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Research Article

Effect of Caraway Seeds as Dietary Supplements on Growth Performance and Economic Efficiency of Growing Rabbits

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Abstract:

The present study was designed to investigate the effect of caraway seed powder level as a dietary supplement on the growth performance and economic efficiency of growing rabbits. A total of 160 five- weeks of age rabbits were divided and assigned randomly into four experimental groups of 40 rabbits in each. Rabbits in the 1st group were received the basal die without any supplements (control group). While those in the 2nd, 3rd and 4th groups were fed diet supplemented with 3, 5 or 7 g caraway seeds powder/ kg diet. All rabbits were kept under the same managerial conditions. Results showed that weekly body weight from the 7th week of age up to the end of the experimental period (12 weeks of age) significantly increased in all treatment groups (3, 5 and 7 g of caraway seeds powder/kg diet) as compared to the control group. Weekly feed intake (FI) was not significantly affected by supplementing caraway seeds powder in diets at all interval periods from 5 weeks of age up to 12 weeks of age. Weekly feed conversion ratio (FCR) was not significantly affected by supplementing caraway seeds powder in diets from 5 weeks of age until 12 weeks of age, except in the intermediate period of 6-7 and 5-12 weeks of age. During the whole experimental period (5-12 weeks of age), rabbits treated with 5 g of caraway seeds powder/kg diet had the best feed conversion ratio as compared to other treatments and the control. The best value of economic efficiency was found in the rabbits that received 3 and 5 g of caraway seeds powder/kg of diet (117.5 and 118.8%), followed by those that received 7 g of caraway seeds powder/kg of diet (109.1%), but the lowest value was recorded with those that received the control diet (108.8%).In summary, adding caraway seeds powder to the diet up to 5 g/kg diet of growing rabbits enhances their growth performance and economic efficiency under Egyptian environmental conditions

1. Introduction

Using antibiotic as growth promoters in animals feeds for long time leads to antibiotic resistant of bacteria and then increases antibiotic residues in animals tissues. Therefore, replacement of antibiotics by plant extracts and spices as substitutes for improving the growth performance, and immune responses in animals life has been recommended (Dosoky et al., 2023; Farag et al., 2024). The plant has gained importance not only in traditional systems but also in contemporary phytotherapy (Deepak, 2013 and El-Soud et al., 2014).Also, the beneficial effects of herbal extracts and their bioactive constituents in animal nutrition include appetite stimulation, enhanced feed intake, and improved secretion of endogenous digestive enzymes. Additionally, these substances have been associated with the activation of immune system and exhibit antibacterial, antiviral, antioxidant, and anthelmintic properties. Various plant-derived secondary metabolites, such as isoprene derivatives, flavonoids, glucosinolates, and others, can modulate the physiological and biochemical functions of the digestive system (Rahimi et al., 2011), with particular emphasis on stimulating bile secretion and pancreatic enzyme activity (Platel et al., 2002). Caraway (*Carum carvi*) is one of such biennial plant species which used as phytogenic feed additives, belonging to the Apiaceae family. It has been cultivated in Europe, Australia, Iran, China, and Egypt (Rasooli and Allameh, 2016). Caraway seeds possess antioxidant, antibacterial, antihelminthic and antiviral activities (Hassan and Abdel-Raheem 2013). Traditionally, it has been employed for the treatment of stomachaches, constipation, nausea, and flatulence (Peter, 2006). Persian traditional medicine describes caraway as an effective remedy for abdominal pain by expelling accumulated gastrointestinal gases and humors (Valizadeh et al., 2007). In modern veterinary practice, caraway is also used as a feed additive to support feed intake, digestive function, immune modulation, and microbial control (Hassan and Abdel-Raheem, 2013). The main constituents of caraway essential oil are carvone and limonene (Sedláková et al., 2001). Caraway essential oil (0.1g oil / kg diet) increased growth performance and feed utilization of Nile tilapia (Mehrim et al., 2024). Therefore, the present study was designed to investigate the effect of caraway seeds powder level as dietary supplements on the growth performance and economic efficiency of growing rabbits.

