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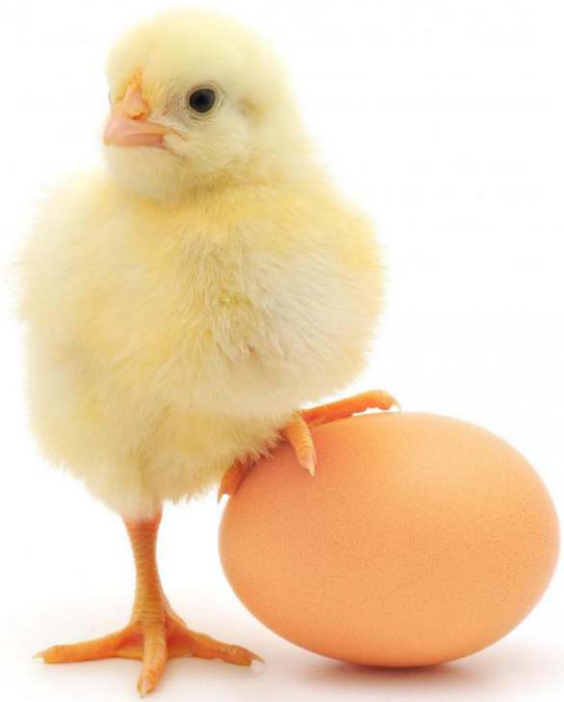

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Effects of Adding Different Dietary Levels of Raw Mung Bean (*Phaseolus aereus*) on Productive Performance and Egg Quality of Laying Hens

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Abstract: The present study was conducted to evaluate the effect of adding different dietary levels of raw mung bean (0, 5, 10 and 15%) on productive performance and egg quality of laying hens. Two hundred forty 55-week old Hisex laying hens with similar body weight and egg production were randomly distributed among 4 treatments with 15 replicates with 4 hens per each replicate. Body weight gain, feed consumption, egg production, egg weight, egg mass, feed conversion ratio, egg shell weight, egg shell weight surface area, egg shell thickness, egg specific gravity, egg yolk color and Haugh unit were measured. Results showed that hens fed diets containing 10 and 15% mung bean showed higher egg mass than those fed control diet containing 0% mung bean. In contrast, hens fed diets containing 10 and 15% raw mung bean showed higher (worst) feed conversion ratio than those fed control diet containing 0% raw mung bean. On the other hand, hens fed diets containing 15% raw mung bean showed higher egg shell weight, egg shell weight surface area and egg yolk color than those fed diets containing 0, 5 and 10% raw mung bean. In addition, hens fed diets containing 15% raw mung bean showed higher egg shell thickness than those fed diet containing 10% raw mung bean. It was concluded that raw mung bean is a promising protein source that can be added up to 15% into laying hen diets contributing as much as 22.21% of the total dietary protein without negative effects on productive performance and egg quality of laying hen from 55 to 63 weeks of age.

Key words: Egg quality, laying hens, mung bean, productive performance

INTRODUCTION

It is well known that poultry feed, the highest cost item for poultry production, represents about two-thirds of the variable cost and the protein is the most costly and important nutrient in poultry diets. One of the most important problem has been facing the poultry nutritionist is the short supply and the expense of the animal and the common plant protein (soybean) used in poultry nutrition (Farrell, 1996). This dearth might be attributed to several factors among them the restriction for using animal protein sources in poultry nutrition, competition between animal, poultry and human requirements and increasing intensive poultry and animal developments over the world. This is lead to the commercial poultry producers depend mainly on the use of soybean meal as protein source due to its high digestibility and palatability and high biological value. Therefore, poultry nutritionist have been focused to find suitable and cheap unconventional plant protein alternatives to partially or completely replace soybean to decrease the cost of the poultry diets.

