

Effects of Ground Echinacea (*Echinacea purpurea*) Supplementation Quail Diets on Growth Performance and Carcass Traits

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Summary

This research was conducted to determine effects of echinacea supplementation quail diets on growth performance and carcass traits. A total of 207 Japanese quail (*Coturnix coturnix japonica*) were used in the study. They were divided into one control and two experimental groups each containing 69 Japanese quail chicks. Each group was divided into three subgroups of 23 chicks. The study lasted 35 days. The control group (C), was fed basic rations without supplement. The rations of experimental groups were supplemented with 1 g/kg (GI) and 5 g/kg (GII) of echinacea, respectively. At the end of the study, there were no statistically significant differences in terms of live weight gain, feed consumption, feed efficiency or carcass yield ($P>0.05$). Nevertheless, live weight increased in the second week in Group II ($P<0.05$). There were statistically significant differences in the weight of heart, liver and wing ($P<0.05$). In conclusion, echinacea supplementation had no additional effect on quail performance.

Keywords: Quail, Echinacea, Performance, Carcass

Bıldırcın Rasyonlarına İlave Edilen Ögütülmüş Ekinezya (*Echinacea purpurea*) bitkisinin Büyüme Performansı ve Karkas Özellikleri Üzerine Etkisi

Özet

Bu araştırma, bıldırcın rasyonlarına ilave edilen ekinezyanın büyüme performansı ve karkas özellikleri üzerine etkilerini belirlemek için yapılmıştır. Bu çalışmada toplam 207 Japon bıldırcını (*Coturnix coturnix japonica*) kullanılmıştır. Her grupta 69 civciv bulunan bir kontrol ve iki deneme grubu, oluşturulmuştur. Her grup kendi arasında 23 civciv içeren üçerli alt gruba ayrılmıştır. Deneme 35 gün sürdürülmüştür. Kontrol grubu (C), temel rasyonla beslenmiştir. Deneme grupları rasyonlarına sırasıyla 1 g/kg (GI) ve 5 g/kg (GII) ekinezya ilave edilmiştir. Araştırma sonunda, canlı ağırlık artışı, yem tüketimi, yemden yararlanma oranı ve karkas verimi ($P>0.05$) açısından istatistiksel olarak anlamlı bir farklılık görülmemiştir. Bununla birlikte, ikinci haftada Grup II de canlı ağırlıkta ($P<0.05$), artış görülmüştür. Kalp, karaciğer ve kanat ağırlığında istatistiksel olarak anlamlı fark ($P<0.05$) bulunmuştur. Sonuç olarak, ekinezya ilavesinin bıldırcınlarda performans üzerinde herhangi bir etkisi olmamıştır.

Anahtar sözcükler: Bıldırcın, Ekinezya, Performans, Karkas

INTRODUCTION

For many years, plants have played an important role in protecting human health and improving their quality of life¹. Throughout history, plants and plant extracts have been used for medicinal purposes to prevent and treat human diseases². With the European Union's decision not

to supplement animal feed with antibiotics beginning in 2006, phenolic feed supplements have begun to attract the attention of scientists³. Concerns and prohibitions surrounding the use of antibiotics and synthetic hormones have encouraged animal feeders to use alternative feed



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supplements such as organic acids, probiotics^{4,5} prebiotics, plant extracts and essential fatty acids⁶. In recent years, plants and plant extracts have begun to be used in feed mixes for poultry as feed supplements that enhance natural productivity².

Because antibiotics used in poultry mixes to prevent disease and increase feed efficiency pose the risk of developing resistance, there has been a search for new supplements. In this context, more resources have recently been devoted to research on identifying the effects that natural and safe aromatic plants and extracts have on living organisms. It has been reported that the use of aromatic plants in broilers significantly improves live weight gain and feed efficiency^{1,7-10}, while use in egg-laying chickens has a positive effect on egg weight and production^{3,11} and in Japanese quail, it has a significant effect on live weight ratios and feed efficiency¹²⁻¹⁴.

