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Preliminary Study on Tomato Pomace as Unusual Feedstuff in Broiler Diets

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Abstract: The objective of this study was to evaluate the tomato pomace (TP) as unusual feed stuff in broiler diets in terms of growth, feed conversion ratio (FCR) and mortality. 300-day old Hubbard broiler chicks were weighed and randomly distributed into 4 groups with three replicates of 25 chicks each. Birds were fed four experimental diets in which the first was the control group (T1) and the other diets contained 10% alkali treated tomato pomace (T2), 10% heat-treated tomato pomace (T3) and 10% sun dried tomato pomace (T4). All diets were isonitrogenous and isocaloric. Feed and water were offered ad-lib during the experiment period. The results of this experiment showed that there were no significant differences ($P<0.05$) in live body weight due to feeding chicks diets containing TP. The only significant difference ($P<0.05$) was observed between the control group and those fed dietary treatments. Body weight gain had nearly the same trend as live body weight. Cumulative feed consumption was significantly ($P<0.05$) affected by feeding TP when compared with control group. There were no significant differences ($P<0.05$) in FCR of chicks fed different dietary treatments when compared with those fed control diets. Mortality rate was 3% during the whole experiment period, which is insignificant.

Key words: Broiler, TP, diets, alkali treatment, heat treatment, sun dried treatment

Introduction

Broiler production in Jordan developed very fast in the last two decades to become the most important sector in animal production. In the year 2002 the total number of broiler farms was 2213 with a capacity of 29.2 million birds in each rotation. In the same year the actual production of broiler reached 115.7 thousands tons (Ministry of Agriculture, Annual Report 2002). The major problems that face poultry production particularly broiler industry in Jordan are the availability and the cost of feed ingredients. This necessitates looking for cheap local sources of feed stuffs. Agro-industrial by-products that are produced as a result of diverse agricultural practices represent one of the most important and promising energy and protein rich sources. Tomato pomace is a mixture of tomato skin, pulp and crushed seeds that remain after the processing of tomato for juice, paste and/or ketchup. Tomato pomace (TP) production is increasing yearly, it reached 74437 tons in year 2000 (Ministry of Agriculture, 2000). Limited amounts of this TP are utilized in feeding ruminant only. Bordowski and Geisman (1980) reported that tomato seeds protein contains approximately 13% more lysine than soy protein, which would allow it to be used in fortifying low lysine foods. Elloitt *et al*. (1981) demonstrated that TP is a good source of protein and the chemical composition of tomato cannery wastes suggests that they have the potential to be a good source of protein, but may be limited in energy due to the high fiber content. Harb (1986) found that moisture, crude protein and crude fiber percentages were 9.25, 21.5 and 39.8% respectively. So the possibility of utilizing improved TP in feeding broiler chicks is promising. The present study was carried out to investigate the effect of using treated and untreated tomato pomace (TP) in broiler rations on the performance of broiler chicks.

Materials and Methods

Experimental birds and rations: A total of 300-day old Hubbard broiler chicks were randomly assigned into 4 experimental groups with 3 replicates of 25 birds each, in which T1 was the control group. The chicks were fed starter diets from 1 to 21-days old and finisher diets from 22 to 35-days old. Rations were isocaloric and isonitrogenous. Feed ingredients and composition of rations are shown in Table 1.

Tomato pomace (TP) treatments: Tomato pomace (TP) was subjected to the following treatments:-

Alkali treatment (T2): TP was treated with 0.0458M NaOH (McDonald *et al*, 1981). TP was soaked in a 3:1 weight to weight for 24hrs. Then NaOH was neutralized with 200 ml of 12N HCl. Four liters of H_2O were added to aid in distribution of the acid throughout the pomace. After one hour of soaking, TP was dried in an air forced oven at 52^{0}C until moisture level of less than 10% was achieved. Tomato pomace then re-grounded in a small

