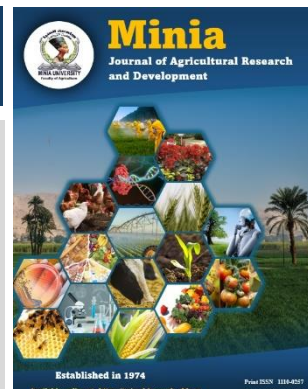




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Using of fennel seeds (*Foeniculum vulgare*) as feed additives in broiler chick diets

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ABSTRACT

The current study set out to determine how broiler chicks' development performance and economic efficiency would be affected by the addition of fennel seed powder as a natural feed supplement. One hundred eighty Arbor-Acres broiler chicks, all unsexed, were assigned randomly into four groups, each consisting of three replicates. At 0, 1, 2, and 3%, respectively, the chicks were given ad-libitum starter (1-3 weeks days of age) and grower (4-6 weeks of age) basal diets supplemented with or without fennel seed powder. The results revealed the following: Body weight, weight gain, and ratio of feed conversion of broiler chicks were significantly ($p < 0.05$) improved when powdered fennel seeds at all levels were added to the control diets during all experimental periods. At the beginning of the experiment, broiler chicks' feed consumption increased ($p < 0.05$) by addition fennel seed powder to their diets; however, during the growth and full experimental periods, this increase in feed consumption was negligible ($p > 0.05$).

Keywords: Fennel seeds, Feed additive, growth performance, broiler chicks.

INTRODUCTION

To increase body weight and feed efficiency at marketing age for different chicken species, a variety of nutritive and non-nutritive feed additives are added as growth promoters in poultry production. Since bacterial resistance, chemical residues in meat, and growing consumer health consciousness have made it illegal

to use antibiotics in poultry and animal feeds. When antibiotics were prohibited, bacterial illnesses spread more widely and chicken flocks' feed conversion ratios deteriorated. Finding alternatives to antibiotics in feed is therefore one of the chicken industry's biggest issues. Consumers now demand meat products that are safe, devoid of antibiotic residues,

and have increased production while maintaining the highest possible quality. Therefore, herbal additives have been used in poultry diets due to their minimal expense, simple accessibility, the prevention of bacterial resistance in consumers and no harmful chemical remains in chicken eggs and meat, vice versa in antibiotic growth promoters. Because of its ability to enhance chicken performance and cost-effective feed efficiency at marketing age, fennel (*Foeniculum vulgare* L.), a fragrant herbal plant in the Apiaceae family, has been employed as a natural feed addition in poultry diets. Protein, fats, carbs, fiber, and a greater variety of minerals, trace elements, and vitamins are among the many nutrients included in fennel seeds (Ahmed, 2015). Also, Egyptian fennel seeds contain essential oils limonene (11.45%), estragole (51.04%) and fenchone (8.19%) of the total essential oils (Adel et al, 2019). Therefore, fennel seeds had positive effect on the growth performance of broiler chicks due to its contents of the essential oils and other chemical compounds, which improve the palatability and odour of the feed, the better digestion of nutrients, improved digestive enzymes secretion, eliminating harmful microorganisms in the digestive systems and feed stuff and increased economical efficiency of broiler chicks (Farid et al, 2024).

The use of fennel seeds in broiler chick diets, however, has produced inconsistent results. This is due to a variety of environmental factors, such as the form of herb (seed powder, alcoholic extract or essential oil), the dosage of supplements, the bioactive molecules concentration in the herbs, and the breeding environment (whether or not heat stress is present). Thus, the goal of the current study was to assess how adding varying amounts of powdered fennel seeds, a natural growth enhancer, to the **diets** of broiler chicks would affect both their growth performance and economic efficiency.

MATERIALS AND METHODS

The current study took place at Minia University's Faculty of Agriculture's Animal and Poultry Production Farm between October 14 and November 24, 2022.

