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Evaluation of raw and processed soybean on feed efficiency, carcass traits and blood parameters in Japanese quails (*Coturnix japonica*)

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Abstract

The aim of this study was to investigate the effect of different types of processed (toasted, autoclaved and extruded soybean) soybean meal and raw soya seed on feed efficiency, carcass traits and blood parameters in Japanese quails (*Coturnix japonica*). A total of 189, twelve days old male and female Japanese quails were randomly assigned to 9 treatments. The first group (control group) was fed the standard diet with soybean meal, and other groups (T2-T9) were fed 10 or 20% of raw (T2 and T3), autoclaved (T4 and T5) and toasted (T6 and T7) and extruded soybean (T8 and T9). The results indicated that these treatments had no significant effect on weight and percent of abdomen fat, carcass percent, breast percent and concentration of blood triglyceride. The results showed that the best and worst feed conversion ratio (FCR) was recorded in T3 and T9 groups respectively. Live weight, weight without feather, carcass weight, gizzard weight and concentration of iron (Fe) and triglyceride were significantly different between male and female birds, but in other traits no significant different (P>0.05) was observed. There was no interaction between treatments and sex of the birds in any studied parameters. In conclusion, the results of present study showed that increasing processed soybean in the diet up to 20% especially extruded soya improved birds feed efficiency. The consumption of raw soybean caused negative effects on feed efficiency.

Keywords: processed soybean; raw soybean; soybean meal; blood parameters; Japanese quail

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Introduction

Poultry feeding is one of the most important aspects of poultry production. Nutrient utilization depends to a great extent on the control of available feed ingredients in relation to the various sources and technological processes used in feed processing (Demeterová, 2009). Soybean is the major vegetable protein source in poultry feed. Now-a-days, the use of soya without oil extraction has a great importance. In addition, high protein content with unique biological value, soya fat content contributes to the energy required for protein synthesis. It is desirable to formulate high-energy diets, so part of the cereals can be replaced (Varga-Visi et al., 2009). Full-fat soya contains anti-nutritive factors which may reduce the digestibility and utilization of protein in non-ruminants and young ruminants (Monary, 1996). These anti-nutrition factors depress the food intake, growth performers and digestibility of nutrients (Perilla et al., 1997; Palacios et al., 2004; Valencia et al., 2009). It has been postulated that a combined effect of endogenous loss of essential amino acids and decreased intestinal proteolysis, reduces growth rate when trypsin inhibitors (TIs) are ingested (Clarke and Wiseman, 2007). The TI and urease activity (UA) are correlated to body weight and feed conversion ratio (Ruiz et al., 2004). Although, thermal treatment removes the anti-nutritional factors, the condition of heat processing affects protein quality and the fat content (Monica et al., 2001). Using high temperature over time in the new processing techniques of seeds such as extrusion, and mechanization jet

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exploding and browning has tremendous effect on reducing anti-nutritional factors in raw soybeans. Autoclave and microwave heating methods are considered as the most important that can play a role to destroy anti-nutritional compounds, in particular, trypsin inhibitor, phytic acid, tannins and lectin (Beukovic et al., 2012). Previous studies showed that the inclusion of full fat soybean in poultry diet have a positive effect on daily, total weight gain and meat quality (Tousimojarrad et al., 2012). Therefore, such a raw material could be used to increase economic efficiency in the process of fattening, but also to improve the protein and fat contents in chicken meat (Popescu and Criste, 2003). Subuh et al. (2002) demonstrated that replacing extruded soybeans with soybean meal had no adverse effects on carcass quality and productivity traits of broilers.

The aim of this study was to investigate the effects of different types of processed soybean (toasted, autoclaved and extruded soybean), soybean meal and raw soya seed on feed efficiency, carcass characteristics and some blood parameters in Japanese quails (*Coturnix japonica*).

