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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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# Effects of Adding Different Dietary Levels of Turmeric (*Curcuma longa* Linn) Powder on Productive Performance and Egg Quality of Laying Hens

Sherif M. Hassan
Department of Animal and Fish Production, King Faisal University,
Al-Ahsa, 31982, Kingdom of Saudi Arabia

**Abstract:** This study was conducted to evaluate the effects of adding different levels of turmeric powder into laying hen diets on productive performance and egg quality over 8-week trial period. One hundred fifty 52 week old Hisex laying hens were randomly distributed among three dietary levels (0, 2 and 4%) of turmeric (*Curcuma longa* Linn) powder with ten replicates with five hens each. Body weight gain, egg production, feed consumption, feed conversion ratio, egg weight, egg mass, egg specific gravity, Haugh unit and egg yolk color were measured. Results obtained from the present study showed that there were no significant differences in body weight gain, feed consumption, egg production, egg specific gravity and Haugh unit among all the dietary treatments. Hens fed diets containing 0 and 2% level of turmeric powder exhibited better feed conversion ratio and lower egg yolk color than those fed diets containing 4% turmeric. However, no significant differences were observed in feed conversion ratio and egg yolk color between hens fed diets containing 0 and 2% turmeric. Egg weight of hens fed diets containing 2% turmeric decreased significantly than those fed diets containing 0 and 4% turmeric. However, no significant differences were observed in egg weight between hens fed diets containing 0 and 4% turmeric. In addition, hens fed diets containing 4% turmeric showed the lowest egg mass compared with those fed diets containing 0 and 2% turmeric. It was concluded that adding turmeric powder into laying hen diets up to 2% from 52 to 60 weeks of age had some beneficial effects on productive performance and egg quality.

**Key words:** Egg production, egg quality, laying hens, productive performance, turmeric (*Curcuma longa* Linn) powder

## INTRODUCTION

Using antibiotics in poultry nutrition as growth promoters had banned to avoid their harmful effects in humans and animals via their residual in tissues and eggs and increasing bacterial resistance (Wegener *et al*., 1998). Therefore, poultry nutritionists have a great attention for searching non-antibiotic natural feed additive (phytobiotics) to use in poultry nutrition as synesthetic antibiotic alternatives (Lopez-Bote *et al*., 1998; Hertrampf, 2001; Zheng and Wang, 2001; Miura *et al*., 2002; Burt and Reinders, 2003; Jamroz *et al*., 2005). Some natural non-antibiotic alternatives have been increasingly claimed to improve poultry performance by enhancing health and stimulating digestive system (Dono, 2013). Turmeric (*Curcuma longa* Linn.) is one of these phytogenic antibiotic-alternatives which can be used as natural feed additives in poultry nutrition. Turmeric (*Curcuma longa* Linn.) is a domesticated perennial herb belongs to the family of Zingiberaceae distributed in tropical and subtropical regions throughout the world (Beevers and Huang, 2011). Turmeric contains 6.3% crude protein, 5.1% crude fat, 69.4% carbohydrates, 13.1% moisture (Chattopadhyay *et al*., 2004), 2.4 to 4% essential fatty acids and 4.7 to 8.2% crude ash (Kermanshahi and Riasi, 2006).

It well known that egg yolk color is a very important interior egg quality trait for consumers. Bartov and Bornstein (1980) reported that laying hens are not able to synthesize color pigments and can transport about 20 to 60% only of the ingested dietary pigments to the egg yolk. Therefore, poultry producers considerably used the natural pigments due to consumer preference and to legal restriction in countries that have banned the adding of the artificial or synthetic coloring in poultry nutrition. One important natural pigment is turmeric containing several active compounds (phytochemicals) such as the non-volatile coloring agent called curcuminoid containing a phenolic yellow pigment called curcumin (Jayaprakasha *et al*., 2005; Rahardja *et al*., 2015). Wang *et al*. (1998) mentioned that curcuminoid and curcumin compounds are natural, less toxic, residue free and thought to be ideal as feed additives in poultry and animal diets. In addition, turmeric was recognized as a natural, non-toxic, residue free, safe, yellow coloring agent and thought to be ideal as feed additives in poultry and animal diets approved by several organizations and researchers (Hallagan *et al*., 1995; Srinivasan, 2005).

