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Effects of Different Levels of Solvent Extracted Rapeseed (Brassica Carinata) Meal Replacement to Soybean Meal on the Performance of Broiler Chicks

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Abstract
A feeding trial was conducted to evaluate the effect of replacing different levels of solvent extracted rapeseed (Brassica carinata) meal (RSM) for soybean meal (SBM) on dry matter (DM) intake, growth performance, carcass characteristics, and economics of commercial broiler chicks. Three hundred thirty day-old Hubbard classic unsexed commercial chicks with initial body weight of 43.56 ± 0.66 g were used for the experiment. Chicks with completely randomized design were distributed to 15 pens of 22 chicks each, which was further randomly distributed to 5 treatment rations. Treatments were replacement of RSM for SBM with the percentage of 0, 25, 50, 75 and 100%. Daily DM intake, during starter phase was reduced beyond 25%, but it was not significantly influenced up to 50% during the finisher phase. The final and daily body weight gain, weight of breast, drumstick-thigh, liver and gizzard for the entire experimental period were significantly reduced ($P<0.001$) beyond 25% replacement of RSM for SBM. In general, replacement of solvent extracted RSM for SBM beyond 25% hampered growth rate, reduced marketable carcass parts and resulted in enlargement of some edible and non-edible carcass offal.
Keywords: Broiler, performance, Glucosinolate, Brassica Carinata

INTRODUCTION

The number of livestock in Ethiopia is high, but the productivity and availability of animal products like meat and milk for human consumption is below the standards. Poultry product consumption is not exceptional to this fact, and it is only about 0.12 kg of egg and 0.14 kg of chicken meat per capital/year (USAID, 2010). Poultry production in Ethiopia is mainly traditional and the country is endowed with a large population of indigenous chicken, almost all of which are owned and managed by small holder farmers. The supply of poultry meat and eggs from this sector is lower than the need of the steadily growing urban population (Ashenafi, 1997). The total national annual poultry meat and eggs production is estimated at 53,493 and 36,624 tons, respectively (FAO, 2008). Poor production and productivity in poultry is due to the absence of breed improvement, poor management and standard of feeding both in terms of quantity and quality.

In developing countries, feed cost is the most important expense accounting for 55 to 75 % of the total production cost of poultry (Ensminger *et al.*, 1990). Both availability and cost of feed are among the major constraints to poultry production, because poultry industry is in a direct competition with man for major feed ingredients. There is shortage of cereal grains, protein source feeds, vitamins and mineral supplements required to formulate balanced poultry ration. Thus, it is necessary to look for alternative feedstuffs, which are locally available, cheap and nutritionally adequate substitute for conventional feedstuffs used in poultry production. Identification and utilization of such feedstuffs would help farmers to reduce cost, and also to improve the efficiency of poultry production (Tegube and beynen, 2005). This demands the evaluation of agricultural and agro-industrial by products and incorporation of suitable ones in poultry rations. Replacement of commonly used and less available agro-industrial by-products with others that have relatively high availability and low cost is one of the solutions to decrease cost and increase the supply of animal protein. One of such agro-industrial by-products is rapeseed meal (RSM). A large proportion of rapeseed is processed for oil production that results in substantial quantity of rapeseed meal as a by-product.

Rapeseed meal is a potentially good source of plant protein for farm animals and it is a good source of calcium, phosphorus, magnesium, manganese, zinc, copper and iron (Thanaseelaan *et al.,* 2007). However, the use of RSM is limited by the presence of anti-nutritional factors like glucosinolates, sinapine, tannins and phytate (Bell,1993). Goitrin (5-vinyl-oxazolidine-2-thionine) derived from degradation of glucosinolates by enzymes contained in the feed or in the animal bacterial flora is known to inhibit thyroid function by blocking the incorporation of iodine into thyroxin precursors and by suppressing thyroxin secretion from the thyroid gland (Wheater *et al.*, 1987). High level RSM inclusion in the diet of poultry is hindered by the presence of such anti-nutritional substances, which reduce the utilization of feed nutrients and may even lead to digestive disorders, affect health and reduce animal performance. Although low glucosinolate cultivars of rapeseed have been developed elsewhere, these are not widely available in Ethiopia and farmers have to depend on indigenous high glucosinolate varieties, and the local processing factories are entirely dependent on such varieties.

Rapeseed meal protein is less digestible than that of the soybean meal (72% vs. 88%), but the amino acids balance is similar, even better than in the soybean meal for the sulphur amino acids (Summers *et al*.,1977; Ceresnakova *et al*., 2002). Rapeseed meal has also higher vitamin content (choline, biotin and folic acid) than soybean meal (Bell, 1984). The metabolisable energy is low and one of the problems of this meal, next to the presence of glucosynolates (Bell, 1993).

