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Effects of Replacement of Soybean Meal with Rapeseed Meal on Organs Weight, Some Blood Biochemical Parameters and Performance of Broiler Chicks

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Abstract: Experiment was designed to investigate the possibility of using rapeseed meal in the diet of broiler chicks. The rapeseed meal was replaced to soybean meal with the levels of 0 (control), 25, 50, 75 and 100 percent for the periods of starter (1-21 d), grower (21-42 d) and finisher (42-49 d) feeding systems. The rate of body weight gain was lower in the 100% treatment during the starter, grower and total feeding periods, while there was no difference between the control and 25% treatments. The feed conversion ratio of 100% replacement for the starter and grower feeding periods were statistically different (P<0.05) from the control and 25% treatment and between control and 25% treatment no difference was found. At the age of 49 days, the lowest concentration of gamma glutamyltransferase, triiodothyronine hormone and ratio of triiodothyronine to thyroxin in blood serum of chicks were seen in 100% treatment (P<0.05). The size of liver and relative weight of gallbladder increased (P<0.05) with increasing dietary rapeseed meal. The lowest weight of abdominal fat pad, carcass and whole body were seen in 100% treatment (P<0.05) and the highest ratio of carcass to whole weight was seen in 25% treatment which was significantly (P<0.05) different from other treatments. Chemical analysis of the rapeseed meal showed that the amount of the aliphatic glucosinolates were higher than canola meal. It can be concluded that 25% of soybean meal can be replaced with rapeseed meal in the diet of broiler chicks. For higher levels of replacement, further investigations and better quality meals are required.

Key Words: Broiler chicks, organs weight, performance, rapeseed meal

Introduction

The protein content of rapeseed meal (RSM) is about 35-40% and has a physiologically suitable amino acid combination (Henkel and Mosenthin, 1989). However, RSM contains nutritionally unfavourable substances such as glucosinolates, sinapin, tannin and phytate. Glucosinolates and their hydrolytic products are commonly referred to as goitrogens. Glucosinolates are hydrolyzed by myrosinase (Ciska and Kozlowska, 1998). Myrosinase activity has been observed in gastro-intestinal bacteria of several animal species and poultry (Zeb, 1998). Presence of glucosinolates in the diets leads to hypothyroidism in animals and poultry, reducing the level of thyroid hormones and alters the ratio between triiodothyronine (T3) and thyroxin (T4) in blood. Enlarged thyroid size, increased thyroid stimulating hormone levels, reduced thyroid hormones and changed activities of liver enzymes in the blood of poultry fed diets containing RSM has been observed (Nassar and Arscott, 1986; Schöne *et al*., 1993). Fasina and Campbell (1997) observed reduced weight gain of chickens with increasing inclusion rate of RSM in the diet and the feed to gain ratio increased. Zeb *et al.* (1999) found that broilers could tolerate high glucosinolate RSM at an inclusion rate of 150 g/kg diet, beyond which would result in decreased live weight gain and feed intake of broilers. The present study was conducted to investigate the effects of replacement of soybean meal (SBM) with RSM on performance, size of various organs, thyroid hormones levels and glutamyltransferase (GGT) and alanine amino transferase (ALT) of blood serum of broiler chicks.

Materials and Methods

Diets: The rapeseed meal (RSM) was purchased from Behpak Ind. Co. Ltd. of Iran that for preparing RSM the oil of the rapeseed removed by hexane extraction process. The glucosinolates content of this meal were determined by HPLC method described by Kaushik and Agnihotri (1999). The five dietary treatments that the RSM protein (38%) replaced 0, 25, 50, 75 and 100% of the soybean meal (SBM) protein (44%), respectively in starter (1-21 d of age) grower (21-42 d of age) and finisher (42-49 d of age) diets were tested (Table 1). All diets met the National Research Council (NRC, 1994) recommendations with 3000 Kcal/kg of MEn and were prepared in the form of meals.

Birds and Housing: Two hundred one-day-old Arian male broiler chicks were used for these experiment.

