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Evaluating the Consequences of Sesame and Sunflower Meal as Partial Replacements for Soybean Meal on Broiler Growth

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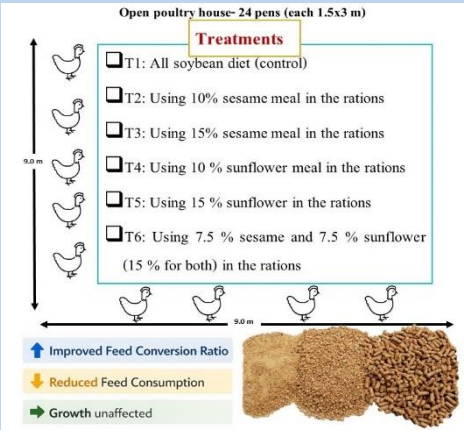
Abstract: The rising cost of animal feed necessitates the search for affordable and sustainable alternatives. In this context, sunflower and sesame meal are considered promising substitutes for soybean meal. Accordingly, this study aims to evaluate the impact of replacement of soybean meal with different levels of sesame and sunflower meals on broiler performance. A total of 960 one-day-old Ross chicks were randomly distributed to six dietary treatments: a control, 10% sesame meal, 15% sesame meal, 10% sunflower meal, 15% sunflower meal, and 15% combined sesame and sunflower meal, with four replicates per treatment. All diets were isonitrogenous and isocaloric. Results indicated that diets containing 10% and 15% sesame meal significantly improved feed conversion ratio (FCR) without affecting body weight (BW), weight gain (WG), mortality, or dressing percentage. However, feed consumption (FC) was significantly lower than in the control diet. The 10% sunflower meal diet did not significantly impact performance, while the 15% sunflower meal diet increased BW. The combined 15% sesame and sunflower meal diet improved FCR without negatively affecting performance. These findings suggest that sesame and sunflower meals can be viable alternatives to soybean meal in broiler diets.



Keywords: Sesame meal, Sunflower meal, Broiler, Alternative protein sources, Sustainable animal feed.

Introduction

The market for poultry meat products has risen in recent decades due to heightened awareness of their nutritional benefits and cost-effectiveness relative to red meat. Poultry meat has high protein content and low fat content, making it a nutritious choice**.** To meet increasing demand for chicken meat, it is essential to optimize feed efficiency by providing energy- and protein-rich sources. Soybean meal, a primary poultry feed ingredient, contains 44–48% protein and essential amino acids necessary for broiler growth [1, 2].

The price of grains has a significant impact on the cost of producing animal feed. The primary ingredient in feed formulation, soybean meal, accounts for around 70% of the total cost. This has led the industry to search for less expensive and similar-quality soybean alternatives [such as sunflower meal, canola and rapeseed meal, cottonseed meal, peanut meal, lupin seeds, *Capsicum Annuum* L. powder and faba beans] [3, 4]. In this regard, a number of agricultural byproducts have been studied as potential replacements or alternatives to soy products [5, 6].

Both sunflower meal and sesame meal are byproducts of oil extraction from sunflower and sesame seeds, respectively. Sunflower meal has a comparatively high residual lipid content, which makes it a useful source of protein and energy [7]. Thus, sunflower cake may be used as a soybean alternative. The growth performance of animals may be impacted by the anti-nutritional elements included in sunflower meal, such as chlorogenic acid. While looking into alternatives, this factor should be considered.

With about 45% crude protein and several important amino acids, sesame meal is a valuable vegetable protein source. But one of the most important amino acids, lysine, is lacking. To improve the level of lysine, sesame meal is usually combined with soybean meal [high in lysine] [8, 9]. Similar to sunflower cake, sesame meal includes phytic and oxalic acids, which are antinutritional factors [10], despite being cheap and often used as animal feed.

The production of broilers in Palestine has increased significantly during the past 20 years. The price of feed is one of the main issues facing Palestinian farmers. Most of poultry ration ingredients are imported. Alternative feed ingredients sources need to be investigated to lower manufacturing costs. Growing production costs necessitate the adoption of more affordable and effective components for the manufacture of balanced feed.

Globally, protein sources are becoming more limited, and it is becoming the most expensive ingredients in poultry feed [11, 12]. Soybean meal [SBM] is an important source of protein for poultry diets [13]. However, because of growing costs, additional feed components are required to create a balanced and economical diet [14].