On the other hand, turmeric contains many flavonoid compounds acting as phytoestrogen which have estrogen-like activity, enhancing vitellogenin (an egg yolk protein precursor) synthesis during egg laying period via

improving parenchymal hepatic cell functions in response to estrogen (Saraswati *et al*., 2013; Rahardja *et al*., 2015).

In addition, several studied claimed that the active compounds in turmeric have several biological activities (Pruthi, 1980; Chattopadhyay *et al*., 2004; Kuroda *et al*., 2005; Beevers and Huang, 2011; Li *et al*., 2011; Krup *et al*., 2013).

There have been little studies conducted to determine the effects of adding different dietary levels of turmeric (*Curcuma longa* Linn) powder as a feed additive on laying hens (Radwan *et al*., 2008). Therefore, the objective of the present study was carried out to evaluate the effects of adding three different dietary levels (0, 2 and 4%) of turmeric (*Curcuma longa* Linn) powder on the production performance and egg quality of Hisex laying hens from 52 to 60 weeks of age.

## MATERIALS AND METHODS

Commercial turmeric (*Curcuma longa* Linn) powder used in the present study was purchased from local market in Al-Ahsa, Kingdom of Arabia Saudi.

**Experimental design:** The current study was conducted from September till December, 2015 at the Agriculture Research and Training Station of King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia. One hundred fifty laying hens (Hisex White®, 52-week-old) with similar body weight and egg production were used over 8-week trail experimental period from 52 to 60 weeks of age. Hens were reared in a close sided laying hen house in battery group cages (100 x 60 x 30 $cm^3$) separated by a 1.0 m aisle, equipped with galvanized-iron trough feeders covering the entire front length of metal cages and nipple drinkers. Hens were randomly distributed among three dietary laying hen treatments containing either 0, 2, or 4% of turmeric (*Curcuma longa* Linn) powder with ten replicates with five hens each for each treatment. The laying hen diets used in this study were calculated to be isocloric containing 2762 Kcal metabolizable energy and isonitrogenus containing 16.89% crude protein/kg feed to meet the recommended nutrition requirements of Hisex laying hens as shown in Table 1. The feed calculated was carried out before adding the turmeric (*Curcuma longa* Linn) powder. At 52 weeks of age, each hen was fed 120 g once daily and water was provided *ad libtum*. Hens were subjected to 16 h light throughout the entire experimental period.

**Measurements:** The initial and final body weight of laying hens were individually measured at the starting and ending of the experimental study at 52 and 60 weeks of age, respectively. Egg production (%), feed consumption (kg), feed conversion ratio (kg feed consumed/kg egg mass produced) were measured per each replicate from 52 to 60 weeks of age. Three eggs were collected from each replicate during the last 3 consecutive days biweekly and individually weighed to the nearest 0.01 g and then stored overnight at room temperature to determine egg specific gravity described by Hempe *et al*. (1998) by using saline solutions ranged from 1.060 to 1.10 g/mL with 0.005 increment. Albumen height was measured by using an Ames micrometer (model S-6428, Ames, Waltham, MA) at a point halfway between the egg yolk and the edge of the albumin widest expanse. Haugh unit was determined by applied the following formula reported by Panda (1996):

$$\text{Haugh unit} = 100 \times \log (AH + 7.57 - 1.7EW^{0.37})$$

where, AH is albumin height (mm) and EW is egg weight (g). In addition, egg yolk color was evaluated by using a Roche colorimetric fan (DSM nutritional products Co.) using color scales ranged from 1 (pale yellow) to 15 (intense orange) as described by Well (1968).

**Statistical analysis:** All data obtained were subjected to one-way ANOVA using the GLM procedure of a statistical software package (SPSS 18.0, SPSS Inc., Chicago, IL). Experimental units were based on replicate averages. Treatment means were expressed as mean±standard error of means (Mean±SEM) and separated ($p \leq 0.05$) using the Duncan's multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

No significant differences were observed in body weight gain, feed consumption, egg production, egg specific gravity and Haugh unit among all the dietary treatments in the present strudy as shown in Table 2. Therefore, non-significant effect in feed consumption observed among all the dietary treatments indicated that adding turmeric powder into laying hen diets up to 4% did not affect the aroma, the palatability of the diets and the appetite of the treated laying hens. Results showed that egg weight of hens fed diets containing 2% decreased significantly than those fed diets containing 0 and 4% turmeric powder. However, no significant differences were observed in egg weight between hens fed diets containing 0 and 4% turmeric powder. The increasing of egg weight of hens fed diets containing 4% turmeric powder might be attributed to increase the dietary essential fatty acids compared with those fed diets containing 2% turmeric powder. Also, it is clear that the reduction in egg weight of hens fed diets containing 2% turmeric powder might be due to decrease their egg mass compared with those fed diets containing 0% turmeric powder. However, a linear reduction in egg mass was observed with increasing turmeric levels into laying hen diets from 0 to 4%, while the best egg mass noted when hens were fed control diet containing 0% turmeric powder. However, hens fed diets containing 4% turmeric powder showed the lowest egg mass

