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Effects of Different Levels of Raisins Pomace Powder on Productive Performance and Blood Parameters in Broiler Chickens

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ABSTRACT

One of the primary concerns in poultry farming is the exploration of natural feed ingredient alternatives that are, concurrently, more cost-effective and environmentally sustainable. Raisin pomace powder (RPP), a by-product from grape processing, may contain numerous beneficial nutrients and natural compounds that contribute to optimal performance in chickens. The present study assessed the impact of incorporating RPP into broiler chicken diets concerning growth performance, carcass characteristics, economic efficiency, blood parameters, and immune indices. A total of 180 unsexed Ross 308 broiler chickens, all one day old with an initial average body weight of approximately 38 g, were randomly divided into four dietary treatments. The present study comprised a control group (T1) and three experimental groups, including 10 g/kg of RPP (T2), 20 g/kg of RPP (T3), and 30 g/kg of RPP (T4). The study duration spanned 35 days, covering both the initial and finisher phases. The present results demonstrated no statistically significant differences in body weight, weight gain, feed intake, dressing percentage, or economic efficiency among the treatment groups. However, the feed conversion ratio was notably higher in T2 in comparison to the control group. Hematological parameters, encompassing packed cell volume, hemoglobin concentration, as well as red and white blood cell counts, were not significantly influenced by the inclusion of RPP. Serum levels of total protein and globulin remained stable across groups, whereas albumin levels exhibited a significant decrease in T4. Additionally, cholesterol levels were reduced in T3 compared to T1. The current findings suggested that RPP can be included in broiler diets up to 30 g/kg without adverse effects on productivity, physiological status, or immune development. Utilizing RPP provided a sustainable strategy for poultry nutrition through the employment of agro-industrial by-products, thereby potentially improving feed resource efficiency and environmental sustainability.

Keywords: Broiler chicken, Bursa of Fabricius, Economic efficiency, Feed conversion ratio, Productive performance, Raisin pomace powder

INTRODUCTION

The increasing global demand for poultry meat and eggs, combined with intensified competition for traditional feed ingredients such as soybean meal and maize, underscores the importance of exploring sustainable alternatives (Alshelmani et al., 2021). In poultry farming, natural feed additives are increasingly employed to enhance growth performance and overall productivity (Kairalla et al., 2022a). Furthermore, concerns regarding the residual effects of antibiotic growth have led to the development of alternative additives designed to improve chicken performance (Kairalla et al., 2022b; Kairalla et al., 2023). Grapes (*Vitis vinifera*) represent one of the most economically significant crops worldwide, with an annual production exceeding 78 million tons (OIV, 2019; Čech et al., 2021). The food processing industry produces significant waste, with fruit processing alone generating large amounts of pomace, peels, and seeds (Muzaffar et al., 2022). The processing of grapes for juice, wine, and raisin production generates substantial by-products globally (Spanghero et al., 2009; Mewa-Ngongang et al., 2019). By-products are rich in beneficial compounds, such as carotenoids, polyphenols, and vitamins, which can be extracted to use as functional foods and nutraceuticals (Ritika et al., 2024; Boruah and Ray, 2024). Sustainable utilization of these by-products can create new industry revenue streams, promote a circular economy, and reduce waste (Foti et al., 2022; Boruah and Ray, 2024). Several compounds, such as antioxidants, flavonoids, and polyphenols, can enhance oxidative stability and promote beneficial gut bacteria in poultry, contributing to overall health (Azizi et al., 2018; Kumanda et al., 2019). The presence of tartaric acid and prebiotic fructooligosaccharides in raisin by-products may positively influence the gut microbiota, supporting their use as functional feed additives in poultry diets (Al-taee et al., 2014). Due to increasing concerns regarding synthetic antioxidants in poultry diets, attributable to their potential toxicity, carcinogenicity, and accumulation in edible tissues, there is a rising interest in investigating safer and natural alternatives (Mousa et al, 2020; Garg, 2024).

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Among these, phenolic compounds derived from grape pomace have garnered significant attention, not only for their antioxidant properties but also as an environmentally sustainable solution for the management of grape processing waste, which comprises approximately 20% of the total grape weight (Llobera and Canellas, 2007). Improper disposal of raisin pomace in landfills can cause environmental pollution by producing greenhouse gases and leachate, increasing the risk of soil and water contamination (Limeneh et al., 2022).

The bioactive composition of grape pomace, including high levels of polyphenolic compounds, along with 25-35% crude cellulose, 4-10% hemicellulose, 5-6% pectin, 8-14% crude protein, 4-10% crude fat, and 30-45% non-nitrogenous substances, supports its potential as a functional ingredient in poultry feed, providing an eco-friendly and cost-effective way to manage pomace waste (Kara et al., 2016; Kasapidou et al., 2016).