Both sunflower meal and soybean meal are readily accessible locally and might partially replace imported soybean meal as the plant protein source in broiler diets. It was found that

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sesame meal has around 43% crude protein [CP] and 2210 kcal/kg metabolizable energy (ME) [14, 15].

Sesame meal and sunflower meal are deficient in lysine [16, 17]. It was found that sesame meal may substitute about 15% of soybean meal in broiler feed with accepted growth performance [18]. Due to variations in cultivars and processing techniques, results on the usage of sunflower seed and meal varied significantly between nations and regions. Several variables influence the chemical composition of sunflower seed oil, including the protein and amino acid content, seed variety, peeling extent, extraction method, and thermal treatment during oil extraction [5, 6].

A study conducted in Jordan examined the challenges faced by broiler farmers that affect the viability and profitability of their production systems. The most significant issues were found to be administrative and financial limitations, especially the high prices of fuel, power, and feed [19]. These conditions are like the Palestinian context.

Thus, the main goal of this study was to investigate how broiler performance is affected when varying amounts of sunflower or sesame meal are substituted for soybean meal in the broiler feed.

Materials and Methods

Rearing conditions

An open poultry house with 24 identical pens, each measuring 1.5 x 3 meters, was used to conduct the experiment. Every pen has a bell-shaped waterer and a feed trough. This experiment was carried out in Tulkarm (June to July 2023), Palestine, at the Deir Elgusun chicken farm. This farm served as the site of the experiment. The density of the birds was ten birds per square meter. There was unlimited access to food and water and commercial house management procedures were followed. Males and females of the commercial line *Ross*, one-day-old broiler chicks, were used in the trials. In the broiler farm's open house, the chicks were raised to 42 days of age after being purchased from nearby commercial hatchers.

A total of 960-day-old commercial broilers were randomly assigned to six treatments. There were 40 chicks in each of the four replicates.

The six experimental treatments were:

T1: All soybean diet (control)

T2: Using 10% sesame meal in the rations

T3: Using 15% sesame meal in the rations

T4: Using 10 % sunflower meal in the rations

T5: Using 15 % sunflower in the rations

T6: Using 7.5 % sesame and 7.5 % sunflower (15 % for both) in the rations from 1 to 21 days of age, the chicks were fed a starter diet; from 22 to 42 days, they were fed a finisher diet. According to NRC guidelines, all diets were isocaloric and isonitrogenous [15].

When the chicks arrived at the farm, they were all weighed. Weekly measurements were made of live body weight, weight gain, feed intake, feed conversion ratio, and mortality rate.

The chemical composition of the starter and the finisher feeds are shown in Table 1 and Table 2, respectively

Table (1): The chemical composition of broiler feed in starter phase.

Ingredient	T1	T2	T3	T4	T5	T6
	Control %	10% Sesame Meal	15% Sesame Meal	10% Sunflower Meal	15% Sunflower Meal	15 % for Both
Yellow Corn	57.63	59.20	59.62	51.01	47.72	54.18
Soybean Meal	38.50	27.90	22.70	32.50	29.60	25.90
Sesame Meal	-	10	15	-	-	7.5
Sunflower Meal	-	-	-	10	15	7.5
Oil	0.48	-	-	2.90	3.90	1.80
DCP	1.65	1.60	1.45	1.65	1.70	1.63
Methionine	0.19	0.10	0.06	0.019	0.35	0.17
Lysine	-	0.09	0.18	-	0.02	0.11
Limestone	1.10	0.65	0.53	1.30	1.20	0.75
NaCL	0.30	0.30	0.30	0.30	0.30	0.30
Vitamins and Minerals	0.10	0.10	0.10	0.10	0.10	0.10
Coccidiostat	0.05	0.05	0.05	0.05	0.05	0.05
Chemical composition						
Crude Protein %	22.01	22.04	22.05	21.98	22.01	21.96
Metabolizable Energy (kcal/kg)	2900	2873	2881	2895	2894	2886
Crude Fiber %	3.95	4.84	5.87	5.79	6.60	5.90
Calcium %	0.90	0.90	0.90	0.90	0.90	0.90
Available Phosphorus %	0.45	0.45	0.45	0.45	0.45	0.45
Methionine and Cystine %	0.90	0.90	0.90	0.90	0.90	0.90
Lysine %	1.10	1.10	1.10	1.10	1.10	1.10

Essential vitamins (A, D, E, K, B-complex) and trace minerals (Zn, Fe, Cu, Mn, Se, I) are included in the vitamins and minerals premix. Coccidiostat is included to prevent coccidiosis. Optional Additives: Depending on the needs of health management, antifungal medicines, antiworm, or other growth stimulants may be added.

