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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Different Levels of Rapeseed Meal Supplemented with Calcium Iodate on Performance, Some Carcass Traits, and Thyroid Hormones of Broiler Chickens

E. Maroufyan and H. Kermanshahi
Department of Animal Science, Faculty of Agriculture, Ferdowsi University of Mashhad,
Mashhad, P. O. Box: 91775-1163, Iran

Abstract: In a completely randomized design with 3*3 factorial arrangements and 4 replicates, 360 day-old Ross male broiler chickens were used to evaluate the effect of different levels of a locally grown rapeseed meal (RSM) supplemented with iodine on performance, organs weight and thyroid hormones of broiler chickens. The RSM was used at the levels of 0.0 (control), 7.5 and 15.0 percent for 7 weeks. The iodine levels added into the diets were 0.35 (NRC, 1994 recommendation, control), 0.75 and 1.05 mg/Kg. Feed intake and feed to gain ratio were affected by added levels of RSM during the starter (0-21 d), grower (21-42), finisher(42-49) and overall (0-49 d) feeding periods ($P<0.05$). Body weight gain was not affected by treatments in any periods. Added high levels of RSM significantly increased the relative weights of liver, spleen ($P<0.05$) and decreased the weights of abdominal fat pad ($P<0.05$). Adding levels of RSM were also significantly increased the concentration of serum tri-idotyronine (T_3) at 42 days of age and the concentration of serum thyroxin (T_4) at 21 days of age ($P<0.05$), while adding iodine into the diets had no significant effect among treatments. Thyroid-stimulating hormone (TSH) was not significantly affected by adding RSM into the diets at 21 and 42 days of age. Under the conditions of this study it was concluded that adding RSM into the diets of broilers decreases their performance. Spite the non significant effect of iodine on performance of broilers, due to the presence of glucosinolates in RSM, use of more iodine needs to be considered.

Key words: Rapeseed meal, iodine, performance, thyroid hormones, chicken

Introduction

Rapeseed meal (RSM) is used as a protein supplement in feeding livestock and poultry. The protein content of RSM is about 35-40% and has a physiologically suitable amino acid combination (Roth-Maier *et al*., 2004). However, RSM contains nutritionally unfavorable substances such as glucosinolates, sinapin, tannin, eurocic acid and phytate (Bell, 1993; Mawson *et al*., 1993). Glucosinolates are not directly responsible for the deleterious effects on thyroid function but toxicity is caused by their derivative production, such as thiocyanate and isothiocyanates. Breakdown is mainly caused during the processing of RSM by myrosinase, which is a specific plant hydrolytic enzyme. High temperatures or the activity of the intestinal micro flora may breakdown the glucosinolate content of RSM (Mawson *et al*., 1993). Negative effects of glucosinolates on animals are relative to their concentration in the diet. The presence of dietary glucosinolates is know to impair the thyroid function of poultry (Akiba and Matsumoto, 1977). The thiocyanate anions are competitors of iodine for active transport across the cell membrane and for binding to tyrosine residues of thyroglobulin (Ludke and Schone, 1988). Glucosinolates reduce the intake (Hill, 1991), induce iodine deficiency (Burel *et al*., 2000), goitrogenicity (Schone *et al*., 1990; Walling *et al*., 2002), mutagenicity, hepatotoxicity and nephrotoxicity (Zang *et al*., 1999; Tanii *et al*., 2001). Due to the presence of glucosinolates in RSM, it is hypothesized that addition of extra iodine into the diet (more than NRC, 1994 recommendation) might be an effective method to alleviate the adverse effects of RSM. Therefore, in this study the effect of different levels of RSM supplemented with iodine on performance, organs weight and thyroid hormones of broiler chickens were evaluated.

Materials and Methods

The locally grown RSM was purchased from an oil extraction company in Neishabour, Iran (Fazl). For preparing RSM, the oil of the RSM was extracted by hexan. Three levels of 0.0, 7.5 and 15.0% RSM and three levels of calcium iodate (0.35, 0.75 and 1.05 mg/kg diet) were added into the diets during starter (0-21 d), grower (21-42 d) and finisher (42-49 d) periods of broiler chickens (Table 1). To avoid the effect of soluble non starch polysaccharide present in RSM, 0.05% Endofeed W (minimum activity of 1200 U/g xylanase and 880 U/g beta-glucanase) was added into the diets. The diets met the National Research Council (NRC, 1994) recommendations. Feed and water provided *ad libitum*. Birds were maintained under continuous light. The environmental temperature in the barn that was initially established on 31°C was gradually reduced to 22°C by week 7. In a completely randomized design with 3*3 factorial arrangements, 360 day-old Ross male broiler chickens were randomly assigned in 36 pens of 4