2. Materials and Methods

The present study was carried out at the rabbits farm of Sakha Station, belonging to the Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Egypt. These experiment pro-

cedures were accepted by the College of Agriculture, Tanta University, Egypt, and agreed with the pertinent rules and regulations ((No. 113 AY2019-2020/ Session 6/ 2020.01.13). A total of 160 APRI line rabbits, five weeks of age, weighing 654.2±16.5 g, were divided and assigned randomly into four experimental groups of 40 rabbits each. Rabbits in the 1st group were received the basal diet without any supplements as control group. While those in the 2nd, 3rd and 4th treatment groups were fed the same diet supplemented with 3, 5 and 7 g of caraway seeds powder/kg diet . According to de Blas and Mateos (1998), the experimental diets were designed to be isocaloric and isonitrogenic (Table1). The rabbits were housed in 50 × 40 × 35 cm wire-galvanized battery cages. The temperature during the experiment was 18°C ± 2°C and the humidity was 60%–70%. All rabbits were kept under the same managerial conditions. The experiment was conducted from November 2024 and January 2025.

Table 1. Formulation and chemical analysis of experimental diets.

Ingredient (g/kg)	Control	Caraway seeds (g/kg diet)		
		3	5	7
Barseem hay	336	335	334	333
Barley grain	270	270	270	270
Soybean meal (44%)	151	151	150	150
Wheat bran	224	222	222	221
Caraway seed	-	3.0	5.0	7.0
Limestone	6.0	6.0	6.0	7.0
Dicalcium phosphate	3.0	3.0	3.0	3.0
DL-Methionine	2.0	2.0	2.0	2.0
NaCl	3.0	3.0	3.0	3.0
Premix[1]	3.0	3.0	3.0	3.0
Antifungal	1.0	1.0	1.0	1.0
Anti-coccidia	1.0	1.0	1.0	1.0
Total	1000	1000	1000	1000
Chemical analysis (% as DM)				
Ash	5.77	5.82	5.79	5.80
CP	17.02	17.03	17.02	17.03
CF	13.30	13.32	13.32	13.33
EE	1.65	1.71	1.75	1.79
DE (MJ/kg)[2]	10.11	10.10	10.10	10.09

CP= Crude protein, CF= Crude fiber, EE= Ether extract, DE= Digestible energy.

[1]Premix. Each 3 kg mixture contains: Vitamin A 12000000 IU ,Vit. D3 2200000 IU, Vit.B1 1000 mg, Vit.K 2000 mg, Vit. E 10000 mg, Vit.B2 4000 mg, Vit.B6 1500 mg, Niacin 20000 mg, Folic acid 1000 mg, Pantothenic Acid 10000 mg, Choline chloride 500 gm, Biotin 50 mg, Manganese 55000 mg, Selenium 100 mg, Iodine 1000 mg, Zinc 50000 mg and carrier CaCO3, to 3000 gm.

[2]Calculated according to de Blas and Mateos (1998).

During the experimental period (5-12 wks of age), feed and water were offered *ad libitum*. Live body weight and feed intake were recorded weekly. The body weight gain and feed conversion ratio were calculated. Economic efficiency was estimated according to Raya et al. (1991) as follow:

Economic efficiency (%) = (Net revenue)/ (Total feed cost) × 100

Where:

Net revenue = (Price of weight gain) - (Total feed cost)

Price of weight gain (LE) = (Average weight gain, kg/head) x (Price/kg live body weight)

Total feed cost (LE) = (Average feed consumption, kg/head) x (Price /kg feed)

Data were statistically analyzed using the General Linear Model Program of SAS (2000). Duncan's multiple range test was performed (Duncan, 1955) to detect significant differences between means. The statistical model was used for the analysis of variance to estimate the effect of different levels caraway seeds powder from as follows:

Yij = U + Ti + eij

Where:

Yij = the observations

U = overall mean

Ti = effect of i the treatment (i = 1, 2, 3 and 4)

eij = residual (random error)

3. Results and Discussion

3.1. Growth performance

3.1.1. Body weight and weight gain

Data in Table (2) show that body weight at 5th and 6th weeks of age was not affected significantly by treatment. However, weekly body weight from the 7th week of age up to the end of the experimental period (12 weeks of age) significantly (P ≤0.01) increased in all treatment

groups (3, 5 and 7 g caraway seeds powder/ kg diet) as compared to the control group. Generally, rabbits treated with 3 and 5 g of caraway seeds powder/kg diet had the highest body weight as compared to other treatment and the control.

Data presented in Table (3) illustrate the effects of caraway seeds supplementation in the feed of growing rabbits on body weight gain (BWG). The interval periods from 6-7 and 5-12 weeks of age, rabbits receiving 3 ad 5 g/kg of caraway seeds demonstrated a significantly ($P \leq 0.01$) improvement in BWG as versus other treatments.

