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Research Article

Influence of Dried Tomato Pomace on the Growth Performance of Heat-Stress Exposed Broiler Chicks

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Abstract | Exposure to high ambient temperature is one of the critical environmental stress factors that would affect the growth performance, feed utilization efficiency, and productivity of broiler chickens. This study investigated the effect of supplementing basic feed with dried tomato pomace on the growth performance and productive traits of broiler chicks exposed to a mild heat stress. A total of 240 one-day-old unsexed Ross 308 broiler chicks, each weighing approximately 41 g, were assigned to four different dietary treatment groups. The experimental design was completely randomized (CRD) with each treatment having three replicates of 20 birds exposed to an ambient temperature of 33°C between 7:00 am to 5:00 pm throughout the 35-day experiment. The experimental diets T1 to T4 contained 0, 5, 7.5, and 10% dried tomato pomace, respectively. Study results showed a significant ($P < 0.05$) and positive impact of tomato pomace supplementation on growth performance and productive characteristics of broilers as compared to the control treatment. All studied parameters *i.e.*, live weight, weight gain, feed intake, and feed conversion ratio were increased compared with control group. It is concluded that adding tomato pomace to the diet of broiler chickens exposed to heat stress would be beneficial for improving their growth, and productive traits.

Keywords | Broiler chicks, Growth performance, Diet supplementation, Tomato pomace, Body weight gain

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INTRODUCTION

The poultry production sector has grown significantly over the past few decades as the demand for white meat has increased tremendously because chicken meat is a nutritionally rich and cost-effective source of animal-based protein both in developed and developing worlds (Erdaw and Beyene, 2022; Kashyap and Goswami, 2024). Poultry meat exhibits high nutritional value and is of dietary importance as it has high protein and low-fat contents (Astrup *et al.*, 2015). However, the production of poultry meat in the subtropical countries of West Asia, including Iraq, is often hampered by many environmental constraints.

Exposure to the high ambient temperature than normal or optimum thermal threshold (*i.e.* 18 – 22°C) is one of the critical environmental stress factors that influences the growth performance, feed utilization efficiency, and productivity of broiler chickens and often induce high mortality rate in broiler chicks under such conditions (Lara and Rostagno, 2013; Apalowo *et al.*, 2024). Heat stress often has various detrimental effects on health, growth

and welfare of broiler breeds of chicken, mostly because of the increased synthesis of reactive oxygen species (ROS) in their bodies in response ot high temperature exposure which ultimately damage different biomolecules including lipids and proteins (Vandana *et al*., 2021; Oke *et al*., 2024).

Therefore, the supplementation of poultry feed with medicinal plants and their by-products is one of the promising strategies to alleviate or mitigate the negative effects of heat stress on poultry birds. These feed additives can supply antioxidant compounds that fight against or suppress different ROS molecules in the bird's body induced by heat stress (Kadhim, 2023; Jassim and Kadhim, 2024; Li *et al*., 2024). For instance, the addition of tomato pomace, which is an essential by-product of the tomato processing industry, can exert many positive effects on poultry health, growth, and performance (Sahin *et al*., 2008; Hosseini-Vashan *et al*., 2016; Lu *et al*., 2022). Tomato pomace constitutes about 2–10% of the total fresh tomato by weight and comprises tomato peels, seeds, and a small amount of pulp (Gustavsson *et al*., 2011). It contains many bioactive molecules, such as lycopene, vitamin C, β-carotene, α-tocopherol, phenolics, and flavonoids and has a significant antioxidant potential and heat-stress attenuation properties (Sahin *et al*., 2011; Szabo *et al*., 2019; Lu *et al*., 2022). It has been used as a feed additive to improve poultry production during heat stress periods (Hosseini-Vashan *et al*., 2016; Lu *et al*., 2022; Muhammad *et al*., 2023).

This research work aimed to assess the influence of dietary supplementation of poultry feed with dried tomato pomace on growth performance and productive traits of Ross 308 broiler breed chicks reared under heat-stress conditions for a period of 35 days. Productive traits determined every week in this study included live body weight, body weight gain, feed intake, and feed conversion ratio.