Materials and Methods

In this experiment, soybean seeds were toasted, autoclaved or extruded at temperatures 130˚C (Moghadam et al., 2009), 121˚C (Moghadam et al., 2009) and 160˚C (Marsman et al. (1997) respectively. A total of 189, twelve day-old mixed sexed Japanese quails (*Coturnix Japonica*) were randomly assigned to nine treatments. Each treatment was further divided into three replicates (7 birds per replicate). The experiment lasted for 35 days. The first group (control group) was fed a diet with soybean meal and other treatments including 10% raw soybean (T2), 20% raw soybean (T3), 10% autoclaved soybean (T4), 20% autoclaved soybean (T5), 10% toasted soybean (T6), 20% toasted soybean (T7), 10% extruded soybean (T8) and 20% extruded soybean (T9). The diets were formulated using National Research Council (NRC, 1994) guidelines and contained 24% protein and 3000 kcal/kg metabolizable energy (ME). All diets were isocaloric and isonitrogenous. During the experiment, food and water were provided *ad libitum* to the birds. The composition and nutrients content of the diets are shown in Table 1. Feed conversion ratio (FCR), live weight, carcass characteristics (carcass weight without feather, carcass weight (without viscera), carcass percent, breast weight and percent, thigh weight and percent, heart weight, weight and percent of abdomen fat, gizzard weight, testis weight) and blood parameters (cholesterol, triglyceride and iron) were determined (Vali et la., 2009).

Weekly feed consumption was recorded, and feed conversion ratio was calculated weekly during the whole experimental period. Body weight was measured weekly with an electronic scale with a sensitivity of ±0.01 gram and recorded. At 42 days of age, four birds per replicate were randomly taken, slaughtered and carcass percent to live weight, percent of carcass parts to carcass weight and abdominal fat content were calculated. Abdominal fat was defined as the fat surrounding the gizzard extending within the ischium and surrounding the bursa of Fabricius, cloaca and adjacent abdominal muscle (Vali et al., 2009). After evisceration, gizzard, heart and testis were removed and weighed. Blood samples from the brachial vein of 4 quails in each pen were collected at the end of the experimental period. Blood samples were collected in test tubes with an anticoagulant, Sodium Eythllene Ditetra Amino (EDTA), and plasma was obtained by centrifugation of blood at 3500 rpm for 15 min. and kept at –18ºC until analyzing. Plasma triglycerides and cholesterol were measured using commercially available assay kits by enzymatic methods. Blood iron (Fe) was determined by atomic absorption spectrophotometer using an AA 240 fast sequential (FS) apparatus with sample introduction pump system (SIPS) as described by Higglns (1981).

Data were analyzed based on completely randomized design using GLM procedure of SAS (SAS, Version 9.1). P value less than 0.05 was considered significantly different.

Results

The results of live weight and carcass characteristics are presented in Table 2 & 3. Percent and weight of abdominal fat, carcass (weight and percentage) and breast percentage had no significant difference between treatments (P>0.05). The maximum live weight belonged to T8 group including 10% extruded soya compared to control and other treatments (P<0.05). Breast and carcass weight of birds that consumed the extruded soybeans was significant (P<0.05) as compared to birds in other groups. Breast had the maximum weight in T8 group and the minimum belonged to T3 group (P<0.05). Maximum gizzard and heart weight was observed in birds that have been fed with 10 and 20% extruded soybeans (P<0.05).

Our results indicated that the testis weight of birds were significantly different between treatments (P<0.05). Significant difference observed in live weight, carcass weight without feather, carcass weight (without viscera) and gizzard weight between male and female birds (P<0.05). There was no significant difference between treatments in carcass and breast percentage (P>0.05). The highest value of femur percent belonged to T3, T4, T6 and T8 groups, while T1 and T7 groups had the lowest value of femur percent (P<0.05). The effect of dietary treatment on FCR is shown in Table 4. The results indicated that the best and worst FCR belonged to treatments with 20% extruded and 20% raw soya, respectively (P<0.05).

Table 1: The ingredients (%) and composition of experimental diets

	Treatments*								
Ingredients (%)	1	2	3	4	5	6	7	8	9
Corn	46.16	45.80	41.80	45.80	41.80	45.80	41.80	45.80	41.80
Soybean Meal	40.73	33.10	27.37	33.10	27.37	33.10	27.37	33.10	27.37
Fish Meal	4.94	4.22	2.74	4.22	2.74	4.22	2.74	4.22	2.74
Fat	3.96	2.55	2.13	2.55	2.13	2.55	2.13	2.55	2.13
Soya Seed	0.00	10.00	20.00	10.00	20.00	10.00	20.00	10.00	20.00
Dcp	1.83	1.87	1.77	1.87	1.77	1.87	1.77	1.87	1.77
Caco3	0.74	0.80	1.00	0.80	1.00	0.80	1.00	0.80	1.00
Sand	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Met	0.04	0.06	0.09	0.06	0.09	0.06	0.09	0.06	0.09
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Min premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Rice Bran	0.50	0.50	2.00	0.50	2.00	0.50	2.00	0.50	2.00
Sum	100	100	100	100	100	100	100	100	100
Calculated values									
ME (Kcal/kg)	3000	3000	3000	3000	3000	3000	3000	3000	3000
CP (%)	24	24	24	24	24	24	24	24	24
Ca (%)	1	1	1	1	1	1	1	1	1
P (%)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lys (%)	1.46	1.45	1.43	1.45	1.43	1.45	1.43	1.45	1.43
Met-Sys (%)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
CF (%)	3.87	3.93	3.93	3.93	3.93	3.93	3.93	3.93	3.93
Linoleic acid (%)	2.09	2.64	3.21	2.64	3.21	2.64	3.21	2.64	3.21