Despite increasing interest in the utilization of fruit by-products in animal nutrition, studies particularly evaluating the use of raisin pomace in poultry diets remain limited. The present study aimed to assess the effects of incorporating different levels of raisin pomace into broiler chickens' diets on growth performance as well as hematological and biochemical blood parameters.

MATERIALS AND METHODS

Ethical approval

The present study received approval from the Central Committee of Research Ethics at the University of Kufa, Iraq, pursuant to the decision made during the fifth session held on 12/07/2023. Ethical clearance was obtained for the project, and the study was carried out in strict accordance with the approved institutional ethical standards (Official Approval Code: 7121).

Raisin pomace preparation

Raisin pomace, which includes skins, seeds, and pulp residues, was collected daily from juice shops in Baghdad, Iraq, until enough quantity was gathered. Samples were immediately air-dried on clean concrete floors in a well-ventilated room at ambient temperature to preserve heat-sensitive compounds such as polyphenols. After drying, the material was sealed in airtight plastic bags and stored at approximately 5°C to maintain nutritional and microbial quality. Before use, the dried pomace was ground into a fine powder to ensure uniform mixing in the experiment diets.

Study area

The field experiment was conducted at the poultry farm of the Department of Animal Production, Faculty of Agriculture, University of Kufa, Iraq. The study commenced on July 20, 2023, and lasted for 35 days, concluding on August 24, 2023. A total of 180 unsexed one-day-old Ross 308 broiler chickens were obtained from Al-Anwar Hatchery in Babil Province and randomly assigned to the experimental treatments.

Experimental design

A total of 180 unsexed Ross 308 broiler chickens were assigned to the experimental design, which consisted of four dietary treatments, each replicated three times with 15 chickens per replicate, totaling 12 pens. The chickens were divided into four treatment groups, with T1 serving as the control group and receiving a basal diet without any additives, T2 was administered the basal diet supplemented with 10 g/kg raisin pomace powder (RPP), T3 was given the basal diet supplemented with 20 g/kg RPP, and T4 was given the basal diet supplemented with 30 g/kg RPP. Raisin pomace powder, after being dried and finely ground, was accurately weighed and manually mixed into the respective feed mixtures for treatments T2, T3, and T4. The supplemented diets were thoroughly blended to ensure homogeneous distribution of the additive throughout both the starter and finisher rations.

Chickens' management

With a total of 12 pens, each measuring 3 m^2, the stocking density was 5 birds/m^2, which complied with the commercial and welfare standards recommended for Ross 308 under moderate environmental conditions. The chickens were reared for a period of 35 days, during which they were subjected to a two-phase feeding regimen; an initial diet from day 1 to 21 and a subsequent finisher diet from day 22 to 35. Throughout the study, feed and clean water were provided *ad libitum*. Environmental conditions were managed following established protocols for broiler chicken management. The temperature started at 33-34°C during the first week and was gradually decreased by 2-3°C each week until reaching 24°C by the end of the study. Relative humidity was kept between 55% and 65%. A lighting schedule of 23 hours of light and 1 hour of darkness was used for the first three days, then shifted to 20 hours of light and 4 hours of darkness from day four onward to enhance feed intake and growth performance.

The experimental diets were formulated in accordance with the National Research Council (NRC, 1994) nutrient requirements for broiler chickens. All diets were designed to be isocaloric and isonitrogenous, thereby ensuring a consistent nutritional intake throughout the duration of the trial.

Routine veterinary health management was applied uniformly across all groups. Vaccination was administered against Newcastle disease and infectious bronchitis on days 7 and 21. In addition, all diets were supplemented with the anticoccidial drug Decoquinate (Deccox®, Netherlands) at 30 ppm in the feed, provided from the first day of age until day 35 as a preventive measure against coccidiosis. Chickens were monitored daily for their health status and behavior. The control group was administered a basal diet, as delineated in Table 1.

Table 1. Percentage composition and chemical analysis of starter and finisher diets in broiler chickens

Ingredients	Starter (1-21 days)	Finisher (22-35 days)
Cracked yellow corn	50.50	58.00
Soybean meal	36.00	27.50
Cracked wheat	8.00	7.00
Premix*	2.50	2.50
Oil	1.50	3.50
Dicalcium phosphate**	0.1	0.1
Limestone	1.1	1.1
Salt	0.3	0.3
Total	100	100
Calculated chemical composition		
Metabolizable energy (kcal/ kg feed)	3015	3210
Crude protein (%)	21.11	19.58
Calcium (%)	1.102	1.08
Available phosphorus (%)	0.74	0.71
Energy: Protein	130.4	163.9

* A Jordanian-manufactured premix containing 4900 kcal/kg metabolizable energy, 18% crude protein, 1.1% fat, 15-19% calcium, 9.4% lysine, 6.8% phosphorus, 4.8% sodium, 5.8% chlorine, 7.8% methionine, 7.8% methionine + cystine, and 0.55% threonine. It contains vitamins and trace minerals to meet the bird's requirements. **Dicalcium phosphate contains 22% non-phytate calcium and 8% non-phytate phosphorus.