Table 1: Composition and calculated analysis of the experimental diets

Treatment	Starter (1-21 d)					Grower (21-42 d)					Finisher (42-49 d)				
Ingredient (%)	0	25	50	75	100	0	25	50	75	100	0	25	50	75	100
Ground corn	53.00	53.00	51.00	50.00	48.00	57.00	57.00	57.00	57.00	57.00	61.00	61.00	61.00	61.00	61.00
Rapeseed meal	0.00	9.55	19.11	28.65	38.20	0.00	7.27	14.47	21.71	28.95	0.00	5.80	11.58	17.37	23.16
Soybean meal	33.00	24.75	16.50	8.250	0.00	25.00	18.75	12.50	6.25	0.00	20.00	15.00	10.00	5.00	0.00
Fish meal	3.44	3.87	4.14	4.470	4.76	2.75	3.06	3.38	3.67	3.95	2.15	2.40	2.65	2.89	3.12
Wheat bran	3.00	1.40	1.40	0.700	0.70	8.00	6.80	5.60	4.50	3.40	10.20	9.20	8.30	7.35	6.47
Sunflower oil	4.15	4.17	4.79	5.100	5.71	4.14	4.16	4.17	4.18	4.19	3.74	3.75	3.76	3.78	3.78
Oyster shell	1.14	1.03	0.92	0.817	0.71	1.24	1.15	1.06	0.98	0.90	1.17	1.10	1.04	0.97	0.90
Dicalcium phosphate	0.99	0.91	0.84	0.768	0.69	0.63	0.57	0.52	0.46	0.40	0.51	0.47	0.41	0.37	0.32
DL methionine	0.14	0.13	0.09	0.045	0.00	0.14	0.11	0.07	0.03	0.00	0.11	0.08	0.05	0.03	0.00
L-lysine	0.00	0.03	0.06	0.09	0.12	0.00	0.02	0.04	0.06	0.08	0.00	0.02	0.03	0.05	0.07
Salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin mix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Mineral mix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated analysis															
ME_n. (Kcal/kg)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
CP (%)	21.56	21.56	21.56	21.56	21.56	18.75	18.75	18.75	18.75	18.75	16.87	16.87	16.88	16.87	16.87
Ca (%)	0.94	0.94	0.94	0.94	0.94	0.84	0.84	0.84	0.84	0.84	0.75	0.75	0.75	0.75	0.75
P. available (%)	0.42	0.42	0.42	0.42	0.42	0.33	0.33	0.33	0.33	0.33	0.28	0.28	0.28	0.28	0.28
Lysine (%)	1.19	1.19	1.19	1.19	1.19	0.99	0.99	0.99	0.99	0.99	0.85	0.85	0.85	0.85	0.85
Met+cyst (%)	0.885	0.885	0.885	0.885	0.885	0.77	0.77	0.77	0.77	0.77	0.69	0.69	0.69	0.69	0.69

[1]Supplied per kilogram of diet: 18000 IU vitamin A; 4000 IU vitamin D_3; 36 IU vitamin E; 4 mg vitamin K_3; 3.6 mg vitamin B_1; 13.2 mg vitamin B_2; 20 mg D-calcium pantonthenat; 60 mg niacin; 6 mg vitamin B_6; 2 mg folic acid; 30µg vitamin B_{12}; 0.2 mg biotin; 1000 mg choline chloride; 200 mg Mn; 100 mg Fe; 200 mg Zn; 20 mg Cu; 2 mg I; 0.4 mg Se.

Each 10 birds were housed andomly in cages with 1m x 1.2m floor space. Each experimental diet was tested with four replicate cages of ten chicks. Birds were maintained under continuous light and the environmental temperature in the barn that was initially established on 31°C was gradually reduced to 20°C by week 7. Feed and water were provided *ad libitum* during starter, grower and finisher periods.

Data collection: Feed consumption and body weight gain of chicks were recorded 4 h after the removal of feed and feed conversion ratio (FCR) calculated as the unit weight of feed per unit of body weight gain at 21, 42 and 49 d of age. When the chicks were 49 d of age, 2 chicks were selected randomly from each replication (cages) and blood samples (8 samples for each treatments) were collected from wing vein by Terumo Syringe with needle 0.7 x 32 mm. Then chicks were weighed and slaughtered. The liver, gallbladder, heart, spleen, gizzard and the abdominal fat pad were immediately weighed. The carcasses without feather, head, feet and internal organs were weighed. Blood samples were centrifuged (2000 x g for 10 min) and serum was separated and then stored at -20°C until assayed. The total triiodothyronine (T3) and thyroxine (T4) concentration in the sera were determined by RIA with using 125I T3 and 125I T4 tracer and human anti-T3, T4 serum-coated tube according to the procedure of Kloss *et al.*, 1994. (Immunotech a Beckman Coulter Company France Kit Cat No.1699, with Automatic Gama Counter 1272. Clinigamma LKB, Wallac). GGT and ALT were determined by colorimetry (Chem Enzymes and Pars Azmun kit, respectively, with Technicon RA-1000).

