Effect of Adding Chia Seeds (Salvia L.) to Japanese Quail Diet on Productive Performance and Egg Quality

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Abstract

This study was conducted to investigate the effect of adding chia (Salvia hispanica) to Japanese quail diet on productive performance and egg quality. A total of 240 female were randomly distributed into four treatments with three replicates per each (10 bird/replicate). The experimental treatments were as follows: T1 control (without any addition), T2, T3 and T4 involved adding 4, 8 and 12 g chia seeds/kg diet respectively. Results showed a significant increasing in egg production% in T4 at most of experimental weeks, moreover, egg mass was increased in all addition treatments. Feed consumption was significantly increased in T4 at 4th, 5th, and 8th weeks, from other hand, T2 showed a significant improve in feed conversion ratio. With the progress in age, a significant increase was found in egg albumin and yolk height in T4. We can conclude from this study that adding chia seeds to Japanese quail female diet could increase egg production and feed consumption with the progress in age especially with the rate 12g/kg diet.

Keywords: Japanese quail, Chia seeds, Productive performance, Egg quality.

1. Introduction

To obtain high nutritional value diets, it must be enriched with qualitative additives that can contribute to supporting growth rates, and feed conversion ratio, in addition to, improving digestion and disease resistance [1], enhancing the effectiveness of nutrients through their effect on intestinal inner lining cells. Fats is one of the qualitative additives used to enrich diets. Fats are major organic compounds with high nutritional value. It is involved in the synthesis of cell membranes therefore increase the fluidity of it [2], source of cell energy and is also a source of essential fatty acids that can be found in some animal oils such as fish oil or vegetable oils such as flax seed oil, soybean and sunflower [3]. Essential fatty acids type omega are important for human health, it maintain cellular membrane function and enzyme activity [4] and the production of hormone-like substances mediate physiological processes such as metabolism and muscle in addition to nerve activity [5], therefore, it is considered functional foods because it improves health [6]. The most common fatty acid among omega-3 is linolenic acid. The seeds oil of some plants is rich in it.

Chia (Salvia hispanica L.), belongs to Lamiaceae family, is rich in unsaturated fatty acids, where, omega-3 fatty acids make up 60% of its seeds oil content in the form of alpha linolenic acid [7]. Several studies were conducted to investigate the effect of adding sources rich in omega-3 to quail diets on their performance and to find the possibility of enriching chicken meat and eggs. In an experiment conducted by [8], they found that adding flaxseed, fish and walnut oils to the diet of laying hens resulted in improve egg mass. Another researcher found that adding chia seeds to Japanese female quail diet resulted in significant increase in yolk linolenic acid [9]. Some researchers found that adding seeds rich in omega-3 acids didn’t affect egg production [10,11], feed consumption and feed conversion ratio [12] while, others found significant improvement in egg production and qualitative characteristics in addition to enrich eggs with omega-3 fatty acids [13] led to significant increase in yolk weight [14]. This experiment was conducted to identifying the effect of adding three different levels of chia seeds to Japanese female quail diets on their productive performance and egg qualitative characteristics.
2. Materials and Methods

This experiment was conducted at the Poultry Research Station in Abu-Graib Ministry of Agriculture. A total of 240, 48-day old, Japanese female quail were randomly distributed into four treatments with three replicates per each (20 quail replicate). The quails were reared on wood shaving floor, water and feed were provided ad libitum. Hose temperature was 22C. Lighting program included 16L:8D. The basal diet ingredients and its chemical calculation are presented in table 1.

Table 1. Ingredients and chemical calculations of the basal diet.

| Ingredient           | Percentage |
|----------------------|------------|
| Yellow corn          | 53.00      |
| Wheat                | 9.00       |
| Soybean meal (48%)   | 26.00      |
| Protein concentrate  | 5.00       |
| Vegetable oil        | 1.20       |
| Limestone            | 5.50       |
| Dicalcium phosphate  | 0.30       |
| Total                | 100.00     |

Calculated chemical analysis*

|                |            |
|----------------|------------|
| Crude protein  | 20.20      |
| ME (kcal kg⁻¹)| 2905.00    |
| Fat            | 3.90       |
| Fiber          | 2.60       |
| Calcium        | 2.50       |
| Available phosphorus | 0.72 |
| Methionine+Cysteine | 0.70   |
| Lysine         | 1.13       |

*according to [15].