Data collection and trait determination

Growth performance

Data were collected at two key time points: The end of the starter phase (Day 21) and the end of the experiment on Day 35. A total of 12 chickens per treatment group (4 chickens per replicate) were randomly chosen at each interval for growth performance assessment. Live body weight (g) was recorded by weighing each chicken individually with a digital precision scale. Weight gain (g) was determined by the difference in body weight over specific intervals (0-21, 22-35, and 0-35 days). Feed intake (g) was calculated as the difference between the total feed offered and the residual feed per replicate, expressed on a per-chicken basis. Feed conversion ratio (FCR) was computed by dividing feed intake by weight gain.

Carcass traits

On day 35, 4 chickens per replicate were utilized for carcass evaluations. The dressing percentage (%) was determined after the chickens had undergone an 8-hour fasting period, followed by weighing, slaughtering, defeathering, and evisceration. The dressing yield was computed as (eviscerated carcass weight / live body weight) × 100.

Economic efficiency

The present study evaluated the economic efficiency by combining three key factors, including production efficiency, feed utilization, and rearing duration. For economic efficiency, the following formula was used. Economic efficiency = (Total marketed chickens' weight in kg × 10,000) / (Number of chickens reared × rearing period in days × FCR). This indicator demonstrates how well production inputs are converted into live body weight output. Higher values indicate better overall production and financial performance (Naji and Hanna, 1999).

Blood parameters

Blood samples were collected from the brachial vein into EDTA tubes for measuring hematological parameters, including hemoglobin (Hb, g/dL) using Sahli's method, packed cell volume (PCV, %) via microhematocrit centrifugation, and red blood cell (RBC) and white blood cell (WBC) counts employing Natt and Herrick's solution under a hemocytometer. For biochemical analysis, blood collected in plain tubes was subjected to centrifugation at 3000 rpm for 10 minutes, after which the serum was stored at -20°C until subsequent analysis. Parameters assessed with commercial kits (Biolabo, France) and a UV-Vis spectrophotometer included total protein and albumin (g/dL), measured respectively by biuret and bromocresol green methods. Globulin (g/dL) was derived by subtracting albumin from total protein, while cholesterol (mg/dL) was determined using the CHOD-PAP enzymatic technique. All procedures adhered to veterinary clinical guidelines as outlined by Jain (1993).

Immune indices

On day 35, the chickens were humanely euthanized for examination of the bursa of Fabricius. The organ was removed, cleaned, and weighed using a digital scale (± 0.01 g). The relative weight of the bursa of Fabricius was calculated as (bursa weight / live body weight) × 100, and the bursal index was calculated using the same formula following the method of Lucio and Hitchner (1979).

Statistical analysis

The data were analyzed using one-way analysis of variance (ANOVA) to evaluate the effects of dietary treatments. When significant differences ($p < 0.05$) were observed, Duncan's multiple range test (Duncan, 1955) was applied to separate means. Statistical analyses were performed using SAS software, version 9.0 (SAS, 2012).

RESULTS

Live body weight

Body weight was measured individually at day 21 (Week 3) and day 35 (Week 5). No statistically significant differences were observed among the treatment groups at either time point ($p > 0.05$). The mean final body weights at day 35 for treatments T1, T2, T3, and T4 were 2318 g, 2253 g, 2303 g, and 2307 g per broiler chicken, respectively. Although there were minor numerical differences, statistical analysis indicated no significant treatment effects on the final live outcomes weight.

Weight gain

The present results indicated that there were no statistically significant differences in average weight gain among broiler chickens across all treatment groups during the intervals day 0 to 21 (Starter phase), day 22-35 (Finisher phase), and day 0-35 (Overall period; $p > 0.05$; Table 2). The total weight gains, which represent the overall increase in body weight from the start to the end of each specified period, were 2280 g, 2215 g, 2265 g, and 2269 g per chicken for treatments T1, T2, T3, and T4, respectively, by the end of the study (Day 35).

Dressing percentage

At the end of the experiment (Day 35), no statistically significant differences were observed in dressing percentage among broiler chickens across treatment groups ($p > 0.05$). The recorded dressing percentages were 73.0% for T1, 73.7% for T2, 73.6% for T3, and 74.0% for T4.