Chicks and housing:

A total of 180 unsexed Arbor-acress broiler chicks, were randomly assigned to four groups, each consisting of three replicates (4 groups x 3 replicates x 15 chicks). All chicks were housed on floor pen in an open house previously cleaned and disinfected. The dimension of each pan Was 1.25 x 1.25 m for length and width respectively. The initial weight of the chicks in each treatment was almost the same on average. At 3 and 6 weeks of age, the end of the starting and growing periods, respectively, the chicks in each replicate were weighed to the closest grams. Chicks weight within each replicate was divided by the number of survived chicks to obtain average body weight (gm /bird). Body weight gains were estimated during the periods (1-3, 4-6 and 1-6 weeks of age) by subtracting the initial weight from the final weight within each period (gm/bird).

Experimental diets:

According to **NRC (1994)**, Table (1), a starter and a grower basal diet were developed to satisfy the nutritional needs of broiler chicks. The supplementation of fennel seeds powder was added to starter and grower basal diets at levels of 0%, 1%, 2% and 3% respectively. Fennel seeds were purchased from local market at Minia Governorate, Egypt. After being finely ground in an electric grinder, the fennel seeds were added to starter and grower basal diets as feed supplements. Throughout the duration of the trial, the birds in each replicate had complete access to feed and water.

Amounts of feed consumed in each replicate at starting, growing and whole experimental period were recorded. Averages feed consumption (gm/bird) during each period were calculated as follow: Feed consumption for each replicate (gm) was estimated for the survived chicks in the same replicate.

Feed conversion ratio:

During the beginning, growing, and full experimental periods, feed conversion was estimated as the amount of feed needed to produce one unit of body weight gain (gm feed/gm body weight gain) as follows:

$$\text{Feed conversion ratio} = \frac{\text{Average feed consumption / survived chicks in each period}}{\text{Average body weight gain (gm) / survived chicks in each period}}$$

Hygiene:

Hitchner B1 was used to vaccinate the chicks against New-castle disease at 7 days of age, while Lasota was used at 18 and 28 days. At 10 days of age, chicks were subcutaneous injected with vaccine in the middle region of the back of the neck against New-castle disease and Avian Influenza. Moreover, chicks were vaccinated against Gumboro disease at 12 and 23 days of age.

Cost of diets and economical return:

At the time of preparation this study (2024), the cost of one kg feed for various diets, feed cost/kg weight gain, and the feed cost/bird were determined using the local market's one-kilogram live body weight and feed ingredient prices. The absolute economical efficiency of birds in each treatment was estimated as the revenue per bird as follow: Bird-cost of feed/bird-selling price In comparison to the control treatment's economical efficiency, the relative economical efficiency was computed.

Statistical analysis:

General linear model (GLM) procedure of Statistical Analysis System (SAS, 2006) was used for data

analyses. Duncans multiple range test (Duncan, 1955) were used to separate significant differences among treatments. The Statistical model was used as following:

$$Y_{ij} = \mu + T_i + E_{ij} \quad \text{Where:}$$

Y_{ij} = The experimental observations.
 μ = The overall means.
 T_i = The effect of dietary treatment.
 E_{ij} = The experimental error.

RESULTS AND DISCUSSION

Body weight and body weight gain:

According to the results shown in tables (2) and (3), adding 1%, 2%, and 3% of fennel seeds to broiler chick diets had a highly significant ($p < 0.01$) impact on both body weight and body weight gains at various age intervals (beginning, growing, and entire experimental periods). Body weight and weight gains throughout the beginning (1-3 weeks of age), growing (4-6 weeks of age), and entire (1-6 weeks of age) experimental periods were improved ($p < 0.05$) by adding fennel seeds to broiler chick diets at levels of 1%, 2%, and 3%. During the entire trial period (1-6 weeks of age), the broiler chicks fed diets supplemented with 1%, 2%, and 3% fennel seeds, respectively, showed improvements in body weight of 4.10%, 7.00%, and 7.64% as compared to the unsupplemented control treatment. Additionally, adding 1%, 2%, and 3% of fennel seeds to broiler chick diets increased ($p < 0.05$) body weight gain by 4.19%, 7.16%, and 7.80%, respectively, during the course of the trial (1-6 weeks of age) in compared to the control treatment. Supplementing broiler chicks' diets with fennel seeds led to improvements in their body weight and weight gain, which grew gradually ($p < 0.05$) as the