*1: control group was fed with diet for quails with soybean meal, 2: contained 10% raw soybean, 3; contained 20% raw soybean, 4: contained 10% autoclaved soybean, 5: contained 20% autoclaved soybean, 6: contained 10% toasted soybean, 7: contained 20% toasted soybean, 8: contained 10% extruded soybean and 9: contained 20% extruded soybean ; **Provided per kilogram of diet: retinol (vitamin A), 7700 IU; cholecalciferol (vitamin D_3), 3300 IU; DL-alpha-tocopherol acetate (vitamin E), 6.6 IU; menadione (vitamin K_3), 0.55 mg; thiamine, 1.5 mg; riboflavin, 4.4 mg; pantothenic acid, 22 mg; niacin, 5.5 mg; pyridoxine, 3 mg; choline chloride, 275 mg; folic acid 1.1 mg ; biotin 0.055 mg; vitamin B_{12} (cyanocobalamin), 0.088 mg; antioxidant,1 mg; Manganese, 66 mg; zinc, 66 mg; iron, 33 mg; copper, 8.8 mg; iodine, 0.9 mg; selenium, 0.3 mg.

Table 2: Effect of treatments on carcass characteristics

Treatments	Parameters						
	Live Weight (g)	Weight without feather (g)	Abdominal fat (g)	Abdominal fat (%)	Heart weight (g)	Gizzard weight (g)	Testes weight (g)
1	236.26±10.59^{ab}	221.15±10.55^{ab}	2.82± 0.43	1.69±0.22	1.96±0.17^{ab}	4.48±0.41^{bc}	6.35±1.06^{ab}
2	226.58± 10.51^{b}	211.6±10.48^{abc}	2.71± 0.43	1.75± 0.22	2.02±0.17^{ab}	4.30±0.41^{c}	3.35±0.81^{b}
3	209.26± 10.59^{b}	185.7±10.55^{c}	2.5± 0.43	1.73± 0.22	1.91± 0.17^{ab}	5.11±0.41^{abc}	5.25±0.85^{ab}
4	225.5± 10.59^{b}	208.43±10.55^{abc}	2.52± 0.43	1.6± 0.22	2.04± 0.17^{ab}	4.23±0.41^{c}	5.15±0.85^{ab}
5	221.33± 10.51^{b}	207.8±10.48 ^{bc}	2.74± 0.43	1.74± 0.22	1.79± 0.17^{b}	5.28±0.41^{abc}	5±0.93^{ab}
6	228.51± 10.59^{b}	212.4±10.55^{abc}	2.57± 0.43	1.59± 0.22	1.96± 0.17^{ab}	4.63±0.41^{abc}	6.35±0.85^{a}
7	216.83± 10.51^{b}	201.6±10.48^{bc}	2.14± 0.43	1.35± 0.22	1.92± 0.17^{ab}	4.35±0.41^{c}	3.8±0.93^{ab}
8	265.65± 10.44^{a}	243.53±10.41^{a}	3.05± 0.42	1.67± 0.22	2.31± 0.17^{ab}	5.98± 0.40^{a}	3.55±0.81^{b}
9	241.26± 10.59^{ab}	228.15±10.55^{ab}	1.82± 0.43	1.06± 0.22	2.41± 0.17^{a}	5.78±0.41^{ab}	5.4±0.85^{ab}
Female	246.36± 5.98^{a}	229.38±5.96^{a}	2.53±0.24	1.51±0.12	1.96±0.09	5.32±0.23^{a}	-
Male	213.90± 5.38^{b}	197.37±5.37^{b}	2.56±0.22	1.65±0.11	2.11±0.08	4.49±0.21^{b}	4.99±0.29
Interaction	N.S*	N.S	N.S	N.S	N.S	N.S	N.S