Table 2. Effects of using different levels of raisin pomace powder on live body weight, weight gain, and dressing percentage during the 35-day trial period in broiler chickens

Treatments	Live body weight (g)		Weight gain (g)			Dressing percentage
	Week 3	Week 5	0-3 weeks	4-5 weeks	0-5 weeks	
T1	1027 ± 161.00	2318 ± 44.94	989 ± 161.00	1292 ± 122.09	2280 ± 44.94	73.0 ± 10.2
T2	1045 ± 166.36	2253 ± 178.44	1007 ± 166.36	1208 ± 73.79	2215 ± 178.44	73.7 ± 8.0
T3	1053 ± 185.15	2303 ± 681.55	1016 ± 185.15	1249 ± 496.41	2265 ± 681.55	73.6 ± 5.9
T4	1025 ± 120.08	2307 ± 379.68	987 ± 120.08	1282 ± 259.61	2269 ± 379.68	74.0 ± 1.00
Significant	NS	NS	NS	NS	NS	NS

T1: Control (without addition), T2: 10g raisins pomace powder/ kg feed, T3: 20g raisins pomace powder/ kg feed, T4: 30g raisins pomace powder/ kg feed, NS: Non-significant

Feed intake

The current findings indicated that there were no statistically significant differences in feed intake among broiler chickens across all experimental periods by the end of the study ($p > 0.05$; Table 3). Treatment T3 recorded the highest total feed intake at 3760 g per chicken, while the control group (T1) indicated the lowest intake at 3573 g per chicken.

Feed conversion ratio

Broiler chickens during the starter phase (0-3 weeks) across all groups exhibited no significant differences ($p > 0.05$). However, during the finisher phase (4-5 weeks), a significant decline in FCR was observed in treatments T2 and T3 compared to the control group ($p < 0.05$), whereas treatment T4 did not demonstrate any significant difference compared to the control and other treatment groups ($p > 0.05$). Over the entire period (0-5 weeks), Treatment T2 demonstrated the lowest feed efficiency, with an FCR of 1.69 g feed/g weight gain, significantly higher than that of the control group (1.57 g feed/g weight gain; $p < 0.05$). Treatments T3 and T4 recorded FCR values of 1.66 and 1.63 g feed/g weight gain, respectively, and indicated no significant differences compared to the control group ($p > 0.05$).

Economic efficiency

The incorporation of different levels of RPP into broiler chickens' diets did not yield a statistically significant impact on the economic outcome across all treatment groups compared to the control group by the end of the study ($p > 0.05$; Table 3).

Hematological parameters

Based on the current results, no statistically significant differences were observed among the experimental treatments in PCV, Hb concentration, RBC, or WBC count in broiler chickens at 35 days of age ($p > 0.05$; Table 4).

Biochemical blood

The current findings indicated that there were no significant differences in serum total protein and globulin concentrations among broiler chickens across experimental groups ($p > 0.05$). However, serum albumin levels in treatment T4 were significantly lower compared to the control group and T2 ($p < 0.05$); no significant differences were detected among treatments T2, T3, and T4 ($p > 0.05$). Concerning serum cholesterol levels, no statistically significant differences were observed between treatments T2 and T4 in comparison to the control group ($p > 0.05$). Conversely, Treatment T3 demonstrated a significant decrease compared to the control group ($p < 0.05$; Table 5).

Relative weight of the bursa of Fabricius and bursal index

Based on the current results, there were no statistically significant differences in the relative weight of the bursa of Fabricius among all groups ($p > 0.05$). The recorded values were 0.142%, 0.182%, 0.169%, and 0.142% for treatments T1, T2, T3, and T4, respectively. Similarly, no significant differences were observed in the bursal index among broiler chickens across all groups at 35 days of age ($p > 0.05$). The bursal index values were 1.00, 1.29, 1.19, and 1.00 for treatments T1, T2, T3, and T4, respectively (Table 6).

Table 3. Effects of using different levels of raisin pomace powder in diets on feed intake, feed conversion ratio, and economic figures during the 35-day trial period in broiler chickens

Treatments	Feed intake (g)			Feed conversion ratio (g feed/ g weight gain)			Economic efficiency
	0-3 weeks	4-5 weeks	0-5 weeks	0-3 weeks	4-5 weeks	0-5 weeks	
T1	1494 ± 201.25	2079 ± 321.99	3572 ± 248.20	1.51 ± 0.07	$1.61^{b} \pm 0.13$	$1.57^{b} \pm 0.07$	423 ± 17.58
T2	1599 ± 588.98	2135 ± 194.54	3734 ± 583.61	1.58 ± 0.27	$1.77^{a} \pm 0.07$	$1.69^{a} \pm 0.27$	382 ± 11.27
T3	1601 ± 223.38	2159 ± 321.99	3760 ± 509.82	1.58 ± 0.13	$1.74^{a} \pm 0.40$	$1.66^{ab} \pm 0.27$	397 ± 183.80
T4	1532 ± 771.44	2169 ± 321.99	3701 ± 409.20	1.55 ± 0.13	$1.69^{ab} \pm 0.20$	$1.63^{ab} \pm 0.20$	404 ± 112.03
Significant	NS	NS	NS	NS	*	*	NS

T1: Control (without addition), T2: 10g raisins pomace powder/ kg feed, T3: 20g raisins pomace powder/ kg feed, T4: 30g raisins pomace powder/ kg feed. *$^{a, b}$ Different superscript letters vertically indicate a significant difference ($p < 0.05$). NS: Non-significant.