Inactivated viruses or plant extracts can be used as immune-stimulators in order to strengthen the immune system. One of the herbal stimulants that is reported to stimulate the immune system is *Echinacea Purpurea*, which is also used in human medicine. It has been claimed that some products derived from *Echinacea* activate lymphocytes¹⁵. *Echinacea Purpurea* is widely used as an herbal medicine for the treatment and prevention of infectious diseases in Europe and North America¹⁶. Extracts derived from *Echinacea Purpurea* are widely used to treat coughs, colds, bronchitis and other upper respiratory infections or to prevent illness¹⁷. It is the cichoric acid and alkylamides present in *Echinacea* that produce these results¹⁸. A limited number of studies have been conducted on the use of *Echinacea* in farm animals, and the purpose of this study therefore is to determine how supplementing the rations of quail with extruded *Echinacea* affects growth performance and carcass quality.

MATERIAL and METHODS

A total of 207 day-old Japanese quail chicks (*Coturnix coturnix japonica*) of both sexes were used in this study. They were divided into 1 control and 2 treatment groups each containing 69 chicks. Groups were divided into three subgroups with 23 chicks in each.

The rations were isocaloric and isonitrogenous. The control and experimental groups were fed with a basic diet of corn and soybean including 23% CP and 2.900 kcal/kg ME. Diets were formulated to meet NRC¹⁹ nutrient requirements. The ration of experimental groups are presented in Table 1. The experimental design consisted of three separate diets: The control group was fed a basic diet without supplements. 1 g/kg of echinacea was added to the diets of experimental group (GI) and 5 g/kg of echinacea was added to the diets of experimental group (GII). Feed and water were supplied *ad-libitum*. Lighting

Table 1. Composition and calculated analysis of basal diets

Tablo 1. Temel rasyonun bileşimi ve hesaplanan analiz değerleri

Ingredients	%	Values Analysed,%
Corn	51.50	Dry matter 92.50
Soybean meal	43.50	Crude protein 23.0
Oil	2.55	Crude extract 2.61
Limestone	1.20	Crude ash 2.1
Dicalcium phosphate	0.25	Crude fiber 4.92
Salt	0.30	ME **, kcal/kg 2900
Vitamin-mineral prem *	0.50	
DL-Methionine	0.10	
L-Lysine	0.10	
Total	100	

* Each 1 kg of vit - min premix: 20.000.000 IU Vit. A, 3.000.000 IU Vit. D₃, 25 g Vitamin E, 4 g Vitamin B₁, 8 g Vitamin B₂, 5 g Vitamin B₆, 20 mg Vitamin B₁₂, 20 g Nicotinamid, 12 g Calcium -D- Pantothenaet, 200 g Choline chloride, 50 g Mn, 50 g Fe, 50 g Zn, 10 g Cu, 0.8 g I, 0.15 g Co, 0.15 g Se
 ** Calculated

was kept constant in an enclosed building. The experiment lasted 35 days.

Crude nutrients in feeds and experimental ration were analyzed using of AOAC²⁰ method. The levels of Metabolic Energy were calculated with the formula developed by TSE²¹. At the beginning (0) and on days 7, 14, 21, 28 and 35 of the study the body weight and body weight gain of the quails was recorded. At the same time, all of the feed residues of the subgroups were weighed weekly to measure feed consumptions and feed conversion ratios.

Six male and six female birds from each subgroups, a total of 144 chicks were randomly chosen and slaughtered to determine the carcass yield. The liver, heart and gizzard were removed and weighed. They were weighted, bled and wet plucked by hand. After plucking, they were eviscerated, and the carcasses were stored for 24 h at +4°C and not analyzed statistically since the group feeding was dissected according to Jones²². The carcass parts used in the experiment (leg, breast, back, wing and neck) were assessed with the skin.

After slaughter, the animals were weighed again and the warm carcass weight was recorded. The slaughter process was conducted by removing the internal organs of the chicks and weighing the internal organs for each animal on a scale with accuracy of ±10 mg. Cold carcass weight was determined after keeping the carcasses at +4°C for 18 h. Cold carcass weight was divided by the slaughter weight to determine cold carcass yield.

Statistical analyses and the significance of the mean scores between the groups for body weight, body weight gain, feed consumption, feed conversion ratio, carcass weight and yield were determined using the variance analysis method. Significant differences between

treatment means were determined using Duncan's multiple range test with a 5% level of probability. The statistical analysis was conducted using the SPSS 16.0 (Inc. Chicago. IL. USA) program.