amount of supplementation increased to 2% fennel seeds. Broiler chicks' body weight and weight gain didn't progressively improve ($p>0.05$) when the amount of powdered fennel seeds supplemented in their diets was increased to 3%. These findings suggest that adding 2% of powdered fennel seeds to broiler chick diets will result in heavier ($p<0.05$) body weight and weight gain for the chicks. Based on these results fennel seed supplementation to broiler chick diets may have improved feed conversion ratios, nutritional digestibility, and feed consumption ($p<0.05$), which may have contributed to the heavier ($p<0.05$) body weight and body weight increases. Additionally, according to **Abdul-Azez (2000)**, the rise in body weight of broilers supplemented with fennel may be attributed to that, some of the essential oils in fennel are stimulants, which encourage the secretion of gastric and digestive juices, thereby reducing intestinal and stomach inflammation and promoting appropriate nutrient absorption. Furthermore, according to **El-Deek et al. (2003)**, fennel increases the efficiency of breaking down fats into fatty acids and promotes the flow of digestive fluid in the stomach and intestine, which results in a rise in body weight and growth. These results are consistent with those obtained by **Saleh et al. (2018)**, who fed broiler chicks diets supplemented with fennel seed powder at levels of 0, 0.5, 1.0, and 1.5% from day one to day 35. They discovered that adding fennel seed to the diet caused a significant ($p<0.05$) increase in body weight and body weight gain when compared to the control treatment. Additionally, according to **Farid et al. (2024)**,

broiler chicks fed diets supplemented with 0, 10, 20, and 30 g of powdered fennel seeds per kilogram of diet had significantly ($p<0.05$) higher final body weight and weight gain than those fed the control diets.

Feed consumption:

Feed consumption during the initial phase (from 1 to 21 days of age) was significantly ($p<0.01$) impacted by the addition of fennel seeds at levels of 1%, 2%, and 3% to broiler chick diets (Table 4). Nevertheless, its impact on feed intake for the entire study period (from 1 to 42 days of age) and during growth (from 22 to 42 days of age) was negligible ($p>0.05$). Broiler chicks fed diets enriched with 1%, 2%, and 3% fennel seed powder at the beginning period (from 1 to 21 days of age) consumed significantly ($p<0.05$) higher feed compared to those fed on basal diets. Additionally, adding fennel seeds to broiler chick diets insignificantly increased feed consumption during the growing ($p<0.05$) and the duration of the trial ($p>0.05$). The improvement ($p<0.05$) in feed consumption at starting period (from 1-21 days of age) represented about, 2.89%, 4.06% and 3.88% by fennel seeds supplementation to the diet at levels of 1%, 2% and 3% respectively. Also, the insignificant ($p>0.05$) improvement in feed consumption resulted from the addition of fennel seeds powder to broiler chick diets at level of 1%, 2% and 3% represented 1.33% 2.26% and 1.81% respectively during the entire experimental period (from 1-42 days of age). Fennel seeds have antibacterial and antifungal properties that help improve nutrient digestion, which may be the cause of the rise in feed consumption brought on by

supplementing with them, according to **Hodgson et al. (1998)**. The presence of essential oil and active ingredients in fennel seeds, such as anethole and estragole, which stimulate the secretion of bile and digestive enzymes (protease, amylase, maltase and lipase) which facilitate digestion and increase feed consumption, may be the reason for the increase in feed consumption that results from supplementing with fennel seeds, according to **Platel and Srinivasan (2001)**. In contrast, **Abd El-latif et al. (2002)** found that the inclusion of fennel seeds may have increased feed consumption due to the diets improved palatability and the fennel seeds' pleasant scent. Additionally, it has been demonstrated

by **Farid et al. (2024)** that natural feed additives can help to stimulate and activate the digestive system by making the diet more palatable and boosting poultry appetite, which in turn leads to higher feed intake. According to **Saleh et al. (2018)** and **Al-Sagan et al. (2020)**, adding powdered fennel seeds to broiler diets increased feed consumption during heat stress. These findings are consistent with those of their study. But according to **Safaei et al. (2018)**, broiler chicks' feed consumption was unaffected by the addition of fennel seed. Additionally, fennel seed supplementation had no effect on the total amount of feed consumed by birds, according to **Farid et al. (2024)**.