Table (2): The chemical composition of broiler feed in finisher phase.

Ingredient	T1	T2	T3	T4	T5	T6
	Control %	10% Sesame Meal	15% Sesame Meal	10% Sunflower Meal	15% Sunflower Meal	15 % for Both
Yellow Corn	62.62	64.12	64.25	57.95	53.57	58.88
Soybean Meal	32.78	22.20	17	26.50	23.80	20.50
Sesame Meal	-	10	15	-	-	7.50
Sunflower Meal	-	-	-	10	15	7.5
Oil	1.53	1	1.20	3	4.50	3
DCP	1.15	1.10	1.10	1.15	1.20	0.65
Methionine	0.06	-	-	-	0.03	0.01
Lysine	-	0.12	0.21	0.02	0.06	0.12
Limestone	1.40	1	0.78	0.92	1.38	1.38
NaCL	0.30	0.30	0.30	0.30	0.30	0.30
Vitamins and Minerals	0.10	0.10	0.10	0.10	0.10	0.10
Coccidiostat	0.05	0.05	0.05	0.05	0.05	0.05
Chemical composition						

Ingredient	T1	T2	T3	T4	T5	T6
	Control %	10% Sesame Meal	15% Sesame Meal	10% Sunflower Meal	15% Sunflower Meal	15 % for Both
Crude Protein %	19.93	19.95	19.93	19.95	19.99	20.00
Metabolizable Energy (kcal/kg)	3023	3009	3026	3015	3023	3039
Crude Fiber %	3.65	4.53	4.95	5.80	6.04	5.70
Calcium %	0.90	0.90	0.90	0.90	0.90	0.90
Available Phosphorus %	0.35	0.35	0.35	0.35	0.35	0.35
Methionine and Cystine %	0.72	0.72	0.72	0.72	0.72	0.72
Lysine %	1	1	1	1	1	1

Chemical composition of sesame and sunflower meal

The AOAC standard procedures were used to establish the approximate composition of sesame meal and sunflower meal. The Kjeldahl method (N × 6.25) was used to measure the crude protein, Soxhlet solvent extraction was used to identify the crude fat, sequential acid–alkali digestion was used to assess the crude fiber, and incineration in a muffle furnace was used to estimate the ash content [20]. The following accepted methods were used to conduct the analyses:

Crude Protein: The Kjeldahl technique, which calculates the sample's total nitrogen concentration, was used to quantify crude protein. To determine crude protein, the nitrogen amount is then multiplied by the standard conversion factor, which is typically 6.25. This process involves the material being carefully digested, nitrogen being converted to ammonium, and measurement by titration utilizing lab apparatus.

Fat content: The Soxhlet technique (a solvent extraction method) was used to measure crude fat. In this process, the lipids are dissolved by exposing the dried sample to an organic solvent. To calculate the total crude fat content, the solvent is evaporated after many extraction cycles, and the residual fat is weighed.

Total crude fiber: The sample was successively treated with solutions that mimic the digestion of non-fiber components to measure the amount of crude fiber. Following these carefully regulated digestive processes, the residue is dried, weighed, and ashed. The crude fiber content is shown by the weight loss following ashing. This technique calculates the amount of plant fibre, such as cellulose and lignin, that cannot be digested.

Crude Ash content: To obtain crude ash, a known quantity of sample was burned at a high temperature in a muffle furnace until all organic matter was burned. The concentration of crude ash is represented by the inorganic mineral residue that remains after cooling.

Growth performance

Body weight and feed intake

Weekly measurements of body weight and feed intake were made, and feed conversion and body gain were computed. The consumption rate of the feed was expressed as intake (grams/bird/week) and it was calculated for all treatment on weekly basis. After each week, the weight of the remaining feed was recorded and subtracted from the initial phase. The amount of feed consumed was divided by the number of birds.

The broilers were weighed at the start of the experiment and every week. Ten birds were randomly selected from each replicate and weighed. The weight gain in the live birds was calculated by the differences in the body weights between the beginning and the end of the week.

Feed conversion ratio

The feed conversion ratio (grams feed/gram gain) was computed weekly as the quantity of feed ingested per unit of body weight increase (average weekly feed intake (g)/average weekly weight gain (g)).