Table 4. Effects of using different levels of raisin pomace powder on haematological indices during the 35-day trial period in broiler chickens

Treatments	Packed cell volume (%)	Hemoglobin (g/dl)	Red blood cells ($\times 10^6$/ mm^3)	White blood cells ($\times 10^3$ / mm^3)
T1	29.23 ± 3.42	10.20 ± 6.98	2.28 ± 2.21	25.96 ± 32.74
T2	33.26 ± 36.22	8.97 ± 2.41	2.86 ± 3.09	21.80 ± 46.15
T3	32.30 ± 17.64	9.60 ± 5.43	2.79 ± 1.81	28.30 ± 8.39
T4	31.25 ± 1.34	9.20 ± 1.54	2.75 ± 0.07	26.05 ± 14.09
Significant	NS	NS	NS	NS

T1: Control (without addition), T2: 10g raisins pomace powder/ kg feed, T3: 20g raisins pomace powder/ kg feed, T4: 30g raisins pomace powder/ kg feed, NS: Non-significant.

Table 5. Effects of using different levels of raisin pomace powder on the blood biochemical indices during the 35-day trial period in broiler chickens

Treatments	Total protein (g/dL)	Albumin (g/dL)	Globulin (g/dL)	Cholesterol (mg/ dL)
T1	3.81 ± 0.47	2.28^{a} ± 0.87	1.53 ± 0.40	159.04^{a} ± 21.47
T2	3.74 ± 2.75	2.25^{a} ± 0.74	1.49 ± 3.09	128.80^{ab} ± 130.94
T3	3.30 ± 0.80	2.02^{ab} ± 1.01	1.28 ± 1.41	106.58^{b} ± 95.59
T4	3.33 ± 0.40	1.77^{b} ± 1.01	1.55 ± 0.60	114.35^{ab} ± 90.69
Significant	NS	*	NS	*

T1: Control (without addition), T2: 10g raisins pomace powder/ kg feed, T3: 20g raisins pomace powder/ kg feed, T4: 30g raisins pomace powder/ kg feed. *$^{a, b}$ Different superscript letters vertically indicate a significant difference ($p < 0.05$). NS: Non-significant.

Table 6. Effect of using different levels of raisin pomace powder on the relative weights of the Bursa of Fabricius and bursal index during the 35-day trial period in broiler chicken

Treatments	Relative weights (%)	Bursal index
T1	0.142 ± 0.10	1.00 ± 0.000
T2	0.182 ± 0.09	1.29 ± 0.60
T3	0.169 ± 0.07	1.19 ± 0.55
T4	0.142 ± 0.13	1.00 ± 0.93
Significant	NS	NS

T1: Control (without addition), T2: 10g raisins pomace powder/ kg feed, T3: 20g raisins pomace powder/ kg feed, T4: 30g raisins pomace powder/ kg feed, NS: Non-significant.