Statistical analysis: All Data were analyzed using the GLM procedure of SAS software (SAS, 1993) for analysis of variance. Regression analysis was carried out to determine the relationship between the replacement level (%) and performance of broiler chicken (feed intake, weight gain and FCR). Significant differences among treatments were identified at 5% level by Duncan's multiple range tests (Duncan, 1955).

Results

The glucosinolates contents of RSM are shown in Table 2. The dominant glucosinolate of the RSM was progoitrin. Progoitrin and napoleiferin have a β-hydroxyl group in the R- group side-chain. Increasing the level of dietary RSM had no effect on feed intake during the starter and finisher periods (P>0.05), but the 100% treatment was lower than the 25% treatment (P<0.05) during the grower and total periods. The rate of body weight gain of the 100% treatment was the minimum during the starter, grower and total feeding periods, while there was no difference between the control and 25% treatments (P>0.05). Different levels of RSM in the

Table 2: Content of aliphatic glucosinolates in rapeseed meal

Glucosinolates	R-Group	µmoles/g of meal
Progoitrin	CH_2=CH.CHOH.CH_3	44.2
Gluconapin	CH_2=CH $(CH_2)_2$	16.8
Napoleiferin	CH_2=CH $(CH_2)_3$	10.5
Glucobrassicanapin	CH_2=CH.CH_2.CHOH.CH_2	7.5
Total		79.0

Table 3: Effects of replacement of soybean meal with rapeseed meal on feed intake (g bird^{-1} day^{-1}) and body weight gain (g bird^{-1} day^{-1}) and feed conversion ratio (g feed intake/g body weight gain) of male broiler chicks.

	Treatments (% Replacement) (X)							
	0	25	50	75	100	Prob.	SEM[1]	Regression equation
Feed intake(Y)								
Starter	50.6	52.8	51.7	52.3	50.7	0.317	0.828	NS
Grower	129.7^{ab}	136.7^{a}	134.7^{a}	129.4^{ab}	121.7^{b}	0.012	2.564	Y= -0.094X+135.1, r= -47.5%, P<0.05
Finisher	177.9	188.3	188.9	187.16	181.1	0.269	3.915	NS
Total	102.7^{bc}	108.1^{a}	106.9^{ab}	104.6^{abc}	99.8^{c}	0.018	1.556	Y= -0.038 X+106.1, r= -32.5%, P<0.05
Body weight gain (Y')								
Starter	25.1^{a}	24.8^{a}	21.4^{b}	19.9^{c}	17.5^{d}	0.0001	0.328	Y'= -0.08 X+25.7, r= -95.3%, P<0.0001
Grower	59.3^{ab}	62.1^{a}	57.9^{bc}	55.7^{c}	50.4^{d}	0.0001	0.953	Y'= -0.097 X+61.9, r= -79.3%, P<0.0001
Finisher	71.6	76.1	78.8	71.9	66.7	0.1471	3.235	NS
Total	46.4^{ab}	48.1^{a}	45.2^{b}	42.7^{c}	38.6^{d}	0.0001	0.642	Y'= -0.084X+48.4, r= -84.7%,P<0.0001
FCR (Y'')								
Starter	2.02^{d}	2.13^{d}	2.41^{c}	2.64^{b}	2.90^{a}	0.0001	0.054	Y''= 0.0091X+1.97, r= 95.3%, P<0.0001
Grower	2.19^{b}	2.20^{b}	2.33^{ab}	2.32^{ab}	2.42^{a}	0.0141	0.045	Y''= 0.0023 X+2.18, r= 70.1%, P<0.001
Finisher	2.48^{b}	2.47^{b}	2.41^{b}	2.61^{ab}	2.73^{a}	0.0453	0.072	Y''= 0.0024 X+2.42, r= 50.7%, P<0.05
Total	2.21^{c}	2.25^{c}	2.36^{b}	2.45^{b}	2.59^{a}	0.0001	0.028	Y''= 0.0038 X+2.18, r= 91.1%, P<0.0001
Mortality (%)	5.0	0.0	2.5	7.5	2.5	0.4735	0.029	