Table 1: Composition of experimental diets age (days)

Treatments	0-21								
Ingredients (%)	1	2	3	4	5	6	7	8	9
Corn	53.95	53.95	53.95	51.74	51.74	51.74	49.53	49.53	49.53
Soybean meal	38.42	38.42	38.42	32.69	32.69	32.69	26.95	26.95	26.95
Rapeseed meal	0.00	0.00	0.00	7.50	7.50	7.50	15.00	15.00	15.00
Veg. oil	3.91	3.91	3.91	4.52	4.52	4.52	5.13	5.13	5.13
Di calcium phosphate	1.46	1.46	1.46	1.41	1.41	1.41	1.36	1.36	1.36
Calcium carbonate	1.15	1.15	1.15	1.1	1.1	1.1	1.05	1.05	1.05
Salt	0.42	0.42	0.42	0.4	0.4	0.4	0.39	0.39	0.39
Vit. Min.premix[1]	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.5
DL-Methionine	0.14	0.14	0.14	0.09	0.09	0.09	0.04	0.04	0.04
L-Lysine	-	-	-	-	-	-	-	-	-
Enzyme[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iodine(mg/Kg)	0.35	0.75	1.05	0.35	0.75	1.05	0.35	0.75	1.05
Calculated analysis									
ME (kcal/kg)	2900	2900	2900	2900	2900	2900	2900	2900	2900
Crude protein (%)	20.86	20.86	20.86	20.86	20.86	20.86	20.86	20.86	20.86
Treatments	21-42								
Ingredients (%)	1	2	3	4	5	6	7	8	9
Corn	65.16	65.16	65.16	64.02	64.02	64.02	61.47	61.47	61.47
Soybean meal	29.81	29.81	29.81	22.85	22.85	22.85	17.41	17.41	17.41
Rapeseed meal	0.00	0.00	0.00	7.50	7.50	7.50	15.00	15.00	15.00
Veg. oil	1.83	1.83	1.83	2.51	2.51	2.51	3.13	3.13	3.13
Di calcium phosphate	1.46	1.46	1.46	1.41	1.41	1.41	1.36	1.36	1.36
Calcium carbonate	1.24	1.24	1.24	1.19	1.19	1.19	1.14	1.14	1.14
Salt	0.31	0.31	0.31	0.3	0.3	0.3	0.28	0.28	0.28
Vit. Min.premix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DL-Methionine	0.03	0.03	0.03	-	-	-	-	-	-
L-Lysine	0.03	0.03	0.03	0.07	0.07	0.07	0.07	0.07	0.07
Enzyme[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iodine(mg/Kg)	0.35	0.75	1.05	0.35	0.75	1.05	0.35	0.75	1.05
Calculated analysis									
ME (kcal/kg)	2900	2900	2900	2900	2900	2900	2900	2900	2900
Crude protein (%)	18.12	18.12	18.12	18.12	18.12	18.12	18.12	18.12	18.12
Treatments	42-49								
Ingredients (%)	1	2	3	4	5	6	7	8	9
Corn	69.59	69.59	69.59	68.72	68.72	68.72	67.92	67.92	67.92
Soybean meal	26.21	26.21	26.21	19.49	19.49	19.49	12.66	12.66	12.66
Rapeseed meal	0.00	0.00	0.00	7.50	7.50	7.50	15.00	15.00	15.00
Veg. oil	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Di calcium phosphate	0.72	0.72	0.72	0.76	0.76	0.76	0.8	0.8	0.8
Calcium carbonate	1.06	1.06	1.06	1.1	1.1	1.1	1.16	1.16	1.16
Salt	0.2	0.2	0.2	0.22	0.22	0.22	0.23	0.23	0.23
Vit. Min.premix[1]	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.5
DL-Methionine	-	-	-	-	-	-	-	-	-
L-Lysine	0.04	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05
Enzyme[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iodine(mg/Kg)	0.35	0.75	1.05	0.35	0.75	1.05	0.35	0.75	1.05
Calculated analysis									
ME (kcal/kg)	2900	2900	2900	2900	2900	2900	2900	2900	2900
Crude protein (%)	16.31	16.31	16.31	16.31	16.31	16.31	16.31	16.31	16.31