RESULTS

Measured body weights are shown in [Table 2](#). The body weight of quail chicks in this study was not significantly influenced by echinacea supplementation. BWG, FC and FCR are shown in [Table 3](#) and the pattern of these parameters was similar in all the groups throughout the experimental period. Feed consumption in the experimental groups which were given echinacea supplements of 1 g/kg and 5 g/kg were found to be higher

than that of the control groups. In the last weeks of the experiment, the carcass parameters were not statistically significant in any of the groups. Slaughter weight and carcass yields were not affected by the different levels of echinacea supplementation ($P>0.05$). Parameters used for the carcass traits of the chicks are provided in [Table 4](#) and [5](#).

During the study, both experimental group I and II lost two animals due to trauma.

DISCUSSION

At the end of the study, no statistically significant difference was realized in terms of live weight in the experimental groups by supplementing feed rations with extruded echinacea at a ratio of 1 g/kg and 5 g/kg ($P>0.05$). A significant increase in live weight ($P<0.05$) was only observed in the experimental groups in the second week of the study when the group that received an additional 5 g/kg of Echinacea was compared to the control group ([Table 2](#)). In recent years a number of studies related to aromatic herbs have been conducted on several farm animals. It has been reported that the use of aromatic plants in broilers significantly improves live weight gain and feed efficiency ^{1,7-10}, while use in egg-laying chickens had a positive effect on egg weight and production ^{11,23} and in Japanese quail, it had a significant effect on live weight ratios and feed efficiency ^{11,13,14}.

In studies using Echinacea on broiler chickens ^{16,24,25}, all of the groups receiving Echinacea supplementation

Table 2. Mean body weights for the groups (g)

Tablo 2. Gruplarda ortalama canlı ağırlıklar (g)

Weeks	Control $\bar{X} \pm S_x$	Group I $\bar{X} \pm S_x$	Group II $\bar{X} \pm S_x$	P
0	8.61 \pm 0.94	8.56 \pm 0.10	8.55 \pm 0.09	-
1	23.60 \pm 0.46	23.15 \pm 0.52	23.28 \pm 0.53	-
2	52.96 \pm 1.17 ^{ab}	52.48 \pm 1.09 ^b	55.74 \pm 1.02 ^a	*
3	99.67 \pm 1.40	99.64 \pm 1.80	99.62 \pm 1.69	-
4	139.01 \pm 1.86	140.72 \pm 1.73	136.15 \pm 1.86	-
5	173.97 \pm 1.81	174.12 \pm 2.35	174.04 \pm 2.35	-

a,b: Means on the same row followed by different letters differ significantly ($P<0.05$)

-: Differences among the groups were not statistically significant ($P>0.05$)

Table 3. Mean feed consumption (g/chick), body weight gain (g), and feed conversion rate* values of groups

Tablo 3. Gruplarda ortalama yem tüketimi (g/civciv), canlı ağırlık artışı (g) ve yemden yararlanma oranı*

Weeks	Parameters	Control $\bar{X} \pm S_x$	Group I $\bar{X} \pm S_x$	Group II $\bar{X} \pm S_x$	P
1	FC	23.83 \pm 1.32	20.74 \pm 0.31	22.00 \pm 0.63	-
	BWG	14.98 \pm 0.47	14.58 \pm 0.53	14.73 \pm 0.54	-
	FCR	1.58 \pm 0.13	1.43 \pm 0.03	1.51 \pm 0.06	-
2	FC	67.89 \pm 1.21	67.23 \pm 2.23	67.74 \pm 0.73	-
	BWG	29.36 \pm 1.22	29.32 \pm 1.31	32.46 \pm 1.16	-
	FCR	2.33 \pm 0.51	2.31 \pm 0.15	2.09 \pm 0.03	-
3	FC	88.75 \pm 3.07	87.18 \pm 1.39	83.94 \pm 0.67	-
	BWG	46.70 \pm 1.78	47.16 \pm 1.99	43.88 \pm 1.89	-
	FCR	1.88 \pm 0.04	1.84 \pm 0.03	1.91 \pm 0.12	-
4	FC	116.3 \pm 5.75	124.00 \pm 1.62	119.75 \pm 4.37	-
	BWG	39.34 \pm 2.23	41.07 \pm 2.60	36.52 \pm 2.35	-
	FCR	2.96 \pm 0.17	3.06 \pm 0.12	3.30 \pm 0.14	-
5	FC	148.29 \pm 2.49 ^b	167.79 \pm 2.87 ^a	161.92 \pm 2.43 ^a	*
	BWG	34.95 \pm 2.54	33.39 \pm 2.88	37.89 \pm 3.24	-
	FCR	4.34 \pm 0.19	4.97 \pm 0.58	4.32 \pm 0.28	-
1-5	FC	445.07 \pm 10.95	466.96 \pm 3.31	455.36 \pm 4.84	-
	BWG	165.35 \pm 1.83	165.55 \pm 2.37	165.48 \pm 2.35	-
	FCR	2.63 \pm 0.03	2.68 \pm 0.15	2.66 \pm 0.09	-