^{abc}Means in a column with different superscripts differ significantly (p<0.05); T1: control group was fed with diet for quails with soybean meal, T2: contained 10% raw soybean, T3; contained 20% raw soybean, T4: contained; 10% autoclaved soybean, T5: contained 20% autoclaved soybean, T6: contained 10% toasted soybean, T7: contained 20% toasted soybean; T8: contained 10% extruded soybean and T9: contained 20% extruded soybean; *Non-significant

Effects of dietary treatments on blood parameters are shown in Table 5. Cholesterol level was the highest in the T5 group, and the lowest in the group which was fed raw soybean (T3) and differences between treatments was statistically significant (P<0.05). Our result indicated that the highest serum Fe concentration belonged to T5 group and the lowest was observed in T6 and T9 groups (P<0.05). Dietary treatments did not have any significant effect on serum triglyceride (P>0.05). There was a significant difference between male and female birds in term of blood Fe and triglyceride (P<0.05). There was no interaction between treatments and birds gender in studied parameters (P>0.05).

Table 3: Effect of treatments on carcass characteristics

Treatment	Parameters					
	Carcass weight (g)	Carcass percent	Femur weight (g)	Femur percent	Breast weight (g)	Breast (%)
1	165.53± 9.56^{ab}	70.04±2.23	36.00±2.07^{b}	21.78±0.67^{b}	59.56±3.16^{ab}	36.26±1.60
2	153.26± 9/5.^{ab}	68.16±2.21	35.16±2.05^{b}	22.95±0.60^{ab}	54.92±3.14^{ab}	35.89±1.59
3	145.93± 9.56^{b}	69.51±2.23	35.22±2.07^{b}	24.24±0.67^{a}	52.46±3.83^{b}	38.20±1.94
4	156.83± 9.56^{ab}	69.51±2.23	37.97±2.07 ^{ab}	24.22±0.67^{a}	55.91±3.16^{ab}	35.58±1.60
5	156.66± 9.50^{ab}	70.77±2.21	36.38±2.05^{b}	22.84±0.66^{ab}	58.67±3.14^{ab}	37.70±1.59
6	160.16± 9.56^{ab}	70.22±2.23	38.25±2.07^{ab}	23.97±0.67^{a}	57.08±3.16^{ab}	35.57±1.60
7	152.39± 9.50^{ab}	70.39±2.21	33.53±2.05^{b}	21.84±0.66^{b}	54.85±3.14^{ab}	36±1/59
8	183.41± 9.43^{a}	69.64±2.20	44.66±2.04^{a}	24.38±0.66^{a}	65±3.11^{a}	35.47±1.58
9	170.06± 9.56^{ab}	70.72±2.23	38.47±2.07^{ab}	22.77±0.67^{ab}	61/23±3.16^{ab}	35.94±1.60
Female	167.65±5.40^{a}	68.23±1.26^{b}	38.2±1.17	22.83±0.37	60.01±1.85^{a}	36.29±0.94
Male	153.3±4.86^{b}	71.53±1.13^{a}	36.38±1.05	23.61±0.34	55.48±1.60^{b}	36.20±0.82
Interaction	N.S*	N.S	N.S	N.S	N.S	N.S

^{abc}Means in a column with different superscripts differ significantly (p<0.05); T1: control group was fed with diet for quails with soybean meal, T2: contained 10% raw soybean, T3; contained 20% raw soybean, T4: contained 10% autoclaved soybean, T5: contained 20% autoclaved soybean, T6: contained 10% toasted soybean, T7: contained 20% toasted soybean, T8: contained 10% extruded soybean and T9: contained 20% extruded soybean; *Non-significant

Table 4: Effect of treatments on feed conversion ratio (FCR)