Table 1: Composition experimental diets

| Feed ingredients | (%) |
|---|---|
| Yellow corn | 62.0 |
| Corn oil | 1.0 |
| Dehulled soybean meal (44.5% CP) | 26.4 |
| Limestone | 8.7 |
| Dicalcium $PO_4$ | 1.0 |
| Antioxidant | 0.10 |
| L-Lysine | 0.10 |
| Choline-chloride | 0.10 |
| DL-Methionine | 0.10 |
| Vitamin-mineral premix* | 0.25 |
| Salt | 0.25 |
| **Calculated nutritional composition** | |
| Dry matter (%) | 90.27 |
| Energy (Kcal ME/kg feed) | 2762 |
| Crude protein (%) | 16.89 |
| Crude fat (%) | 2.65 |
| Crude fiber (%) | 3.30 |
| Linolenic acid (%) | 1.57 |
| Calcium (%) | 3.62 |
| Available phosphorus (%) | 0.31 |

*Vitamin-mineral premix added at this rate yields: 149.60 mg Mn, 16.50 mg Fe, 1.70 mg Cu, 125.40 mg Zn, 0.25 mg Se, 1.05 mg I, 11,023 IU vitamin A, 46 IU vitamin E, 3,858 IU vitamin $D_3$, 1.47 mg minadione, 2.94 mg thiamine, 5.85 mg riboflavin, 20.21 mg pantothenic acid, 0.55 mg biotin, 1.75 mg folic acid, 478 mg choline, 16.50 µg vitamin $B_{12}$, 45.93 mg niacin and 7.17 mg pyridoxine per kg diet

compared with those fed diets containing 0 and 2% turmeric powder. This explains the worst feed conversion ratio obtained from hens fed diets containing 4% turmeric powder compared with those fed diets containing 0 and 2% turmeric. On the other hand, hens fed diets containing 0 and 2% turmeric powder showed lower (better) feed conversion ratio than those fed diets containing 4% turmeric powder. However, no significant differences were observed in feed conversion ratio between hens fed diets containing 0 and 2% turmeric powder. The worst feed conversion ratio was observed for hens fed diets containing 4% turmeric powder compared with those fed diets containing 0 and 2% turmeric powder attributed to the reduction in egg mass. On the other hand, hens fed diets containing 0 and 2% turmeric powder showed lower egg yolk color than those fed diets containing 4% turmeric powder. However, no significant differences were observed in egg yolk color between hens fed diets containing 0 and 2% turmeric powder. This improvement in the egg yolk color might be attributed to increasing the contents of the non-volatile coloring agent called curcuminoid the most important component in turmeric rich in a phenolic yellow pigment called curcumin. These results showed that adding 4% turmeric powder in laying hen diets was the only supplementation level able to improve the egg yolk color compared with 0 and 2% turmeric powder supplementation. Therefore, it was concluded that adding 4% turmeric into laying hen diets have positive effect on egg yolk color.

The results obtained in the present study were consistent with the early findings of Keshavarz (1976), who noted that adding turmeric powder into laying hen diets had no effects on egg production. In addition, the results were similar to those found by Lagana *et al.* (2011), who found that adding 2% turmeric into laying hen diets did not affect egg production, feed consumption and egg specific gravity. However, they were contrasting with their observation that adding 2% turmeric into laying hen diets did not affect egg weight, egg mass, feed conversion ratio and egg yolk color. Also, Moorthy *et al.* (2009) found that adding 0.1% turmeric powder into Single Comb White Leghorn laying hen diets did not affect egg production.

