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Effect of Different Combinations of Unboiled and Boiled Tomato Waste in Diet on Performance, Internal Organ Development and Serum Lipid Profile of Broiler Chicken

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Abstract: Owing to the beneficial effects of a carotenoid called lycopene in tomatoes, the present work was undertaken to study the effect of dietary unboiled (UT) and boiled tomato (BT) waste in broiler chicken on performance, internal organ development and serum lipid profile. One hundred fifty Arbor Acress strain broiler chicken of one week age were used for the study. The experiment was performed in a completely randomized design with different combination of UT and BT (0% UT: 0% BT; 25% UT: 75% BT; 50% UT: 50% BT; 75% UT: 25% BT; 100% UB and 100% BT) to completely replace rice-bran and altering the levels of yellow corn and coconut oil in diet. Each treatment was repeated five times. The results revealed that feed consumption, daily weight gain and feed conversion of broiler chicken were not significantly ($p>0.05$) affected by various dietary combinations of UT and BT waste. The weights of said internal organs of broiler chicken did not vary significantly ($p>0.05$) by various combination of dietary UT and BT waste. Further, except for HDL, there was a significant ($p<0.05$) effect on serum total cholesterol, LDL and triglyseride values of broiler chicken fed different combinations of UT and BT waste in diet. In conclusion, boiled tomato waste up to 7% level in the diet of broiler chicken is highly effective in regulation of lipid metabolism in a positive manner and could prove as an important tool for health conscious people in the prevention of atherosclerosis or coronary heart diseases.

Key words: Broiler chicken, lipid profile, organ development, performance, tomato waste

INTRODUCTION

The production of fresh tomato (*Lycopersicon esculentum*) in Indonesia is increasing annually. In 2012, Indonesia produced 893,463 tons of fresh tomato which increased to 992,780 tons in 2013 (Indonesian Central Bureau of Statistics and Directorate General of Horticulture, 2015). The price of fresh tomatoes in some areas of Indonesia is decreasing owing to its over production. As the harvesting and transportation charges are more than its selling price, farmers usually prefer to leave the fresh tomatoes on trees or dispose them in river or gutter. Therefore, the tomatoes have become an agricultural waste in some areas of Indonesia. Tomatoes are rich in nutrients with lycopene as a predominant carotenoid (Boileau *et al*., 2002). Fresh tomatoes, tomato sauce and tomato paste contains 0.9-4.2, 7.3-18.0 and 5.4-55.5 mg/100 g lycopene, respectively (Pohar *et al*., 2003). Mahata *et al*. (2015) reported that boiled tomato powder contains 62.900 ppm and unboiled tomatoes 57.406 ppm lycopene. The variability of lycopene content in tomatoes is affected by many factors like processing, storage etc., (Anguelova and Warthesen, 2000; Takeoka *et al*., 2001; Dewanto *et al*., 2002; Hackett *et al*., 2004; Seybold *et al*., 2004; Goula *et al*., 2006). In nature, lycopenee occurs primarily in the trans-isomeric form and hard to be absorbed (Bramley, 2000; Rao and Agarwal, 2000; Donaldson, 2004). When tomatoes are processed (by chemical reactions, cooking and temperature), some of the lycopene is isomerized into cis form (Shi *et al*., 1999; Tapiero *et al*., 2004; Goula *et al*., 2006). This cis-isomers of lycopene are better absorbed than trans forms because of shorter length of cis-isomer, greater solubility of cis-isomers in mixed micelles and/or their lower tendency to aggregate (Boileau *et al*., 2002). Lycopene inhibits cholesterol syntesis by inhibiting 3hydroxy-3methylglutaryl-CoA reductase (HMGCR) (Furman *et al*., 1997). According to Arab and Steck (2000), lycopene also decreases serum LDL (low density lipids) levels by inhibiting copper-induced oxidation of LDL (Ghaffari and Ghiasvand, 2011).

Owing to such beneficial effects of tomato, the present work was undertaken to study the effect of tomatoes in the diet of broiler chicken. Previously, it has been reported that heat processed tomato waste could be used as much up to 10% in broiler diet (Betawi, 2005). Unprocessed tomato waste could be included as much as 20% (Lira *et al*., 2010) and 8% (Safamehr *et al*., 2011) in broiler and layer chicken diets, respectively. Since, there is lack of literature regarding the effect of

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different combinations of unboiled (UT) and boiled (BT) tomato waste, the present study was designed to evaluate dietary combination effect of UT and BT waste on performance, internal organ development and serum lipid profile of broiler chicken.

