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Impact of different dietary levels of soybean oil on the performance and egg quality through 3-4 months of age of Japanese quail

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Abstract

Polyunsaturated fatty acids (PUFA), including n-6 and n-3 fatty acids, are essential for enhancing the performance and health of poultry. Avian species lack desaturase enzymes for endogenous synthesis of n-6 and n-3 fatty acids. Our aim in this work is to study whether different levels of soybean oil (SOYO) can affect the performance and egg quality of quails during 3-4 months of age. A total of 180 healthy mature quails (120 females + 60 males), aged 3 months, were randomly distributed into 3 groups. Each group contained 4 replicates with 10 females + 5 males each. The first group received the standard diet including no oils, while the 2nd and the 3rd groups received the standard diet included 0.5% and 1.0% SOYO, respectively. The trial continued for one month, until the 4th month of age. The data revealed that adding SOYO to mature quail diets at levels of 0.5% and 1.0% had insignificant effect on egg weight (P= 0. 179), egg production rate (P= 0. 067) and egg mass (P= 0. 102). However, values of egg weight, egg production rate, and egg mass were numerically higher in SOYO-treated groups than control (untreated group). There were no significant differences among all experimental groups in all studied egg quality traits including: egg weight (P=0.635), egg shape index (P=0.714), yolk relative weight (P=0.308), albumen relative weight (P=0.516), shell relative weight (P=0.581), shell thickness (P=0.768), yolk index (P=0.470), and Haugh units (P=0.640). In conclusion, adding SOYO to a mature quail diet has advantageous effects on feed utilization and the higher levels may be capable of improving egg production indices.

Keywords: Japanese quail, Soybean oil, Productivity, and Egg quality.

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1. Introduction

Various studies have elucidated different compositions of fatty acids, which consist of oxygen, hydrogen, and carbon, categorized as saturated, polyunsaturated, or monounsaturated fatty acids [1,3]. Vegetable oils are rich sources of polyunsaturated fatty acids (PUFA), including n-6 fatty acids. PUFA are essential for enhancing the performance and health of poultry. Avian species lack desaturase enzymes for endogenous synthesis of n-6 fatty acids. Oils are typically incorporated into poultry feeds to augment energy density as an economic strategy for formulating energy-rich feeds. Vegetable oils contain varying levels of long-chain unsaturated fatty acids. Research by [4] highlighted the significance of fat content and fatty acid composition in egg lipids for human health. [5] established a direct correlation between saturated fatty acid intake and the prevalence of cardiovascular diseases. [6] observed that increasing the dietary ratio of polyunsaturated to saturated fatty acids led to decreased cholesterol levels in blood plasma. [7] found that feeding 1-week old chicks on low-fat diets reduced bile salt secretion and lipase activity. Alterations in egg yolk fatty acid content can enhance the perceived health benefits of eggs and potentially elevate their nutritional value. [8] demonstrated that the lipid types in layer feed can influence the lipid profile of egg yolk. SOYO, a prevalent energy source in poultry diets, has high content of PUFAs (~53.2% n-6 FAs and ~7.8% n-3 FAs), in addition to 15% saturated FAs and 24% monounsaturated FAs [9]. The high energy value of SOYO is attributed to its high percentage of (poly) unsaturated fatty acids, which are well absorbed and utilized as a source of energy by the animal [10]. Recent research endeavors have shifted towards modifying the fatty acid composition in food [11–13]. SOYO is composed mainly of oleic, linoleic, linolenic, and palmitic fatty acids. Soybean oil is very rich in polyunsaturated fatty acids particularly omega-6 and omega-3 fatty acid [14]. The current investigation aims to evaluate the effects of different levels of SOYO on the laying performance and egg quality of mature quail.

