Effect of Pomegranate Peel Powder Added to the Diet of Broiler Chickens on Productivity Characteristics and Chemical Composition of the Main Carcass Parts

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Abstract

This study was conducted over a 49-day period at the research field of Shaqlawa College, Erbil Polytechnic University, to evaluate the effects of dietary supplementation with different levels of pomegranate peel powder (PPP) on broiler chickens (Cobb 308 strain). A total of 60 birds were randomly assigned to four groups of 15 birds each. The experiment followed a completely randomized design in a 2×2×2 factorial arrangement, with three treatment groups receiving PPP at 2% (T1), 4% (T2), and 6% (T3) inclusion levels, and a control group (C) receiving no supplementation. The trial lasted for seven weeks. The results showed that most PPP-supplemented groups exhibited significantly higher live body weight and carcass weight compared to the control. Five birds from each group were randomly selected for slaughter to assess meat quality. The fatty acid profile of the meat was analyzed using gas chromatography. The findings revealed that higher PPP levels tended to reduce protein content in the thigh meat. However, the feed conversion ratio (FCR) remained unaffected. Additionally, supplementation with sesame oil led to an increase in live body weight, although overall weight differences among the PPP-fed groups and the control were not statistically significant. An inverse relationship was observed between PPP inclusion level and certain performance parameters.

Keywords: *Pomegranate peel powder, broiler, productivity, chemical composition, carcass.*

Introduction

The continuous use of antibiotics in poultry feed has contributed to the emergence of antibiotic-resistant bacterial strains and raised potential health concerns for consumers due to the accumulation of residues in poultry products such as eggs and meat. As a result, there is a growing need for safe and effective alternatives to antibiotics in poultry production (Suresh et al., 2018). One such alternative is the use of medicinal plants, which, when included in poultry diets, offer promising benefits. These plants contain bioactive compounds known for their therapeutic properties and positive physiological effects in both humans and animals, without causing adverse side effects or health risks (Ahmad and Sharma, 1992).

Pomegranate peels are a rich source of antioxidants, accounting for approximately 92% of the fruit's total antioxidant content (Ismail et al., 2012). These antioxidants, particularly phenolic compounds, flavonoids, tannins, alkaloids, and saponins, play a crucial role in enhancing the oxidative stability of chicken meat and eggs when included in poultry diets. Remarkably, pomegranate peels contain a higher concentration of these bioactive compounds—about 30% of the fruit's total weight—compared to the pulp, which contains around 26%. Due to the abundance of these active compounds, several studies have highlighted the antimicrobial potential of pomegranate peels against various pathogenic bacteria and microorganisms (Li et al., 2006; AL-Noaimi et al., 2017; Ali et al., 2017; Atya et al., 2018). In addition to their antibacterial properties, pomegranate peels have demonstrated antihelminthic activity (Aksad, 2012; Sabri, 2013; Dkhil, 2013). Beyond pathogen control, pomegranate peel powder (PPP) may positively influence blood lipid profiles by reducing harmful low-density lipoprotein (LDL) cholesterol and triglyceride

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levels while increasing high-density lipoprotein (HDL) cholesterol, thus offering further health benefits (Ahmed et al., 2005, Li et al., 2006; Sabri, 2013; Abood and Fahad, 2011). Despite these promising properties, limited research has been conducted on the inclusion of pomegranate peels in broiler diets, particularly under hot climate conditions. Therefore, the current study aimed to evaluate the effects of incorporating different levels of PPP (2%, 4%, and 6%) into a standard broiler diet on selected production traits and the chemical composition of key carcass components.

Material and Methods

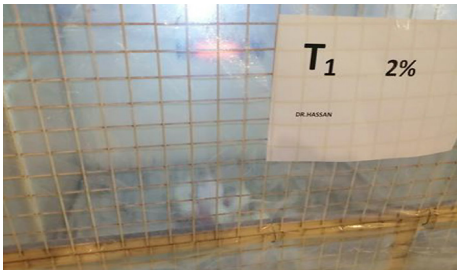
Chicks experiment

A total of 60 chicks, one -wk.-old broiler strain (308) were divided into 4 dietary groups with four replicates per group (15 birds per replicate). A completely randomized design with factorial arrangement 2×2×2 consisted of three levels of pomegranate peels powder levels (T1. 2%, T2. 4%, and T3 6%). Further group control (C) without any additive of Pomegranate peels powder the feeding trial lasted 7 weeks.