Table 1: The experimental rations and their calculated feeding values

Ingredient	Starter rations%		Finisher rations%	
	Treatments *	Control	Treatments*	Control
Yellow corn	54	59.25	60	65
Soybean meal 48%	56.5	30	18.75	21
Concentrate 50%	7	7	6	7.25
Tomato pomace	10		10	
Vitamins: mineral premix	0.75	0.9	0.5	0.75
Dicalcium phosphate	0.5	1	0.5	1
Limestone	1.5		1.25	
NaCl	0.25	0.25	0.25	0.25
Vegetable oil	1	0.1	4	3.5
Total	100	100	100	100
Calculated feeding value				
CP%	22.91	22.93625	19.2	19.23
MEKcal/Kg diet	2935.025	2941.075	3174.9373	3213.975
EE %	5.279	3.303	8.3075	6.6847
Methionine	0.44225	0.46515	0.37853	0.42083
Cystine	0.3265	0.36115	0.276	0.30808
Cystine+meyhionine	0.76875	0.8263	0.6563	0.72891
Lysine	1.2773	1.23455	1.036	0.99
Ca	0.19735	0.89285	0.17763	0.7747
Linoliec acid	1.294	1.4235	1.395	1.514

roller mill before inclusion in the rotation (T2).

Heat treatment (T3): Tomato pomace was subjected to a temperature of 121°C in an air-forced oven for 30 minutes in pans filled to a depth of 2.5 cm (Antoniou and Marquardt, 1983).

Sun-dried treatment (T4): TP was subjected to the sun-drying until complete removal of moisture (less than 10%).

Proximate analysis was carried out for randomized samples of all treated tomato pomace (TP) to determine moisture, ether extract, crude fiber, ash and nitrogen (AOAC, 1995).

Experimental procedure: Chicks had free access of feed and water. Chicks were vaccinated according to the sanitary veterinary programs for this category and no other medical treatments were applied except for the coccidiostats (Amprole in prophylactic dose). Feed consumption (FC) was weekly recorded for each replicate and treatment. Weekly feed conversion ratio (FCR) was calculated. Live body weight in grams was measured for all birds at the beginning of the experiment (day-old) and was weekly repeated at the same time. Body weight gain was calculated by subtraction of the live body weight at the beginning of the week from that of the next week. Daily mortality was recorded for each replicate and treatment, and then weekly mortality rate was calculated by subtracting the number of dead chicks from the number of live chicks at each interval. This figure was divided by the total number of the chicks at the beginning of the interval.

Statistical analysis: The data were analyzed by ANOVA using General Linear Modle (GLM) procedure of statistical analysis system (SAS, 2002). All results are presented as means ± standard error (SE) of the means.

Results

Live body weights and live weight gain: Means ± SE of live body weight and live weight gain of broiler chicks fed different dietary treatments are presented in Table 2, 3 and Fig. 1 and 2.

Concerning final live body weight, no significant differences ($p<0.05$) were detected among treatments. The only significant difference ($p<0.05$) was observed between control group (T1) and other treatments (T2, T3, and T4). It can be also noticed that there were no significant differences ($p<0.05$) among treatments and control group at first week of age. At the second week of age the highest ($p<0.05$) live body weight was recorded for chicks fed diet contains alkali treated TP (T2), and the lowest was recorded for those fed control diet (T1). The same trend was also observed at the third week of age. At fourth week of age feeding chicks diets contain either heat treated (T3) or sun dried (T4) tomato pomace gave significantly ($p<0.05$) the highest live body weight when compared with those fed alkali treated TP (T2) or with those fed control diet (T1).

No significant differences ($p<0.05$) in live weight gain

Table 2: Means ± SE of live body weight in grams/ chick

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1-day	34.467 ±0.378*	34.067 ±0.378	33.617 ±0.378	35.133 ±0.378
1-week	136.443 ±5.442*	138.000 ±5.442	149.667 ±5.442	153.000 ±5.442
2-weeks	343.153 ±10.395	383.807 ±10.395	375.093 ±10.395	352.620 ±10.395
3-weeks	649.467 ±16.367	696.667 ±16.367	695.667 ±16.367	678.333 ±16.367
4-weeks	1064.300 ±23.871	1049.767 ±23.871	1151.400 ±23.871	1136.167 ±23.871
5-weeks	1499.333 ±43.845	1638.000 ±43.845	1676.333 ±43.845	1675.000 ±43.845

* ± Standard error (SE). Averaged with the same letter are not significantly different at (0.05). T1 = control group (C)
T2 = Alkali treatment (A) . T3 = Heat treatment (H). T4 = Sun dried treatment (S)

