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Research Article
Effects of Boiled Tomato Waste Utilization in the Diet on Serum Lipid Profile and Egg Quality of Laying-hens

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Abstract

Objective: An experiment had been conducted to study the effects of boiled tomato waste utilization in the diet on the serum lipid profile: total cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL) and the egg quality (egg yolk cholesterol, egg yolk lipid and egg yolk color index) of 200 Isa Brown laying-hens of 60 weeks-old fed diet containing boiled tomato waste powder and to determine the appropriate level of boiled tomato waste in the diet. **Materials and Methods:** The experiment was performed in a completely randomized design with five different levels of boiled tomato waste powder in diets (0, 3, 6, 9 and 12%) as treatments and each treatment was replicated four times. Measured variables were total cholesterol, LDL and HDL of blood serum and total cholesterol, fat contents of egg yolk as well as egg yolk color index of laying-hens. **Results:** The experiment showed that the total cholesterol, LDL and HDL of laying-hen's blood serum and fat content of egg yolk was not affected ($p>0.05$) by different levels of boiled tomato waste powder in diets, while the egg yolk total cholesterol and egg yolk color index were significantly influenced ($p<0.05$). The increase in the level of boiled tomato waste powder in the diet reduced the total cholesterol in egg yolk but increased the egg yolk color index. **Conclusion:** The inclusion of 12% boiled tomato waste powder in laying-hen's diet was the best level for lowering egg yolk total cholesterol and improving egg yolk color index.

Key words: Boiled tomato waste, laying-hens, serum, egg yolk, cholesterol, LDL, HDL, color index

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Diversification of feed or feed substitution with agro-industrial by-product/waste is an attempt to overcome the scarcity of feed and to reduce the price of the ration. Our previous study showed that juice waste mixture could be used as an alternative feed in replacing some of corn in broiler diets[1-3]. Tomatoes could also be utilized as a source of feed because in a certain time they could be over production in some places in Indonesia and tomatoe's price becomes cheaper and farmers loose their profit. In some tomato production centers, there are no tomato processing industry, so that fresh tomato becomes waste when over-production and is discarded by farmers around their fields, because farmers do not have skills for processing tomatoes become certain product for human consumption. These discarded tomatoes might be used as the source of feed because they contain nutrients. Tomato pomace is one of the waste from processing tomato become a juice. This tomato pomace contains 16.6-23.7% crude protein and 30.0-37.8% crude fiber[4,5]. According to Mappiratu *et al.*[6] tomatoes contain vitamins B, C, E and pro-vitamin A/carotene and also macro-minerals such as Ca, P, Mg, K, Na, Cl and S and micro-mineral Fe. Tomatoes also contain high lycopene that can act as anti-oxidants and lowers the cholesterol synthesis. According to Fuhrman *et al.*[7], the mechanism of lycopene in lowering the cholesterol synthesis is by inhibiting the activity of enzyme 3-hydroxy-3-methylglutaryl-CoA reductase (HMGCR). Lycopene produced by plants is in the trans form structure and poorly absorbed. Heating the tomatoes will affect the lycopene in tomatoes. Boiling tomatoes at a temperature of 100°C for 8 min will damage the cell wall of tomato thereby increasing the availability of free lycopene without damaging its structure[8]. Our previous study showed that the inclusion of 7% boiled tomatoes in broiler diets was highly effective in regulating the lipid metabolism in a positive manner[9]. However, there is no information on the utilization of boiled tomato waste in laying-hen's diet and its effects on the blood parameters and egg quality of laying-hens. Thus, we conducted an experiment by including boiled tomato waste in laying-hen's diet to investigate the effects of this boiled tomato waste on the serum lipid profile and quality of eggs.

MATERIALS AND METHODS

Birds: The experiment was conducted at a poultry farm in Padang Pariaman, West Sumatra Province, Indonesia by using 200 Isa Brown laying-hens at the age of 32 weeks with 80% hen-day egg production (HDEP) condition and the average body weight was 1650 g bird^{-1}. The experiment was performed for 30 days.

Tomato boiled preparation: Boiled tomato waste powder was prepared by boiling fresh tomato waste in boiled water (100°C) for 8 min and then was directly dried under sunlight before grinding it to be powder[8].

Experimental design: The experiment was performed in a completely randomized design with five different levels of boiled tomato waste powder in diets (0, 3, 6, 9 and 12%) as treatments and each treatment was replicated four times. Diets were formulated in iso-protein (16%) and iso-energy (2990 kcal kg^{-1}) as figured out in Table 1.