Housing management

The chickens were housed in the experimental hall of the Veterinary Department at Shaqlawa Technical College, under uniform technological and environmental conditions. Climatic variables were carefully monitored to meet the specific requirements for the type and category of the animals used in the study. Key technological systems, such as ventilation, lighting intensity, and photoperiod (daylight duration)—were standardized throughout the experiment (Pictures 1 – 4).

Picture 1. Treatment control without any additive



Treatment one included the addition 2% of pomegranate peels

one included the addition 4% of pomegranate peels

one included the addition 6% of pomegranate peels

The trial was completed when the broiler chickens reached 49 days of age, with biological tests conducted and finalized within two months. The chickens were managed according to Ross management guidelines. Water and feed were provided ad libitum, and uniform lighting was maintained for 24 hours per day. Housing temperature and vaccination programs were applied based on standard recommendations for broiler production. Throughout the trial, chickens were kept on deep litter under identical technological conditions. Microclimate parameters—including temperature and humidity—were measured three times daily (at 7:00 a.m., 12:00 p.m., and 5:00 p.m.) and recorded (see Figure 3). Measurements were taken at the level corresponding to the birds' body zone, near floor level, to ensure accurate reflection of their environmental conditions.

Feeding formula

Feeding formula for starter and finisher is presented in Tables 1 and 2.

Table 1. Formula of starter feed mixture Components

	Groups %			
Attribute	C	T1	T2	T3
Maize	48.50	48.50	48.50	48.50
Soybean meal	29.00	29.00	29.00	30.00
Wheat	11.5	11.00	11.00	12.00
Fishmeal	4.00	4.00	4.00	4.00
Limeston(Ca Co3)	1.30	1.30	1.30	1.30
monocalcum phosphate	0.85	0.85	0.85	0.85
*PX BR Unit	1.00	1.00	1.00	1.00
Methionen 99%	0.05	0.05	0.05	0.05
Total salt	0.22	0.22	0.22	0.22
lysine	0.03	0.03	0.03	0.03
Therionine 99 %	0.05	0.05	0.05	0.05
Pomegranate peels powder	0	2	4	6
Sunflower oil	4	2	0	0
Total	100.00	100.00	100.00	100.00

Table 2. Formula of finisher feed mixture Components

Groups %				
Attribute	C	T1	T2	T3
Maize	40.50	40.50	48.50	40.50
Soybean meal	20.0	20.00	20.00	20.00
Wheat	28.0	28.0	28.0	26.0
Fishmeal	4.00	4.00	4.00	4.00
Limeston(Ca Co3)	1.30	1.30	1.30	1.30
monocalcum phosphate	0.85	0.85	0.85	0.85
*PX BR Unit	1.00	1.00	1.00	1.00
Methionen 99%	0.05	0.05	0.05	0.05
Total salt	0.22	0.22	0.22	0.22
lysine	0.03	0.03	0.03	0.03
Therionine 99 %	0.05	0.05	0.05	0.05
Pomegranate peels powder	0	2	4	6
Sunflower oil	4	2	0	0
Total	100.00	100.00	100.00	100.00

*vit. A=4,500,000 IU, vit. D=1,660,000 IU, vit. E=20,000 mg.kg-1, K3=1, mg.kg-1, vit. B1=1,800 mg.kg-1, vit. B2=2,500 mg. vit. B6=1,600 mg.kg-1, vit. B12=8.75 mg.kg-1, folic acid=600 mg.kg-calcium pentonite=5,500 mg.kg-1, niacinamid=18,000 mg.kg-1, biotin=60 mg cholin clorid=30,000 mg.kg-1, betain=65,000 mg.kg-1, cobalt=150 mg.kg-1, Iodine=380 mg.kg-1, Mn=45,800 mg.kg-1, cupper=6,500 mg.kg-1, Si=110 mg.kg-1, Zn=28,300 mg.kg-1, Fe=27,200mg.kg-1, Mo=350 mg.kg-1.

Experimental parameters

Body weight

Final body weight was measured by individually weighing the chickens at 49 days of age, after an overnight fast, using a scale with an accuracy of ±5 grams (see Figure 5). Initial body weights were similar across all groups before dietary treatments were applied, with an average of 41 grams per bird.

Daily weight gain

Daily weight gain was calculated in grams (g) by dividing the living gained body weight in feeding period by the number of the days. It was calculated at the day 49.

Daily feed consumption

Feed consumption was recorded at the end of the feeding period, and average daily feed intake was calculated by dividing the total feed consumed by the number of days in the period. All calculations were performed at day 49.