Mung bean is one of the untraditional plant protein alternative that can be used in poultry nutrition. Mung bean also well-known as green gram, mungdal, moong dal, mash bean, munggo, green gram, golden gram and green soy (Daghir, 2008). Mung bean (*Phaseolus aereus* synonym: *Vigna radiata*), native to India belonged to the Leguminosae or Fabaceae family, is a drought-tolerant annual tropical legume plant and is cultivated in numerous tropical and Asian countries for human and animal consumption (Park, 1978; Hussain and Burhanddin, 2011). Raw mung bean contains about 6.26 to 12.07% moisture, 20 to 30% crude protein, 53.38 to 67.68% nitrogen free extract, 6.6% sugars, more than 45% starch, 0.07 to 1.9% crude fat, 0.63 to 16.3% crude fiber and 3.3 to 5% ash (Deshpande, 1992; Ravindran and Blair, 1992; Wiryawan *et al.*, 1995; El-Adawy, 1996; USDA, 2000; Robinson and Singh, 2001; Mubarak, 2005; Habibullah and Shah, 2007; Agugo and Onimawo, 2009; Paul *et al.*, 2011; Oburuoga and Anyika, 2012; Ganzon-Naret, 2014; Padmashree *et al.*, 2016).

Wiryawan *et al.* (1995) stated that raw mung bean has a higher energy value than many other legume beans. Some studies reported that raw mung bean contains about 3035 to 3470 kcal metabolizable energy/kg feed (Creswell, 1981; USDA, 2000; Padmashree *et al.*, 2016). In addition, El-Adawy (1996) and Robinson and Singh (2001) establish that the amino acid profile of raw mung bean is comparable or similar to that of soybean and it is rich in lysine and tryptophan, but methionine and cysteine are the limiting amino acids. Also, Ganzon-Naret (2014) noted that raw mung bean contains about 41.6 g lysine, 24.6 g histidine, 63.5 g arginine, 134.5 g aspartic acid, 31.2 g threonine, 49.4 g serine, 215 g glutamic acid, 41.5 proline, 42.2 g glycine, 43.2 g alanine, 53 g valine, 19.5 g methionine, 47.4 g isoleucine, 83.2 g leucine, 32.2 tyrosine, 56.4 g phenylalanine and 9.5 g tryptophan/kg.

On the other hand, raw mung bean has about 840 to 1320 mg calcium, 67.4 to 97 mg iron, 556 to 1890 mg magnesium, 10.35 to 17 mg manganese, 3670 to 3910 mg phosphorus, 36.2 mg potassium, 120 mg sodium and 26.8 mg zinc/kg (USDA, 2000; Mubarak, 2005).

Robinson and Singh (2001) mentioned that raw mung bean is rich in vitamins A, B_1, B_2, C and niacin. Raw mung bean contains about 6.21 to 6.4 mg thiamine, 1.8 to 2.33 mg riboflavin, 22.51 mg niacin, 19.1 mg pantothenic acid, 3.82 mg vitamin B_6, 6250 µg folate, 48 mg vitamin C, 5.1 mg vitamin E, 90 µg vitamin K/kg (USDA, 2000; Padmashree *et al*., 2016). On the other hand, raw mung bean contains different pigments in seed coat (Sen and Ghosh, 1959; Murty and Patel, 1972).

Nevertheless, like many legume protein sources, mung bean contains different endogenous anti-nutritional factors such as trypsin inhibitor, chymotrypsin inhibitor, amylase inhibitor, protease inhibitor, phytic acid, tannins, lectins, saponin, flatulence, gossypol and anti-thiamine factor (Wiryawan *et al*., 1997), which reduce its nutrient utilization and biological value and limit its usage directly in poultry diets at high levels without some suitable processing (Kay, 1979). Chrispeels and Baumgartner (1978) found that the trypsin inhibitor in mung bean is different from that of soybeans. On the other hand, Elias *et al*. (1979) noted that mung beans having colored coats have higher levels of tannin than beans with white coats. Some studies mentioned that raw mung bean contains about 15.8 to 17.23 mg trypsin inhibitor activity unit, 2670 hemagglutinin activity unit, 3.30 mg tannin, 3.74 to 6.65 mg phytic acid/g (Mubarak, 2005; Padmashree *et al*., 2016).

There are very limited numbers of the scientific literature determined the effects of adding different dietary levels of raw mung bean on the productive performance of laying hens. Therefore, the objective of the present study was carried out to evaluate the effects of adding different dietary levels (0, 5, 10 and 15%) of raw mung bean on productive performance and egg quality of laying hens from 55 to 63 weeks of age.