DISCUSSION

The incorporation of RPP into the diet at a level of 10-30 g/kg did not have a significant impact on body weight gain in broiler chickens. The present findings are consistent with those of Jonathan et al. (2021) and Şen and Başalan (2022), which indicated that adding grape pomace at levels up to 60 g/kg did not adversely affect growth. Furthermore, Aditya et al. (2018) and Dupak et al. (2021) reported no adverse effects at a dosage of 10 g/kg. In contrast, Romero et al. (2022) identified growth inhibition at elevated inclusion levels, which was attributed to the potential tannin or fiber overload. Conversely, the consistent growth observed in the current study implied that raisin pomace, characterized by lower levels of anti-nutritional factors, may be more beneficial for the broiler chickens' performance. During the current study, feed intake remained statistically unchanged among all groups, which was consistent with the findings of Aditya et al. (2018) and Şen and Başalan (2022). Notably, FCR markedly improved in T2 (10 g/kg), in contrast to the findings of Kumanda et al. (2019), who found a decrease in FCR as grape pomace levels increased. The improvement might be due to enhanced digestibility or nutrient absorption, possibly linked to the bioactive compounds found in raisin pomace. Based on the current findings, the inclusion of RPP in broiler chickens' diets did not lead to significant changes in dressing percentage or carcass yield across all treatment groups. The present findings aligned with the results reported by Aditya et al. (2018) and Kumanda et al. (2019), who noted minimal impacts of grape pomace inclusion on carcass characteristics. Additionally, Aljumaili et al. (2023), who examined grape seed oil, an alternative grape by-product, observed no adverse effects on growth performance or carcass attributes. These results further supported the potential benefits of grape derivatives in poultry nutrition. However, Bennato et al. (2020) observed that slight improvements in carcass traits with grape pomace supplementation, which was attributed to increased antioxidant levels in the diet, and these differences may result from variations in the type and processing of the pomace used. Hematological parameters, including PCV, Hb, RBC, and WBC, remained stable across all groups. The present hematological finding was consistent with the findings of Pascariu et al. (2017) and Jonathan et al. (2021), who reported no significant changes in RBC, WBC, and PCV values when broiler chickens were fed grape pomace at different inclusion levels. These results closely align with the present findings using RPP, which confirmed that polyphenol-rich by-products such as grape or raisin residues do not negatively affect hematological stability, especially RBS, WBC counts, and PCV, even at higher dietary levels. Additionally, Aditya et al. (2018) reported consistent levels of glucose, HDL, and triglycerides with the use of grape pomace. Furthermore, no significant differences were observed in the weight or index of the bursa of Fabricius across different treatments during the present study. While Mavrommatis et al. (2021) indicated that grape pomace influenced immune gene expression, they did not examine its anatomical effects. Therefore, the present study assessed the anatomical impact of raisin pomace on the bursa of Fabricius, offering new evidence for its safety in supporting the immune system development. The inclusion of RPP at different dietary levels did not lead to significant differences in the calculated economic efficiency among treatment groups. These findings aligned with those of Reyes et al. (2020), who reported similar results when assessing grape pomace in broiler chickens' diets, and the current findings indicated that RPP inclusion up to 30 g/kg did not negatively impact feed efficiency or growth performance, nor did it alter overall production efficiency. Notably, the present study was the first investigation to document the effect of RPP on performance assessment grounded in economic efficiency within poultry production, thereby presenting a novel contribution to the scholarly literature on functional feed additives.

CONCLUSION

Raisin pomace powder can be safely included in broiler chickens' diets at levels of up to 30 g/kg without negative effects on performance, health, or economic efficiency. The current findings not only supported the safe use of agro-industrial by-products in poultry nutrition but also offered new insights into the application of RPP, particularly concerning the bursal index and economic evaluation. Future studies are warranted to explore raisin pomace's functional roles in gut health, meat quality, antioxidant status, and large-scale economic implications.

DECLARATIONS

Authors' contributions

Atheer Salih Mahdi was responsible for developing the research idea, designing the experiment, collecting and analyzing the data, drafting the manuscript, and preparing the final edition for publication. All stages of the study and manuscript preparation were carried out independently by the author. The author has read and approved the final edition of the manuscript.

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Availability of data and materials

All data generated or analyzed during the present study are included in the manuscript. Additional datasets, if required, are available from the corresponding author upon reasonable request.

Competing interests

The author has declared any conflict of interest.

Ethical considerations

The author has checked the ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy.

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REFERENCES

Aditya S, Ohh SJ, Ahammed M, and Lohakare J (2018). Supplementation of grape pomace (*Vitis vinifera*) in broiler diets and its effect on growth performance, apparent total tract digestibility of nutrients, blood profile, and meat quality. Animal Nutrition, 4(2): 210-214. DOI: https://www.doi.org/10.1016/j.aninu.2018.01.004

Aljumaili OA, Humam AM, Al-Mashhadani HA, Alshelmani MI, and Abdulrazzaq NZ (2023). Effect of different dietary of grape seed oil level on the growth performance and carcass characteristics in broiler chickens (*Gallus gallus domesticus*). Journal of Kerbala for Agricultural Sciences, 10: 1-12. Available at: https://www.journals.uokerbala.edu.iq/index.php/Agriculture/article/view/1114

Alshelmani MI, Abdalla EA, Kaka U, and Basit MA (2021). Nontraditional feedstuffs as an alternative in poultry feed. In: A. K. Patra (Editor), Advances in poultry nutrition research. IntechOpen, pp. 1-2. DOI: http://www.doi.org/10.5772/intechopen.95946

Al-Taee MF, Waleed H, and Kamona Z (2014). Cytogenetic and fertility study for the effect of alcoholic and water extracts of gold and black raisin in mice. International Journal of Pharma Sciences, 4(5): 718-724. Available at: https://repository.uobaghdad.edu.iq/articles/YBbDdIcBVTCNdQwCs0wz?page=2945

Azizi M, Seidavi AR, Ragni M, Laudadio V, and Tufarelli V (2018). Practical applications of agricultural wastes in poultry feeding in Mediterranean and Middle East regions. Part 1: Citrus, grape, pomegranate and apple wastes. World's Poultry Science Journal, 74(3): 489-498. DOI: https://www.doi.org/10.1017/S0043933918000478