2. Material and Methods

2.1. The study design and quail husbandry

A total of 180 healthy mature quails (120 females + 60 males), aged 3 months, were randomly divided equally into 3 groups. Each group contained 4 replicates with 10 females + 5 males each. The first group received the standard diet included no oils, while the 2nd and the 3rd groups received the standard diet included 0.5% and 1.0% SOYO, respectively. The trial continued for one month, until the 4th month of age. The birds were housed in conventional cages measuring 60 × 50 × 30 cm^3 and were subjected to identical hygienic, environmental, and managerial conditions. The quails received 16 hours of light exposure per day throughout the study period. They had ad libitum access to mash feed and fresh water. The standard diets (Table 1) were formulated based on the quail requirements outlined in [15].

Table 1: Composition and calculated analysis of the experimental diets.

Ingredient	**Control**	**0.5% oil**	**1% oil**
Yellow corn	63.00	61.85	60.85
Soybean meal (44%)	21.55	23.20	24.70
Corn gluten meal (60%)	8.30	7.30	6.30
Bone meal	3.00	3.00	3.00
Limestone	3.50	3.50	3.50
Vit. & Min. premix (1)	0.25	0.25	0.25
NaCl	0.20	0.20	0.20
Dl- Methionine	0.05	0.05	0.05
L-Lysine Hcl	0.15	0.15	0.15
Soybean oil	0.00	0.50	1.00
Total	100.00	100.00	100.00
Calculated analysis (2)			
Crude protein %	20.00	20.03	20.00
ME (kcal/kg)	2900	2900	2903
Crude fiber %	3.22	3.22	3.22
Crude fat %	2.62	2.62	2.62
Calcium %	2.51	2.51	2.51
Available phosphorus %	0.55	0.55	0.55
Lysine %	1.08	1.08	1.08
Methionine + Cystine %	0.77	0.77	0.77

(1) Layer Vit. & Min. premix: Each 2.5 kg of vitamins and minerals premix (commercial source pfiezer Co.): consist of Vit. A 12 MIU, VIT E 15 KIU, Vit. D_3 4 MIU, Vit. B1 1g, Vit B2 8 g, Vit B6 2 g, Vit B12 10 mg, Pantothonic acid 10.87 g, Niacin30 g, Folic acid 1 g, Biotin 150 mg, Copper 5 g, Iron 15 g, manganese 70 g, Iodine 0.5 g, Selenium 0.15 g, Zinc 60 g and antioxidant 10g.

(2) Calculated according to [15].

2.2. Data Gathering and Computation

2.2.1. Productive Performance

Egg weight and egg number were daily recorded for each replicate. Egg production rate and average egg weight were calculated for each replicate through the experimental period. Egg mass was computed as: average egg weight × egg production rate. Feed consumption (g) was calculated for each replicate during the experimental period (3-4 months of age) and divided by the number of live quails. FCR (g feed/g egg) was calculated as the amount of consumed feed divided by the value of egg mass.

2.2.2. Egg quality criteria

Egg quality criteria were assessed every week on 7 eggs per replicate. Eggs were weighed using a precise electronic balance. Egg length and width were measured with a caliper to compute the shape index as: egg width/egg length × 100. For internal egg quality parameters, eggs were cracked and opened in a glass Petri dish, and shells were carefully removed. Eggshell relative weight was determined. The yolk and albumen were separated and weighed. The albumen weight was calculated by subtracting the yolk and shell weights from the whole egg weight. Yolk index was determined using the formula by [16] as yolk index = yolk height/yolk diameter. Haugh units (HU) were calculated as per the equation by [17] as: HU = 100 log (H + 7.57 – 1.7 x W0.37), where H = height of the albumen (mm) and W = egg weight (g). Additionally, eggshell thickness (mm) was measured using a micrometer.

2.3. Data analysis

All statistical analyses were conducted utilizing [18] (version 17.0). The production and egg quality parameters were evaluated through one-way ANOVA (with the level of SOYO as the fixed factor) followed by the post-hoc Tukey's range test (P < 0.05).