MATERIALS AND METHODS

Raw mung bean was obtained from local market, Al-Ahsa, Kingdom of Arabia Saudi. Then raw mung beans were grounded and chemically analyzed according to the Association of Official Agricultural Chemists (AOAC) methods (AOAC, 1990) in the feed laboratory belonged to the Collage of Agricultural and Food Sciences, King Faisal University, Al-Ahsa, Kingdom of Arabia Saudi.

Experimental design: The present study was conducted in the period from January to March, 2016 at the Agricultural and Research and Training Station belonged to King Faisal University, Al-Ahsa city, Kingdom of Saudi Arabia. The current study was carried out to evaluate the effect of adding different dietary levels of raw mung bean on productive performance and egg quality of laying hens over 8-week trial period. A total of 240 Hisex laying hens at 55 weeks of age with similar body weight and egg production were used. Hens were reared in a close sided laying hen house in battery group cages (100 × 60 × 30 cm^3) separated by a 1.0 m lane, equipped with galvanized-iron trough feeders covering the entire front length of metal cages and nipple drinkers. Hens were individually weighed, randomly distributed among 4 dietary treatment groups with 15 replicates with 4 hens per each replicate. Hens were fed laying hen diets containing either 0, 5, 10, or 15% raw mung bean from 55 to 63 weeks of age. The diets were formulated to meet the recommended nutritional requirements of Hisex laying hens as shown in Table 1. The laying diets used in this study were calculated to be isocloric and isonitrogenous with an average of 2782 Kcal metabolizable energy and 16.17% crude protein per kg of feed, respectively. Each hen was received 120 g feed once daily during the experimental period and water was provided to all laying hens *ad libitum*. All hens received 16 light daily hours throughout the whole experimental period.

Measurements: The initial and final body weights of laying hens used were individually measured at the beginning and finishing of the experimental study at 55 and 63 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 55 to 63 weeks of age. Three eggs were collected from each replicate during the last 3 consecutive days once every two weeks and individually weighed to the nearest 0.01 g and then stored overnight at room temperature to determine egg specific gravity according to the method of Hempe *et al*. (1998) by using saline solutions ranged from 1.060 to 1.10 g/mL with 0.005 increment. Then, the same eggs were broken and their components were separated and eggshell with shell membranes were washed and left to dry in the air before being individually weighed. The eggshell thickness including its membranes was calculated by using an electronic digital caliper scale (pachymeter) with 0.01 mm precision as an average for three separate different sites (air cell, equator and sharp end) of the equatorial region. Eggshell weight per surface area expressed in mg/cm^2 was determined according to Abdullah *et al*. (1993). The following formula was used:

$$\text{ESWSA} = \frac{\text{ESW}}{3.9782 \times (\text{EW}0.7056)} \times 1000$$

where, ESW: Eggshell weight, EW: Egg weight, ESWSA: Eggshell weight/surface area.

Albumen height was measured with an Ames micrometer (model S-6428, Ames, Waltham, MA) at a point halfway between the yolk and the edge of the widest area of the albumen (USDA, 2000). Haugh units were calculated as follows:

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

where, H is albumin height of the interior thick albumen (mm) and W is egg weight (g) (Panda, 1996). The egg yolk color was measured using a Roche colorimetric fan (DSM nutritional products Co.). Color scales ranged from 1 (light yellow) to 15 (deep orange) according to Well (1968).

Statistical analysis: 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

Results obtained from the present study showed that no significant differences were detected in body weight gain, feed consumption, egg production, egg weight, egg specific gravity and Haugh unit. However, results exhibited that adding raw mung bean into laying hen diets at different levels (0, 5, 10 and 15%) significantly affected egg mass, feed conversion ratio, egg shell weight, egg shell weight surface area, egg shell thickness and egg yolk color as shown in Table 2.

Hens fed diets containing 10 and 15% raw mung bean showed higher egg mass than those fed control diet containing 0% raw mung bean, but were not different from those fed diets containing 5% raw mung bean. In contrast, hens fed diets containing 10 and 15% mung bean showed higher (poorer) feed conversion ratio than those fed control diet containing 0% raw mung bean, but were not different from those fed diets containing 5% raw mung bean.

