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Effect of Dietary Purslane (*Portulaca Oleracea L.*) Extract Supplementation on Performance and Carcass Characteristics of Quails under High Stocking Density

Mehmet EROĞLU [1, a]
Ali Osman TURGUT [1, b]
Mehmet IRMAK [2, c]
Cahit ÖZCAN [2, d]
Tuncay TUFAN [2, e]
İbrahim Halil KESKİN [2, f]
Rahmi DOĞAN [2, g]
Sultan ASLAN [3, h]

[1] Siirt University, Faculty of Veterinary Medicine, Department of Animal Science, Siirt, TÜRKİYE

[2] Siirt University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Disease, Siirt, TÜRKİYE

[3] Dicle University, Faculty of Veterinary Medicine, Department of Animal Science, Diyarbakır, TÜRKİYE

[a] ORCİD: 0000-0001-9471-6410
[b] ORCİD: 0000-0001-6863-0939
[c] ORCİD: 0000-0003-3988-2859
[d] ORCİD: 0000-0002-1047-5347
[e] ORCİD: 0000-0001-8420-4235
[f] ORCİD: 0009-0005-0574-1785
[g] ORCİD: 0009-0003-6711-9612
[h] ORCİD: 0000-0001-8480-1515

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Correspondence

Mehmet EROĞLU
Siirt University,
Faculty of Veterinary Medicine,
Department of Animal Science
Siirt – TÜRKİYE

mehmet.eroglu@siirt.edu.tr

This study aimed to evaluate the effects of dietary supplementation with 2% purslane (*Portulaca oleracea L.*) extract on growth performance and carcass characteristics of Japanese quails reared under high stocking density conditions. A total of 255 fifteen-day-old quails were randomly allocated into three groups: The control group (low stocking density, 160 cm²/bird, basal diet), the HS0 group (high stocking density, 80 cm²/bird, basal diet), and the HS2 group (high stocking density, 80 cm²/bird, basal diet supplemented with 2% purslane extract). The experiment lasted 28 days. Throughout the study, body weight (BW) and average daily gain (ADG) were not significantly different among the groups ($p>0.05$). However, feed intake (FI) was significantly lower in the HS2 group during days 29–35 and across the total feeding period (days 15–42) ($p<0.05$). A significant improvement in feed conversion ratio (FCR) was observed in the HS2 group during the same period ($p<0.05$). Carcass traits were mostly unaffected, except for gizzard weight, which was significantly different among groups ($p<0.05$). In conclusion, while purslane extract had no effect on body weight under high stocking density, it improved feed efficiency. These findings indicate that purslane may be a useful natural supplement for enhancing performance in quail production under intensive rearing conditions.

Key Words: *Quail, Purslane, stocking density, performance, carcass characteristics*

Yüksek Yerleşim Sıklığı Altındaki Bıldırcın Rasyonlarına Farklı Seviyelerde Semizotu Ekstraktı (*Portulaca Oleracea L.*) İlavesinin Büyüme ve Karkas Özelliklerine Etkisi

Bu araştırmada, yüksek yerleşim sıkılığında yetiştirilen Japon bıldırcınlarının rasyonlarına %2 oranında semizotu (*Portulaca oleracea L.*) ekstresi takviyesinin büyüme performansı ve karkas özellikleri üzerindeki etkileri incelenmiştir. Çalışmada 15 günlük yaşta olan toplam 255 bıldırcın cinsiyet ayrımı olmadan rastgele olarak üç gruba dağıtılmış ve her grup üç tekerrür içermiştir. Kontrol grubu (düşük yerleşim sıkılığı (160 cm²/kanatlı) bazal rasyon), HS0 grubu (yüksek yerleşim sıkılığı (80 cm²/kanatlı), bazal rasyon) ve HS2 grubu (yüksek yerleşim sıkılığı (80 cm²/kanatlı), bazal rasyona %2 semizotu ekstresi ilavesi). Deneme 28 gün süreyle yürütülmüştür. Deneme süresince vücut ağırlığı ve ortalama günlük canlı ağırlık artışı parametreleri bakımından gruplar arasında istatistiksel olarak anlamlı farklılık görülmemiştir ($p>0.05$). HS2 grubunda yem tüketimi, hem 29–35. günler arasındaki dönemde hem de toplam besi periyodu (15–42. günler) boyunca istatistiksel olarak daha düşük düzeyde tespit edilmiştir ($p<0.05$). Buna paralel olarak, yemden yararlanma oranı aynı 15–42 gün yaş aralığında HS2 grubunda anlamlı düzeyde iyileşme göstermiştir ($p<0.05$). Karkas özellikleri genel anlamda etkilenmemiş olup, yalnızca taşlık ağırlığında gruplar arasında istatistiksel olarak anlamlı farklılık tespit edilmiştir ($p<0.05$). Sonuç olarak, semizotu ekstresi yüksek yerleşim sıkılığı altında vücut ağırlığını etkilememekle birlikte yemden yararlanma oranı bakımından verimliliği artırmıştır. Elde edilen bulgular, semizotu ekstresinin yüksek yerleşim sıklığı şartlarında bıldırcınların performansını iyileştirmeye yönelik doğal bir katkı maddesi olarak kullanılabileceği düşünülmektedir.