Treatments	Feed conversion ratio (gm/day/bird)					
	First weeks	Second weeks	Third weeks	Forth weeks	Fifth weeks	Whole experimental period
T1	2.26 ±0.14^{ab}	2.28±0.08^{cde}	2.58±0.07^{ab}	2.77±0.07^{ab}	2.96±0.05^{b}	2.57±0.15^{ab}
T2	2.52 ±0.14^{a}	2.83±0.08^{a}	2.72±0.07^{a}	2.83±0.07^{ab}	3.00±0.05^{b}	2.78±0.15^{a}
T3	2.49 ±0.14^{a}	2.85±0.08^{a}	2.74±0.07^{a}	3.00±0.07^{a}	3.32±0.05^{a}	2.88±0.15^{a}
T4	2.52 ±0.14^{a}	2.52±0.08^{bc}	2.45±0.07^{b}	2.74±0.07^{ab}	2.95±0.05^{b}	2.63±0.15^{ab}
T5	1.96 ±0.14^{bc}	2.43±0.08^{bcd}	2.62±0.07^{ab}	2.77±0.07^{ab}	2.92±0.05^{b}	2.54±0.15^{ab}
T6	2.12 ±0.14^{abc}	2.58±0.08^{b}	2.63±0.07^{ab}	2.81±0.07^{ab}	2.96±0.05^{b}	2.62±0.15^{ab}
T7	2.07 ±0.14 ^{abc}	2.35±0.08^{bcde}	2.65±0.07^{ab}	3.01±0.07^{a}	2.93±0.05^{b}	2.60±0.15^{ab}
T8	1.66 ±0.14 ^{c}	2.20±0.08^{de}	2.54±0.07^{ab}	2.77±0.07^{ab}	2.88±0.05^{b}	2.37±0.15^{ab}
T9	1.69 ±0.14 ^{c}	2.13±0.08^{e}	2.56±0.07^{ab}	2.72±0.07^{b}	2.70±0.05^{c}	2.23±0.15^{b}

T1: control group was fed with diet for quails with soybean meal, T2: contained 10% raw soybean, T3; contained 20% raw soybean, T4: contained 10% autoclaved soybean, T5: contained 20% autoclaved soybean, T6: contained 10% toasted soybean, T7: contained 20% toasted soybean, T8: contained 10% extruded soybean and T9: contained 20% extruded soybean; ^{abc}Means in a column with different superscripts differ significantly (p<0.05).

Discussion

Percent and weight of abdominal fat, carcass percent and breast percent did not differ significantly between treatments, while the other parameters were significantly affected by treatments. The maximum live weight belonged to T8 group include 10% of extruded soya (P<0.05). This result is in agreement with those of Subuh et al. (2002) and Beukovic et al. (2012). Beukovic et al. (2012) showed that chickens fed with mixture of untreated soybeans had lower final mass than group fed with the mixture of heat treated soybeans. In contrary, the results of Perilla (1997), Monica (2001) and Demeterova (2009) indicated that live weight of birds treated with soybean meal and processed soybean had no significant difference.

Breast and carcass weight of birds that consumed the extruded soybeans was statistically highly as compared to birds in other groups. Breast had the maximum weight in T8 group and the minimum weight of breast belonged to T3 group which may be due to the presence of anti-nutritive factors such as proteases (Beukovic et al., 2012). Maximum gizzard and heart weight were observed in birds fed with 10 and 20% extruded soybeans. These results are in opposite with results of Carew et al. (2003) and Beukovic et al. (2012) who observed a significantly higher relative heart weight of chickens fed with raw soybeans and concluded that this increase may represent an additional burden that can lead to stress and disease. Tousimojarrad et al. (2012) showed that heat processed soybean meal had no significant effects on gizzard and heart weight of broilers.

There was no significant difference between treatments in weight and percentage of abdominal fat. These results are parallel with results of Demeterova (2009) and Subuh et al., (2002). Beukovic et al. (2012) indicated that the abdominal fat of chickens fed with raw soybean was significantly lower than control diet. This could be explained due to the presence of anti-nutritive factors (Arija et al., 2006). Our results indicated that the testis

Table 5: Effect of treatments on blood parameters

Treatments	Parameters		
	Triglyceride (mg/dl)	Cholesterol (mg/dl)	Fe (mg/cc×100)
T1	280.85±108.06	168.14±29.93[ab]	340.17±55.93[abc]
T2	284.39±107.32	212.49±29.72[ab]	314.36±67.68[bc]
T3	183.35±108.06	127.39±29.93[b]	216.23±55.93[bc]
T4	318.85±108.06	146.39±29.93[b]	331.02±70.86[abc]
T5	253.14±107.32	264.49±29.72[a]	514.41±80.62[a]
T6	71.35±107.32	186.89±29.93[ab]	185.09±55.93[c]
T7	314.89±107.32	190.99±29.72[ab]	381.31±67.68[ab]
T8	427.5±106.57	203.61±29.51[ab]	273.64±55.23[bc]
T9	255.35±108.06	172.14±29.93[ab]	184.45±55.93[c]
Female	376.71±61.09[a]	167.66±16.92	363.49±32.91[a]
Male	154.32±54.97[b]	204.01±15.22	199.27±32.91[b]
Interaction	N.S[*]	N.S	N.S