On the other hand, hens fed diets containing 15% raw mung bean showed higher egg shell weight, egg shell weight surface area and egg yolk color than those fed diets containing 0, 5 and 10% raw mung bean. However, there were no significant differences observed among hens fed diets containing 0, 5 and 10% raw mung bean in egg shell weight, egg shell weight surface area and egg yolk color. In addition, hens fed diets containing 15% raw mung bean revealed higher egg shell thickness than those fed diet containing 10% raw mung bean, but were not different from those fed diets containing 0 and 5% raw mung bean.

The results obtained from the present study were in agreement with the findings of Robinson and Singh (2001), who noted that adding raw mung bean into laying hen diets did not affect feed consumption, egg weight and egg specific gravity, but affect egg mass and feed conversion ratio. However, Robinson and Singh (2001) found that adding raw mung bean into laying hen diets did not affect egg yolk color but affect egg production and body weight gain. Robinson and Singh (2001) also reported that adding raw mung bean up to 45% did not affect feed consumption, egg weight, egg specific gravity and egg yolk color for ISA Brown laying hens for 16-week trial period. In addition, they found that egg production and egg mass were lower and feed conversion ratio was poorer, but body weight gain was higher for laying hens fed diets containing 45% raw mung bean than those fed diets containing 0, 15 and 30% raw mung bean. Therefore, they suggested that adding 30% raw mung bean into laying hen diets without adverse effects on productive performance and egg quality when compared with those fed control diets.

Regardless of dietary treatment, the feed consumption of the laying hens in the present study did not change suggesting that mung bean had no negative effects on the palatability of the formulated laying hen diets used. The improvement observed in egg yolk color for hens fed 15% raw mung bean compared with those fed 0, 5 and 10% raw mung bean might be attributed to the presence of some pigments in seed coat color at the highest level (15%) of raw mung bean used in the present study. Some studies reported that raw mung beans contain seven different sap-soluble pigments in seed coat color (green and black spotted, bottle-green, yellowish-green) and numbers of chloroplasts containing chlorophyll (Sen and Ghosh, 1959; Murty and Patel, 1972).

The decline in the feed conversion ratio for hens fed laying hen diets containing 10 and 15% mung bean compared with those fed laying hen diets containing 0% raw mung bean reflected the reduction in the egg mass. In addition, the reduction in the feed conversion ratio might attribute to the presence of some anti-nutritional factors at the highest level (15%) of raw mung bean used in the present study. Some studies reported that raw mung bean contained some anti-nutritional factors (Kay, 1979; Creswell, 1981; Robinson and Singh, 2001). These anti-nutritional factors have adverse effects on poultry performance (Kay, 1979). Creswell (1981) found in some cases that these anti-nutritional factors (metabolites) were found to have no negative effects. In addition, Robinson and Singh (2001) observed that raw mung bean has a high *in vitro* viscosity values, but contains very low levels of anti-nutritional factors such as trypsin inhibitor activity (1.9 to 2.9 mg/g) compared with the other legume protein sources. Nevertheless, some studies reported that the amounts of anti-nutritional factors vary greatly among raw mung bean types (Wiryawan *et al.*, 1997).

Legume beans recommended to subject for several processing methods before using in poultry diets to improve the nutritional quality, to deactivate the anti-nutritional factors, to enhance the nutrients digestibility and utilization and to use higher levels of the raw mung bean in poultry diets (Van der Poel, 1990; Wiryawan and Dingle, 1998).