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D3,9790 IU; vitamin E, 121 IU; B_{12}, 20 µg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline,.840 mg; biotin, 30 µg; thiamin, 4 mg; zinc sulfate, 60 mg; manganese oxide, 60 mg;.
[2]Endofeed W from GNC Bioferm Inc., Canada.

replicates per treatment (1*1.2m). Feed intake and body weight gain of chickens were recorded weekly, 4 h after the removal of feed, and feed to gain ratio calculated as the unit weight of feed per unit of body weight gain. At 49 days of age, one chicken from each replicate (pen) was randomly selected, weighed, slaughtered and the liver, spleen, pancreas, heart and the abdominal fat pad weights were immediately recorded. At 21 and 42 days

Table 2: Effect of levels of Rapeseed meal and iodine on performance of broiler chickens

Age (days)	0-21			21-42			42-49		
Performance treatments	Feed intake (g)	Weight gain (g)	Feed to Gain ratio	Feed intake (g)	Weight gain (g)	Feed to gain ratio	Feed intake (g)	Weight gain (g)	Feed to gain ratio
Rapeseed level (%)									
A1	499.38^{ab}	224.00	2.262^{b}	1188.20^{a}	580.00	2.050^{ab}	1773.20^{ab}	1254.00	1.435^{ab}
A2	570.74^{a}	216.00	2.678^{a}	1429.10^{a}	608.00	2.40^{a}	2096.70^{a}	1289.00	1.605^{a}
A3	425.5^{b}	222.00	1.942^{b}	946.40^{b}	581.00	1.653^{b}	1420.70^{b}	1327.00	1.325^{b}
P value	0.0020	0.8184	0.0016	0.0015	0.5810	0.0042	0.0038	0.5404	0.0329
Iodine level (%)									
B1	482.00	220.00	2.204	1169.80	617.00	2.204	1711.90	1348.00	1.287
B2	528.74	221.00	2.464	1244.20	554.00	2.214	1871.40	1266.00	1.496
B3	484.92	221.00	2.214	1150.70	597.00	2.148	1707.20	1256.00	1.392
P value	0.3700	0.9962	0.2862	0.7071	0.1216	0.1395	0.5963	0.3249	0.4822
Rapeseed * Iodine									
A1B1	508.70	602.00	2.147	1175.10	235.00	1.937	1755.80	1395.00	1.285
A1B2	537.10	578.00	2.502	1294.60	226.00	2.257	1954.50	1253.00	1.552
A1B3	452.20	559.00	2.136	1097.70	211.00	1.955	1609.20	1114.00	1.495
A2B1	539.10	640.00	2.647	1398.50	205.00	2.172	1974.00	1318.00	1.548
A2B2	598.30	556.00	2.764	1494.50	219.00	2.758	2246.10	1364.00	1.655
A2B3	574.70	627.00	2.624	1394.30	223.00	2.293	2071.80	1300.00	1.612
A3B1	398.10	609.00	1.817	935.70	221.00	1.539	1405.80	1320.00	1.056
A3B2	450.70	529.00	2.127	943.30	216.00	1.819	1415.50	1180.00	1.282
A3B3	427.70	606.00	1.882	960.00	231.00	1.600	1440.60	1355.00	1.068
P value	0.8413	0.7631	0.9802	0.9653	0.6914	0.9737	0.9193	0.1769	0.9736

Age (days)	0-49		
Performance treatments	Feed intake (g)	Weight gain (g)	Feed to Gain ratio
Rapeseed level (%)			
A1	3461.80^{ab}	2095.00	1.659^{ab}
A2	4096.50^{a}	2188.00	1.892^{a}
A3	2792.60^{b}	2129.00	1.337^{b}
P value	0.0022	0.5944	0.0087
Iodine level (%)			
B1	3363.70	2222.00	1.764
B2	3644.30	2078.00	1.603
B3	3342.90	2112.00	1.510
P value	0.6027	0.2744.00	0.3307
Rapeseed * Iodine			
A1B1	3439.70	2268.00	1.510
A1B2	3786.40	2094.00	1.800
A1B3	3159.10	1921.00	1.657
A2B1	3911.60	2200.00	1.594
A2B2	4336.90	2176.00	2.006
A2B3	4040.90	2186.00	2.877
A3B1	2739.60	2197.00	1.248
A3B2	2809.60	1963.00	1.487
A3B3	2828.40	2229.00	1.276
P value	0.9403	0.2680	0.9983