Table (1) Ingredients and calculated chemical analysis of starter and grower experimental diets

Ingredient	Starter diets (1-3wks)	Grower diets (4-6wks)
Yellow corn%	56.69	68.01
Soybean meal (44 %cp)	31.53	17.14
Corn gluten (60 %cp)	8.00	11.45
Mono calcium phosphate%	1.30	0.90
Limestone%	1.82	1.75
Lysine %	0.02	0.10
Methionine%	0.09	0.00
Sunflower oil%	00	0.10
Common Salt%	0.25	0.25
Premix*	0.30	0.30
Total%	100	100
Chemical analysis (calculated)		
Crude protein %	23.01	20.00
Lysine %	1.10	0.90
Methionine + Cystine%	0.90	0.78
Calcium %	1.00	0.93
Available phosphors %	0.45	0.38
ME kcal/kg	2904	3100

*Each 0.3 kg of Premix contained:12000.000 IU vitamin A acetate; 10.000 mg vitamin E acetate; 2000.000 IU vitamin D3; 2000 mg vitamin K3; 4000 mg vitamin B2; 100 mg vitamin B1; 1500 mg vitamin B6; 10.000 mg pantothenic acid; 10 mg vitamin B12; 20.000 mg Nicotinic acid; 50 mg Biotin; 500.000 mg chorine; 1000 mg Folic acid; 10.000 mg Copper; 300.00 mg Iron; 1000 mg Iodine; 55.000 mg Manganese; 100 mg Selenium, and 55.000 mg Zinc.

Table (2) Effect of dietary fennel seeds on body weight (gm) of broiler chicks at different age intervals:

Age (days)	1 – 21 days	21 – 42 days	1 – 42 days
Treatments	***	***	***
Control	700.00 ^c	1998.67 ^c	1998.67 ^c
Fennel 1%	720.33 ^b	2080.67 ^b	2080.67 ^b
Fennel 2%	736.67 ^a	2138.67 ^a	2138.67 ^a
Fennel 3%	739.67 ^a	2151.33 ^a	2151.33 ^a
SE	2.685	10.677	10.677

Significant differences ($p < 0.05$) exist between means that have different letters within the same column. SE is the standard error. *** Highly significant at ($p < 0.001$).

Table (3) Effect of dietary fennel seeds on body weight gain (gm) of broiler chicks at different age intervals:

Age (days)	1 – 21 days	21 – 42 days	1 – 42 days
Treatments	***	***	***
Control	658.00 ^c	1298.67 ^c	1956.67 ^c
Fennel 1%	678.33 ^b	1360.33 ^b	2038.67 ^b
Fennel 2%	694.67 ^a	1402.00 ^a	2096.67 ^a
Fennel 3%	697.67 ^a	1411.67 ^a	2109.33 ^a
SE	2.685	8.089	10.677

Significant differences ($p < 0.05$) exist between means that have different letters within the same column. SE is the standard error, *** Highly significant at ($p < 0.001$)

Table (4) Effect of dietary fennel seeds on feed consumption (gm) of broiler chicks at different age intervals:

Age (days)	1 – 21 days	21 – 42 days	1 – 42 days
Treatments	**	NS	NS
Control	1025.67 ^b	3009.33	4035.00
Fennel 1%	1055.33 ^a	3033.33	4088.67
Fennel 2%	1067.33 ^a	3058.67	4126.00
Fennel 3%	1064.67 ^a	3043.67	4108.33
SE	3.93	15.973	19.769

Means heaving different letter (s) within each column are significantly different ($p < 0.05$). Ns= Not significant, SE = standard error.