Feed Conversion Ratio

The chickens were inspected daily, and any mortalities were recorded, including the date and body weight of the deceased birds. Dead birds were promptly removed. The feed conversion ratio (FCR) was calculated as the ratio of body weight gain (BWG, in grams) to feed intake (FI, in grams). When calculating FCR, the body weights of dead birds were included in the overall analysis. FCR values were determined at 49 days of age.

Protein intake and protein efficiency ratio

Values of Protein Intake (PI) and Protein Efficiency Ratio (PER) of dietary treatments were calculated using the following formula:

PI (g) = Percentage of protein in diet × FI (g)

FI= feed intake

PER (g) = BWG (g)/ PI (g)

All above farm parameter calculated of 200 birds for each treatment.

Slaughter outputs

Immediately after slaughter, the liver and heart were carefully removed from each carcass, sealed in plastic bags, and preserved in liquid nitrogen for subsequent analysis (see Figure 6). Following organ removal, the carcasses were chilled to 4 °C. The abdominal fat pad—extending from the proventriculus and surrounding the gizzard down to the cloaca—was then dissected and weighed, according to the method described by Cahaner and Nitsan (1985). At the end of the experimental period (49 days of age), one bird with an average body weight was selected from each replicate within the treatment groups, resulting in a total of 15 sampled birds per treatment. These birds were slaughtered to determine the relative weights of the following carcass components: **a**. The hot carcass weight. **b**. The breast. **c**. The legs. **d**. Thighs**. e**. The drumstick. **f.** The back half. **g**. Wings. **h**. Abdominal fat. **i**. The gizzard. **j**. The heart. **k**. The Liver. **l**. Feathers.

Meat quality

The basic chemical analysis of the muscles was determined and represented in percentage in the meat represented in $g.kg^{-1}$

Determination of crude fat methyl esters (FAME)

The fat content in the meat and liver samples was analyzed using the procedureISO – 11085 (2008) standard method.

Determination of total Ash

The ISO 5984:2002 methodology was used to assess the total ash content.

Basic nutrients determination in the meat

Dry matter was measured using thermal drying at 105°C, in accordance with ISO 1442:2000 as per Slovak Standard. Crude protein levels were calculated using the Kjeldahl method, following Slovak Standard 75/A-04018:1975. Crude fat was analyzed via the Soxhlet extraction technique. Crude ash (CA) acc. to Standard PN-72/A-82245.

Statistical analysis.

A completely randomized design (CRD) with four treatment groups was used for statistical analysis. Data from all experiments were analyzed using analysis of variance (ANOVA) appropriate for a CRD. Differences between treatment means were assessed using Duncan's New Multiple Range Test. Statistical significance was set at $P < 0.05$, except for chemical composition parameters, where a more stringent threshold of $P < 0.01$ was applied. Percentage data were subjected to appropriate transformations prior to analysis to meet assumptions of normality and homogeneity of variance. All statistical analyses were performed using SPSS software, version 23.1 for Windows® (SPSS Inc., Chicago, IL, USA).

Result and discussion

Effect of different dietary treatments with different level of pomegranate peel powder on performance weight (g. day-1) of birds.

As shown in Table 3, there was no significant difference ($P \geq 0.05$) in the initial body weight among groups, as birds with similar weights were selected from the hatchery. Final live body weight (Table 3) showed no significant difference ($P \geq 0.05$) between the control group (C) and treatment 2 (T2), while both groups differed significantly from treatments 1 (T1) and 3 (T3), with the highest body weight observed in the control group. This decrease in weight gain in T1 and T3 may be attributed to reduced feed intake, possibly caused by digestive limitations associated with the early-stage inclusion of pomegranate peel components. Similar significant trends were observed for weight gain, daily weight gain, and feed consumption. Regarding feed conversion ratio (FCR), the best values were recorded in T2 and T3, which aligns with the calculations based on the feed intake and weight gain data. These results agree with the previous results (Banerjee et al., 2013).

Table 3. Effect of different dietary treatments with different level of pomegranate peel powder on performance weight (g. day-1) of birds.