A1-A3 are 0.0, 7.5 and 15% rapeseed meal; B1-B3 are 0.35, 0.75 and 1.05 mg/Kg iodine.

a-f Means in each column with different superscripts are significantly different (P<0.05).

of age, one bird from each replicate was randomly selected and their blood samples were collected. For measuring the concentrations of thyroid hormones, T_3, T_4 and TSH, serum blood samples were separated. The total T_3, T_4 and TSH concentrations in the sera were determined by RIA (Gama manic1, Contron, Italy, with automatic Gama counter) using standard commercial kits (Kavoshyar kit) according to the procedure of Kloss *et al.* (1994) Data were analyzed based on a general linear model procedure of SAS (SAS, 1993) and treatment means when significant (P<0.05), were compared using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

The results of performance of broiler chickens fed RSM and iodine are given in Table 2. Feed intake and feed to gain ratio were significantly affected by RSM (P<0.05). Feed intake of broiler chickens at 0-21, 21-42, 42-49 and 0-49 days of age were significantly decreased as the level of RSM increased in the diets. The reduction in feed intake may partly due to presence of derivatives of glucosinolates (sinigrin and progoitrin) having bitter taste (Fenwick *et al.*, 1982), Progoitrin produces more profound bitter taste compared to sinigrin (Van Doorn *et al.*, 1998). Enzymatic hydrolysis of gluconapin and glucobrassicanapin in Brassica leads to formation of epinitrile, nitrile and goitrin (Ciska and Kozlowska, 1998). Goitrin, isothyocyanates and glucobrassicin are known as bitter taste in Brassica (Drewnowski and Gomez-Carneros, 2000). The evidences indicate that diet palatability can be adversely affected by the glucosinolates of the RSM (Mawson *et al.*, 1993). The palatability of diets can be 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, a reduction in feed intake at 0-21, 21-42, 42-49

Table 3: Effect of Rapeseed meal and iodine on relative organs weight and thyroid hormones of broiler chickens

Age (days)	49					21		42		21	42
Carcass traits/ Treatments	liver weight[1]	spleen weight	Abdom-inal fat pad weight	pancr-eas weight	Heart weight	Serum T_3 (µg/dl)	Serum T_4 (µg/dl)	Serum T_3 (ng/ml)	Serum T_4 (µg/dl)	Serum TSH (ng/ml)	Serum TSH (ng/ml)
Rapeseed level (%)											
A1	8.10[b]	2.11[a]	6.53[a]	2.69	3.91	3.75	5.15[a]	0.79[a]	3.14	0.80	0.85
A2	8.07[b]	1.83[b]	5.74[b]	2.70	3.90	3.99	6.13[b]	1.50[b]	3.67	0.73	0.83
A3	8.58[a]	2.05[a]	5.25[b]	2.76	4.10	4.20	6.15[b]	1.90[c]	3.35	0.73	0.82
P value	0.004	0.032	0.0004	0.520	0.443	0.569	0.022	0.032	0.728	0.772	0.947
Iodine level (%)											
B1	8.23	1.91	5.83	2.73	3.98	3.36	5.59	1.50	3.26	0.76	0.85
B2	8.28	1.98	5.74	2.72	4.10	4.35	5.71	1.65	3.01	0.88	0.85
B3	8.24	2.091	5.95	2.70	3.84	4.22	6.14	1.45	3.98	0.62	0.80
P value	0.931	0.249	0.761	0.889	0.345	0.058	0.366	0.486	0.222	0.0620	0.719
Rapeseed * Iodine											
A1B1	7.85	2.14	6.57	2.76	3.73	3.82	4.85	0.57	2.85	0.95	0.80
A1B2	8.26	2.16	6.25	2.65	4.10	3.47	4.95	1.12	3.10	0.95	1.00
A1B3	8.19	2.02	6.78	2.66	3.81	3.95	5.67	0.68	3.77	0.50	0.75
A2B1	8.07	1.65	6.27	2.74	3.85	2.37	5.77	1.75	3.57	0.71	0.95
A2B2	7.90	1.87	5.99	2.70	3.85	4.87	6.12	1.85	3.55	0.92	0.75
A2B3	8.25	1.97	5.44	2.66	4.00	4.72	6.57	2.27	3.90	0.57	0.80
A3B1	8.78	1.95	4.65	2.71	4.25	3.90	6.15	1.12	4.37	0.62	0.82
A3B2	8.70	1.92	5.48	2.82	4.33	4.72	6.07	2.00	2.40	0.77	0.80
A3B3	8.27	2.29	5.63	2.77	3.71	4.00	6.17	1.14	4.27	0.80	0.85
P value	0.113	0.215	0.092	0.767	0.390	0.067	0.897	0.866	0.799	0.164	0.245