MATERIALS AND METHODS

Birds: One hundred fifty Arbor Acress strain broiler chicken of one week age were used in the present study.

Preparation of UT and BT waste: UT was prepared by drying the fresh tomato waste under direct sunlight till the moisture content decreased to 14%. The material was then grinded to form a mash. BT was prepared by soaking the fresh tomato waste in boiling water at 100°C for 8 minutes, followed by sun drying to 14% moisture and grinding into a mash.

Experimental design: The experiment was performed in a completely randomized design with different combination of UT and BT waste (0% UT: 0% BT; 25% UT: 75% BT; 50% UT: 50% BT; 75% UT: 25% BT; 100% UB and 100% BT completely replace rice-bran and altering the levels of yellow corn and coconut oil in diet. Each treatment was repeated five times.

Ration formulation: All the rations formulated during the trial were iso-nitrogenous (22%) and iso-caloric (2900 Kcal/kg ME) as shown in Table 1.

Variables: The measured variables were feed consumption (g/head/day), average daily gain (g/head/day), feed conversion ratio, internal organ development (weight of heart, liver, pancreas, gizzard and spleen) and serum lipid profile (Total of Cholesterol, HDL, LDL and Triglyseride) of broiler chicken.

Data analysis: The data obtained were statistically analyzed by analysis of variance. The difference among treatments was determined by using Duncan Multiple Range Test (DMRT) according to Steel and Torrie (1990).

RESULTS

Effect of performance: The mean values of feed consumption, daily weight gain and feed conversion are depicted in Table 2. Feed consumption, daily weight gain and feed conversion of broiler chicken were not significantly ($p>0.05$) affected by various dietary combinations of UT and BT waste.

Effect on internal organ development: The mean weights of heart, liver, pancreas, gizzard and spleen are shown in Table 3. The weights of said internal organs of broiler chicken did not vary significantly ($p>0.05$) by various combination of dietary UT and BT waste.

Effect on serum lipid profile: The mean values of total cholesterol, LDL, HDL and triglyseride of broiler chicken are depicted in Table 4. Except for HDL, there was a significant ($p<0.05$) effect on serum total cholesterol, LDL and triglyseride values of broiler chicken fed different combinations of UT and BT waste in diet.

DISCUSSION

Effect of performance: Feed consumption was not affected by different combinations of UT and BT in broiler diets. This indicated that tomato waste could be incorporated up to 7% in the diet of broiler chicken without having any effect on palatability and acceptability of feed. Further, daily weight gain and feed conversion ratio also did not affect by all combinations of dietary UT and BT in broiler chicken.

Effect on internal organ development: The development and weight of various internal organs of broiler chicken viz. heart, liver, pancreas, gizzard and spleen did not affect by all dietary combinations of UT and BT. This may indicate that tomato waste, either UT or BT, had no anti-nutritional factor which could inhibit the development of various internal organs of broiler chicken.

Effect on serum lipid profile: Except for HDL, there was a significant ($p<0.05$) effect on serum total cholesterol, LDL and triglyseride values of broiler chicken fed different combinations of boiled and unboiled tomato waste in the diet. The total cholesterol levels and LDL of broiler chicken decreased in all the groups fed different combinations of UT and BT waste when compared to the group fed diet without UT and BT waste. These results are in agreement with Kavitha *et al*. (2004) who reported that inclusion of dried tomato pomacea (DTP) up to 15% level in broiler diets reduced the serum cholesterol content. In the present study, the reduction in cholesterol and LDL was more pronounced in the groups fed higher quantity of BT than UT waste. As mentioned earlier, this might be due to the higher availability of easily absorbable lycopene content in BT waste. Fuhrman *et al*. (1997) stated that supplementation of tomato's lycopenee resulted in a significant reduction in plasma LDL cholesterol and inhibitory effect on macrophage 3-hydroxy-3-methyl glutaryl coenzyme A (HMGCoA) reductase. Furthermore, according to Goldstein and Brown (1990), the enzyme HMGCoA reductase catalyzes the primary rate step in the mevalonate biosynthetic pathway. Cholesterol, an end product of this pathway, negatively regulates the activity of HMGCoA reductase and thus inhibits cellular cholesterol synthesis. Moreover, the values of HDL did not vary significantly ($p>0.05$) among various treatment groups thus confirming the reports of Rahmatnejad *et al*. (2009) who found that inclusion of tomato waste in diet up to 8% did not affect blood serum HDL content of