* (kg, feed consumption/kg, body weight gain)

a,b: Means on the same row followed by different letters differ significantly ($P<0.05$)

-: Differences among the groups were not statistically significant ($P>0.05$)

FC: Feed Consumption, **BWG:** Body Weight Gain, **FCR:** Feed Conversion Rate

Table 4. Mean slaughter weight (g), carcass weight (g) and yields (%) of experimental groups**Tablo 4.** Grupların Grupların ortalama kesim ve karkas ağırlıkları (g) ile karkas randımanları (%)

Parameters	Control X±S _x	Group I X±S _x	Group II X±S _x	P
Slaughter weight	171.82±2.11	169.37±2.74	173.44±3.14	-
Warm carcass	117.76±1.61	116.01±1.91	117.32±2.21	-
Cold carcass	115.91±1.60	115.23±1.96	116.03±2.26	-
Warm carcass percentage	68.81±1.10	69.29±1.80	68.23±1.57	-
Cold carcass percentage	67.78±1.21	68.80±1.77	67.75±1.88	-

∴ Differences among the groups were not statistically significant (P>0.05)

Table 5. Heart, liver, gut, leg, breast, wing and other part weights in experimental groups (g)**Tablo 5.** Grupların kalp, karaciğer, bağırsak, bacak, göğüs, kanat ve diğer kısım ağırlıkları (g)

Parameters	Control X±S _x	Group I X±S _x	Group II X±S _x	P
Heart	1.56±0.30 ^b	1.62±0.36 ^{ab}	1.69±0.23 ^a	*
Liver	4.09±0.13 ^b	4.28±0.18 ^b	4.94±0.18 ^a	*
Gut	7.35±0.24	7.09±0.24	7.48±0.22	-
Leg	27.69±0.44	27.64±0.50	28.75±0.55	-
Breast	43.18±1.16	40.64±1.05	43.08±1.19	-
Wing	10.61±0.15 ^b	11.34±0.18 ^a	10.70±0.20 ^b	*
Others	33.45±1.09	35.60±0.99	33.63±1.14	-

a,b: Means on the same row followed by different letters differ significantly, (P <0.05)

∴ Differences among the groups were not statistically significant (P>0.05)

exhibited lower performance when compared with the control group. In a study conducted on pigs^{26,27}, echinacea supplements did not result in any difference between the groups and similar results were observed in a study conducted with rats²⁸. The number of studies conducted on quail was found to be inadequate. In most of the studies that were conducted, the extract studies that were generally conducted focusing on the active ingredient. In this study, the extruded herbal form was used and this did not produce any significant difference in terms of live weight. There are no other studies regarding the use of echinacea in quail, so it is impossible to compare data. When assessed in terms of both live weight and increases in live weight, the increases in live weight which were achieved from our study results are similar to those of²⁵.

No statistically significant difference was seen until the last week of the experiment in terms of feed consumption (P>0.05), but the feed consumption of the experimental groups at the end of the study was significantly higher (P<0.05) than the control group (Table 3). When the entire study period is taken into account, the feed consumption ratios of the control group, Group I and Group II were found to be 445.07, 466.96, and 455.36 and no significant differences were realized (P>0.05). The study data was comparable to the results of studies that reported how supplementing rations of broilers with Echinacea in different doses had no effect on feed consumption^{15,25}.

