuma domestica can be obtained from seed and has various colors from yellow to dark red. In addition, it is used as food colorant and spice with the high antioxidant and antimicrobial properties. The use of herbs as antioxidants is not only important for the health of the animals, but also for the oxidative stability of their products [6]. Medicinal plant of Curcuma rhizome in laying hens diets as a growth promoter and found that diet with 1% of curcuma powder improved the performances and egg quality in laying hens [7]. The aims of this research study were to investigate the effect Curcumin on egg yolk colorimetry and color stability of laying hen’s egg.

2. Materials and methods

2.1. Research materials
Research was carried out at the Poultry Research Farm, Dairy Laboratory and Breeding laboratory in Animal Science Department, National Pingtung University of Science and Technology (NPUST), Taiwan. The experiment was conducted 18 weeks started from laying hens aged 14 up to 28 weeks. Curcumin was given on water started from 14-20 week aged of laying hens (adaptation period). Chicken started laying at 18 weeks, then eggs were collected everyday. The analysis of egg conducted every weeks started at 20 weeks up to 28 weeks. In this experiment used thirty two (32) of Lohman LSL-Lite white laying hens were divided into 4 treatments, where placed in individual battery cages (40 x 30 x 40) equipped with feeder and bottle drinker. Feed was provided ad libitum and drinking water as restricted.

2.2. Research methods
This experimental were divided into two stages, consist of identified concentration of Curcuma domestica extraction and examined the addition of Curcuma domestica extraction on laying hens then evaluated egg yolk colorimetry and egg color stability. Ten grams of Curcuma domestica was dissolved in 100 mL RO water. It was incubation at 35 °C during 8 hours, and filtered for separated solid and liquid of Curcuma domestica. Where the liquid of Curcuma domestica consist of curcumin as bioactive compound.

The addition of curcumin on laying hens as feed additive was done with 4 treatments and 8 replications, where in every replications has 1 laying hens. The composition level of experiment was shown below:

T0: Basal diet + drinking water (control)
T1: Basal diet + 1 mL/100 mL curcumin on drinking water (1%)
T2: Basal diet + 2 mL/100 mL curcumin on drinking water (2%)
T3: Basal diet + 3 mL/100 mL curcumin on drinking water (3%)

2.3. Variable
Egg yolk pigmentation was reflected by color of egg yolk. Two eggs per treatment were used for measuring egg yolk pigmentation. Egg yolk pigmentation was measured every week. Egg yolk pigmentation include reflectance colorimetry and color stability. Reflectance colorimetry showed the L*a*b* and colorimetry consist of fresh YCS and boiled YCS.

2.3.1. Reflectance colorimetry
A colorimetry measurement of the yolk were carried out using colorimeter according to the L’ a’ b’ system. The L’, a’, and b’ values reflect lightness (0 = black, 100 = white), redness (-100 = green, 100 = red), and yellowness (0 = black, 100 = yellow), respectively.
= red), and yellowness (-100 = blue, 100 = yellow). This variable was analyzed by a Colorimeter (ZE 2000, Nippon Denshoku Co. Ltd, Japan) showed on Figure 1. The instrument was calibration daily against a white standard plate. The angle of observation was set at 2°, geometry of observation at 45°, diameter of measuring area at 11 mm, respectively. The measurements were taken of fresh egg yolk.

![Colorimeter ZE 2000, Nippon Denshoku Co. Ltd, Japan](image1)

**Figure 1.** Colorimeter ZE 2000, Nippon Denshoku Co. Ltd, Japan

### 2.3.2. Color stability

Color stability is the ratio of Yolk Color Stability (YCS) of boiled eggs to fresh eggs. The eggs were boiled in water bath at 93 °C for 15 minutes, cooled with cold water at 16.5 °C. Hereafter, eggs were longitudinally sliced down the middle into approximately two equal parts. Fresh eggs were broke up to separate between albumen and yolk. Boiled and fresh yolk were measured by DSM yolk color fan showed on Figure 2. The color stability was calculated by the following equation:

\[
\text{Color stability} \% = \frac{\text{YCS of boiled eggs} \times 100\%}{\text{YCS of raw eggs}}
\]

![Yolk color fan DSM](image2)

**Figure 2.** Yolk color fan DSM.

### 2.4. Statistical analysis

Data were analysed for reflectance colorimetry (L* a* b*) and color stability. The data of egg yolk colorimetry and color stability were tested using General Linear Model based software package, SAS version 9.1. The differences between treatment was tested by least squares mean. Significant level in treatment comparisons was set at \( p < 5\% \).