Treatment	Initial weight	Final weight	Weight access	Daily weight access	Feed consumption	F.C.R
C	44.87±0.85	3492.22±10.41^{a}	3447.35±9.99 ^{a}	82.08±9.99^{a}	7858.41±472.29^{a}	2.25±0.13^{a}
T1	45.38±0.75	2543.11.38±11.38^{c}	2498.53±11.47^{c}	59.48±0.28^{c}	4707.26±348.55^{c}	1.85±0.13^{b}
T2	44.82±0.78	3488.40±40.59^{a}	3443.820±24.75^{a}	81.10±0.58^{a}	4460.99±1028.55^{c}	1.28±0.30^{c}
T3	45.05±1.01	3157.10±10.10^{b}	3112.05±10.10^{b}	74.09±0.24^{b}	6543.06±542.79^{b}	2.07±0.17^{bc}

^{a,b} means with different superscript within row are significantly different ($P< 0.05$) and values will increase from (^{d}) to (^{a}) value. Values mean ±S.D. Standered Devetion of 15 birds.

Effect of different dietary treatments with different level of pomegranate peel powder on carcass, main and secondary parts weight (g. day-1) of birds.

Table 4 shows that the differences in live body weight were reflected in carcass weight; however, these differences were not statistically significant among the treatment groups. The highest carcass weight was observed in the control group (C), which did not receive pomegranate peel supplementation—likely due to better early-stage growth performance. All treatments showed significant differences ($P \leq 0.05$) in breast weight, with the highest value recorded in T2. This may be attributed to a lower fat content and higher protein and moisture levels in this group. For thigh weight, the control group had the highest value, significantly different from all treatment groups, which were also significantly different from each other. Leg weights were not significantly different ($P \geq 0.05$) between T2 and T1 but were significantly different from the other treatments, with the highest value observed in T1. Significant differences were also found in wing and neck weights, with T2 and C groups recording the highest values, respectively. Back and head weights followed a similar pattern, with the control group showing significant differences compared to the other groups, while differences among the treatment groups themselves were not significant. This pattern corresponds with the overall carcass weight, where higher values were noted in T3 and T2, respectively.

Effect of pomegranate peel powder on carcass, with, without edible and edible parts of chicks

Table 5 shows similar significant patterns for carcass weights both including and excluding edible parts, which likely reflect the variations in live body weights. Treatment 2 (T2) had a significantly higher edible carcass weight compared to the other groups. The

Table 4. Effect of different dietary treatments with different level of pomegranate peel powder on carcass, main and secondary parts weight (g. day-1) of birds.

Treatment	Carcass without head	Breast	Thigh	leg	Wing	Back	Neck	head
C	3018.47±9.63^{a}	1209.25±7.04^{b}	794.77±3.81^{a}	82.75±18.48^{b}	234.50±1.29^{b}	523.25±1.071^{a}	110.00±0.81^{a}	64.00±1.83^{b}
T1	2108.90±11.90^{d}	557.50±5.067^{d}	476.50±5.80^{d}	140.50±1.29^{a}	389.00±1.83^{a}	452.25±2.63^{b}	86.00±2.16^{c}	122.75±2.22^{a}
T2	2980.85±26.05^{b}	1362.75±25.23^{a}	690.50±1.29^{b}	134.50±1.29^{a}	221.13±1.31^{c}	451.75±2.22^{b}	90.98±1.83^{b}	124.50±1.29^{a}
T3	2660.35±10.50^{c}	982.25±8.42^{c}	625.75±2.99^{c}	85.50±1.29^{b}	216.25±2.63^{d}	639.50±1.29^{a}	71.75±1.71^{d}	122.50±1.29^{a}

^{a,b} means with different superscript within row are significantly different (P< 0.05) and values will increase from (^{d}) to (^{a}) value. Values mean ±S.D. Standered Devetion of 15 birds.

control group (C) and Treatment 1 (T1) were not significantly different from each other but differed significantly from the other treatments, likely due to variations in the weights of specific carcass parts. Regarding organ weights, the highest liver weight was observed in T2, followed by T3; these two groups were not significantly different from each other but were significantly different from the other treatments. The lowest heart weight was found in the control group, which was significantly different from the other treatments that did not differ significantly among themselves. This difference may be attributed to an increased heart rate influenced by pomegranate supplementation. For gizzard weight, T1 was not significantly different from the control group but was significantly lower than both T2 and T3, which themselves differed significantly, similarly these results are in accordance with the previous findings (Hammad and Kareem, 2019).

Effect of pomegranate peel powder on chemical contain of breast

Table 6 presents the results of the chemical and statistical analyses of the samples. Moisture content was not significantly different between T2 and T3, nor between the control group (C) and T1. However, each of these two group pairs differed significantly from one another ($P \leq 0.05$). Ash content did not differ significantly among treatments, which may be attributed to the relatively consistent levels of organic matter across all groups.