Feed conversion ratio:

Feed conversion ratios at the beginning (from 1–21 days of age), growth (from 22–42 days of age) and complete (from 1–42 days of age) experimental periods were all significantly ($p<0.01$) impacted by the addition of fennel seed powder to the diets of broiler chicks at varying doses (Table 5). Broiler chicks fed diets supplemented with 2% and 3% fennel seeds during the starting phase (from 1–21 days of age) showed an enhanced feed conversion ratio ($p<0.05$). Additionally, throughout the initial phase (from 1 to 21 days of age), birds fed the feed supplemented with 3% fennel seed powder showed a superior ($p<0.05$) feed conversion ratio compared to those fed the diet supplied with 2% fennel seed powder. Feed conversion ratios of broilers were improved progressively ($p<0.05$) when the amount of fennel seed powder in their diets increased from 1% to 3% during the growing (22–42 days of age) and full (1–42 days of age) experimental periods. When fennel seed powder was added at levels of 1%, 2%, and 3% over the course of the entire trial period (from 1 to 42 days of age), the feed conversion ratios improved by 2.84%, 4.78%, and 5.85%, respectively, in comparison to the control dietary treatment.

Based on these findings, it can be said that adding 1%, 2%, and 3% fennel seed powder to broiler chick diets improved ($p<0.05$) the chicks'

feed conversion ratios at all age intervals under study (beginning, growing, and entire experimental periods). This effect increased ($p<0.05$) as the amount of fennel seed powder in the chicks' diets increased in comparison to the unsupplemented control diet. According to **Jamroz et al. (2003)**, the addition of fennel seed to broiler chick diets may improve feed conversion by boosting appetite and feed consumption, improving the secretion of endogenous digestive enzymes, activating the immune system, and having antibacterial, antiviral, antioxidant, and antihelminthic properties.

These data concur with those of **Al-Sagan et al. (2020)**, who reported that, under typical conditions, broilers supplemented with 3.2% fennel seed powder had the best ($p<0.05$) feed conversion ratio. Additionally, after 35 days of age, **Sayed et al. (2023)** discovered that birds fed 2 or 3 grammes of fennel seed powder had the superior ($p<0.05$) feed conversion ratios when compared to those fed 1 gramme of fennel seed powder or the control dietary treatment. Furthermore, according to **Farid et al. (2024)**, broiler chick feed-to-gain ratios were improved ($p<0.05$) by increasing the amount of fennel seed powder from 10 to 30 gm/kg diet.

Table (5) Effect of dietary fennel seeds on feed conversion ratio (gm feed/ gm gain) of broiler chicks at different age intervals:

Age (days)	1 – 21 days	21 – 42 days	1 – 42 days
Treatments	***	***	***
Control	1.559 ^a	2.317 ^a	2.062 ^a
Fennel 1%	1.556 ^a	2.230 ^b	2.005 ^b
Fennel 2%	1.537 ^b	2.182 ^c	1.968 ^c
Fennel 3%	1.526 ^c	2.156 ^d	1.948 ^d
SE	0.002	0.006	0.004

Means having different letter (s) within each column are significantly different ($p < 0.05$). Ns= Not significant, SE = standard error, *** Highly significant at ($p < 0.001$).

Economical efficiency:

The economical efficiency of broiler chicks was significantly ($p < 0.01$) impacted by the addition of fennel seed powder to their diets (Table 6). When broiler chick diets were supplemented with fennel seeds at increasing levels from 1% to 3%, the total feed cost per bird increased gradually ($p < 0.05$). However, increasing the amount of fennel seed supplementation in broiler chick diets from 1% to 3% gradually enhanced selling price/bird, absolute and relative net revenue/bird ($p < 0.05$). The improvements in net revenue /bird resulted from the addition of fennel seeds powder in broiler chick diets at levels 1%, 2% and 3% were 4.05%, 6.32% and 5.76% respectively compared to the control dietary treatment. The increase in total feed cost/bird was due to the cost of fennel seeds which increase with increasing the level of supplementation from 1% up to 3% in broiler chick diets. However, when fennel seed powder was added to broiler chick diets, the