Table 3: Means ± SE of live weight gain in grams/ chick

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1-week	101.976 ±54.36*	103.933 ±5.436	116.050 ±5.436	117.867 ±5.436
2-weeks	206.710 ±12.274*	245.807 ±12.274	225.427 ±12.274	199.620 ±12.274
3-weeks	306.314 ±11.913	312.860 ±11.913	320.573 ±11.913	352.713 ±11.913
4-weeks	414.833 ±17.337	353.100 ±17.337	455.733 ±17.337	457.834 ±17.337
5-weeks	435.033 ±51.325	558.233 ±51.325	524.933 ±51.325	538.833 ±51.325

* ± Standard error (SE). Averaged with the same letter are not significantly different at (0.05). T1 = control group (C)
T2 = Alkali treatment (A). T3 = Heat treatment (H). T4 = Sun dried treatment (S)

Table 4: Means ± SE of weekly feed consumption (FC) in grams/chick

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1	126.670 ±8.473*	127.340 ±8.473*	106.943 ±8.473	130.473 ±8.473
2	334.933 ±12.215*	323.843 ±12.215*	346.467 ±12.215	342.857 ±12.215
3	546.463 ±14.710*	443.047 ±14.710	448.720 ±14.710	494.897 ±14.710
4	727.923 ±23.279*	870.530 ±23.279	856.303 ±23.279	859.447 ±23.279
5	757.780 ±21.889*	1040.990 ±21.889	1044.847 ±21.889	1131.180 ±21.889

* ± Standard error (SE). Averaged with the same letter are not significantly different at (0.05). T1= control group (C)
T2= Alkali treatment (A) . T3= Heat treatment (H). T4= Sun dried treatment (S)

were noticed at first and third week of age, while significant differences (P<0.05) were observed at the second week of age among treatments and among treatments and control group (T1). At fourth week of age the lowest (p<0.05) live weight gain was recorded for chicks fed alkali treated TP (T2), while there were no significant differences (p<0.05) between control group (T1) and T3 and T4. At the end of the experiment there were noticeable but not significant differences in live weight gain of chicks fed different dietary treatments (T2, T3 and T4), the only significant difference (p<0.05) was detected only between control group (T1) and other dietary treatments (T2, T3 and T4).

Means ± SE of weekly and cumulative feed consumption (FC) are presented in tables 4,5 and figures 3 and 4.

The data obtained from Table 4 showed that there were no significant differences (p<0.05) in weekly feed consumption of all treatments. Significant differences (p<0.05) in weekly FC were observed at weeks one and three. While at first week of age the highest weekly FC was recorded for T4, at third week of age the highest FC was recorded for T1. At fourth week of age no significant differences (p<0.05) in weekly FC were observed between dietary treatments 2,3 and 4, on the other hand significant differences (p<0.05) were observed between chicks fed control diet (T1) and those fed diets contains treated TP (T2, T3 and T4). Significant differences (p<0.05) were observed at five weeks of age between chicks fed dietary treatments 2 and 3 and those fed dietary treatment 4 and those fed control diet 1. The highest weekly FC was recorded for chicks fed diet contains sun dried TP (T4), and the lowest was recorded for those fed control diet (T1). From Table 5 and Fig. 4 it can be seen that at both second and fourth week of age there were no significant differences (p<0.05) in FCR. Significant differences (p<0.05) were observed at third

Table 5: Means ± SE of cumulative feed consumption in grams/ chick

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1	126.670 ±8.427*	127.340 ±8.427	106.943 ±8.427	126.670 ±8.427
2	461.603 ±13.063*	451.183 ±13.063	453.41 ±13.063	473.33 ±13.063
3	1008.066 ±23.903*	894.230 ±23.903	902.130 ±23.903	968.227 ±23.903
4	1735.989 ±41.742*	1764.760 ±41.742	1758.433 ±41.742	1827.674 ±41.742
5	2493.769 ±57.486*	2805.75 ±57.486	2803.280 ±57.486	2958.854 ±57.486

* ± Standard error (SE). Averaged with the same letter are not significantly different at (0.05). T1= control group (C)
T2= Alkali treatment (A). T3= Heat treatment (H). T4= Air dried treatment (A)

Table 6: Means + SE of feed conversion ratio (FCR).