Bennato F, Di Luca A, Martino C, Ianni A, Marone E, Grotta L, Ramazzotti S, Cichelli, A, and Martino G (2020). Influence of grape pomace intake on nutritional value, lipid oxidation and volatile profile of poultry meat. Foods, 9(4): 508. DOI: https://www.doi.org/10.3390/foods9040508

Boruah B and Ray S (2024). Current progress in the valorization of food industrial by-products for the development of functional food products. Food Science and Applied Biotechnology, 7(2): 289-317. DOI: https://www.doi.org/10.30721/fsab2024.v7.i2.349

Čech M, Haščík P, Pavelková A, Čuboň J, Bučko O, Tkáčová J, Kačániová M, Bobko M, Imrich I, and Šár K (2021). Chemical composition of muscle after red grape pomace application in the nutrition of broiler chickens. Journal of Microbiology, Biotechnology and Food Sciences, 10(6): e3726. DOI: https://www.doi.org/10.15414/jmbfs.3726

Duncan DB (1955). Multiple range and multiple F tests. Biometrics, 11(1): 1-42. DOI: https://www.doi.org/10.2307/3001478

Dupak R, Kovac J, Kalafova A, Kovacik A, Tokarova K, Hascik P, Simonova N, Kacaniova M, Mellen M, and Capcarova M (2021). Supplementation of grape pomace in broiler chickens diets and its effect on body weight, lipid profile, antioxidant status and serum biochemistry. Biologia, 76: 2511-2518. DOI: https://www.doi.org/10.1007/s11756-021-00737-6

Foti P, Pino A, Romeo FV, Vaccalluzzo A, Caggia C, and Randazzo CL (2022). Olive pomace and pâté olive cake as suitable ingredients for food and feed. Microorganisms, 10(2): 237. DOI: https://www.doi.org/10.3390/microorganisms10020237

Garg S (2024). Synthetic antioxidants. Dietary supplements and nutraceuticals, pp. 150-154. DOI: https://www.doi.org/10.58532/nbennurdsch15

International organisation of vine and wine (OIV) (2019). 2019 Statistical report on world vitiviniculture. Available at: https://www.oiv.int/public/medias/6782/oiv-2019-statistical-report-on-world-vitiviniculture.pdf

Jain NC (1993). Essentials of veterinary hematology. Lea and Febiger., Philadelphia, pp. 365-372. Available at: https://www.scirp.org/reference/referencespapers?referenceid=1554845

Jonathan O, Mnisi CM, Kumanda C, and Mlambo V (2021). Effect of dietary red grape pomace on growth performance, hematology, serum biochemistry, and meat quality parameters in Hy-line Silver Brown cockerels. PLoS ONE, 16(11): e0259630. DOI: https://www.doi.org/10.1371/journal.pone.0259630

Kairalla MA, Aburas AA, and Alshelmani MI (2022a). Effect of diet supplemented with graded levels of ginger (*Zingiber officinale*) powder on growth performance, hematological parameters, and serum lipids of broiler chickens. Archives of Razi Institute, 77(6): 2089. DOI: https://www.doi.org/10.22092/ARI.2022.359958.2524

Kairalla MA, Alshelmani MI, and Aburas AA (2022b). Effect of diet supplemented with graded levels of garlic (*Allium sativum L.*) powder on growth performance, carcass characteristics, blood hematology, and biochemistry of broilers. Open Veterinary Journal, 12(5): 595-601. DOI: https://www.doi.org/10.5455/OVJ.2022.v12.i5.1

Kairalla MA, Alshelmani MI, and Imdakim MM (2023). Effect of diet supplemented with different levels of moringa powder on growth performance, carcass characteristics, meat quality, hematological parameters, serum lipids, and economic efficiency of broiler chickens. Archives of Razi Institute, 78(5): 1647. Available at: https://www.archrazi.areeo.ac.ir/article_128780.html

Kara K, Guclu BK, Baytok E, and Senturk ME (2016). Effects of grape pomace supplementation to laying hen diet on performance, egg quality, egg lipid peroxidation and some biochemical parameters. Journal of Applied Animal Research, 44(1): 303-310. DOI: https://www.doi.org/10.1080/09712119.2015.1031785

Kasapidou E, Soddidou E N, Zdragas A, Papadaki C, Vafeas G, and Mtlianga P (2016). Effect of grape pomace supplementation on broiler meat quality characteristics. European Poultry Science, 80: 135-142. DOI: https://www.doi.org/10.1399/eps.2016.135

Kumanda C, Mlambo V, and Mnisi CM (2019). From landfills to the dinner table: Red grape pomace waste as a nutraceutical for broiler chickens. Sustainability, 11(7): 1931. DOI: https://www.doi.org/10.3390/su11071931