selling price/bird, absolute, and relative net revenue all improved. This was because the broiler chicks gained more body weight and weight than the unsupplemented control group. These findings suggest that, in comparison to the unsupplemented control group, adding fennel seeds to broiler chick diets at levels of 1%, 2%, and 3% gradually increased ($p < 0.05$) both the absolute and relative net revenue/bird. **Abd El-Latif et al. (2002)**, **Soliman et al. (2003)**, **Hassan et al. (2004)**, and **Bahnas et al. (2009)** found that adding herbal feed additives to the diets of quails or broilers produced the lowest feed cost/kg gain and the highest ($p < 0.05$) net revenue per unit feed cost values when compared to the unsupplemented control group. These results are consistent with those of these studies. Additionally, **Ragab et al. (2013)** found that, at 42 days of age, chicks fed a diet containing 1% fennel seeds had the best relative and economic efficiency when compared to the control group.

Table (6) Effect of dietary fennel seeds on economical efficiency of broiler chicks at different age intervals:

Items	Control	Fennel seeds			SE	Sig.
		1%	2%	3%		
Total feed consumption (gm)	4035.00	4088.67	4126.00	4108.33	19.77	ns
Total feed cost/ bird (LE)	73.59 ^d	76.67 ^c	79.44 ^b	81.13 ^a	0.371	**
Body weight (gm)	1998.67 ^c	2080.67 ^b	2138.67 ^a	2151.33 ^a	10.68	**
Selling price /bird (L.E)	175.88 ^c	183.10 ^b	188.20 ^a	189.32 ^a	0.940	**
Absolute net revenue	102.29 ^c	106.43 ^b	108.76 ^a	108.18 ^{ab}	0.619	**
Relative net revenue	100 ^c	104.05 ^b	106.32 ^a	105.76 ^{ab}	0.606	**

Means heaving different letter(s) in the same column are significantly different ($p < 0.05$) the economical efficiency was calculated according to the prevailing prices in the local market (2025), The price of fennel seeds was 42 L.E/kg. Ns= Not significant, SE = standard error

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استخدام بذور الشمر كإضافات غذائية في علائق بدارى اللحم

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كان الهدف من هذه الدراسة هو تقدير تأثير إضافة مسحوق بذور الشمر كمنشط طبيعي في علائق بدارى اللحم على الكفاءة الإنتاجية والاقتصادية.

إستخدّم في هذه الدراسة ١٨٠ كتكوت تسمين إربورايكرز غير مجنس عمر يوم وزعت عشوائيا إلى أربع مجموعات بكل مجموعه ٣ مكررات.

غذيت الكتاكيت لحد الشبع على عليقه البادىء (من عمر ١ - ٢١ يوم) وعلى عليقه النامي (من عمر ٢٢ - ٤٢ يوم) المضاف أو الغير مضاف اليها مسحوق بذور الشمر بمعدلات ١، ٢، ٣% على الترتيب.

أوضحت النتائج ما يلي:

أدت إضافة مسحوق بذور الشمر بمعدلات ١، ٢، ٣% في علائق بدارى اللحم إلى تحسين جوهري (٥%) في وزن الجسم ومعدل الزيادة في وزن الجسم ومعدلات التحويل الغذائي لبدارى اللحم خلال فترات البادىء والنامي وطول فترة تجربته مقارنة بالطيور المغذاه على عليقة المقارنه.

أدت إضافة مسحوق بذور الشمر إلى علائق بدارى اللحم إلى زيادة جوهريه (٥%) في معدل إستهلاك العليقه خلال فترة البادىء، بينما لم تؤدي إلى زيادة جوهريه في معدل إستهلاك العليقه خلال فترة النامي وطوال فترة تجربته.

أدت إضافة مسحوق بذور الشمر بالمستويات المختلفه إلى علائق بدارى اللحم إلى تحسين جوهري (٥%) في الكفاءة الإقتصادية لبدارى اللحم مقارنه بمجموعة الأساس