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1	0.929 ±0.112*	0.925 ±0.112	0.718 ±0.112	0.850 ±0.112
2	1.347 ±0.055*	1.186 ±0.055	1.209 ±0.055	1.350 ±0.055
3	1.551 ±0.029*	1.284 ±0.029	1.298 ±0.029	1.429 ±0.029
4	1.630 ±0.024*	1.612 ±0.024	1.527 ±0.024	1.610 ±0.024
5	1.675 ±0.067*	1.714 ±0.037	1.669 ±0.067	1.767 ±0.067

* ± Standard error (SE). Averaged with the same letter are not significantly different at (0.05). T1= control group (C)
T2= Alkali treatment (A). T3= Heat treatment (H). T4= Air dried treatment (A)

Table 7: Mortality rate

Age/ Week	Control	Treatments		
	T1	T2	T3	T4
1	-	4.347	2.083	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
Total	-	4.347	2.083	-

T1= control group (C). T2 = Alkali treatment (A) . T3 = Heat treatment (H). T4 = Air-dry treatment (D)

week of age among all treatments. At five weeks of age there were no significant differences ($p<0.05$) can be referred to feeding chicks treated TP (T2, T3 and T4), the only significant differences ($p<0.05$) in FCR were detected between chicks fed control diet (T1) and those fed other dietary treatments (T2, T3 and T4).

Means ± SE of feed conversion ratio (FCR) are presented in Table 6 and Fig. 5 .

Concerning final feed conversion ratio (FCR), there were noticeable but not significant differences between treatments and between treatments and control group. Better FCR was obtained from feeding chicks diets contain heat-treated TP (T3) followed by those fed control diet (T1). The same tend was observed at fourth week of age, while the best (significantly) $p<0.05$ was for chicks fed T3, the lowest was for those fed control diet (T1). Significant differences ($p<0.05$) also observed in FCR of all treatments at third and first week of age. The same data showed no significant differences at the second of age among all treatments.

Table 7 shows that the only mortality had been happened in the first week of age in treatments 2 and 3. Mortality rate was 4.347% and 2.083% for T2 and T3 respectively. This mortality may be due to any reason rather than treatments such as management factors.

Discussion

One of the major problems facing poultry industry particularly broiler production in Jordan as well as in most development countries is the availability and cost of feed ingredients. This study is intended to examine the potential use of some unusual feed resources that obtained from agro-industrial by-products such as tomato pomace (TP) which could be used in poultry feeding under local management conditions by using different chemical and physical treatments. Tomato pomace (TP) is a mixture of seeds, skin, and some adhering pulps that remains after processing of tomato. TP is a good source of protein 21.9-23.0% crude protein (NRC, 1971), containing 13% more lysine than soybean protein (Bordowski and Geisman, 1980). Elloitt *et al.* (1981) reported that TP is a good source of protein and fiber. Moreover, it is a good source of vitamin B, fair source of vitamin A, and no known antinutritive factors (Geisman, 1981). Recent studies by King and Zeidler (2004) indicates that TP could be used as a source of -tocopherol in broiler diets to decrease lipid oxidation during heating and long-term frozen storage of dark meat, and to poling shelf life.

Data obtained from this experiment showed that in the first week of age (Table 2, Fig. 1) there were only