Chia seeds were added to the diet in three different levels according to the experimental treatments as follows:

T1: control (basal diet without any addition)
T2: adding 4g chia seeds/ kg basal diet
T3: adding 8g chia seeds/ kg basal diet
T4: adding 12g chia seeds/ kg basal diet

The data taken weekly were included: the number of eggs produced, egg weight and feed consumption Albumin height, yolk height, yolk index and egg shell thickness were measured at 74 and 105 days old (fourth and eighth week of experiment). From these data, the following measurements were calculated: egg production%, feed conversion ratio, egg relative weight% and mass, albumin and yolk relative weight%, yolk index and the relative weight of egg shell. The statistical analysis was conducted in a complete randomized design using SAS program [16]. Significant differences among treatments determined by [17].

3. Results and Discussion

3.1. Egg production

The effect of adding chia seeds to quail diet on egg production% is shown in table 2. Statistical analysis showed a significant effect in experimental weeks except the first, third and fifth weeks of egg production. In general, T4 was significantly (p<0.05) the highest at the second, fourth, sixth, seventh and eighth weeks in comparison with control group, while, T2 was significantly (p<0.05) the highest in comparison with control group at the fourth, sixth, seventh and eighth weeks of egg production period. T3 increased significantly (p<0.05) egg production% at sixth and seventh weeks in comparison with control group. From these results, we can note that adding chia seeds to the diet has led to an increase in egg production%, this increasing was clear with the female progress in age. This superiority may be due the fact that chia seeds are rich in polyunsaturated fatty acids (linoleic and alpha linoleic acid) which have an effect on the growth and number of ovary follicles, especially pre-ovulatory follicle, this effect resulted from increasing enzyme activity included in female sexual
steroids synthesis process, like estrogens which play a role in increasing vitellogenin and lipoprotein synthesis and their transfer through blood to ovary, then, increase follicle size. It is known that there is a positive association between the concentration of these hormones in blood plasma and egg production [18,19]. Our results are agreed with [20] who found a significant increase in egg production%, egg mass and feed conversion ratio in layers and quails [21] which fed diets supplemented with rich omega-3 plant sources.

3.2. Egg mass

Results presented in table 3 showed that there were significant differences between control and chia seeds treated groups in all weeks of experiment except the first week. T2 and T4 increased significantly (p<0.05) egg mass in comparison with control group from the second week until the end of the eighth week, while, T3 get the same effect except in the third week. The significant increase in egg mass due to adding chia seeds to the diet could be related to the improving in egg production, where, egg mass is calculated by the multiplying the percentage of egg production in its weight, in addition to, the egg size increased with the age of bird [22].

3.3. Feed consumption

Statistical analysis of feed consumption presented in table 4 showed that there was a significant (p<0.05) increase in control group (T1) at the first week in comparison with T2 and T4, from other hands, in comparison, with T2 at the second week. No significant differences were found between all experimental groups at third, sixth and seventh weeks. Feed consumption was significantly (p<0.05) increased in T4 in comparison with control in fourth, fifth and eight weeks while, at fifth week, all chia seeds treated groups (T2, T3 and T4) increased feed consumption in comparison with control. From these results, we can notice that adding chia seeds to the diet led to lowering the consumption of feed at the beginning of egg production period, then it was increased with the progress in egg production especially in the treatment with higher addition T4 (12g chia seeds/kg diet).

3.4. Feed conversion ratio

From table 5 we can notice a significant (p<0.05) improving in feed conversion ratio in chia seeds supplemented groups at all experimental weeks except fifth and eighth weeks. It was appearing that adding 4g chia seeds/kg diet achieved the best results compared to other addition (T3 and T4). Feed conversion ratio is an indicator to the bird benefits from diet components, and, it is affected by the amount of feed consumed to produce amount of eggs, and since, egg mass produced affected by eggs weight and the rate of its production, thus, all the positive or negative factors affecting the overall productive performance will affect their yield [23]. In our study, the improvement in feed conversion ratio in supplemented groups could be due to the effect of unsaturated fatty acids which led to increase the efficiency in the absorption and metabolism of nutrients [24].