MATERIAL AND METHODS

Preparation of Tomato Pomace

Experimental protocol: This experiment was conducted in the poultry rearing facility of the Department of Animal Production Technologies, Al-Mussaib Technical College of the Al-Furat Al-Awsat Technical University, Babil, Iraq. The trial period was 35 days. A total of 240 one-day-old unsexed chicks of the Rose 308 broiler breed were used in this research, and each bird weighed about 41 grams. The chicks were distributed randomly into four experimental treatments, each replicated thrice and containing 20 chicks. The experimental design was completely randomized (CRD). The birds were exposed to an ambient temperature of 33˚C between 7:00 am to 5:00 pm throughout the 35-day feeding experiment. The birds were fed on two types of feed: the starter feed was provided from day 1 to 14, and the growth feed was provided from day 15 to 35 of the birds' age. The chemical analyses of feed were conducted according to National Research Council (NRC, 1994) recommendations.

Experimental dietary treatments and feed analyses: Four types of bird feed were compared in the study. The detailed composition (w/w) regarding the ingredients of these diets is presented in Table 1. Chemical analysis for starter feed provided during the first phase of rearing, *i.e.*, from day 1 to 14, showed on average 21.19% crude protein, 2971 metabolizable energy (kcal/kg feed), 153 calcium: phosphorus ratio, and 6.12% crude fiber. Meanwhile, the chemical analysis of the growth feed provided to chicks during the final period (from day 15 to 35) contained, on average, about 19.20% crude protein, 3029 metabolizable energy (kcal/kg ration), 157 calcium: phosphorus ratio, and 3.43% crude fiber. Moreover, for tomato pomace, tomatoes were collected from local markets (grocery stores) and dried for a week, then crushed and replaced with part of the feed ingredients listed above.

Table 1: Composition (%) of dietary treatments or experimental diets evaluated in this study.

Treatments / Diet ingredients	T1	T2	T3	T4
Yellow corn	60	57	55	53
Soybeans	30	29	28.5	28
Wheat bran	4	3	3	3
Cottonseed oil	3	3	3	3
Tomato pomace	0	5	7.5	10
Dicalcium phosphate	2.44	2.44	2.44	2.44
Vitamins and minerals premix *	0.25	0.25	0.25	0.25
Table salt	0.25	0.25	0.25	0.25
Methionine	0.06	0.06	0.06	0.06

* A Jordanian product containing vitamin A, 25,000 IU; vitamin D, 5000 IU; vitamin E, 12.5 IU; vitamin K, 2.5 IU; vitamin B1, 1 mg; vitamin B2, 8 mg; vitamin B6, 3 mg; vitamin B12, 0.015 mg; folic acid, 0.025 mg; nicotinic acid, 17.5 mg; calcium pantothenate, 12.5 mg; Fe, 80 mg; Cu, 10 mg; Mn, 80 mg; Se, 0.15 mg; and I, 0.35 mg.

Study parameters: The individual weight of each bird from each replicate was taken once per week. The feed intake of each chick was recorded daily throughout the experimental period. Body weight gain (BWG) was determined by subtracting the initial weekly body weight from the weight on the second measurement day (g/d). Gram feed intake per gram of body weight gain was used to computing the feed conversion ratio.

Statistical Analysis

The statistical analysis of data was conducted according to a completely randomized design (CRD). In order to de-

termine the effect of treatments on the productive traits of broiler chicks, data were subjected to statistical analysis using statistical software SPSS (IBM; version 21). Moreover, treatment means were compared using the Duncan multinomial test (1955) using the standard level of significance ($P \leq 0.05$).

Table 2: The effect of different dietary treatments having varying amounts of tomato pomace powder on the live body weight (g ± SE) of Ross 308 broiler chicks exposed to heat stress.

Time intervals / Treatments	7 days	14 days	21 days	28 days	35 days
T1	148.63 ±0.98c	438.49± 0.57b	962.43 ± 12.06c	1576.49 ± 32.78b	2249.14 ± 13.88c
T2	159.42 ± 1.30b	443.43± 9.83b	995.74 ± 19.73ab	1526.36 ±13.22b	2246.17 ± 19.17c
T3	161.20 ± 0.41b	447.84± 7.42b	983.57 ± 16. 50b	1648.55 ±16.16a	2341.72 ± 21.41b
T4	166.36 ± 0.33a	502.67± 11.40a	1063.41 ± 14.20a	1682.42 ±13.26a	2473.79 ± 17.18a
Significance	**	**	**	**	**

Within each column, average values with different alphabets indicate a significant difference ($P < 0.01$) among them (Duncan's multinomial test). ** $P<0.05$.