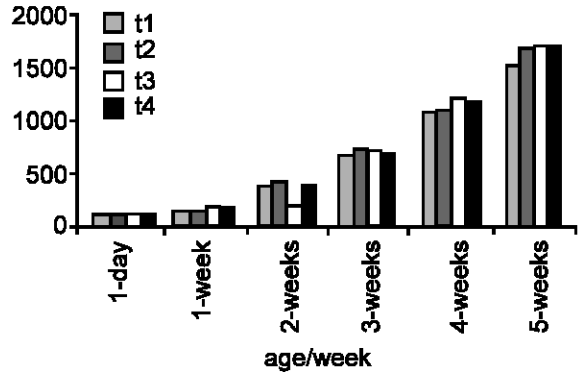

Fig. 1: Means of live body weight in grams/chicks

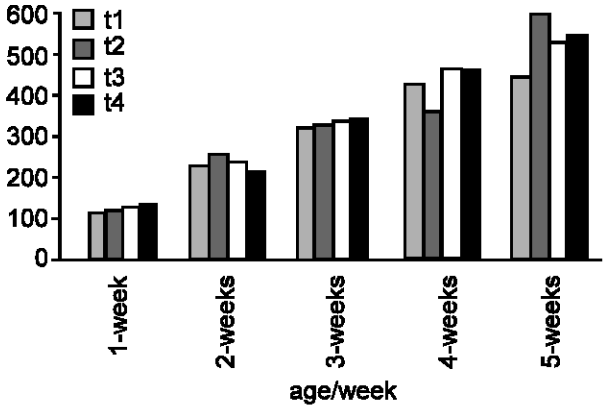

Fig. 2: Means of live weight gain in grams/chick

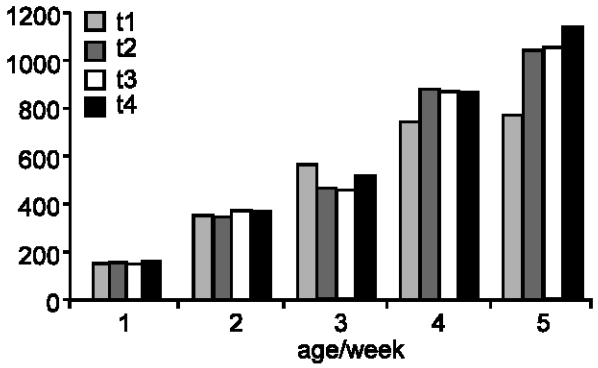

Fig. 3: Means of weekly consumption (FC) in grams/chicks

noticeable but not significant ($p<0.05$) differences in average live body weight of chicks fed all treatments and control diets. Significant differences ($p<0.05$) in average live body weight were observed at second week of age. Chicks fed diet contains alkali treated TP (T2) gave significantly ($p<0.05$) the higher average live body weight, while the lowest was for those fed control diet (T1). These data support the conclusion that alkali treatment of TP improved the growth of broiler chicks when sodium level was within the accepted range (NRC, 1984) when compared with chicks fed diets containing heat-treated and untreated TP. Squires *et al.* (1992) reported that alkali treatment of tomato cannery waste increased body weight. No significant differences ($p<0.05$) were detected in average live body weight of chicks fed different dietary treatments (T2, T3 and T4) in both third and fifth week of age. The only significant difference ($p<0.05$) was detected between dietary treatments (T2, T3 and T4) and control group (T1). This improvement in average live body weight may be due to the nutritional value of TP (Bordowski and Geisman, 1980; Elloitt *et al.*, 1981; Squires *et al.*, 1992; and King and Zeider, 2004). Moreover, Giesman (1981) suggested that tomato seeds (major component of TP) have never been contained any antinutritive factors.

Harb (1986) reported that the inclusion of 10,20 and 30% of TP in Awassi male lambs improved average initial body weight.

From Table 3 and Fig. 2 it can be noticed that in the first and third week of age there were no significant differences ($p<0.05$) were detected within treatments and between treatments and control. Feeding chicks alkali treated TP (T2) gave the highest live weight gain at both second and fifth week of age when compared with other treatments and control group. This result agreed with those obtained by Squires *et al.* (1992) who reported that alkali treatment of canary waste might cause additional improvements in gain when fed to broiler chicks. Concerning final live weight gain there were no significant differences ($p<0.05$) between treatments (T2, T3 and T4). Meanwhile, chicks fed control diet (T1) gave significantly ($p<0.05$) the low live weight gain when compared with other treatments. Squires *et al.*,(1992) reported that untreated tomato canary waste might be used as a feed ingredient in low energy diets. However, Dewey, (1989) and Faqih and Haddidin (1986) demonstrate that steam treatment, alkali treatment and enzymatic pretreatment of cellulose feed resources appear to be most promising for improvement of nutritive value and digestibility by animals. Misir and Marquardt (1987) concluded that autoclaved treatment of rye 10 or 30 minutes improved weight gain of broiler chicks.