Protein percentage showed no significant difference between C and T2, but both were significantly different from the other treatments. The highest protein content was recorded in T3. Regarding fat content, the control group (C) had the highest value, significantly higher than the other treatment groups, which did not differ significantly among themselves. This reduction in fat content in the pomegranate peel-treated groups may be attributed to bioactive compounds in the peel that inhibit fat accumulation in body tissues.

Effect of pomegranate peel powder on chemical contain of thigh

Table 7 indicates that ash percentage was not significantly different between the control group (C) and T1, nor between T2 and T3. However, these two pairs of treatments were significantly different from each other ($P \leq 0.05$). The protein percentage in the thigh was generally not significantly different among treatments, except for T3, which showed a significantly higher value compared to the other groups. Regarding fat content, the highest value was observed in T1, followed by the control group (C) and T2, respectively.

Table 5. Effect of pomegranate peel powder on carcass, with, without edible and edible parts of chicks

Treatment	Carcass with edible	Carcass without edible	Edible	liver	Heart	gizzard
C	3018.47±9.63[a]	2871.78±6.34[a]	146.70±3.44[b]	72.38±2.29[b]	15.15±0.13[b]	59.18±2.30[a]
T1	2108.90±11.90[d]	1961.25±12.42[d]	145.65±1.35[b]	60.20±0.18[c]	24.70±1.01[a]	60.59±0.96[a]
T2	2980.85±26.05[b]	2817.10±27.14[b]	163.75±1.50[a]	105.25±1.26[a]	25.00±2.16[a]	33.50±1.29[c]
T3	2660.35±10.50[c]	2535.50±11.70[c]	124.85±4.95[c]	60.10±0.18[c]	24.75±4.03[a]	40.00±0.82[b]

[a,b] means with different superscript within row are significantly different (P< 0.05) and values will increase from ([d]) to ([a])value. Values mean ±S.D. Standered Devetion of 15 birds.

Table 6. Effect of pomegranate peel powder on chemical contain of breast

Treatments	Moisture%	%Ash	Protein%	Fat%
C	73.40±0.04[b]	1.09±0.01	17.63±0.12[b]	5.83±0.05[a]
T1	73.18±0.23[b]	1.14±0.05	17.23±0.02[c]	5.53±0.05[b]
T2	73.98±0.03[a]	1.09±0.02	17.80±0.02[b]	5.53±0.09[b]
T3	74.05±0.19[a]	1.08±0.01	18.28±0.12[a]	5.43±0.17[b]

[a,b] means with different superscript within row are significantly different (P< 0.05) and values will increase from ([d]) to ([a]) value. Values mean ±S.D. Standered Devetion of 15 birds.

Table 7. Effect of pomegranate peel powder on chemical contain of thigh

Treatments	Moisture%	%Ash	Protein%	Fat%
C	73.09±0.01[b]	1.10±0.01[b]	16.23±0.12[b]	6.66±0.49[ab]
T1	73.16±0.43[b]	1.11±0.01[ab]	15.63±0.98[b]	7.00±0.21[a]
T2	73.35±0.07[a]	1.12±0.01[a]	16.51±0.86[ab]	6.91±0.03[ab]
T3	73.42±0.08[a]	1.09±0.01[b]	17.38±0.05[a]	6.31±0.13[b]

[a,b] means with different superscript within row are significantly different (P< 0.05) and values will increase from ([d]) to ([a]) value. Values mean ±S.D. Standered Devetion of 15 birds.

Conclusion

Based on the results of this study, it can be concluded that incorporating pomegranate peel powder (PPP) into broiler chicken diets positively influences several productive performance parameters and enhances the chemical composition of carcass parts. Notably, a 4% inclusion level (T2) provided the most balanced improvements in feed conversion ratio, carcass characteristics, and meat quality—particularly through increased protein content and reduced fat levels. These benefits are likely attributable to the rich content of bioactive phytochemicals and antioxidant compounds in pomegranate peels, which may enhance metabolic efficiency and modulate lipid deposition in tissues

This study highlights the potential of PPP as a natural functional feed additive that not only improves broiler productivity but may also reduce reliance on synthetic growth promoters. The findings align with a growing body of research supporting the use of plant-based alternatives in poultry nutrition, particularly under heat stress or in semi-arid environments.

Future research should focus on assessing the immunomodulatory properties of PPP, its long-term effects on organ function, and its applicability across various poultry species such as ducks and geese. Additionally, molecular studies are recommended to investigate the mechanisms by which PPP influences gene expression related to metabolism and immune responses.

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