1Relative to live body weight; A1-A3 are 0.0, 7.5 and 15% rapeseed meal; B1-B3 are 0.35, 0.75 and 1.05 mg/Kg iodine;
a-b Means in each column with different superscripts are significantly different (P<0.05); T3, tri-idotyronine; T4, tyroxine.; TSH, thyroid stimulating hormone.

and 0-49 days of age seen in this study shows that the above mentioned compounds may present in RSM are partly responsible for this effect when the inclusion level of RSM into the diets was 15%. Theses results are in agreement with those of Kermanshahi and Abbasi Pour (2006) who showed the negative effect of RSM on feed intake. Summers *et al.* (1990) found that sulphur in RSM may bind with calcium thereby reduces feed intake. Inclusion of RSM into the diets had significant effect on feed to gain ratio of broiler chickens at all periods (P<0.05). These results may partly attribute to the desirable profile of amino acids in RSM, lower feed intake and/or lower body weight gain. Addition of iodine itself into the diets had no significant effect on performance of the chickens in any periods. Body weight gain was not significantly affected by RSM that are in agreement with those of Mawson *et al.* (1993) who reported that inclusion of canola meal into the diets has no significant effect on body weight gain. The effect of RSM and iodine on organs weight, serum T_3, T_4 and TSH are shown in table 3. RSM significantly increased relative liver, spleen and abdominal fat pad to live body weight of chickens (P<0.05). Hypertrophy of liver of chickens fed RSM has been frequently reported (Slominski and Campbell, 1990; Summers *et al.*, 1992). Nitril content of RSM may responsible for hypertrophy and liver damage of chickens (Ciska and Kozlowska, 1998). Some changes in liver enzymes such as aspartate transaminase, lactate dehydrogenase and alkaline dehydrogenase in the plasma of layers and broilers fed RSM are reported (Pearson *et al.*, 1983). Highest spleen weight was seen in birds fed 15% RSM possibly due to the anti nutritional factors present in RSM (P<0.05). Abdominal fat pad was also decreased by RSM (P<0.05). Jalali *et al.* (2004) reported that inclusion of RSM into the diet decreases abdominal fat pad that is possibly due to the hydrolytic products of glucosinolates present in RSM. Adding levels of RSM were also significantly increased (P<0.05) the concentration of serum triidotyronine (T_3) at 42 days of age and the concentration of serum thyroxin (T_4) at 21 days of age. Adding extra iodine didn't show any significant effect on T_3 and T_4 hormones. The hydrolysis products of glucosinolates impair the thyroid uptake of iodide, its oxidation, the iodine binding to thyroglobulin, synthesis and release of hormone (Schone *et al.*, 1990). Thyroid hyperplasia induced by iodine deficiency is associated with an altered pattern of thyroid hormonogenesis. The shift to increase T_3 secretion plays an important role in the adaptation to iodine deficiency because T_3 possesses about 4 times the metabolic potency of T_4 but requires only 75 % as much iodine for synthesis (Ermans *et al.*, 1963). Anti-thyroid compounds of RSM could destroy cellular T_3 receptors (Schone *et al.*, 1990) and change outer ring deiodination of T_4 in peripheral tissue (Darras *et al.*, 2000). Thyroid-

stimulating hormone (TSH) was not significantly affected by RSM and iodine at 21 and 42 days of age.

Conclusion: Researchers classified the RSM to four categories as very low, low, medium and high based on their glucosinolates content (Mawson *et al*., 1993) and based on this classification, the RSM used in this study may had high levels of glucosinolate. Under the conditions of this study it was concluded that adding RSM into the diets of broilers decrease their performance and spite the non significant effect of iodine on performance of broilers, it seems that the need of iodine in intestine due to the presence of glucosinolates in RSM, use of more iodine, more that 0.35 mg/kg recommended y NRC (1994), needs to be considered. In addition to this, it might be possible that due to blocking properties of iodine by glucosinolates in RSM, the poultry meat needs to be fortified with iodine that is historically deficient in soils of middle east area like Iran. More research is needed to clarify this.

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