RESULTS AND DISCUSSION

Influence of Dietary Treatments on Live Body Weight of Chicks

The effect of supplementing a basic poultry diet with varying levels of dried tomato pomace in broiler feed on the live body weight is presented in Table 2. The diet containing 10% tomato pomace (treatment T4) exhibited a significantly ($P<0.05$) higher weekly live body weight (166 to 2474 g from week 1 to week 5, respectively) than those with a 7.5 and 5% tomato pomace. The weekly live body weight in control treatment (T1) varied from 149 to 2249 g from week 1 to week 5, respectively (Table 2). The routine poultry diet is usually deficient in some essential amino acids such as lysine, methionine, tryptophane glycine, and arginine (Flanders and Gillespie, 2016). In addition, fats, carbohydrates, vitamins (A, D E, K, and B groups), and minerals (calcium, phosphorus, manganese, iodine) are not present in sufficient amounts as well in high-fiber diets (Adams *et al*., 2018; Manyeula *et al*., 2025). Tomato pomace contains these amino acids and could fulfill the amino acid and other diet requirements of birds, thus leading to an increased live body weight through the utilization and assimilation of these nutritional requirements (Al-Betawi, 2005; Lu *et al*., 2022; Ravi, 2022). However, the trend observed in this study is not consistent with the study of Ghazi and Drakhshan (2006), who indicated that there were no significant differences in weight gain among chicks fed with 10 and 15% tomato pomace compared to the control group. Similarly, the sun-dried tomato pomace supplemented @ 10% to the broilers' feed also resulted in similar live body weight as compared to that of the control group (Mohammed *et al*., 2021).

Table 3: The effect of different dietary treatments having varying amounts of tomato pomace powder on the average weight gain (g ± SE) of Ross 308 broiler chicks exposed to heat stress.

Time intervals / Treatments	7 days	14 days	21 days	28 days	35 days
T1	107.63 ± 0.23c	229.86 ± 22.12c	523.94 ±37.18c	614.06 ±87.12b	672.65 ± 34.20c
T2	118.42 ± 1.22b	284.01 ± 14.30b	552.31 ±24.59a	530.62 ± 24.47c	719.81 ± 42.86b
T3	120.20 ± 0.68a	286.64 ± 31.90b	535.73 ± 9.80b	664.98 ± 55.02a	693.17 ± 38.42bc
T4	125.36 ± 3.09a	329.31 ± 15.21a	560.74 ±29.11a	619.01 ±25.17b	791.37 ± 33.13a
Significance	**	**	**	**	**

Within each column, average values with different alphabets indicate a significant difference ($P < 0.01$) among them (Duncan's multinomial test). ** $P<0.05$.

Effect of Tomato Pomace Supplementation on Bird Weight Gain

Table 3 shows the effect of supplementation of poultry feed with tomato pomace on body weight gain for 7 – 35 days of rearing age. The results indicated significant differences ($P < 0.05$) among the treatments for all weeks. The weight gain rate of broiler chicks increased from week 1 to week 5 with increasing tomato pomace replacement, particularly for 7.5 and 10% tomato pomace from 120 g to 791 g for week 1 to week 5, respectively (Table 3). The reason for this increased weight gain of birds for tomato pomace addition may be due to the presence of active compounds in tomato pomace, such as lycopene and β-carotene, which led to an improvement in the weight gain of broiler chicks. Sahin *et al*. (2008), under thermoneutral conditions, supplementing Japanese quails with tomato powder showed no significant impact on measured values during growth.Nevertheless, performance improved (live weight gain, feed conversion), and antioxidant components increased in heat-stressed (34°C) quails. Our results are in agreement with Alagawany *et al*. (2022) and Muhammad *et al*. (2023) showing a significant improvement in chicken body weight and weight gains as compared to those fed a control diet. However, using 6% sun-dried tomato waste seems to be the optimal level to use throughout the first 3 to 5 weeks of life; it resulted in the highest body weight gain when compared to other levels (*i.e.* 3, 9, and 12%).

Table 4: The effect of different dietary treatments having varying amounts of tomato pomace powder on the average feed intake (g ± SE) of Ross 308 broiler chicks exposed to heat stress.

Time intervals /Treatments	7 days	14 days	21 days	28 days	35 days
T1	134.87 ± 6. 30	318.26 ± 2.62b	717.88± 13. 74b	1085.36 ±27.15a	1016.16 ± 48.92a
T2	137.58 ± 5.06	316.81 ± 10.40b	788.96± 44.79a	1061.76 ±49.67a	977.69 ± 26.28b
T3	135.74 ± 4.84	360.42 ± 7.19a	792.39± 43.81a	907.22± 45. 21c	968.47 ± 22.44b
T4	133.69 ± 6.08	331.81 ± 8.26b	720.56± 39.44b	1006.17 ±51. 70b	864.31 ± 30.19c
Significance	ns	**	**	**	**

Within each column, average values with different alphabets indicate a significant difference (P < 0.01) among them (Duncan's multinomial test). ** P<0.05.