3.5. Egg quality

Qualitative measurements of eggs included: shell thickness and its relative weight, albumin and yolk height, albumin and yolk relative weight, yolk index in fourth and eight weeks of experiment are presented in table 7. Statistical analysis showed that no significant differences were found between all treatments in the fourth week while in eighth week, albumin and yolk height were increased significantly (p<0.05) in T4 in comparison with control group. It is well known that as the layers grows older and passes the peak of egg production, the qualitative characteristics of the egg, included yolk height, gradually being to decrease. Seeds oils contain essential polyunsaturated fatty acids could stimulates female sex hormones secretion [25] like androgens, which increase oviduct tubular glands secretion that help to synthesis of special albumin proteins like ovalbumin, conalbumin and lysozyme[26].
### Table 2. Effect of adding chia seeds to quail diet on egg production%.

| Experimental weeks | T1           | T2           | T3           | T4           | Signify |
|-------------------|--------------|--------------|--------------|--------------|---------|
| 1                 | 75.00±3.6    | 72.14±3.7    | 74.29±5.6    | 8.81±3.0     | NS      |
| 2                 | 70.2±4±1.4b  | 79.04±5.2ab  | 75.71±3.4ab  | 81.90±1.2a   | *       |
| 3                 | 67.38±7.3    | 81.7±2.9     | 68.57±10.7   | 85.48±4.4    | NS      |
| 4                 | 66.90±6.2b   | 85.71±2.7a   | 76.91±4.1ab  | 87.62±4.4a   | *       |
| 5                 | 75.00±5.7    | 87.38±3.3    | 81.91±4.1    | 84.05±3.7    | NS      |
| 6                 | 67.38±2.3b   | 86.19±3.3a   | 82.38±6.0a   | 88.33±4.0a   | *       |
| 7                 | 67.33±2.0b   | 86.33±3.2a   | 82.33±6.1a   | 88.33±3.5a   | *       |
| 8                 | 67.00±1.2b   | 85.67±2.9a   | 76.66±4.0ab  | 87.67±1.4a   | *       |

p<0.05 Means having different letters in the same raw are significantly different, NS= non-significant. T1(control without any addition), T2,T3 and T4: adding 4g, 8g or 12g chia seeds/kg diet respectively.

### Table 3. Effect of adding chia seeds to quail diet on egg mass (g/quail/week).

| Experimental weeks | T1           | T2           | T3           | T4           | Signify |
|-------------------|--------------|--------------|--------------|--------------|---------|
| 1                 | 67.92±6.8    | 77.42±5.2    | 73.75±3.0    | 72.85±2.67   | NS      |
| 2                 | 76.85±1.5b   | 89.17±3.6a   | 86.67±0.4a   | 91.67±0.7a   | *       |
| 3                 | 66.07±10.0b  | 94.25±2.8a   | 81.25±11.1ab | 93.92±3.14a  | *       |
| 4                 | 72.33±8.36b  | 97.17±1.0a   | 90.50±2.0a   | 97.58±1.6a   | *       |
| 5                 | 73.88±7.6b   | 94.67±3.5a   | 90.80±3.4a   | 91.42±3.2a   | *       |
| 6                 | 77.38±4.0b   | 89.98±3.4a   | 90.75±1.4a   | 94.08±1.2a   | *       |
| 7                 | 77.33±4.1b   | 90.00±3.5a   | 91.00±1.5a   | 94.33±1.3a   | *       |
| 8                 | 72.67±8.4b   | 97.33±0.9a   | 90.67±1.8a   | 98.00±1.5a   | *       |

Means having different letters in the same raw are significantly different (p<0.05), NS= non-significant. T1(control without any addition), T2,T3 and T4: adding 4g, 8g or 12g chia seeds/kg diet respectively.

### Table 4. Effect of adding chia seeds to quail diet on feed consumption (g/quail).

| Experimental weeks | T1           | T2           | T3           | T4           | Signify |
|-------------------|--------------|--------------|--------------|--------------|---------|
| 1                 | 157.25±2.7b  | 169.02±7.0ab | 171.60±4.7ab | 181.28±6.43a | *       |
| 2                 | 187.7±1.5ab  | 185.42±2.0ab | 182.75±8.4b  | 198.17±1.0a  | *       |
| 3                 | 206.97±4.2a  | 188.33±0.4b  | 199.17±0.4a  | 178.20±4.9b  | *       |
| 4                 | 193.88±3.1a  | 191.33±4.2a  | 198.58±0.8a  | 173.13±7.6b  | *       |
| 5                 | 194.33±1.3   | 197.08±0.8   | 193.67±5.13  | 194.75±1.5   | NS      |
| 6                 | 194.67±1.0   | 197.33±0.8   | 194.00±5.0   | 197.00±4.2a  | *       |
| 7                 | 207.00±4.2a  | 198.58±0.8   | 193.33±4.2a  | 193.88±3.1a  | *       |

Means having different letters in the same raw are significantly different (p<0.05), NS= non-significant. T1(control without any addition), T2,T3 and T4: adding 4g, 8g or 12g chia seeds/kg diet respectively.