Limeneh DY, Tesfaye T, Ayele M, Husien NM, Ferede E, Haile A, Mengie W, Abuhay A, Gelebo GG, Gibril M et al. (2022). A comprehensive review on utilization of slaughterhouse by-product: Current status and prospect. Sustainability, 14(11): 6469. DOI: https://www.doi.org/10.3390/su14116469

Llobera A and Cañellas J (2007). Dietary fibre content and antioxidant activity of Manto Negro red grape (*Vitis vinifera*): Pomace and stem. Food Chemistry, 101(2): 659-666. DOI: https://www.doi.org/10.1016/j.foodchem.2006.02.025

Lucio B and Hitchner SB (1979). Infection bursal disease emulsified vaccine: Effect upon neutralizing-antibody levels in the dam and subsequent protection of the progeny. Avian Diseases, 23(2): 466-478. DOI: https://www.doi.org/10.2307/1589577

Mavrommatis A, Simitzis PE, Kyriakaki P, Giamouri E, Myrtsi ED, Evergetis E, Filippi K, Papapostolou H, Koulocheri SD, Pappas AC et al. (2021). Immune-related gene expression profiling of broiler chickens fed diets supplemented with vinification by-products: A valorization approach II. Animals, 11(11): 3038. DOI: https://www.doi.org/10.3390/ani11113038

Mewa-Ngongang M, du Plessis HW, Ntwampe SK, Chidi BS, Hutchinson UF, Mekuto L, and Jolly NP (2019). Grape pomace extracts as fermentation medium for the production of potential bio preservation compounds. Foods, 8(2): 51. DOI: https://www.doi.org/10.3390/foods8020051

Mousa BH, Abdulateef SM, Alhamdani HAAA, Alhamdani AA, and Nafea HH (2020). Effect of dietary natural feed additives to minimize negative role of peroxide hydrogen in broiler. Biochemical and Cellular Archives, 20(2): 5223-5230. Available at: https://www.connectjournals.com/file_html_pdf/3239002H_5223A.pdf

Muzaffar K, Sofi SA, Kamran F, Teixeira-Costa BE, Mir SA, and Dar BN (2022). Fruit processing wastes and by-products. Handbook of fruit wastes and by-products, CRC Press, pp. 1-18. Available at: https://www.taylorfrancis.com/chapters/edit/10.1201/9781003164463-1.com

Naji SAH and Hanna AK (1999). Broiler chicken production guide, 1st Edition. Arab Union for Food Industries, Hiba Publishing and Printing Office.

National Research Council (NRC) (1994). Nutrient requirements of poultry. National Academies Press., Washington, DC, USA, pp. 3-23. Available at: https://books.google.iq/books?hl=ar&lr=&id=bbV1FUqRcM0C&oi=fnd&pg=PR11&dq=NRC,+1994)+&ots=IljR1yhwXw&sig=GIQAfoiTdzry011snDvhi8-ThRY&redir_esc=y#v=onepage&q=NRC%2C%201994)&f=false

Pascariu SM, Pop IM, Simeanu D, Pavel G, and Solcan C (2017). Effects of wine by-products on growth performance, complete blood count and total antioxidant status in broilers. Revista Brasileira de Ciência Avícola, 19(2): 191-202. DOI: https://www.doi.org/10.1590/1806-9061-2016-0305

Reyes P, Urquiaga I, Echeverría G, Durán E, Morales MS, and Valenzuela C (2020). Wine grape pomace flour in broiler diets effects growth and some meat characteristics. Animal Production Science, 60(9): 1210-1216. DOI: https://www.doi.org/10.1071/AN19385

Ritika R, Shukla S, Sondhi A, Tripathi AD, Lee JK, Patel SKS, and Agarwal A (2024). Valorisation of fruit waste for harnessing the bioactive compounds and its therapeutic application. Trends in Food Science and Technology, 144: 104302. DOI: https://www.doi.org/10.1016/j.tifs.2023.104302

Romero C, Arija I, Viveros A, and Chamorro S (2022). Productive performance, egg quality and yolk lipid oxidation in laying hens fed diets including grape pomace or grape extract. Animals, 12(9): 1076. DOI: https://www.doi.org/10.3390/ani12091076

Şen G and Başalan M (2022). Effects of using inulin and grape pomace in broiler diets on performance, carcass yield, intestinal viscosity, immunity, and antioxidant status. Journal of the Hellenic Veterinary Medical Society, 73(3): 4583-4592. DOI: https://www.doi.org/10.12681/jhvms.28031

Spanghero M, Salem AZM, and Robinson PH (2009). Chemical composition, including secondary metabolites, and rumen fermentability of seeds and pulp of Californian (USA) and Italian grape pomaces. Animal Feed Science and Technology, 152(3-4): 243-255. DOI: https://www.doi.org/10.1016/j.anifeedsci.2009.04.015

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