Anahtar Kelimeler: *Japon bıldırcını, semizotu, yerleşim sıkılığı, performans, karkas özellikleri*

Introduction

In modern poultry production, animals are subjected to intensive selection for rapid body weight gain and high productivity with reduced feed intake. Under intensive rearing conditions, poultry are exposed to various stressors such as vaccination, beak trimming, handling and transportation, molting, high humidity, and stocking density. These high-stress conditions induce significant metabolic changes that adversely affect both productivity and overall health (1, 2). Among these factors, high stocking density is particularly critical, as it increases stress and disease risk, potentially resulting in decreased growth performance and lower meat quality. Conversely, excessively low stocking density leads to economic inefficiency (3). Excessive stocking density contributes to elevated ambient temperatures, reduced airflow, and impaired heat dissipation. Furthermore, it compromises ventilation quality, increases ammonia concentrations, and restricts access to feed and water, ultimately reducing performance (4, 5).

Portulaca oleracea L., commonly known as purslane, is a widely consumed plant in Turkey and around the world, particularly in salads and cooked meals. Although it frequently appears as a weed in agricultural fields, it is also intentionally cultivated as a crop. Recent research has demonstrated that purslane possesses superior nutritional qualities compared to many conventional crops. It is notably rich in beta-carotene, ascorbic acid (vitamin C), and alpha-linolenic acid, an omega-3 fatty acid (6, 7). Additionally, purslane is acknowledged for its substantial antioxidant capacity, positioning it as both a nutritious and functional food source (7, 8). The plant's antioxidant effects are primarily due to bioactive constituents such as gallotannins, omega-3 fatty acids, ascorbic acid, alpha-tocopherol, kaempferol, quercetin, and apigenin (9, 10).

Although there is no research specifically addressing the effects of purslane supplementation in relation to stocking density, numerous studies have explored its use as a feed additive in quail and other poultry species, reporting promising outcomes. Abd El-Hack et al. (11) found that purslane extract supports the immune system and enhances antioxidant capacity, in addition to reducing harmful microbial load in the intestines, suggesting its suitability as a dietary supplement. Aydın and Doğan (12) reported improvements in egg production, egg weight, feed conversion ratio, and omega-3 fatty acid content in eggs when dried purslane was added at 0.1% and 0.2% to layer hen diets. Similarly, Jian et al. (13) observed that supplementation of broiler drinking water with 2, 20 and 40 mg/mL purslane polysaccharides improved growth performance. Zhao et al. (14) demonstrated that inclusion of 0.2% and 0.4% purslane extract in broiler diets enhanced body weight gain and feed efficiency, and positively influenced intestinal microflora. Ghorbani et al. (10) reported an increase in blood antioxidant capacity with the addition of purslane seeds in poultry diets. Konca et al. (15) showed that purslane seed inclusion at 2.5%, 5%, and 10% in quail diets enhanced serum antioxidant levels without affecting carcass traits or lipid profiles.

This study aims to investigate the effects of dietary supplementation (2%) purslane extract under high stocking density conditions on growth performance and carcass chracteristics in Japanese Quails.