3. Results and Discussion

3.1. Egg production

Table 2 displayed data for egg weight, egg production rate, and egg mass as affected by adding different levels of SOYO in quail diets through 3-4 months of age. The data revealed that adding SOYO to mature quail diets at levels of 0.5% and 1.0% had insignificant effect on egg weight (P= 0. 179), egg production rate (P= 0. 067) and egg mass (P= 0. 102). However, values of egg weight, egg production rate, and egg mass were numerically higher in SOYO-treated groups than control (untreated group). Similarly, [14] fed Isa Brown laying hens at 20 weeks of age on diets containing 2.5-10% SOYO and showed no significant difference (P>0.05) on EW and EPR. Also, [19] used 2-4% SOYO in layer' feeds and noted no significant effect on laying performance parameters. [20] recorded no significant effect of adding 3% SOYO to hens' diets. [21] showed significant increases due to including SOYO in broiler Breeder diets in the percentage of egg production (HD%), eggs weight, and egg mass. [22] noted that laying hens fed on SOYO rations achieved the lowest average egg weight and egg mass comparable with birds fed linseed oil. They also noted a significant improvement in hen-day egg production%, egg weight, and egg mass in the group fed diet containing 2% vegetable oil, followed by those fed 1.5%, and then those received 1% vegetable oil. [23] concluded that dietary fatty acid saturation had no substantial effect on laying hens' egg production rate. A similar trend was observed by [24] who noted no significant effect of fatty acid saturation on egg weight, egg production rate, and egg mass of aged laying hens during 58–74 weeks of age. On the other hand, [25] stated that egg weight and egg production rate of laying hens were decreased by the increase of the dietary fatty acid unsaturation level. [22] stated that vegetable oils in poultry diets could improve egg production rate through increasing feed density, enhancing palatability, increasing metabolic energy, and boosting the absorption of all nutrients [26]. On the same context, [27] stated that the digestibility of lipids increases as the degree of unsaturation increases.

Regarding feed consumption, data in Table 2 indicated that quail groups which received diets with 1.0% SOYO consumed feed less (P=0.017) than control group and 0.5% SOYO-treated group. Also, FCR was significantly improved (P=0.022) by including 1.0% SOYO in comparison with the control group and 0.5% SOYO-treated group. It is worth mentioning that values of feed consumption and FCR were numerically lower in 0.5% SOYO-treated group than the control. [28] reported that the digestibility of crude fat in SOYO and linseed oil-treated broilers was greater than that in Lard- treated broilers. [29] stated that calories of saturated fats are mostly stored as fat in the body, while calories of unsaturated fats are mostly used for various metabolic functions. [22] noted that laying hens fed on SOYO rations achieved the worst FCR comparable with birds fed linseed oil or sunflower oil. They also noted a significant improvement in FCR in the group fed diet containing 2% vegetable oil, followed by those fed 1.5%, and then those received 1% vegetable oil. Feed intake was not affected by different oil sources, but it was decreased by increasing level of dietary oils. On the same context, [21] showed significant improvement due to including SOYO in broiler Breeder diets in feed conversion ratio (FCR). [14] noted no change in FI and FCR of 20-week-age laying hens received diets containing 2.5-10% SOYO. [20] recorded no significant effect of adding 3% SO to hens' diets. [30] stated that adding omega oils to poultry diets enhances performance through enhancing feed and energy utilization. According to [27], the digestibility of lipids increases as the degree of unsaturation increases, hence the reduction in feed consumption could be attributed to the reduction in palpability which attributed to higher digested energy in oils than other feedstuffs. The improvement in FCR by feeding oils is linked to the reduction in feed consumption (Table 2) and the increase (P>0.05) in egg production rate (Table 2). [26] reported that including vegetable oils in poultry feeds enhances positive effects on the metabolic energy and the nutrient absorption. In contrast, [24] concluded no impact of dietary FAs saturation on feed utilization of laying hens.