Table 1: Ingredient and nutrient composition of experimental diets

	Experimental diets					
Feed stuffs (%)	A	B	C	D	E	F
Commercial diet (BR 511)	41.5	41.5	41.5	41.5	41.5	41.5
Yellow corn	30	27	27	27	27	27
Rice bran	5.5	0	0	0	0	0
Fish meal	7.5	7.5	7.5	7.5	7.5	7.5
Soybean meal	14	14	14	14	14	14
0% UT: 0% BT	0	0	0	0	0	0
25% UT : 75% BT	0	7	0	0	0	0
50% UT:50 % BT	0	0	7	0	0	0
75% UT:25% BT	0	0	0	7	0	0
100 % UT	0	0	0	0	7	0
100 % BT	0	0	0	0	0	7
Coconut oil	1.5	3	3	3	3	3
Total (%)	100	100	100	100	100	100
Calculated analysis						
Crude protein (%)	21.25	21.12	21.09	21.06	21.02	21.15
Ether -extract (%)	5.97	6.84	6.84	6.84	6.84	6.84
Crude fiber (%)	4.56	5.48	5.53	5.58	5.63	5.43
Ca (%)	0.79	0.80	0.80	0.80	0.80	0.81
P availabe(%)	0.37	0.37	0.37	0.37	0.37	0.37
Metabolizable energy (kcal/kg)	2919.77	2909.32	2907.44	2905.57	2903.69	2911.19
Methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50
Lysine (%)	0.96	0.96	0.96	0.96	0.96	0.96

Table 2: Effect of different combinations of UT and BT waste on broiler chicken performance

Combination of UT and BT waste in diet	Feed consumption (g/bird/day)	Daily weight gain (g/bird/day)	Feed conversion ratio
0% UT: 0% BT	88.69	52.43	1.56
25% UT: 75% BT	88.34	51.29	1.70
50% UT: 50% BT	87.00	50.54	1.70
75% UT: 25% BT	88.17	50.90	1.71
100% UT	88.57	51.15	1.71
100% BT	87.52	50.68	1.71
SE	1.16	1.13	0.14

UT: Unboiled tomato BT: Boiled tomato SE: Standard error of the mean

Table 3: Effect of different combination of UT and BT waste on internal organ development

Combination of UT and BT waste in diet	Heart (g)	Liver (g)	Pancreas (g)	Gizzard (g)	Spleen (g)
0% UT: 0% BT	6.70	29.40	3.16	27.44	1.42
25% UT: 75% BT	6.00	27.60	3.98	23.40	1.84
50% UT: 50% BT	6.92	26.62	3.38	24.14	1.34
75% UT: 25% BT	6.74	26.70	3.60	26.10	1.92
100% UT	7.10	29.96	4.20	22.18	1.96
100% BT	7.16	27.66	3.28	26.84	1.82
SE	0.58	1.90	0.35	1.49	0.03

UT: Unboiled tomato BT: Boiled tomato SE: Standard error of the mean

Table 4: Effect of different combinations of UT and BT waste on blood serum lipid profile of broiler chicken

Combination of UT and BT waste in diet	Total cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	Triglyseride (mg/dl)
0% UT: 0% BT	151.40^{a}	57.60^{a}	86.00	39.00^{a}
25% UT: 75% BT	138.60^{bc}	35.16^{c}	97.60	29.20^{b}
50% UT: 50% BT	142.60^{bc}	43.20^{bc}	92.80	33.00^{b}
75% UT: 25% BT	147.40^{ab}	48.56^{ab}	92.20	33.20^{b}
100% UT	151.40^{ab}	54.28^{ab}	90.60	34.60^{ab}
100% BT	140.20^{bc}	34.00^{c}	101.80	22.00^{c}
SE	2.39	4.18	3.65	1.47

UT: Unboiled tomato BT: Boiled tomato SE: Standard error of the mean

broiler birds. Similar to total cholesterol and LDL, the triglyseride levels decreased significantly ($p<0.05$) in all the groups fed various dietary combinations of UT and BT waste and effects were much more pronounced in the groups fed higher levels of BT waste. These results are however in contrast with the findings of Jouzi *et al*.

(2015) who reported that the inclusion of tomato pulp powder up to 8% in broiler diet had no effect ($p>0.05$) on blood serum triglyseride levels of broiler chicken.

Conclusion: In conclusion, tomato waste up to 7% level in the diet of broiler chicken, especially the boiled one, is highly effective in regulation of lipid metabolism in a positive manner by lowering serum total cholesterol, LDL and triglyceride values. This in turn could prove as an important tool for health conscious people in the prevention of atherosclerosis or coronary heart diseases.

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