### 3. Results and Discussion

#### 3.1. The used of curcumin on reflectance of colorimetry (L’ a’ b’) on egg yolk
Table 1 showed that an overview of reflectance colorimetry was analysed during 8 weeks of experimental period, then the analysis was conducted every weeks used two samples per treatment. L*, a*, and b* values were used to calculate the reflectance colorimetry of fresh egg yolk. L*, a*, and b* values were measurement of the lightness, redness, and yellowness, respectively. The results showed that the used of Curcumin on laying hens has significantly effect (P < 0.05) on the reflectance colorimetry consist of L* (lightness), a* (redness), and b* (yellowness).

### Table 1. Effect of Curcuma domestica extraction on egg pigmentation

| Parameters          | Control | T1 (1%) | T2 (2%) | T3 (3%) | SEM  |
|---------------------|---------|---------|---------|---------|------|
| L*                  | 15.63   | 14.51   | 12.15   | 12.10   | 0.44 |
| Colorimeter a*      | -1.29   | -2.19   | -1.87   | -2.11   | 0.27 |
| b*                  | -0.16   | 0.63    | 3.96    | 1.04    | 0.12 |

SEM: Standard error of mean.

The treatments consisted of a control group and the use of 1%, 2%, and 3% *Curcumin*, respectively.

L* (Lightness), a* (redness), b* (yellowness)

Based on the data showed that L* and a* value in control group has higher than other level. However, b* value in control group has lower than other level. Conversely, layer fed of 2% of curcumin has low L* and high a* b*. Results show the addition of 2% layer fed curcumin more darkness, yellowness, and redness. Yellow color of curcumin has ability to increased pigmentation on animal product [8].

The highest L’ a’ b’ values in 3% indicated the consistency analytical methods. Addition of 3% curcumin has 43.33% of color stability and more lightness, yellowness, redness. Curcumin has oil solubility and affected on pigment deposition in the egg yolk. The other hand, curcumin has ability to increased color stability of egg yolk. According to Hernandez that the color is a key criterion of consumer preferences is also consumer in most parts of the world prefer golden-yellow yolks. The other hand, consumers believe that the higher intensity of yolk colour infer to better egg quality and higher nutrition value for the egg.

### 3.2. The used of curcumin on egg yolk color stability

Different levels of the addition curcumin as a feed additive on laying hens affected the color stability. Color stability was calculated by the ratio between fresh egg YCS and boiled egg YCS. Based on the results showed that the addition of curcumin has significantly effect (P<0.05) on fresh YCS and boiled YCS. Therefore, the addition of curcumin as feed additive also has significantly improved (P<0.05) on yolk color stability.

### Table 2. Effect of feeding level of Curcuma domestica on fresh and boiled yolk color score laying hens egg

| Items            | Control | T1 (1%) | T2 (2%) | T3 (3%) | SEM  |
|------------------|---------|---------|---------|---------|------|
| Fresh YCS2       | 9.19    | 8.00    | 7.40    | 7.50    | 0.82 |
| Boiled YCS2      | 1.66    | 2.00    | 2.66    | 3.25    | 1.98 |
| Color stability (%) | 18.06   | 25.00   | 35.95   | 43.33   | 2.88 |

SEM: Standard error of mean.

*The treatments consisted of a control group and the use of 1%, 2%, and 3% *Curcumin*, respectively.

Yolk color score.

The addition of 3% curcumin increased 26.38% color stability of egg yolk. Consumers believed that the higher yolk colour intensity infer to better egg quality. The higher yolk colour intensity provides higher nutrition value for the human [1] and shows positive impact on egg quality. Curcumin
is a yellow pigment from rhizomes of *Curcuma domestica* and commonly used as a spice and food colouring. Yellow pigment on *Curcuma domestica* improved colour stability of egg yolk [8]. In this Figure below showed the comparison of fresh yolk color among treatments. The used of curcumin as feed additive decreased YCS of egg yolk compared control group. However, the used curcumin as feed additive improved the YCS on boiled egg yolk. It can be concluded that the addition curcumin increased color stability.

![Figure 3. Comparison of fresh yolk color among treatments of laying hens](image)

(a) Treatment 1, (b) Treatment 2, (c) Treatment 3, (d) Treatment 4

4. Conclusion
The conclusions of this research showed that the used of curcumin as feed additive has the ability to improved reflectance colorimetry and color stability of egg.

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