Effect of Tomato Pomace Supplementation on Feed Intake of the Birds

The weekly feed intake of broiler chicks fed with the feed having different levels of tomato pomace is presented in Table 4. Compared to the control group, the average weekly feed intake for diets containing tomato pomace showed a statistically significant difference (P <0.05) throughout the experiment. Indeed, average feed intake was significantly reduced in feed treatments having tomato pomace, and the relationship was inversely proportional, as the higher the level of tomato, pomace in the feed, the lower the feed consumption (Table 4). Unlike the results of King and Zeidler (2004) and Mohammed et al. (2021) which showed higher feed consumption for diets with seeds and tomato pomace, our study found no such effect. On the other hand, increasing the content of tomato pomace in the feed did not exert any negative effect on palatability; the appeal of the feed increases the appetite of poultry (Al-Souti *et al*., 2019). Other authors found that palatability was highly influenced by the feed components. Our results indicated that the components present in tomato pomace are acceptable for broiler nutrition, as shown by some previous studies (Khan *et al*., 2023).

Impact of Dietary Treatments on Feed Conversion Ratio

Feed conversion ratio of the experimental chicks expressed as grams of feed consumption per unit body weight gain are shown in Table 5. Feed conversion ratios varied significantly among treatments compared to the control throughout the five-week study. Chicks feeding on diet with 10% dried tomato pomace had a significantly (P<0.05) lower feed conversion ratio (1.06 to 1.09 for week 1 to week 7, respectively) compared to the control group (1.25 to 1.51 for week 1 to week 7, respectively). The other two treatments, having 0, 5, and 7.5% tomato pomace, showed intermediate response regarding feed utilization efficiency (Table 5). This result might be because of eating tomatoes and their processed products containing lycopene which usually prevents some chronic diseases due to its antioxidant activity, which is twice the activity of β-carotene and ten times the activity of tocopherol (Choksi and Joshi, 2007; Arain *et al*., 2018; Fathi *et al*., 2022). These results corroborate the findings of Yitbarek (2013) who reported that the feed conversion was significantly improved in a diet containing 2.5 to 5% dried tomato pomace. The lowest feed conversion ratio was measured in the control chicks fed with the lowest level of tomato pomace (0%). Our results are not in agreement with Rahmatnejad *et al*. (2009), who indicated that a feed containing 24% tomato pomace had the worst feed conversion ratio due to high fiber content.

Table 5: The effect of different dietary treatments having varying amounts of tomato pomace powder on the average feed conversion ratio (± SE) of Ross 308 broiler chicks exposed to heat stress.

Time intervals / Treatments	7 days	14 days	21 days	28 days	35 days
T1	1.25 ± 0.08a	1.38 ± 2.02a	1.37 ± 3.04b	1.76 ± 7.12b	1.51 ± 20.02a
T2	1.16 ± 0.06b	1.11 ± 1.8c	1.42 ± 4.9a	2.00 ± 9.07a	1.35 ± 14.21b
T3	1.12 ± 0.04b	1.25 ± 0.19b	1.47 ± 3.08a	1.36 ± 5. 64c	1.39 ± 17.65b
T4	1.06 ± 0.10c	1.00 ± 1.16c	1.28 ± 0.04c	1.62 ± 7. 08b	1.09 ± 10.22c
Significance	**	**	**	**	**

Within each column, average values with different alphabets indicate a significant difference (P < 0.01) among them (Duncan's multinomial test). ** P<0.05.

CONCLUSIONS AND RECOMMENDATIONS

The overall results of the study demonstrated a statistically significant and substantial effect of powdered tomato pomace supplementation in poultry feed on the growth performance and productive traits of broiler chickens exposed to a high ambient temperature of 33°C, simulating mild heat stress. These findings suggest that tomato pomace is a valuable dietary ingredient, providing a rich source of protein, fiber, carbohydrates, and β-carotene. Due to its high concentration of bioactive compounds and favorable fatty acid profile, incorporating tomato pomace into poultry diets can positively influence broiler performance and help alleviate the adverse effects of heat stress.

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NOVELTY STATEMENTS

Broiler chick performance is boosted by incorporating Dried Tomato Pomace into their feed via organic nutritional supplements. A promising way to improve the growth of broiler chicks exposed to heat stress.

AUTHOR'S CONTRIBUTIONS

MJK designed and experimented, analysed the data, and wrote the manuscript.

Conflict of Interest

The authors have declared no conflict of interest.

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