### Table 5. Effect of adding chia seeds to quail diet on feed conversion ratio (g diet/g egg).

| Experimental weeks | T1           | T2           | T3           | T4           | Signify |
|-------------------|--------------|--------------|--------------|--------------|---------|
| 1                 | 2.71±0.2a    | 2.23±0.1b    | 2.29±0.0b    | 2.16±0.6b    | *       |
| 2                 | 2.58±0.0a    | 2.05±0.0c    | 2.14±0.0b    | 2.05±0.0c    | *       |
| 3                 | 2.80±0.3a    | 2.07±0.0b    | 2.29±0.1ab   | 2.12±0.0b    | *       |
| 4                 | 2.52±0.3a    | 2.05±0.0b    | 2.08±0.0b    | 2.12±0.0ab   | *       |
| 5                 | 2.38±0.2     | 2.10±0.1     | 2.11±0.0     | 2.12±0.1     | NS      |
| 6                 | 2.53±0.1a    | 2.15±0.0b    | 2.17±0.0b    | 2.07±0.0b    | *       |
| 7                 | 2.50±0.1a    | 2.13±0.0b    | 2.17±0.0b    | 2.07±0.0b    | *       |
| 8                 | 2.50±0.3     | 2.07±0.0     | 2.07±0.0     | 2.10±0.0     | NS      |

Means having different letters in the same raw are significantly different (p<0.05), NS= non-significant. T1(control without any addition), T2,T3 and T4: adding 4g, 8g or 12g chia seeds/kg diet respectively.
Table 6. Effect of adding chia seeds to quail diet on egg quality.

| Items                      | Age(day) | T1       | T2       | T3       | T4       | Signify |
|----------------------------|----------|----------|----------|----------|----------|---------|
| Albumin height (mm)        | 74       | 3.60±0.4 | 4.03±0.6 | 4.32±0.0 | 4.34±0.61 NS       |
|                            | 105      | 3.71±0.31b | 3.97±0.13ab | 3.71±0.24b | 4.67±0.37a *       |
| Albumin weight%            | 74       | 53.31±0.0 | 53.76±2.8 | 56.63±1.9 | 54.98±1.3 NS       |
|                            | 105      | 54.63±0.7 | 57.67±2.8 | 57.17±1.9 | 57.56±0.50 NS       |
| Yolk height (mm)           | 74       | 10.59±0.3 | 11.30±0.5 | 10.64±0.3 | 10.86±0.4 NS       |
|                            | 105      | 9.52±0.3b | 10.14±0.1ab | 10.22±0.1ab | 10.60±0.4a *       |
| Yolk diameter (mm)         | 74       | 25.89±1.3 | 26.12±1.0 | 26.27±1.2 | 27.13±0.2 NS       |
|                            | 105      | 26.90±0.43 | 27.11±0.2 | 22.16±0.3 | 27.47±0.8 NS       |
| Yolk index                 | 74       | 0.41±0.0 | 0.43±0.0 | 0.41±0.0 | 0.40±0.0 NS       |
|                            | 105      | 0.35±0.0 | 0.37±0.0 | 0.36±0.0 | 0.39±0.0 NS       |

| Items                      | Age(day) | T1       | T2       | T3       | T4       | Signify |
|----------------------------|----------|----------|----------|----------|----------|---------|
| Yolk weight%               | 74       | 32.50±1.0 | 32.07±2.9 | 31.67±2.2 | 19.42±7.0 NS       |
|                            | 105      | 35.68±0.5 | 33.44±2.6 | 33.77±2.0 | 33.60±0.8 NS       |
| Shell thickness (mm)       | 74       | 0.32±0.0 | 0.28±0.0 | 0.29±0.0 | 0.30±0.0 NS       |
|                            | 105      | 0.34±0.0 | 0.30±0.0 | 0.38±0.0 | 0.39±0.0 NS       |
| Shell weight%              | 74       | 14.18±0.2 | 14.16±0.1 | 11.65±1.6 | 12.90±0.5 NS       |
|                            | 105      | 9.68±0.2 | 8.89±0.4 | 9.07±0.1 | 8.84±0.3 NS       |

Means having different letters in the same row are significantly different (p<0.05)

NS= non-significant. T1(control without any addition), T2,T3 and T4: adding 4g,8g or 12g chia seeds/kg diet respectively.

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