The increased growth efficiency of growing rabbits seen in this study may be due to the caraway seed powder have possessed fatty acids such as oleic, linoleic, petroselinic, and palmitic acids (Sedlakova et al., 2001), terpenes, flavonoids, coumarins, and other phenolic contents (Rahman and Hossain, 2003). Addition, the caraway seeds ability to stimulate gastric juice secretion and promote bile discharge, which collectively enhance appetite and digestion (Peter, 2006). Furthermore, the caraway seeds powder improved digestibility coefficients for CP, NFE. and DE (Badr, 2019), explaining the noticed enhance in body weight. The same results were obtained by Khajeali et al. (2012), who showed that adding caraway to broiler diets at levels of 1, 1.5, and 2% during 42 days enhanced final live body weight. Also, Badr (2019) observed that the inclusion of caraway seeds sieving (2, 4 and 6%) in rabbit diets significantly increased final live body weight, total body weight gain and average daily gain compared to the control. On the contrary, Stastník et al. (2022) observed that the addition of caraway (1%) to broiler chickens' diet did not significantly affect live weight and weight gain.

Table 2. Effect of dietary caraway seeds powder levels on live body weight (g) of growing rabbits.

Age (Weeks)	Control	Caraway seed powder (g/kg diet)			SEM	P-value
		3	5	7		
5	656.1	654.2	652.3	654.3	16.50	0.998
6	824.0	841.9	839.2	828.8	18.52	0.895
7	942.7^{b}	1009.1^{a}	1013.3^{a}	966.4^{ab}	18.63	0.027
8	1098.6^{b}	1158.0^{a}	1160.5^{a}	1114.7^{ab}	16.10	0.017
9	1241.7^{b}	1313.3^{a}	1315.8^{a}	1260.5^{b}	15.90	0.003
10	1392.3^{b}	1474.3^{a}	1473.5^{a}	1436.7^{ab}	17.48	0.003
11	1555.9^{b}	1624.8^{a}	1627.3^{a}	1583.5^{ab}	15.94	0.007
12	1691.9^{b}	1752.9^{a}	1764.6^{a}	1721.9^{ab}	15.41	0.009

SEM = Standard error of means,

Means in the same row with different superscripts are significantly different ($P<0.05$).

Table 3. Effect of dietary caraway seeds powder levels on body weight gain (g) of growing rabbits.

Periods (Weeks)	Control	Caraway seed powder (g/kg diet)			SEM	P-value
		3	5	7		
5-6	167.9	187.7	186.9	174.5	8.649	0.405
6-7	118.7^{b}	167.3^{a}	174.1^{a}	137.6^{b}	8.663	0.001
7-8	155.9	148.9	147.2	148.3	10.59	0.956
8-9	143.1	155.3	155.3	145.8	8.117	0.594
9-10	150.5	161.0	157.7	176.2	8.368	0.189
10-11	163.6	150.5	160.1	146.8	7.100	0.630
11-12	136.1	128.1	137.1	138.3	6.669	0.771
5-12	1035.8^{b}	1098.7^{a}	1112.3^{a}	1067.6^{ab}	17.760	0.0246

SEM = Standard error of means.

Means in the same row with different superscripts are significantly different ($P<0.05$).

3.1.2. Feed intake and feed conversion ratio

Weekly feed intake (FI) was not significantly affected by supplementing caraway seeds powder in diets at all interval periods from 5 weeks of age up to 12 weeks of age (Table 4).

Table 4. Effect of dietary caraway seeds powder levels on feed intake (g/ rabbit/ week) of growing rabbits.

Periods (Weeks)	Control	Caraway seed powder (g/kg diet)			SEM	P-value
		3	5	7		
5-6	358.8	361.7	359.5	360.5	7.381	0.993
6-7	410.5	412.4	412.8	411.1	3.870	0.976
7-8	461.3	464.1	465.2	461.6	5.233	0.946
8-9	526.7	529.5	531.3	529.2	5.912	0.967
9-10	588.7	592.9	591.4	589.3	4.650	0.936
10-11	664.2	668.4	665.5	664.0	8.193	0.980
11-12	725.8	728.3	729.0	727.3	5.024	0.973
5-12	3736.0	3757.3	3754.7	3743.0	12.301	0.684

SEM = Standard error of means.

Weekly feed conversion ratio (FCR) was not significantly affected by supplementing caraway seeds powder in diets from 5 weeks of age until 12 weeks of age, except in the intermediate period of 6-7 weeks of age (Table 5). During this period (6-7 weeks of age), rabbits fed 3 and 5 g caraway seeds powder/kg diet had the best significant (P<0.01) values of feed conversion ratio as compared with those fed the control diet. During the whole experimental period (5-12 weeks of age), rabbits treated with 3 and 5 g of caraway seeds powder/kg diet had the best significant (P<0.01) values of feed conversion ratio compared to other treatments and the control. While, insignificant differences among treatments were detected.