Feed efficiency ratios did not result in significant differences between the groups during the experiment. This stands in contrast to the results of studies conducted by¹⁶, in which echinacea was added to broiler rations. However, it is similar to the results of the study conducted by Nasir and Grashorn²⁵. Supplementing quail rations with different amounts of extruded Echinacea was not determined to have any positive impact on growth performance, feed consumption or feed efficiency in the study as a whole.

In terms of carcass quality, no difference was observed between the control and the experimental groups that consumed echinacea (P>0.05). The weight of the heart, liver and wing in the experimental groups was greater than those of the control group and the data was found to be statistically significant (P<0.05). In a study conducted on broilers²⁵, differences were observed in groups that consumed echinacea in terms of carcass characteristics and the liver, but no difference was found between the groups in terms of the weight of the breast and wings.

No study researching quail rations supplemented with Echinacea was found in the literature, so the levels of extruded Echinacea to be added to the rations was set by relying on previous studies conducted on broilers as a reference¹⁶. There are a limited number of studies examining how supplementing poultry rations with Echinacea in different amounts affects feed performance

and carcass production. According to the results of this study, supplementing quail rations with Echinacea does not lead to increased performance.

REFERENCES

1. **Ertas ON, Güler T, Çiftçi M, Dalkılıç B, Simsek GÜ:** The effect of an essential oil mix derived from Oregano, Clove and Anise on broiler performance. *Int J Poult Sci*, 4 (11): 879-884, 2005.
2. **Yeşilbağ D:** Fitobiyotikler. *Uludağ Univ J Fac Vet Med*, 26 (1-2): 33-39, 2007.
3. **Windisch W, Schedle K, Plitzner C, Kroismayr A:** Use of phytogenic products as feed additives for swine and poultry. *J Anim Sci*, 86, 140-148, 2008
4. **Sahin T, Aksu Elmalı D, Kaya I, Sarı M, Kaya O:** The effect of single and combined use of probiotic and humate in Quail (*Coturnix coturnix japonica*) diet on fattening performance and carcass parameters. *Kafkas Univ Vet Fak Derg* 17 (1): 1-5, 2011.
5. **Aksu T, Bozkurt AS:** Effect of dietary essential oils and/or humic acids on broiler performance, microbial population of intestinal content and antibody titres in the summer season. *Kafkas Univ Vet Fak Derg*, 15 (2): 185- 190, 2009.
6. **Yıldız G, Köksal BH, Sızmaç Ö:** Rasyonlara ilave edilen maya ve borik asidin broylerlerde performans, karkas ve bazı kan parametreleri üzerine etkisi. *Kafkas Univ Vet Fak Derg* 17 (3): 429-434, 2011.
7. **Alçiçek A, Bozkurt M, Çabuk M:** The effect of an essential oil combination derived from selected herbs growing wild in turkey on broiler performance. *S Afr J Anim Sci*, 33 (2): 89-94, 2003.
8. **Bozkurt M, Çatlı AU, Küçükylmaz K, Çınar M, Bintaş E:** Etlik piliç yemlerine organik asit ve esansiyel yağ karışımı ile kombinasyonlarının ilave edilmesinin besi performansı üzerine etkileri. *IV. Ulusal Hayvan Besleme Kongresi*, s. 217-220, 24-28 Haziran, Bursa, 2007.
9. **Çiftçi M, Güler T, Dalkılıç B, Ertaş N:** The effect of anise oil (*Pimpinella Anisum* L.) on broiler performance. *Int J Poult Sci*, 4 (11): 851- 855, 2005.
10. **Şimşek GÜ, Güler T, Çiftçi M, Ertaş ON, Dalkılıç B:** Esansiyel yağ karışımının (kekik, karanfil, anason) etlik piliçlerde canlı ağırlık, karkas ve etlerin duyuusal özellikleri üzerine etkisi. *IV. Ulusal Hayvan Besleme Kongresi*, s. 238-240, 24-28 Haziran, Bursa, 2007.