[abc]Means in a column with different superscripts differ significantly (P<0.05); T1: control group was fed with diet for quails with soybean meal, T2: contained 10% raw soybean, T3; contained 20% raw soybean, T4: contained; 10% autoclaved soybean, T5: contained 20% autoclaved soybean, T6: contained 10% toasted soybean, T7: contained 20% toasted soybean; T8: contained 10% extruded soybean and T9: contained 20% extruded soybean; [*]non-significant

weight of birds was significantly different between treatments which agreed to the result of Tousimojarrad et al. (2012). Testes weight depends on the age at sexual maturity, genetics, environmental condition, body weight and some parameters in diet. In present study, all of these factors were the same, so the difference between testis weights can be related to individual differences in birds and measurement error. Significant differences were observed in live weight, defeatherd carcass weight, carcass weight and gizzard weight between male and female birds under different treatments (P<0.05). There were no significant differences between treatments in carcass and breast percent (P>0.05). These results are comparable with the results of Subuh et al. (2002). In contrast, Demeterova (2009) indicated that the use of toasted full-fat soybean (FFSB) caused a significant decrease in hot carcass yield in the FFSB group after 42 days of the trial in comparison to control birds fed with diet based on soybean meal. The highest value of femur percent was observed in T3, T4, T6 and T8 groups, while T1 and T7 groups had the lowest value of femur percent (P<0.05). Also Beukovic et al. (2012) indicated that the percentage of breast and thigh of chickens that consumed the mixture with heat processed soybeans was significant as compared to the group whose feed contained heat untreated soybean. In the present study, carcass percentage in male birds was greater than female birds, while breast weight in female birds was greater than male. These results are not in harmony with those of Demeterova (2009).

The results indicated that the best FCR was found in 20% extruded soya. Probably, the worse FCR in group with raw soya is due to the higher urease activity than other groups (data not shown). Lower than 0.1 urease activity of processed soybean is considered as optimum for maximum production (Batal et al., 2000; Ruiz et al., 2004**)**. Zanella et al. (1999) and Subuh et al. (2002) also indicated that the use of processed soybean in diet could improve feed conversion ratio in comparison to use of raw soybean. Raw soybeans contain anti-nutritional factors that depress nutrient digestibility and decreased birds' performance. It is well established that the most important anti-nutritional factors contained in beans (proteases, hemagglutinins or lectins and urease) are destroyed by heat. Ruiz et al. (2004) demonstrated that trypsin inhibitor and urease activity are correlated to body weight and feed conversion ratio.

Cholesterol level was the highest in the T5 group, and the lowest in the group which was fed raw soybean (T3) and differences between treatments were statistically significant. This result was in parallel with result of Carew et al. (1998) and Beukovic et al. (2011). Cholesterol is the precursor of all steroid hormones and bile salts. Cholesterol levels may vary depending on the climatic conditions of the environment, nutrition, fitness broilers and sexual activity (Itoh et al., 1998). Lowered plasma cholesterol in chickens that received raw grain legumes indicates disruption of endogenous cholesterol metabolism, which is caused by ingestion of food (Arija, 2006). The results of Martins et al. (2004) suggested the reduction of total cholesterol in plasma of piglets that were fed raw peas. Carew et al. (1998) showed that the effect of legumes on cholesterol in plasma is not associated with thermo sensitive factors in raw beans. Our result indicated that the highest serum Fe concentration was observed in T5 group and the lowest concentration belonged to T9 and T6 groups (P<0.05). Dietary treatments had no significant effect on plasma triglyceride (P>0.05). Adesehinwa (2008) demonstrated that the use of processed full fat soybean did not have significant effect on blood cholesterol and triglyceride concentration in piglets. In contrary, Arija et al. (2006) reported increased levels of triglycerides in groups that were fed extruded diets with a grain of beans. Beukovic et al. (2011) showed that serum triglyceride level in broilers was significantly higher in standard extruded soybeans and extruded soybeans with low levels of Kunitz trypsin inhibitor (LG) groups fed extruded food in comparison to the group which was fed raw soybeans. There were significant differences between male and female birds in term of blood Fe and triglyceride (P<0.05). Further, there was no interaction between treatments and sex in studied parameters (P>0.05).

In conclusion, the results of present study showed that increasing processed soybean in the diet up to 20% especially full fat soya (extruded soya) improved birds performance. The consumption of raw soybean caused negative effects on performance and its use is not recommended in the diet.

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