These findings suggest that caraway seeds powder positively influences feed conversion ratio in rabbits may be due to bioactive compounds which found in caraway seeds that may stimulate digestive enzymes and nutrient absorption. This enhancement in feed efficiency may be attributed to the positive effects of plant essential oil on nutrient digestibility (Langhout,2000; Madrid et al. ,2003).

Similarly, Abd-El-Hady (2014) found that addition Digestarom (3.00% Peppermint; 0.45% Anise and Fennel; and 0.035% Caraway) to growing rabbits diets at levels of 300 and 400 g/ton had no significant effect on feed consumption, except during 5-6 weeks of age in rabbits fed 300 gm Digestarom /ton. Whereas, feed conversion ratio of rabbits was improved with the increase in Digestarom levels. Also, Badr (2019) observed that the inclusion of caraway seeds sieving (2, 4 and 6%) in rabbit diets has significantly improved feed conversion ratio.

Table 5. Effect of dietary caraway seeds powder levels on feed conversion ratio of growing rabbits.

Periods (Weeks)	Control	Caraway seed powder (g/kg diet)			SEM	P-value
		3	5	7		
5-6	2.14	1.93	1.92	2.07	0.137	0.494
6-7	3.46^{a}	2.47^{bc}	2.37^{c}	2.99 ^{ab}	0.213	0.002
7-8	2.96	3.12	3.16	3.11	0.293	0.592
8-9	3.68	3.41	3.42	3.63	0.184	0.603
9-10	3.91	3.68	3.75	3.35	0.174	0.128
10-11	4.06	4.44	4.16	4.52	0.317	0.688
11-12	5.33	5.69	5.32	6.26	0.371	0.845
5-12	3.61 ^{a}	3.42 ^{b}	3.38 ^{b}	3.51 ^{ab}	0.047	0.036

SEM = Standard error of means,
Means in the same row with different superscripts are significantly different (P<0.05).

3.2. Economic Efficiency

Economical traits as affected by dietary caraway seeds powder supplementation in diets are shown in Table 6. Total feed cost increased by supplementing caraway seeds powder in diets. Also, the selling price was increased by supplementing caraway seeds powder in diets. This increase in selling price may be due to an increase in average weight gain (kg/head). The same trend was found in the net revenue and economic efficiency, which were increased by supplementing caraway seeds powder in diets. The best value of economic efficiency was found in the rabbits that received 3 and 5 g of caraway seeds powder/kg of diet (117.5 and 118.8%), followed by those that received 7 g of caraway seeds powder/kg of diet (109.1%), but the poorest value was recorded with those that received the control diet (108.8%). These results are in agreement with the results of Badr (2019), who observed that the inclusion of caraway seeds sieving (2, 4 and 6%) in rabbit diets increases net revenue and relative economic efficiency. Also, he found that rabbits received 4% caraway seeds sieving recorded the best, total revenue, economic efficiency, and relative economic efficiency.

Table 6. Effect of dietary caraway seed powder level on economical traits of growing rabbits at 12 wks of age.

Items	Control	Caraway seed powder (g/kg diet)		
		3	5	7
Average feed intake (kg/ head)	3.736	3.757	3.754	3.743
Price /kg diet (L.E.)	14.6	14.8	14.9	15.0
Total feed cost (L.E.)	54.6	55.6	55.9	56.2
Average weight gain (kg/head)	1.036	1.099	1.112	1.068
Selling price (L.E.) [1]	114.0	120.9	122.32	117.5
Net revenue (L.E.)	59.4	65.3	66.4	61.3
Economic efficiency (%)	108.8	117.5	118.8	109.1

- Other conditions like management are fixed.
- Ingredients price (L.E. per ton) at 2024 were: 14500 barley; 10500 berseem hay; 11500 wheat bran; 23500 soybean meal (44%) ; 1500 limestone; 56250 premix; 80000 methionine; 62500 di-calcium phosphate; 2500 salt; 69000 caraway seed powder.
- Adding 100 L.E. /ton for pelleting.

[1] Price of kg live body weight was 110 L.E.

4. Conclusions

It can be concluded that caraway seeds powder could be successfully supplemented into the diet of growing rabbits up to 5 g/kg diet, which improved growth performance and economic efficiency under Egyptian environmental conditions.

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