Materials and Methods

Research and Publication Ethics: A total of 255 fifteen-day-old Japanese quails (Coturnix coturnix japonica) were selected for this study based on an a priori power analysis (Cohen's f= 0.25, α= 0.05, power= 0.95). Approval of Siirt University Animal Research Ethics Committee (Protocol Number: 2025/31). The animals used in the study were obtained from the Quail Unit of the Siirt University Wildlife Protection, Rehabilitation, and Research Center. The study was carried out at the Poultry Unit, Siirt University and animals were housed in standard cages with dimensions of 60 × 45 × 25 cm (length x width x height). The experiment consisted of three groups: The control group (low stocking density (160 cm²/quail), and basal diet), the HS0 group (high stocking density (80 cm²/quail), and basal diet), and the HS2 group (high stocking density (80 cm²/quail), and basal diet supplemented with 2% purslane extract). In the study, a total of 255 quails at 15 days of age were allocated into three groups, each consisting of three replicates. In the control group, 17 quails were housed per cage, whereas in the HS0 and HS2 groups with high stocking density, 34 quails were housed per cage. Birds were assigned to experimental groups balanced according to body weight (BW). Throughout the trial, all quails were fed a basal diet containing 22.60% crude protein (CP) and 2930 kcal/kg metabolizable energy (ME), the details of which are presented in Table 1. Feed and water were provided *ad libitum* throughout the study. The environmental temperature was maintained at 22 ± 2°C with continuous 24-hour lighting (16, 17).

The trial lasted for 28 days, during which live body weights and feed consumption were recorded weekly. The average daily gain (ADG) was calculated by dividing the difference between weekly body weight measurements by the number of days and individuals.

Table 1. Composition and nutrient content of the basal diet

Feed Composition	Proportion (%)	Nutrient Composition (%)	Value
Yellow Corn	43.39	Dry matter	89.80
Wheat	9.50	Crude protein	22.60
Wheat Bran	1.29	Metabolizable energy ** (kcal/kg)	2930
Vegetable Oil	13.00	Calcium	0.80
Sunflower Meal (32% CP)	6.00	Phosphorus	0.31
Cottonseed Meal (32% CP)	6.50	Crude fat	4.70
Soybean Meal (48% CP)	27.13	Crude fiber	4.97
Dicalcium Phosphate	0.75	Crude ash	5.91
Limestone	1.29	DL-methionine	0.75
Salt	0.35	L-lysine	1.34
Vitamin-Mineral Premix*	0.25	L-threonine	1.05
L-lysine	0.30		
L-threonine	0.25		

*Vitamin-mineral premix composition per kg of diet: 13,000 IU vitamin A, 3,500 IU vitamin D_3, 100 mg vitamin E, 3 mg vitamin K_3, 3 mg vitamin B_1, 8 mg vitamin B_2, 6 mg vitamin B_6, 30 mg vitamin B_{12}, 30 mg niacin, 8 mg calcium-D-pantothenate, 2 mg folic acid, 70 mg vitamin C, 70 mg D-biotin, 200 mg choline chloride, 2 mg canthaxanthin, 0.75 mg apo-carotenoic acid ester, 120 mg Mn, 100 mg Zn, 90 mg Fe, 16 mg Cu, 1.5 mg I, 0.75 mg Co, 0.30 mg Se.

** Calculated

Weekly net feed intake was determined by subtracting feed refusals from the amount of feed offered. Based on these data, the feed conversion ratio (FCR) was calculated using daily feed intake and daily weight gain. (17, 18). On day 42 of the trial, twelve quails from each treatment group with body weights near the group average were slaughtered. The feathers, heads, legs, and internal organs were removed. The obtained carcasses were stored at +4°C for 24 hours and subsequently dissected into leg (at the articulatio genus), breast (at the articulatio sternocostalis), wing (at the articulatio humeri), neck, and back sections according to the regulations and requirements of the Turkish Standards Institution (19).

Statistical Analyses: The data were evaluated for homogeneity of variances using Levene’s test and for normality of distribution using the Shapiro–Wilk test. One-way Analysis of Variance (ANOVA) followed by Tukey’s post hoc test was performed to assess statistical differences among groups. All statistical analyses were conducted using the SPSS 21.0 software package. Data are presented as mean ± standard error of the mean (SEM), and differences were considered statistically significant at $p<0.05$ (20, 21).

Results

Table 2 presents the values of body weight, feed intake, and feed conversion ratio for the groups. Throughout the trial, BW values, no statistically significant differences were observed between the groups at any period ($p>0.05$). Regarding feed intake (FI), statistically significant differences were detected between groups during the 29–35 and 15–42 days of age ($p<0.05$). In these periods, the HS2 group exhibited lower feed intake compared to the other groups.

Mortality rates and average daily body weight gain (ADG) values did not differ significantly among groups during any of the periods studied ($p>0.05$). In terms of FCR, statistically significant differences were observed in 15–42 days of age ($p<0.05$). Based on these results, it is considered that the HS2 group demonstrated better feed efficiency.