Dressing, Giblets and Fat pad percentage

Ten birds were chosen at random from each replication in a treatment, and they were killed at the end of the experiment to determine the dressing percentage. In accordance with ethical and animal-welfare standards, birds chosen for carcass examination were killed using the halal neck-cut procedure. To guarantee quick unconsciousness and appropriate bleeding, each bird was carefully confined before being killed by a trained individual by severing the main blood veins in the neck. Both regular poultry processing techniques and halal criteria are satisfied by this procedure.

Carcasses were analyzed to determine the dressing % once bleeding had stopped. The hot carcass weight, which was obtained just after slaughter and full bleeding, prior to any cooling, was used to determine the dressing %. This method reflects the carcass mass at the time of processing and prevents weight loss from cooling.

Prior to slaughter, each bird was weighed and individually numbered.

Dressing% (1), giblets% (2) and fat pad% (3) were then measured as follows:

$$\text{Dressing\%} = \frac{\text{Carcass weight}}{\text{Live weight}} * 100 \quad (1)$$

$$\text{Giblets\%} = \frac{\text{Liver +gizzard+ heart weight}}{\text{Live weight}} * 100 \quad (2)$$

$$\text{Fat Pad\%} = \frac{\text{Fat Pad weight}}{\text{Live weight}} * 100 \quad (3)$$

Statistical analysis

The data were analyzed by ANOVA using the linear model procedures (SAS Institute Inc., Cary, NC, USA; version 9.1) to determine the effect of diets on feed intake, body weight, weight gain, feed conversion, mortality and dressing percentage. Means were separated using the least significant difference (LSD) test at a significance level of $P < 0.05$ when significant differences were found.

Results and Discussion

The results for the proximate composition of sesame meal and sunflower meal are shown in Tables 3 and 4, respectively. Local sesame meal and National Research Council (NRC) had almost similar crude protein compositions (46.9% vs. 48%) [15]. Our results agreed with previous data regarding protein content. Capellini *et al*. [8] reported that the crude protein content was 45%. The crude fiber content of local sesame meal was higher than that reported by the NRC [15]. Regarding crude fat content, similar findings were observed. The values recorded in the present study differed from those reported by NRC [15] which may be attributed to variations in oil extraction methods that influence the chemical composition of sesame meal [21].

Table (3): Chemical composition of the local sesame meal compared to NRC [15].

	Local sesame meal (on dry matter basis)	Sesame meal in NRC (on dry matter basis)
Crude protein %	46.9	48.6
Crude fiber %	16.1	7.7
Crude fat %	30.4	7.2
Ash %	6	NA

The chemical composition of local sunflower meal was found to be similar to that reported by the NRC [15]. Our findings were consistent with Sredanovic *et al*. [22], who reported that sunflower meal had a protein level of 30–34%. The amount of crude fiber varied from study to study. Senkoylu and Dale [23] discovered that fiber content in sunflower meal has around 11.5%.

Table (4): Chemical composition of the local sunflower meal compared to NRC [15].

	Local sunflower meal (on dry matter basis)	Sunflower meal in NRC 1994 as (dry matter basis)
Crude protein %	31.2	35.5
Crude fiber %	32.1	26.6
Crude fat %	1.5	1.2
Ash %	7.1	NA

The average body weights of broilers during six weeks of the rearing period for all treatments are shown in Table 5. Overall, the impact of the inclusion of sesame and sunflower meal in broiler diets on body weights were varied according to inclusion level, age, and type of meal. At the end of rearing period (week six), the addition of sesame meal to broiler feed led to a slight reduction in the body weight of the bird compared to control treatment. On the other hand, inclusion of sunflower meal at level 15% increased body weight compared to control. The effect of sesame meal on the bird weights were varied according to the age and the level of inclusion.

Aftab [24] studied the effect of various oilseed meal combinations with exogenous enzyme supplementation in broiler feed. The results showed that broiler fed with feed containing sunflower meal exhibited significantly higher gain in body weight and a lower feed conversion rate than those fed feed based on rapeseed meal or cottonseed meal.

In general, the results showed the body weight of the birds fed the 10% and the 15% sesame meal diets was comparable with the soybean meal control diet at most ages of the experiment, especially at weeks 1, 3, 5, and 6. It was found that birds fed with a 15% diet showed the lowest body weight, but the difference was not significant compared to the control diet. Moreover, Pan *et al*. [25] found that increasing the level of inclusion from 0% to15% of sesame meal from 1 day to 4 weeks, showed lower weights at higher inclusion but 0-21.5% sesame meal from 4 to 8 weeks showed no difference in (BW).