On the other hand, Emadi and Kermanshahi (2007) reported no significant difference in feed consumption, body weight gain and feed conversion ratio by adding turmeric powder into broiler diets at the levels of 0.25, 0.50 and 0.75%. Radwan *et al.* (2008) reported that adding 0.5% turmeric powder into laying hen diets increased egg production, egg weight and egg mass. Also, Gowda *et al.* (2008) observed that feed conversion ratio, body weight gain and feed consumption were not affected by adding 0.5% turmeric powder into broiler diets for 3 weeks. Malekizadeh *et al.* (2012) noted that adding 1 or 3% turmeric powder into laying hen diets from 103 to 112 weeks of age significantly decreased feed consumption, but did not affect feed conversion ratio, egg production, egg mass and egg weight compared with those fed diets containing 0 and 3% turmeric powder. Also, Riasi *et al.* (2012) noted that adding 0.2% turmeric powder into laying (Hy-Line W-36) hen diets from 100-104 weeks of age significantly increased egg mass and improved feed conversion ratio. However, they found that adding 0.05, 0.1, 0.15, or 0.2% turmeric powder into laying hen diets had no significant effect on egg specific gravity, but increased egg yolk color value. Also they noted that hens fed diets containing 0.15 and 0.2% turmeric had lower feed consumption than those fed diets containing 0, 0.05, or 0.1% turmeric. Park *et al.* (2012) noted that adding 0, 0.1, 0.25, or 0.5% turmeric powder into Lohmann Brown laying hen diets from 60 to 67 weeks of age increased significantly egg production than those fed diets containing 0% turmeric. Also, they found no effect for adding different dietary levels of turmeric powder on feed consumption, but egg yolk color for hens fed diets containing 0.5% turmeric powder was significantly higher than those fed diets containing 0% turmeric powder. In recent study, Rahardja *et al.* (2015) added 0, 1, 2, 4% turmeric powder into Hisex Brown laying hen diets from 80 to 92 weeks of age and found a significant reduction in feed consumption, but egg production was significantly increased and maintained at a higher level by adding 4% turmeric powder into laying hen diets compared with those fed diet containing 0% turmeric,

Table 2: Effect of adding different dietary levels (0, 2 and 4%) of turmeric powder on productive performance and egg quality of laying hens from 52 to 60 weeks of age

| | Turmeric powder (%) | | |
|---|---|---|---|
| Productive and egg quality traits | 0 | 2 | 4 |
| Initial body weight (g) | 1405.05±12.02 | 1372.47±19.62 | 1390.21±24.94 |
| Body weight gain (g) | 121.95±17.94 | 157.53±22.89 | 89.99±38.73 |
| Egg production (%) | 61.12±3.24 | 67.65±2.61 | 60.37±2.42 |
| Egg weight (g) | 69.87±0.92$^{a}$ | 65.13±0.49$^{b}$ | 67.73±0.87$^{a}$ |
| Feed consumption (kg) | 5.79±0.02 | 5.69±0.06 | 5.78±0.01 |
| Feed conversion ratio (kg feed/kg egg mass) | 2.09±0.03$^{b}$ | 2.21±0.04$^{b}$ | 2.54±0.09$^{a}$ |
| Egg mass (kg) | 2.77±0.04$^{a}$ | 2.58±0.02$^{b}$ | 2.29±0.08$^{c}$ |
| Egg specific gravity (g/cm$^{3}$) | 1.07±0.00 | 1.07±0.01 | 1.07±0.00 |
| Egg yolk color | 3.67±0.18$^{b}$ | 3.87±0.25$^{b}$ | 4.67±0.15$^{a}$ |
| Haugh unit | 86.99±3.57 | 86.61±2.75 | 87.79±2.56 |

$^{a-c}$Means±standard error of mean within a row that do not share a common superscript are significantly different ($p \leq 0.05$)

while the egg weight was not significantly affected. In addition, they showed that adding turmeric powder up to 2% into laying hen diets did not significantly affect feed consumption, but addition of turmeric powder up to 4% resulted in a significant reduction in feed consumption. Also, they noted that adding turmeric powder up to 4% into old laying hen diets improved significantly egg production, but did not affect egg weight and Haugh unit. The variations in the effects of adding turmeric powder into laying hen diets among the different studies might be attributed to the differences in the concentration levels and periods of turmeric supplemented, age and strain of laying hens, turmeric sources, stability of active compounds, drying method, turmeric products, experimental methods used.

**Conclusions:** It was concluded that turmeric powder can be added into layer hen diets at the level of 2% without negative effects on productive performance and egg quality from 52 to 60 weeks of age. However, adding turmeric at 4% into laying hen diets can be also used as a feed additive for producing eggs with high yolk color from 52 to 60 weeks of age.

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