These processing techniques include the heat treatments (cooking, boiling, roasting and autoclaving),

Table 1: Composition experimental diets

	Raw mung bean* (%)			
Ingredients	0	5	10	15
Yellow corn	59.5	56.9	54.1	51.4
Dehulled soybean meal (44% CP)	23.5	21.3	19.2	17.0
Wheat bran	5	4.8	4.7	4.6
Limestone	10.4	10.4	10.4	10.4
Dicalcium phosphate	1.2	1.2	1.2	1.2
Vitamin-mineral premix**	0.2	0.2	0.2	0.2
Salt	0.2	0.2	0.2	0.2
Calculated nutritional composition				
Dry matter (%)	89.0	89.0	89.0	89.0
Energy (Kcal ME/kg feed)	2782	2784	2782	2782
Crude protein (%)	16.18	16.16	16.18	16.17
Crude fat (%)	2.60	2.54	2.47	2.41
Crude fiber (%)	3.50	3.43	3.38	3.32
Linolenic acid (%)	1.49	1.42	1.35	1.28
Calcium (%)	4.30	4.30	4.29	4.28
Available phosphorus (%)	0.35	0.34	0.33	0.32

*Raw mung bean used was as follows: 23.96% crude protein, 2865.73 kcal metabolizable energy, 1.2% crude fat, 3.28% crude fiber, 3.88% crude ash/kg

**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

Table 2: Effect of adding four dietary levels (0, 5, 10 and 15%) of raw mung bean on productive performance and egg quality of laying hens from 55 to 63 weeks of age

	Mung bean (%)			
Productive and egg quality parameters	0	5	10	15%
Body weight gain (g)	128.25±40.26	141.50±33.31	142.83±23.25	142.17±27.57
Feed consumption (kg)	6.63±0.01	6.63±0.02	6.66±0.01	6.66±0.01
Egg production (%)	76.03±0.64	72.86±2.53	71.79±2.24	72.01±1.14
Egg weight (g)	65.25±0.71	64.80±0.71	64.93±1.24	64.28±0.62
Egg mass (kg)	2.78±0.03[a]	2.64±0.05[ab]	2.60±0.07[b]	2.59±0.06[b]
Feed conversion ratio (kg feed/kg egg mass)	2.39±0.03[b]	2.52±0.05[ab]	2.58±0.07[a]	2.58±0.06[a]
Egg specific gravity (g/cm^3)	1.096±0.02	1.078±0.00	1.076±0.00	1.098±0.02
Egg shell thickness (mm)	0.34±0.00[ab]	0.35±0.00[ab]	0.34±0.01[b]	0.36±0.00[a]
Egg shell weight (g)	8.88±0.21[b]	8.93±0.23[b]	8.90±0.24[b]	9.68±0.27[a]
Egg shell weight surface area (g/cm^2)	11.70±0.27[b]	11.82±0.29[b]	11.76±0.29[b]	12.88±0.32[a]
Egg yolk color	4.95±0.12[b]	5.13±0.11[b]	4.88±0.15[b]	5.93±0.12[a]
Haugh unit	87.29±0.72	86.02±1.19	84.99±1.76	84.82±1.01

[a-b]Means±standard error of mean within a raw that do not share a common superscript are significantly different ($p \leq 0.05$)

soaking, sprouting, or extruding. Some studies reported a reduction in the trypsin inhibitors above 90% by treating the raw mung bean by using these processing procedures (Trugo *et al*., 1990; Farran *et al*., 2001; Ghadge *et al*., 2008; Akande and Fabiyi, 2010). Mubarak (2005) also reported 20 to 30% and 33 to 67% reduction in phytic acid and tannins, respectively in the raw mung bean heat-treated compared with untreated raw mung bean. The results obtained from the present study indicating that the effects of the adding 0, 5 10 or 15% raw mung bean into laying hen diets on the productive performance and egg quality parameters were different compared with the other studies. These differences might be attributed to the variances in the concentration levels and usage periods of raw mung bean, age and strain of laying hens, raw mung bean varieties and sources, the differences in bean coat colors and the alterations in the nutritional values of the raw mung bean used. Allen and Arnold (2000) mentioned that feedstuffs that contain at least 20% protein are considered as a potential protein source. Therefore, current study obviously reported that mung bean with a protein content of 23.96% is a promising dietary protein source for commercial laying hens.

Conclusions: It was concluded that raw mung bean can be added up to 15% into laying hen diets contributing as much as 22.21% of the total dietary protein and as much as 48.05% of the soybean protein used without negative effects on productive performance and egg quality of laying hen from 55 to 63 weeks of age. Further research with higher levels of raw mung bean with or without enzymes is required to determine the optimal levels of raw mung bean that can be used in laying hen diets.

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