Feeding the diet containing 10% sunflower meal showed in general comparable average body weight at all ages with the control diet. These results disagreed with those obtained by Sherif *et al*. [26] who found that substituting soybean meal with sunflower meal in broiler feed at levels 5, 10, 15, and 20% had no impact on body weight.

Current research confirms previous findings that, when diets are well balanced, broiler growth performance is not negatively impacted by partially substituting sunflower meal for soybean meal. According to Munawar *et al*. [27], body weight growth, feed intake, and feed conversion ratio did not significantly change when up to 20% sunflower meal was substituted; nevertheless, digesta viscosity rose with greater inclusion; these effects were mitigated using non-starch polysaccharide (NSP) degrading enzymes. Similarly, Yaqoob *et al*. [28] discovered that substituting 3–9% sunflower meal for soybean meal, together with a multienzyme supplement, enhanced ileal crude protein digestibility at lower inclusion levels and had no discernible effect on broiler body weight or growth performance.

The effects of varying amounts of sunflower meal and a combination of the enzymes endoxylanase and B-glucanase on the performance of broilers, the quality of their carcasses, the growth of their gizzards, and the viscosity of their digesta were investigated by Amerah *et al*. [29]. During the starter phase, the birds were fed 0, 5, and 6% `SFM; during the grower/finisher stage, they were fed 0, 8, and 12% SFM. Compared to birds fed the medium and low SFM treatments, those fed the high SFM treatment gained less body weight. Rama Rao *et al*. [30] examined the effect of substituting soybean meal by sesame meal on growth performance. The study showed that substituting 67% of the soybean meal with sesame meal had no impact on body weight and feed efficiency.

Table (5): Body weight (g/bird) for broilers fed the different diets during the experimental period (weekly measurements).

Treatment	Week 1 Mean±SD*	Week 2 Mean±SD	Week 3 Mean±SD	Week 4 Mean±SD	Week 5 Mean±SD	Week 6 Mean±SD
Control	116.0^{ab} 2.8±	319.2^{ab} 4.9±	639.0^{ab} 15.5±	1101.2^{c} 10.6±	1535.0^{b} 48.7±	2022.3^{bc} 30.6±
10 % sesame meal	116.7^{ab} 3.2±	319.2^{ab} 7.3±	658.5^{a} 4.7±	1153.5^{ab} 14.5±	1568.2^{ab} 22.0±	2062.5^{abc} 1.0±
15 % sesame meal	110.7^{b} 2.7±	296.5^{c} 3.1±	628.0^{a} 5.8±	1111.7^{b} 2.9±	1507.5^{b} 16.52±	2037.5^{bc} 29.5±
10 % sunflower meal	113.5^{ab} 1.3±	314.2^{ab} 5.9±	661.2^{a} 15.5±	1106.5^{ab} 17.1±	1567.5^{ab} 31.4±	1995.0^{c} 23.2±
15 % sunflower meal	120.2^{a} 1.7±	328.5^{a} 5.7±	660.2^{a} 12.1±	1156.7^{a} 18.08±	1632.0^{a} 6.61±	2117.5^{a} 36.6±
15 % of both sesame and sunflower meal	113.2^{ab} 3.7±	305.0^{bc} 7.1±	654.7^{a} 10.2±	1107.5^{ab} 13.2±	1572.5^{ab} 16.5±	2087.5^{ab} 4.7±

*SD: Standard Deviation

The mean values within the same column that have different superscript letters are significantly different (P<0.05).

The average weekly weight gains for all diets at the different ages are shown in Table 6. The results of 10% sesame meal showed no significant differences in the average weekly weight gain (WG) at all ages compared to the control diet. The results of the 15% sesame meal ration also showed no significant weekly weight gain (WG) at all ages compared to the control diet. These results agreed with that obtained by Mamputu and Buhr [31], who found that broiler fed with feed containing sesame meal up to 15% was not different weight gain from broiler fed with feed containing soybean meal.

As for sunflower meal, WG for the 10 and 15% levels of inclusion in the diets showed comparable results with the all soybean control diets for all ages. These results agreed with Cheva-Isarakul and Tnqtaweewipat [32], who found that birds fed sunflower seed diets gained more weight than bird in the control group. This mean that improving the nutritive value of sunflower meal gives better (WG) compared to control diet.