Table 2: Impact of different dietary levels of soybean oil on the productive performance through 3-4 months of age of Japanese quail

Items	Dietary soy oil levels			Sig.
	0.0 % (Control)	0.5 %	1.0 %	
Egg Weight (g)	12.81 ± 0.306	12.95 ± 0.058	13.51 ± 0.283	0.179
Egg Production rate (%)	80.97 ± 2.448	82.87 ± 0.432	87.66 ± 1.388	0.067
Egg Mass (g/bird/day)	10.39 ± 0.562	10.73 ± 0.070	11.85 ± 0.439	0.102
Feed Consumption (g/bird/day)	33.47 ± 0.342^{a}	33.38 ± 0.468^{a}	31.59 ± 0.234^{b}	0.017
FCR (g feed / g gain)	3.240 ± 0.168^{a}	3.111 ± 0.030^{a}	2.672 ± 0.077^{b}	0.022

Means in the same row bearing different letters are significantly different (P≤0.05).
FCR: Feed conversion ratio

3.2. Egg quality traits

Table 3 shows the effect of including different levels of SOYO in mature quail diets on egg quality traits during 3-4 months of age. There were no significant differences among all experimental groups in all studied egg quality traits including: egg weight (P=0.635), egg shape index (P=0.714), yolk relative weight (P=0.308), albumen relative weight (P=0.516), shell relative weight (P=0.581), shell thickness (P=0.768), yolk index (P=0.470), and Haugh units (P=0.640). This insignificant effect could be attributed to the short-term oil treatment, or to the low dose of oil inclusion. Several studies affirmed this effect and indicated that using vegetables oils (including SOYO) in poultry diets had no significant impact on egg quality traits [19,20,31,33]. [34] discovered no significant variations in eggshell index, eggshell strength, or eggshell thickness due to the inclusion of either SOYO, lard, or mixed oils at levels of 1.5 or 3% in layers' diets. While Haugh unit was significantly decreased in SOYO -treated groups than the control group. [22] indicated that using 1% linseed oil in layers feeds significantly increased Haugh unit, with insignificant variations with using SOYO or sunflower oil. In contrast, [21] showed significant improvements due to including SOYO in broiler Breeder diets in the egg shape index, normal eggs for hatching, the percentage of broken eggs and intact eggs, yolk index, albumin: yolk ratio, Haigh unit, yolk color, egg shell strength, and egg shell thickness. The inconstant results among these studies could be related to the differences in genetic and environmental factors, as well as oil inclusion dose and manner.

Table 3: Impact of different dietary levels of soybean oil on the egg quality through 3-4 months of age of Japanese quail

Items	Dietary soy oil levels			Sig.
	0.0 % (Control)	0.5 %	1.0 %	
Egg Weight (g)	13.59 ± 0.427	13.14 ± 0.281	13.36 ± 0.208	0.635
Egg Shape Index (%)	77.27 ± 0.651	77.88 ± 1.345	76.82 ± 0.345	0.714
Yolk Weight (%)	30.72 ± 0.514	31.73 ± 0.594	30.79 ± 0.189	0.308
Albumen Weight (%)	56.38 ± 0.816	55.76 ± 0.357	56.76 ± 0.495	0.516
Shell Weight (%)	12.89 ± 0.358	12.51 ± 0.240	12.44 ± 0.332	0.581
Shell Thickness (mm)	0.276 ± 0.010	0.275 ± 0.009	0.268 ± 0.006	0.768
Yolk Index (%)	44.94 ± 1.155	43.53 ± 1.185	45.52 ± 0.961	0.470
Haugh unit	96.76 ± 0.666	96.07 ± 0.440	96.41 ± 0.325	0.640

4. Conclusion

In conclusion, despite the non-significant effect of adding SOYO to a mature quail diet on laying performance and egg quality, the use of higher levels of SOYO may be capable of improving egg production indices and feed utilization. In addition, the longer term of manipulation may have more noticeable effects.

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