Concerning average weekly feed consumption, Table 4 and Fig. 3 show that at first week of age there were no significant differences ($p<0.05$) between control group (T1) and treatments 2 and 4. The lowest ($p<0.05$) feed consumption was for chicks fed T4 when compared with other treatments. There were no significant differences ($p<0.05$) among all treatments at second week of age. On the other hand, significant differences ($p<0.05$) were detected in average weekly feed consumption at third week of age. The highest feed consumption was for chicks fed control diet (T1), and the lowest was for those fed alkali treated TP (T2). At fourth week of age there were significant differences ($p<0.05$) between control

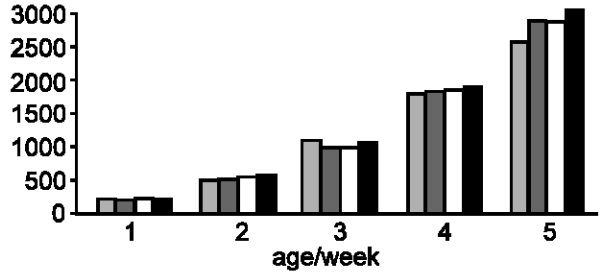

Fig. 4: Means of commulative feed consumption in grams/chicks

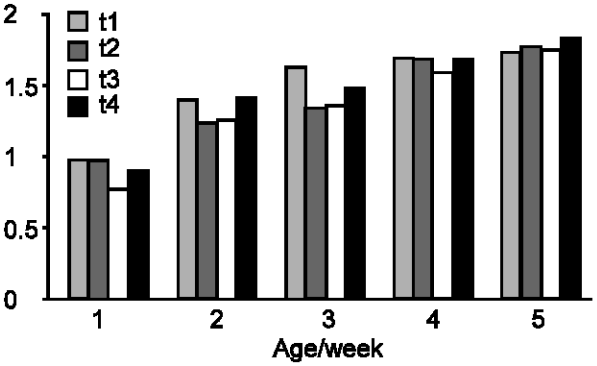

Fig. 5: Means of feed consumption ration (FCR)

group (T1) and other treatments. The same trend was observed at last week of age (5-weeks), the lowest average weekly feed consumption was obtained from chicks fed control diet (T4), while the highest was for those fed diet contained sun-dried TP (T4). No significant differences ($p<0.05$) between T2 and T3, but there were significant differences between these two treatments and other treatments (T1 and T4). Table 5 and figure 4 shows that there were no significant differences ($p<0.05$) in the final cumulative feed consumption of different dietary treatments (T2, T3 and T4), the only significant difference ($p<0.05$) was observed between control diet (T1) and other three dietary treatments (T2, T3 and T4). These results agreed with those obtained by Dewy (1989) and Squires *et al.*, 1992. Meanwhile, Ammerman *et al.*, 1965, El-Alally (1974) and Tomezynski (1976) indicates that various tomato canary waste and by-products can be included in small amounts (<5%) in both broiler and layer diets. The results obtained from this experiment (Table 6 and Fig. 5) show that there were no significant differences ($p<0.05$) in final feed conversion ratio (FCR) among all treatments. These results may be due to nutritive value of TP, as it is a good source of vitamins and fair source of vitamin A and middle protein source (NRC, 1971 and Bordowski and Geisman, 1980), 13% more lysine than soybean meal protein and no known antinutritive factors (Geisman, 1981). However, Camara *et al.*, demonstrated that total fat content ranged from 19.79/100 gm for tomato seeds to 0.464/100gm TP, and linoleic acid accounted for approximately 50% of total Fats followed by oleic acid 20% and palitic acid 15%. Squires *et al.* (1992) reported that untreated canary waste might be used as a feed ingredient in low-energy diets of broiler breeders, grower laying hens and ruminant rations. King and Zeidler (2004) demonstrated that TP can contain 242 parts per million (PPM) of -tocopherol (Vit. E) and this level of -tocopherol in TP may be particularly useful in feeds of mest type animals, on the other hand, other investigators have shown that vitamin C and vitamin improved E feed conversion and layer performance (Whitehead *et al.*,1998, Bollenger Lee *et al.*, 1999, Sahin and Kucuk 2001; Sahin and Kucuk *et al.*, 2002).

Concerning mortality rate a total of chicks died during the whole experimental period, which is equivalent to 3%, an insignificant event. The mortality of birds was 2,5 and 2 for T1, T2 and T3 respectively.

Conclusion: The present results indicate that TP can be used in broiler rations at a level of 10% from the total diet, and more researches are needed on this subject.

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