Table 3 presents the effects that the experimental treatment has on the carcass characteristics. No statistically significant differences were found between the groups in slaughter weight, cold carcass weight, heart, liver, neck, breast, back, thigh, wing weights, and carcass yield ($p>0.05$). However, a significant difference was observed in gizzard weight among the groups ($p<0.05$).

Table 2. Effects of Treatments on Growth Performance in Japanese Quails

Traits	Control	HS0	HS2	*p*
Body weight, g				
Day 15	26.10 ± 0.06	26.06 ± 0.05	26.05 ± 0.02	0.694
Day 22	65.68 ± 0.89	67.08 ± 1.17	64.41 ± 1.15	0.287
Day 29	110.04 ± 1.28	109.21 ± 2.04	105.76 ± 0.92	0.178
Day 36	150.71 ± 1.94	143.15 ± 3.61	145.66 ± 2.83	0.245
Day 42	177.88 ± 0.78	169.05 ± 2.02	171.60 ± 3.04	0.079
Feed intake, g / bird / week				
Days 15-21	12.65 ± 0.17	12.96 ± 0.35	11.98 ± 0.33	0.133
Days 22-28	16.15 ± 0.60	16.10 ± 0.67	16.65 ± 0.34	0.750
Days 29-35	22.95 ± 0.15^{a}	21.35 ± 0.81^{ab}	20.14 ± 0.18^{b}	0.018
Days 36-42	28.76 ± 1.05	25.99 ± 0.88	24.90 ± 0.96	0.071
Days 15-42	20.13 ± 0.24 ^{a}	19.10 ± 0.27 ^{b}	18.42 ± 0.41 ^{b}	0.023
Average Daily Gain, g / bird / day				
Days 15-21	5.52 ± 0.16	5.86 ± 0.17	5.46 ± 0.16	0.258
Days 22-28	6.47 ± 0.05	6.02 ± 0.13	5.92 ± 0.03	0.060
Days 29-35	5.81 ± 0.16	4.85 ± 0.47	5.70 ± 0.32	0.099
Days 36-42	3.88 ± 0.38	3.71± 0.40	3.69 ± 0.11	0.903
Days 15-42	5.42 ± 0.03	5.11 ± 0.07	5.20 ± 0.11	0.067
Feed conversion ratio, g feed / g gain				
Days 15-21	2.24 ± 0.07	2.21 ± 0.02	2.19 ± 0.03	0.446
Days 22-28	2.43 ± 0.08	2.31 ± 0.04	2.38 ± 0.08	0.045
Days 29-35	3.96 ± 0.11	4.50 ± 0.51	3.55 ± 0.16	0.187
Days 36-42	7.52 ± 0.62	7.33 ± 0.75	6.58 ± 0.19	0.096
Days 15-42	3.71 ± 0.05^{a}	3.74 ± 0.03^{a}	3.54 ± 0.02^{b}	0.015
Mortality rates (%)				
Days 15-42	0.67± 0.32	2.33±1.20	1.66± 0.32	0.297

a,b: Mean values with different superscripts within a row differ significantly ($p<0.05$).

Table 3. Effects of treatments on carcass characteristics in japanese quails

Traits	Control	HS0	HS2	*p*
Slaughter Weight (g)	163.80 ± 5.77	155.10 ± 5.58	154.12 ± 6.29	0.449
Cold Carcass Weight (g)	114.58 ± 4.64	109.18 ± 4.15	107.86 ± 4.74	0.542
Heart (g)	1.44 ± 0.04	1.32 ± 0.07	1.26 ± 0.08	0.194
Liver (g)	2.95 ± 0.18	3.21 ± 0.21	3.09 ± 0.27	0.782
Gizzard (g)	3.76 ± 0.16^{a}	3.30 ± 0.11^{b}	3.21 ± 0.12^{b}	0.014
Neck (g)	7.91 ± 0.64	6.37 ± 0.38	7.03 ± 0.57	0.148
Breast (g)	43.34 ± 2.15	42.48 ± 1.85	40.58 ± 1.67	0.714
Back (g)	13.97 ± 0.80	14.79 ± 0.99	13.55 ± 0.75	0.702
Thigh (g)	41.09 ± 1.81	37.25 ± 1.62	36.75 ± 1.69	0.133
Wing (g)	8.27 ± 0.35	8.28 ± 0.28	8.56 ± 0.50	0.830
Cold Carcass Yield (%)	69.95 ± 1.47	70.35 ± 0.41	69.97 ± 1.17	0.960

a,b: Mean values with different superscripts within a row differ significantly (p<0.05).