[1]SEM = Standard error of mean. [2] FCR: Feed conversion ratio. NS: No significance. a-d:Row values with same superscript or no superscript are not significantly different (P<0.05). Prob.: Probability

Table 4: Effects of replacement of soybean meal with rapeseed meal on thyroid hormones and liver enzymes in blood serum of male broiler chicks

	Treatments (% Replacement)						
	0	25	50	75	100	Probability	SEM[1]
T3 (ng/ml)	2.43^{a}	2.30^{ab}	1.97^{ab}	1.66^{b}	1.63^{b}	0.036	0.236
T4 (ng/ml)	28.75	28.13	31.00	27.12	30.38	0.143	1.216
T3:T4 (%)	8.45^{a}	8.17^{ab}	6.35^{ab}	6.12^{ab}	5.36^{b}	0.042	0.886
GGT[2](IU/L[4])	15.87^{a}	12.87^{ab}	12.28^{b}	11.85^{b}	10.50^{b}	0.016	1.009
ALT[3](IU/L[4])	264.7	256.1	270.1	233.8	257.7	0.293	10.87

[1]SEM =Standard error of mean. [2]GGT: Gamma glutamyltransferase. [3]ALT: Alanin aminotransferase. [4] IU/L: International Unit/liter.
a-d: Row values with same superscript or no superscript are not significantly different (P<0.05).

diets also affected the feed conversion ratio (FCR) and correlation between the replacement and FCR decreased with increasing age of chicken. The FCR in 100% replacement for the starter and grower feeding periods were statistically different (P<0.05) from the control and 25% treatment and between control and 25% treatment no difference was found (Table 3).

The lowest concentration of T3, T3:T4 ratio and GGT in serum of chicks were seen in 100% replacement (P<0.05). RSM had no effect on the concentration of T4 and ALT (P>0.05) in blood chicks at 49th d of age (Table 4). The effects of treatments on organs weight are shown in table 5. The RSM increased the size of liver, its relative weight and relative weight of gallbladder (P<0.05). The size of spleen and gizzard were not affected (P>0.05) by the amount of RSM in diets. The lowest weight of abdominal fat pad, carcass and whole live body were seen in 100% replacement treatment (P<0.05) and the highest ratio of carcass to whole body weight was seen in 25% replacement treatment which was significantly (P<0.05) different from other treatments.

Discussion

The total aliphatic glucosinolate content (79.0 µmoles/g of fat-free meal) in the RSM exceeded the canola standard (30 µmoles/g of fat-free meal) and also content of erucic acid in this meal (37.2mg/g, analyze not show) was higher than the canola standard (20mg/g) (Rymer and Short, 2003). Researchers classified the RSM based on their glucosinolates content. Four categories have been identified as very low, low, medium and high glucosinolate RSM for 1-5, 10-25, 30-55 and over 55 µmoles/g of fat-free meal, respectively (Mawson *et al.*, 1993). According to this, examined meal has been a RSM with high level of glucosinolate. Hydrolysis of gluconapin and glucobrassicanapin leads to forming apart from nitriles, thiocyanides and also allyl isothyocyanates but enzymatic hydrolysis of progoitrin and napoleiferin leads to forming epiniterile, nitrile and goitrin (Ciska and Kozlowska, 1998). The distribution of glucosinolates in this meal were similar to RSM of Europe and other temperate countries that contain mainly progoitrin and gluconapin. Variations in glucosinolate content and composition of the meal produced in different countries may be related to climatic

Table 5: Effects of replacement of soybean meal with rapeseed meal on the organs weight of male broiler chicks