Furlan *et al*. [33] showed a significant enhancement in the weight gain and feed intake when sunflower meal was included

in the feed as partial replacement with soybean meal. The result of feeding the diet of 15% of both sunflower and sesame meal showed that WG at all ages were comparable with those on the control diet. This may be explained by the phenomenon of mixing different sources of plant proteins will complement the amino acids found in each source.

In a thorough investigation of enzyme and lysine supplementation on broiler diets with either 20% or 30% sunflower meal, Mushtaq *et al*. [34] came to the conclusion that adding enzymes to diets with low nutritional density and high SFM had a favorable effect. Alagawany *et al*. [35] conducted the most current evaluation of sunflower meal and came to the conclusion that it is a suitable addition to chicken diets, with 25% of broiler and 20% of layer rations being given this meal.

Supplementing with enzymes increased feed conversion but did not reverse the decrease of weight gain brought on by a high SFM inclusion rate. The effects of enzyme supplementation on broiler diets that include SFM instead of SBM was further investigated by [36]They found that if an appropriate enzyme (Microzyme) is added; 35% of SBM may be substituted with SFM.

Table (6): Average weekly weight gain (g/bird) for broilers fed the different diets during the experimental weeks.

Week Treatment	Week 1 Mean±SD	Week 2	Week 3 Mean±SD	Week 4 Mean±SD	Week 5 Mean±SD	Week 6 Mean±SD
Control	120.1^{a} 6.2±	349.3^{a} 6.2±	801.7^{a} 16.7±	929 .1^{a} 18.4±	1038.8^{bc} 17.4±	1131.3^{a} 24.2±
10 % sesame meal	114.4^{c} 1.9±	300.2^{b} 6.6±	498.7^{b} 17.8±	732.6^{b} 13.6±	963.4^{bc} 11.8±	1044.3^{a} 17.3±
15 % sesame meal	115.2^{bc} 9.0±	280.1^{b} 16.6±	485.2^{b} 13.2±	716.7^{b} 33.3±	936.0^{c} 36.9±	1085.9^{a} 76.2±
10 % sunflower meal	118.5^{ab} 0.9±	331.3^{a} 11.1±	744.5^{a} 38.5±	899.5^{a} 40.1±	1186.0^{a} 87.5±	1167.5^{a} 11.1±
15 % sunflower meal	118.5^{ab} 1.0±	337.0^{a} 8.5±	733.9^{a} 36.8±	857.0^{a} 42.8±	1077.2^{ab} 27.2±	1122.4^{a} 37.9±
15 % of both sesame and sunflower meal	116.6^{bc} 1.2±	292.9^{b} 10.8±	519.0^{b} 31.3±	722.8^{b} 32.2±	957.1^{bc} 30.3±	1059.1^{a} 40.4±

*SD: Standard Deviation
The mean values within the same column that have different superscript letters are significantly different (P<0.05)

The average weekly feed consumption (FC) for all diets at the different ages is shown in Table 7. Feeding the diet contained 10% and 15% sesame meal showed a significant decrease in the average weekly (FC) during weeks 1, 2, 3, and 4 compared to the control diet, while during weeks 5 and 6, the differences were not significant. These results do not agree with those obtained by Mamputu and Buhr [31], who found that the FC of chicken birds fed the feed containing sesame meal at 15% were different than birds fed with soybean feed.

The 10% and 15% level of sunflower meal in the diet showed insignificant differences in general on average weekly (FC) at all ages compared to the control diet. These results agree with that obtained by Sherif *et al*. [26] who found no significant differences in (FC) when feeding sunflower to chicks.

Using 15% of both sunflower and sesame meal in the diet showed a significant decrease from weeks 1 to 4 in average weekly (FC) compared to control diet. Rahimian *et al*. [37] investigated the impact of supplementing broiler diets with sesame meal and the phytase enzyme. They discovered that adding enzymes to sesame meal increased feed intake but had no effect on feed conversion. According to Mahmoud *et al*. [38], broilers fed varying amounts of roasted sesame husks for up to 42 days showed growth improvements of up to 12% as compared to the corn-soybean-based diet. The quality of the meat and carcass traits were unchanged and were comparable to the control.

Table (7): The consumption rate (g/bird) of the feed for birds fed the different types of feed during the experimental time.