Despite the fact that rapeseed (*B. carinata*) is grown in many parts of Ethiopia and largely utilized for oil production leaving large quantity of meal to be used as animal feed, information on feeding value of RSM in the diets of broiler chickens is inadequate. Moreover, its use in animal feed is limited because of fear of its effect on animals. As a result, the current recommended inclusion level of high glucosinolate rapeseed cultivars is only between 5 to 10% in poultry diets (Gohl, 1981, Schloffel *et al*., 1993). Currently, the Ethiopian spice factory in Kality, Addis Ababa is implementing solvent extraction method which is claimed to reduced the glucosinolates content of RSM. In agreement with this claim, Khattak *et al.* (1996) noted that addition of enzymatic preparations improved the efficiency of RSM nutrient utilization. Hence, it is essential to assess the effects of inclusion levels of solvent extracted RSM as a replacement for soybean meal (SBM) in broiler chicks, so as to affirm the claim by the industry, and to make information available to poultry farmers. Therefore, this study was conducted with the following objective:

- To investigate the effects of replacement of SBM by different levels of solvent extracted RSM on feed intake, growth rate, and carcass yield of broiler chicks.
- To assess the cost efficiency of SBM replacement with RSM by employing partial budget analysis.

MATERIALS AND METHODS

Description of the Study Area

This study was conducted at Debre Zeit Agricultural Research Center located at an altitude of 1900 m.a.s.l and 45 km south east of Addis Ababa, and at latitude and longitude of 8° 44' N and 38° 58' E, respectively. The area has an average annual rainfall of 843 mm and average minimum and maximum temperatures ranging from 10.5 to 26.1^{o}C with a mean value of 18.7 ^{o}C (DZARC, 2001).

Feed Ingredients and Experimental Rations

The feed ingredients used for the formulation of the different experimental ration of this study were rapeseed meal (RSM), corn grain, wheat short (WS), soybean meal (SBM), noug seed cake (NSC), vitamin premix, limestone and salt. The RSM and SBM were purchased from Addis Ababa oil extraction plants. Wheat short and corn grain were purchased from Debre Ziet flour mill factory. Nougseed cake and salt were purchased from dealers in Debre-Zeit Town. The vitamin premix was purchased from Gasco private enterprises in Addis Ababa. Vaccines were purchased from natioal veterinary institute (NVI) in Debre Zeit. Except WS, SBM, RSM and vitamin premix, other feed ingredients were hammer milled to pass through 5 mm sieve size and stored until required for formulation of the experimental ration. The five treatment rations used in the experiment were formulated on isocaloric and isonitrogenous basis to have 23% and 21% CP and an energy content of 3,100 kcal/kg and 3,200 kcal/kg ME for starter (1-28 day) and finisher (29-56 day) diet, respectively. The treatment rations were replacement of RSM for SBM with the percentage of 0, 25, 50, 75, and 100%. In replacing SBM with RSM, there were also slight change in the proportion of other ingredients as the level of RSM increased to balance the ration for CP and ME content (Table 1 and Table 2).

Table 2. Proportion of ingredients in starter diet per 100 kg ration (dry matter basis)

	Treatments (%)				
Ingredients	T1	T2	T3	T4	T5
Maize grain	33	34	34	36.5	36.5
Soybean meal	30	22.5	15	7.5	-
Rapeseed meal	-	7.5	15	22.5	30
Nougseed cake	22	20	20	17.5	17.5
Wheat short	12.5	13.5	13.5	13.5	13.5
Limestone	1	1	1	1	1
Vitamin-premix	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5
Total (100 kg)	100	100	100	100	100

Table 3. Proportion of ingredients in finisher diet per 100 kg ration (dry matter basis)

Ingredients	Treatments (%)				
	T1	T2	T3	T4	T5
Maize grain	41.5	43	45.5	52	54.6
Soybean meal	30	22.5	15	7.5	-
Rapeseed meal	-	7.5	15	22.5	30
Nougseed cake	13	11.5	10	10.5	10.5
Wheat short	13	13	12	5	2.5
Limestone	1	1	0.9	1	0.9
Vitamin-premix	1	1	1.1	1	1
Salt	0.5	0.5	0.5	0.5	0.5
Total 100 (kg)	100	100	100	100	100

Experimental Design and Treatments

The experiment was arranged in a Completely Randomised Design (CRD) and five dietary treatments each with three replications. The following treatment combinations were used.