Treatments (% Replacment)		0	25	50	75	100	Probability	SEM[1]
Liver	[2]Abs.(g)	43.18[c]	59.37[b]	54.22[b]	60.81[a]	55.06[c]	0.0001	1.701
	[3]Rel.Who. (g)	1.75[c]	2.49[b]	2.37[b]	2.66[a]	2.64[a]	0.0001	0.078
Gallbladder	[2]Abs (mg)	1537	1725	1745	2219	1868	0.2193	198.4
	[3]Rel.Who.(mg)	62[b]	73[ab]	76[ab]	97[a]	89[a]	0.0378	7.86
Heart	[2]Abs.(g)	10.09[a]	10.12[a]	10.27[a]	10.03[a]	9.17[b]	0.0273	0.245
	[3] Rel.Who. (g)	0.409	0.426	0.448	0.438	0.438	0.168	0.011
Spleen	[2]Abs.(g)	2.64	2.44	2.78	2.95	2.57	0.659	0.244
	[3]Rel.Who. (g)	0.107	0.103	0.121	0.129	0.123	0.426	0.011
Gizzard	[2]Abs.(g)	38.90	34.47	35.75	36.02	32.25	0.1761	1.040
	[3]Rel.Who. (g)	1.58	1.45	1.56	1.57	1.54	0.8280	0.084
Abdominal fat pad	[2]Abs.(g)	70.13[a]	65.76[a]	65.69[a]	60.66[ab]	45.84[b]	0.0346	5.389
	[3]Rel.Who. (g)	2.84	2.63	2.87	2.65	2.19	0.1867	0.202
Carcass	[2]Abs.(g)	1721.9[a]	1711.9[a]	1586.9[a]	1594.4[a]	1454.4[b]	0.0009	43.55
	[3]Rel.Who. (g)	69.84[b]±	72.08[a]	69.29[b]	69.70[b]	69.65[b]	0.0024	0.483
Whole body	[2]Abs.(g)	2465.6[a]	2375.0[ab]	2290.0[b]	2287.5[b]	2088.1[c]	0.0008	54.59

[1]SEM = Standard error of mean. [2]Abs. = Absolute weight. [3]Rel. Who. = Weight relative to 100g whole (live) body.
a-d: Row values with same superscript or no superscript are not significantly different (P<0.05).

variations among tropical and temperate countries (Tripathi and Mishra, 2007).

The results of the present study demonstrated that feed intake of broiler chicks at grower and total period was influenced by inclusion of RSM at higher levels in the diets. The RSM contains substantial concentrations of phenolic compound that causes bitter taste and astringency to the diet containing it (Shahidi and Naczk, 1992). Goitrin, isothyocyanates and glucobrassicin are known as bitter taste in Brassica (Drewnowski and Gomez-Carneros, 2000). The evidence indicates that diet palatability can be adversely affected by the glucosinolates of the RSM (Mawson *et al.*, 1993). The influence of flavor on feed intake is less important for poultry than other livestock animal because the senses of taste and smell among the birds are not developed as well as the other species (Zeb, 1998). The palatability of diets was reduced with increasing the age of chicks and level of RSM. Also researchers found that the palatability of diets is improved with low glucosinolates RSM, very low glucosinolates RSM (Mawson *et al.*, 1993) and lower dietary inclusion of high glucosinolates RSM (Elwinger and Saterby, 1986). However, in present study a reduction in feed consumption at grower period was seen when the inclusion level was above 21.7% (75% replacement) and without considering the control group, reduction in feed intake was above 14.5% RSM in diet (50% replacement). Leeson *et al.* (1987) found that even complete replacement of SBM (100%) with canola meal (<30 µmoles/g glucosinolate) did not affect the feed intake in broilers and laying hens but Karunajewa *et al.* (1990) found that inclusion 149g/kg (50% replacement), or more, of RSM (42 µmoles/g glucosinolate) in diet reduced feed intake. The present study shows that replacement of RSM with SBM up to 25% had no adverse effect on body weight gain and FCR of broiler chicks at starter, grower and finisher period and even improved the body weight gain in the grower period. This can attributed to amino acid balance of diet in this level of replacement. The reduction of body weight gain may be related to the lysine-arginine imbalance in higher levels of RSM in diets (Summers and Leeson, 1978). The use of large amounts of RSM is limited because of the lower energy and higher fiber contents compared with SBM (Mawson *et al.*, 1993). Crude fibber content of RSM negatively affected AMEn value for broiler chicken (Chibowska *et al.*, 2000).

Karunajewa *et al.* (1990) reported that the inclusion of 149 g/kg of RSM in the starter and finisher diets reduced body weight gain. Salmon *et al.* (1981) observed in an experiment on broiler chickens that inclusion of candle RSM (contains low glucosinolate and low erucic acid) up to 218g/kg diet did not affect the live weights as compared to those chicks fed on SBM and also feed efficiency was not influenced by RSM. Tangtaweeipat *et al.* (1998) showed that body weight gain of broilers was reduced, when canola meal was substituted for 75% soybean meal in the diet. Different results may be related to the different level of glucosinolate and erucic acid in the meals.