Treatment	Week 1 Mean±SD	Week 2	Week 3 Mean±SD	Week 4 Mean±SD	Week 5 Mean±SD	Week 6 Mean±SD
Control	78.0^{ab*} 2.8±	203.2^{ab} 6.6±	319.7^{a} 15.7±	462.2^{bc} 5.0±	433.7^{ab} 44.1±	487.5^{ab} 29.5±
10% sesame meal	78.7^{ab} 3.2±	202.5^{ab} 7.3±	339.2^{a} 3.4±	495.0^{ab} 10.3±	414.7^{ab} 10.3±	494.2^{ab} 22.7±
15% sesame meal	72.2^{b} 2.7±	185.7^{b} 2.0±	331.5^{a} 5.3±	483.7^{abc} 7.5±	395.7 b 15.4±	530.0^{a} 41.0±
10% sunflower meal	75.5^{ab} 1.3±	207.7^{ab} 5.4±	347.0^{a} 15.8±	448.2^{c} 17.1±	458.0^{ab} 19.7±	427.5^{c} 13.1±
15% sunflower meal	82.2^{a} 1.7±	208.2^{a} 6.9±	330.0^{a} 7.6±	511.5^{a} 14.6±	475.2^{a} 20.9±	485.5^{ab} 33.2±
15 % of both sesame and sunflower meal	75.2^{ab} 3.7±	191.7^{ab} 4.5±	349.7^{a} 8.1±	452.7^{c} 6.4±	465.0^{ab} 10±	515.0^{a} 18.4±

The mean values within the same column that have different superscript letters are significantly different (P<0.05).

The average weekly feed conversion ratio (FCR) for the different diets at the different ages is shown in Table 8. The results when including 10% sesame meal in the diet showed improved weekly (FCR) at all ages, but the improvement was significant only for weeks 2, 3, and 4 compared to the control diet. Using 15% sesame meal showed that the average weekly FCR was not significantly different at weeks 1, 2, 5, and 6 compared to the control diet. These results showed that using sesame meal at levels of 10% and 15% of the diet improves (FCR) compared to feeding an all-soybean diet. These results agree with those obtained by Mamputu and Buhr [31], who revealed that FCR for birds fed with feed containing sesame meal were similar to the FCR for control birds.

Feeding 10% sunflower meal showed that average weekly (FCR) was better for all ages and significant in week 3 which showed significant improvement compared with all soybean control diet. Using 15% sunflower meal in the diet showed that the average weekly (FCR) was not significantly different for all ages except in week 4. The result using the diet with 15% of both sesame and sunflower meal showed improved weekly (FCR) at all ages, but the improvement was significant only for weeks 3, 4, and 5.

Table (8): Feed conversion ratio (kg feed/kg live weight gain) for birds fed the different types of feed during the experimental time.

Week Treatment	Week 1 Mean±SD	Week 2	Week 3 Mean±SD	Week 4 Mean±SD	Week 5 Mean±SD	Week 6 Mean±SD
Control	1.5a 0.1±	1.7a 0.1±	2.5a 0.1±	2.0a 0.1±	2.4a 0.2±	2.3ab 0.1±
10 % sesame meal	1.4a 0.1±	1.4b 0.1±	1.4c 0.1±	1.4b 0.1±	2.3ab 0.1±	2.1b 0.1±
15 % sesame meal	1.5a 0.1±	1.5ab 0.1±	1.4c 0.1±	1.4b 0.1±	2.3ab 0.1±	2.0b 0.1±
10 % sunflower meal	1.5a 0.1±	1.6ab 0.1±	2.1b 0.1±	2.0a 0.1±	2.5a 1.3±	2.7a 0.1±
15 % sunflower meal	1.4a 0.1±	1.6ab 0.1±	2.2ab 0.1±	1.6b 0.1±	2.2ab 0.1±	2.3ab 0.1±
15 % of both sesame and sunflower meal	1.5a 0.1±	1.5ab 0.1±	1.4c 0.1 ±	1.5b 0.1±	2.0b 0.1±	2.1b 0.1±

The mean values within the same column that have different superscript letters are significantly different (P<0.05).

The average carcass, giblets and fat pad % for broilers fed the different diets is shown in Table 9. The 10% and 15% of sesame meal diets did not affect dressing, giblets, and fat pad % for broiler chicks. Replacing 10% sunflower meal showed no significant differences in dressing and giblets compared to the control diet, but there was a higher and significant difference in fat pad compared to control diet. These results don't agree with that obtained by Sherif *et al*. [26], who found that there were significant differences among treatments in giblets% but the differences in carcass and abdominal fat % were not significant.