11. **Bölükbaşı ŞC, Erhan MK:** Effect of dietary thyme (*Thymus vulgaris*) on laying hens performance and *Escherichia coli* (*E. coli*) concentration in feces. *IJNES*, 1 (2): 55-58, 2007.
12. **Çabuk M, Eratak S, Alçiçek A:** Karma yeme esansiyel yağ karışımı ilavesinin Japon bıldırcınlarında büyüme performansına etkisi. *IV. Ulusal Hayvan Besleme Kongresi*, s. 224-227, 24-28 Haziran, Bursa, 2007.
13. **Denli M, Okan F Uluocak AN:** Effect of dietary supplementation of herb essential oils on the growth performance, carcass and intestinal characteristics of Quail (*Coturnix coturnix japonica*). *S Afr J Anim Sci*, 34, 174-179, 2004.
14. **Parlat SS, Alp ÖY, Cufadar Y, Olgun O:** Japon bıldırcınlarında deneysel alfatoksin zehirlenmesine karşı kekik uçucu yağı kullanımı. *Selçuk Üniv Ziraat Fak Derg*, 19 (36): 1-6, 2005.
15. **Gülbüz E, Balevi T, Kurtoğlu V, Coşkun B, Öznurlu Y, Kan Y, Kartal M:** Yumurtacı civcivlerde ekinezya (*Echinacea purpurea*) ekstraktının performans, immun sistem ve bağırsak dokusu üzerine etkileri. *V. Ulusal Hayvan Besleme Kongresi*, s. 26-31, 30 Eylül - 03 Ekim, Çorlu - Tekirdağ, 2009.
16. **Aituan MA, Wanyu SHI, Xiaofei NIU, Wang M, Zhong X:** Effects of *Echinacea purpurea* extract on the immunological response to infectious bursal vaccine in broilers. *Front Agric China*, 3 (4): 452- 456, 2009.
17. **Sharma M, Arnason JT, Burt A, Hudson JB:** Echinacea extracts modulate the pattern of chemokine and cytokine secretion in rhinovirus-infected cells. *Phytother Res*, 20 (2): 1074-1079, 2006.
18. **Bauer R, Wagner H:** Echinacea spices as potential immunostimulatory grugs. In, Wagner H, Farnsworth NR (Eds): *Economic and Medical Plant Research*. Vol. 5, London Academic Press Limited, 1991.
19. **NRC:** Nutrient Requirements of Poultry. 9th Revised ed., Natl Acad Press, Washington, 1994.
20. **AOAC:** Official methods of analysis of the association of official analytical chemist. 16th ed., Arlington, VA. 1996.
21. **TSE:** Hayvan yemleri, metabolik (çevrilebilir) enerji tayini (Kimyasal metot). TSE No: 9610, 1991.
22. **Jones R:** A standart method for the dissection of poultryfor carcass analysis. The West of Scotland Agricultural College, Technical Note, No. 222, 1984.
23. **Aydın R, Bal MA, Özüğür AK, Toprak HHC, Kamalak A, Karaman M:** Effect of black seed (*Nigella sativa* L.) supplementation on feed efficiency egg yield, egg yield parameters and shell quality in chicks. *Pakistan J Biol Sci*, 9 (2): 243- 247, 2006.
24. **Roth-Maier DA, Böhmer BM, Maab Nicole, Damme K, Paulicks BR:** Efficiency of *Echinacea purpurea* on performance of broiler and layers. *Arch Geflügelk*, 69 (3): 123-127, 2005.
25. **Nasir Z, Grashorn MA:** Effects of *Echinacea purpurea* and *Nigella sativa* supplementation on broiler performance, carcass and meat quality. *J Anim Feed Sci*, 19, 94-104, 2010.
26. **Hermann JR, Honeyman MS, Zimmerman JJ, Thacker BJ, Holden PJ, Chong CC:** Effect of dieatry Echinacea purpurea on viremia and performance in porcine reproductive and respiratory syndrome virus-infected nursery pigs. *J Anim Sci*, 81, 2139-2144, 2003.
27. **Maass N, Bauer J, Paulicks BR, Böhmer BM, Roth Maier DA:** Efficiency of *Echinacea purpurea* on performance and immune status in pigs. *J Anim Physiol Anim Nutr*, 89, 224-252, 2005.
28. **Nematalla Kh, M Sahar, AA Ghada, M Yousef, Zainb A Shabib:** Effect of Echinacea as antioxidant on markers of aging. *AJBAS J*, 5 (2): 18-26, 2011.