Results of the present study demonstrated that inclusion of RSM in broiler's diet did not affect T4 concentration of blood in chicks at 49th day of age (Table 4). This may be related to the long time of using RSM in broiler's diet and causing a physiological equilibrium in the thyroid gland of chicks. According to Clandinin *et al.* (1966) using of goitirin in the diet of chicks caused a physiological equilibrium in thyroid gland of chicks after 3-4 weeks. The hydrolysis products of glucosinolates impair the thyroid uptake of iodide, its oxidation, the iodine binding to thyroglobulin, synthesis and release of hormone (Schöne *et al.*, 1993). Reduction of T4 releasing affected the release of thyroid stimulating hormone from pituitary and thereinafter increased thyroid size and hyperplasia of thyroid cell. When thyroid gland was reached to a physiological equilibrium after 3-4 (Clandinin *et al.*,

1966) or 3-5 (Chiasson and Sharp, 1979) weeks, T_4 concentration in blood is sufficient. As it can be seen through the data, inclusion of RSM in broiler's diet reduced T_3 concentration in blood chicken at 49th day of age (Table 4). Most of the actions of thyroid hormones seem to be dependent on binding to a nuclear thyroid hormone receptors (α and β) and these receptors preferentially bind to T_3. Antithyroid compounds of RSM could destroy cellular T_3 receptors (Schöne *et al.*, 1993) and change outer ring deiodination of T_4 in peripheral tissue (Darras *et al.*, 2000). The lower concentration of T_3 and T_3 to T_4 ratio in the RSM diet may be due to effect of hydrolysis of glucosinolates on deiodinase enzyme activity of peripheral tissue. Spiegel *et al.* (1993) reported that feeding of rapeseed presscake meal would result in the reduction of hepatic 5'-monodeiodinase activity (on a protein basis) of pigs. Reductions of T_3 concentration may reduce body weight gain of broiler, because T_3 can stimulate the transcription of growth hormone mRNA and growth hormone synthesis in pituitary (Yen, 2001).

RSM had no effect on ALT serum activity but reduced GGT serum activity. Some researches showed the changes in liver enzymes activity of blood (Pearson *et al.*, 1983) but some others did not (Szymkiewicz *et al.*, 1988). For instance, Kloss *et al.* (1994) did not find any impact from feeding glucosinolate-extracted crambe meal on aspartate transaminase, GGT, lipase and amylase. Seemingly those serum enzymes are not suitable for pathognomic of liver hemorrhage. The hypertrophy of the liver in chicks fed on RSM was probably a consequence of the toxic effects of the hydrolytic products of glucosinolates (Karunajewa *et al.*, 1990) and may be related to changes of thyroid state because, Kahl *et al.* (2002) indicated that permutations in thyroid state alter the liver size of the chicken.

The reduction in abdominal fat pad content has been observed previously (Karunajewa *et al.*, 1990; Janjecic *et al.*, 2002) and may be related to reduction of T_3 hormone in the blood serum. T_3 not only induced intracellular lipid accumulation and various adipocyte-specific markers such as malic enzyme and glycerophosphate dehydrogenase, but also stimulated adipocyte cell proliferation and fat cell cluster formation (Yen, 2001). Therefore reduction of T_3 in blood serum may decrease the content of abdominal fat pad. The hypertrophy of the gallbladder of chicks, which are followed the RSM diets, has not been reported before. The hypertrophy of the gallbladder may be related to effects of hypothyroidism on sphincter of oddi contractility. Because Laukkarinen *et al.* (2003) reported that T_4 had a direct prorelaxing effect on sphincter of oddi contractility and the reduced prorelaxing effect of T_4 on the sphincter of oddi in hypothyroidism results in delayed emptying of biliary tract. The results indicated that replacement of RSM with SBM up to 25% does not affect carcass and whole weight of broiler chicks and in the 25% replacement resulted in better carcass to whole weight ratio. It is concluded that 25% of dietary SBM of broiler chicks can be replaced with RSM. For higher levels of replacement, further investigations and better quality meals are required.

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