Using 15% sunflower meal or 15% for both sunflower and sesame meal showed no significant difference in dressing, giblets, and fat pad compared to the control diet.

Sesame meal (SM) and sunflower meal (SFM) have been identified as viable partial alternatives for traditional soybean meal in recent studies on alternative protein sources for broiler diets, with implications on growth performance, nutrient utilization, and carcass characteristics. The significance of mineral–enzyme interactions in SM-based diets was highlighted by a 2024 study [39] that examined the substitution of sesame meal for soybean meal at 0%, 10%, and 20%. It found that inclusion levels above 10% generally impair growth performance, but that performance could be improved by increasing dietary calcium and supplementing phytase. Furthermore, broiler body weight gain and feed conversion were markedly increased by dietary supplementation with sesame meal bioactive peptides and essential oils, indicating possible advantages for gut health and performance beyond the contribution of crude protein [40]. Research on sunflower meal has also shown that, when dietary fiber levels and enzyme supplements are considered, it can be a cost-effective source of protein. Although nutrient digestibility varied with fiber concentration, a 2026 study shown that broilers fed diets containing up to 30% SFM (both high- and low-fiber forms) exhibited equivalent production performance to control, underscoring the necessity of taking fiber effects into consideration in formulation [41]. Furthermore, substituting up to 50% of soybean meal with SFM improved growth performance and increased digestive enzyme activity, according to study on graded inclusion of SFM with exogenous enzymes. This suggests that enzyme addition can somewhat alleviate the drawbacks of high-fiber diets [42]. To maximize performance and nutrient absorption, these studies collectively recommend the strategic use of sesame and sunflower meals in broiler diets, if inclusion levels, fiber content, and additional enzymes/minerals are carefully handled.

Table (9): Average Carcass, Giblets and Fat pad % for broilers fed the different diets during the experimental weeks.

Treatment	Carcass %	Giblets %	Fat pad %
Control	76.0 ^{a} 0.7±	4.1 ^{ab} 0.1±	1.3 ^{bc} 0.1±
10 % sesame meal	75.6 ^{a} 0.7±	4.8 ^{ab} 0.1±	1.3 ^{c} 0.1±
15 % sesame meal	76.3 ^{a} 0.5±	5.0 ^{a} 0.1±	1.7 ^{abc} 0.1±
10 % sunflower meal	76.3 ^{a} 0.5±	4.7 ^{ab} 0.1±	1.8 ^{a} 0.1±
15 % sunflower meal	75.5 ^{a} 0.3±	4.4 ^{b} 0.1±	1.6 ^{abc} 0.1±
15 % of both sesame and sunflower meal	76.3 ^{a} 0.4±	4.7 ^{ab} 0.1±	1.7 ^{ab} 0.1 ±

The mean values within the same column that have different superscript letters are significantly different (P<0.05).

Conclusions

The current study showed that under open poultry house settings, sesame meal (SM) and sunflower meal (SFM), either separately or in combination, can be used as partial substitutes for soybean meal in broiler diets without negatively impacting growth performance. There were no negative impacts on final body weight, weight growth, or overall productivity at inclusion levels up to 15%.

Crucially, improved feed conversion ratio (FCR), which indicates increased feed usage efficiency, was linked to certain inclusion levels. Furthermore, in certain treatment groups, feed intake was either kept constant or significantly decreased without affecting growth, indicating increased nutrient use efficiency. There were no detrimental effects on overall performance metrics or flock uniformity.

These results demonstrate that sunflower and sesame meals are practical, accessible, and financially advantageous substitutes for soybean meal. under chicken production systems, their utilization can help lower feed costs, improve sustainability, and lessen reliance on imported protein sources, especially when raised under the region's typical open-house circumstances. To optimize the nutritional and financial advantages of these alternative protein sources, more study may concentrate on improving amino acid balancing techniques and assessing long-term carcass and meat quality characteristics.

Disclosure Statement

- **Ethics approval and consent to participate:** Not applicable
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- **Availability of data and materials:** All relevant data to the results of this study were presented in the manuscript
- **Author's contribution:** The authors confirm contribution to the paper as follows: study conception and design: Iyad B and Samer M, theoretical calculations and modeling: Iyad B and Samer M; data analysis and validation, Iyad B and Samer M., draft manuscript preparation: Iyad B and Samer M. All authors reviewed the results and approved the final version of the manuscript.
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