Discussion

Stocking density plays a vital role in maximizing farm profitability by optimizing production per unit area within poultry facilities (22). As the poultry industry increasingly prioritizes the balance between animal welfare and production costs, the spatial requirements for birds have become a significant consideration, encompassing not only large-scale production but also health and economic factors. The relationship between optimal stocking density, health status, and economic performance has been extensively investigated across various poultry species, including broilers managed under both extensive and intensive systems (23). Among the primary economic indicators, BW at the conclusion of the rearing period is particularly important. Previous studies have demonstrated that dietary supplementation with purslane-derived products, including purslane extract, crude polysaccharides, and dried herbs, can improve BW in broiler chickens, mice, and rabbits (14, 24, 25). Conversely, in the present study, quails exposed to higher stocking densities (HS0 and HS2 groups) showed reduced final BW and average daily gain compared to the control group, although these differences were not statistically significant ($p>0.05$). This outcome contrasts with findings from Estevez et al. (26) and Özbey et al. (27), who reported that increased stocking density elevates stress levels in poultry, thereby adversely affecting weight gain. The observed discrepancy may be explained by the relatively lower initial BW of the quails at the start of the experiment, which likely contributed to lower final weights overall. Additionally, the reduced total live weight per unit area throughout this study, compared to previous research, may have mitigated the impact of stocking density (23).

In terms of feed intake, weekly measurements revealed a statistically significant difference between groups only during days 29 to 35 days of age ($p<0.05$), while no significant differences were observed between groups during other weeks. When considering the entire experimental period, the highest feed intake was recorded in the control group with low stocking density (20.13 g), whereas significantly lower feed intake was detected in the high stocking density groups ($p<0.05$). This finding aligns with the results reported by Jayalakshmi et al. (28), who indicated that insufficient space reduces airflow at the animal level, increasing temperature, humidity, and ammonia levels, which in turn limits access to feed and water. Furthermore, increased stocking density intensifies competition for feeders and drinkers, potentially preventing subordinate individuals from consuming adequate nutrients. Accordingly, the reduced feed intake observed in the high-density groups is likely attributable to both microclimatic deterioration and social stress (29). Additionally, the non-significant effect of purslane extract supplementation on feed intake in the high stocking density groups (HS0 and HS2) is consistent with findings from Özcan et al. (30), who reported similar results when using comparable levels of purslane.

FCR, an important indicator of economic efficiency and profitability, showed no significant differences between groups during the weekly measurements throughout the study. However, similar to feed intake, a statistically significant difference was observed between groups when evaluated over the entire experimental period ($p<0.05$). Previous studies examining the effects of stocking density in binary comparisons have reported higher feed conversion ratios in groups subjected to high stocking densities, attributed to environmental stress factors (23, 31). In the present study, the inclusion of purslane extract resulted in a significant improvement in feed conversion efficiency compared to the other groups. Shehata and Abd El-Krim (32) reported that purslane extract enhances antioxidant defense mechanisms by preventing cellular damage caused by free radicals, thereby preserving tissue integrity and positively influencing growth performance. Similarly, Güngören et al. (33) demonstrated that the high content of ascorbic acid and flavonoids in purslane exerts anti-inflammatory and free radical scavenging effects, which minimize oxidative damage induced by stress conditions in animals, supporting growth and development. These biochemical interactions suggest that the use of purslane as a dietary supplement can mitigate stress-related performance declines, improving weight gain and overall health status (7, 8).

No statistically significant differences were observed between groups in terms of slaughter weight, cold carcass weight, and carcass yield ($p>0.05$). These results indicate that neither stocking density nor purslane supplementation had a significant effect on these parameters. Among the internal organs examined, a significant difference was found only in gizzard weight ($p<0.05$), suggesting that purslane may exert specific effects on the digestive system. On the other hand, the weights of the breast, thigh, back, and other carcass parts were not affected by purslane supplementation. These findings are consistent with those reported by Sur Arslan et al. (31), who found no significant impact of stress on muscle metabolism and carcass characteristics. Overall, the data indicate that stocking density and purslane supplementation do not cause significant positive or negative changes in carcass efficiency during production.

In conclusion, the present study demonstrated that while live body weight remained unaffected, feed conversion rate improved with purslane supplementation under high stocking density conditions. These findings suggest that incorporating natural antioxidants such as purslane may help mitigate stress-related inefficiencies in intensive quail production. Future research should focus on determining optimal dosing strategies and elucidating the physiological mechanisms behind these benefits to promote more sustainable and profitable poultry farming.

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