Table 1: Diet composition (%), nutrients (%) and metabolizable energy (kcal kg^{-1}) contents of experimental diets

	Experimental diets				
Ingredients	A	B	C	D	E
Concentrate diet					
K38 royal	32.50	32.25	32.00	31.75	31.50
Corn	46.00	44.75	43.50	42.25	41.00
Rice bran	14.25	12.50	10.50	8.75	6.75
Clam shell	3.00	3.00	3.00	3.00	3.00
Palm oil	4.00	4.25	4.75	5.00	5.50
Boiled tomato waste	0.00	3.00	6.00	9.00	12.00
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Crude protein	16.05	16.12	16.16	16.23	16.28
Crude fat (%)	8.28	8.46	8.87	9.05	9.46
Crude fiber (%)	3.89	4.42	4.92	5.46	5.96
Ca (%)	3.58	3.57	3.56	3.54	3.53
Pavail. (%)	0.40	0.40	0.40	0.41	0.41
Met (%)	0.13	0.13	0.12	0.11	0.11
Lys (%)	0.16	0.16	0.15	0.14	0.13
Lycopene (ppm)	0.00	1.89	3.77	5.66	7.55
ME (kcal kg^{-1})	2630.00	2617.00	2623.00	2611.00	2616.00

Table 2: Effects of treatments on the blood serum cholesterol, LDL, HDL, egg yolk cholesterol, fat contents as well as egg yolk color index

Treatments	Serum (mg dL^{-1})			Egg yolk cholesterol in DM (mg/100 g)	Egg yolk fat content in DM (%)	Egg yolk color index
	Cholesterol in blood	LDL in blood	HDL in blood			
Boiled tomato waste (0%)	150.13	44.25	37.75	662.09^{d}	54.93	6.98^{c}
Boiled tomato waste (3%)	158.92	45.00	46.50	621.85^{bc}	55.13	9.12^{b}
Boiled tomato waste (6%)	110.08	42.25	37.75	643.03^{cd}	56.24	9.57^{b}
Boiled tomato waste (9%)	106.39	36.00	38.67	585.15^{ab}	54.58	10.41^{a}
Boiled tomato waste (12%)	118.28	40.33	48.67	560.92^{a}	56.21	10.35^{a}
SEM	25.01	5.80	10.35	12.21	0.96	0.23

SEM: Standard error of the mean, $^{a-d}$Means with different superscript at the same column are significantly differed ($p<0.05$)

Measured variables: Total cholesterol, LDL and HDL of blood serum were determined by enzymatic colorimetri[10], while the total cholesterol of egg yolk by Liebermen and Burchard method, egg yolk fat content by proximate analysis according to AOAC[11] and egg yolk color by egg yolk roche color fan.

Data analysis: Data obtained were statistically analyzed by analysis of variance of a completely randomized design. The difference among treatment means was determined by using Duncan Multiple Range Test (DMRT) according to Steel and Torrie[12].

RESULTS AND DISCUSSION

Blood serum parameters: The means of total cholesterol, LDL and HDL of laying-hen's blood serum and total cholesterol, fat content and color index of egg yolk are depicted in Table 2. It is shown that the total cholesterol, LDL and HDL of laying-hens blood serum were not affected by levels of boiled tomato waste in diets ($p>0.05$). Even though there were no difference among treatments statistically but numerically it appeared that increasing in the level of boiled tomato waste powder in the diet lowered the total cholesterol and LDL tremendously and increased the HDL. It seems that cis-lycopene concentration in boiled tomato could lowering the cholesterol and LDL in this experiment but it is suspected the observation period was not long enough (only 30 days), so that the difference among treatments is not detected statistically. The prolong observation might affect total cholesterol, LDL and HDL of blood serum significantly. Total cholesterol of laying-hens blood serum (106.39-158.92 mg dL^{-1}) found in this experiment was almost the same as total cholesterol of laying-hens blood serum values (115.50-126.60 mg dL^{-1})[13], meanwhile the LDL (36.00-45 mg dL^{-1}) was higher than LDL values (17.33-28.50 mg dL^{-1}) and HDL (37.75-48.67) were lower than HDL values (78.98-86.76 mg dL^{-1})[14].

Egg yolk parameters: Egg yolk total cholesterol was significantly affected ($p<0.05$) by the levels of boiled tomato waste in the diets. Increasing in tomato boiled waste levels in the diets lowering the total cholesterol in egg yolk but the levels of tomato boiled waste 9 and 12% in diets did not differ statistically ($p>0.05$). It is indicated that the cis-lycopene in boiled tomato waste influenced cholesterol synthesis, especially for cholesterol deposition in egg yolk. This result was not similar to the result of experiment by Safamehr[14] who found that dried tomato pomace levels up to 10% in the diet did not affect the cholesterol content of egg yolk in laying-hens. The egg yolk fat content was not affected ($p>0.05$) by the levels of boiled tomato waste in the diets. The egg yolk color index was significantly influenced ($p<0.05$) by the levels of boiled tomato waste in the diets. Increasing in the levels of boiled tomato waste in the diet improved the egg yolk color index. According to Lesson and Caston[15] and Karadas *et al.*[16] this egg yolk color index was influenced by the types and concentration of carotenoid content in the diet. The boiled tomato waste contains cis-lycopene that coloring the egg yolk and the inclusion of 9-12% boiled tomato waste in layer diets had higher coloring effect on the egg yolk pigmentation when compared with other levels of boiled tomato waste in diets. According to Kang *et al.*[17], the addition of lycopene above 4 μg g^{-1} meal significantly improved egg yolk color index after 4 days of supplementation.

CONCLUSION

The increase in the level of boiled tomato waste in the diet decreased the egg yolk cholesterol content and improve the egg yolk color index. About 12% inclusion of boiled tomato waste in laying-hen's diet is the best treatment for lowering cholesterol and improving egg yolk color index.

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