T 1 = Ration where 0 % of SBM substituted by RSM
T 2 = Ration where 25 % of SBM substituted by RSM
T 3 = Ration where 50 % of SBM substituted by RSM
T 4 = Ration where 75% of SBM substituted by RSM
T 5 = Ration where 100 % of SBM substituted by RSM

Experimental Chicks and Their Management

Fifteen days before the start of the actual experiment, the experimental pens, watering and feeding troughs were thoroughly cleaned and disinfected with HI-7 after mixing the disinfectant at a ratio of 1 L to 330 L of water. The house was also disinfected three days before the start of the experiment. The floors of the 15 pens were covered with teff straw and each pen was provided with 250 watts infrared heat lamp. Three hundred thirty one-day old unsexed Hubbard classic commercial broiler chicks with uniform body weight were used for the experiment. The chicks were purchased from Debre-Zeit Agricultural Research Center. The day old chicks were examined for outer anatomical defects and they were randomly assigned to the 15 pens, each pen/replication consisting of 22 chicks. Therefore, each treatment is replicated three times. Birds were housed in pens with a dimension of 1.45 x 1.5 m. The chicks were vaccinated against NCD at day-one and day twenty one by HB1 and Lasota vaccine, respectively through ocular route. Vaccination for Infectious Bursal Disease (gumboro) was conducted at seven and nineteen days through ocular route. They were also given oxy-tetracycline against salmonellosis and other bacterial diseases (1g/1L of water) for five consecutive days at week six. Chicks were provided feed by plastic tray and a cylindrical tin and wire made feeder for the first two and the next six weeks of age, respectively. Water was provided by round drinker. Feed and water were provided twice a day at 7:30 and 18: 00 hr. Feed was offered *ad libitum* and water was available all the time throughout the experimental period. Feed refusal were collected, weighed and recorded every morning at 7:00 am. The chicks were also weighed in group (per pen) at the beginning and subsequently every week until the experiment was completed.

Chemical analysis

Representative samples were taken from each of the feed ingredients used in the experiment and analyzed before formulating the actual dietary treatment, and the result was used for formulation of the experiment diets. Samples from the compound diets of starter and finisher phase were taken and kept in bags till analyzed. All samples were analyzed for DM, N, EE, CF, Ash, Ca, and P using the weende or proximate analysis methods of the AOAC (1990). Crude protein (CP) was analyzed by multiplying the N obtained by a factor of 6.25. Metabolisable energy (ME) of the experimental diets were determined by indirect methods, according to Wiseman (1987) as follows: ME (Kcal / kg DM) = 3951 + 54.4 EE-88.7CF-40.8 ash. Chemical analysis of feeds was done at Ethiopian Health and Nutrition Research Institute laboratory in Addis Ababa.

Dry matter intake

Mean daily dry matter intakes were determined every day by subtracting ort collected from the feed.

Live Weight Change

Animal were weighed initially and weekly with sensitive balance and then after average daily body weights gain (ADG) of the chicks were computed for each replication.

Carcass Yield Characteristics

At the end of the feeding trial, 6 randomly taken birds (3 female and 3 male) from each replication were starved on average for 12 hours and weighed immediately before slaughter. After slaughtering, the birds were defeathered and dressed weight, eviscerated carcass, organ parts and gastro-intestinal tracts weights were determined. The dressing percentage was calculated as percent of slaughter weight after removing the leg below fetlock, head, blood and feather. Eviscerated carcass weight were determined after removing blood, feather, lower leg, head, kidney, lung, pancreas, crop, proventriculus, small intestine, large intestine, ceacum and urogenital tracts, but with giblets (heart, liver and gizzard) and its percentage were calculated as percent of slaughter weight.

Abdominal fat were determined by weighing the fat trimmed from proventriculus up to cloaca. Its percentage were calculated as the proportion of slaughter weight and multiplied by hundred. The organ parts such as liver, heart, gizzard, lung, kidney and spleen was weighed and their percentages were determined in relation to slaughter weight. Length of leg and wing, length and weight of esophagus, crop, proventriculus, gizzard, small intestine, large intestine and ceacum were measured using a centimeter tape and sensitive balance accordingly. Any mortality, morbidity and abnormalities were recorded as they occurred.

Economic Analysis

The net profits from broiler were calculated based on the cost of feed that each bird consumed and price of birds from the respective treatments and the partial budget was analyzed according to the principles developed by Upton (1970). Partial budget measures the chicken cost, feed and others if any and the profit after the experiment, or differences between gains and losses for the proposed change. The net income (NI) was calculated by subtracting total variable cost (TVC) from total return (TR).

Statistical Analysis

The experimental design used in this study was Completely Randomised Design (CRD). Data were analysed using the general linear model of SAS (SAS, 2002). When the analysis of variance revealed the existence of significant differences among the treatment means, least significant difference (LSD) were used to locate treatment means that were significantly different from one another. The following model was used for analysis of data.

$Y_{ij} = \mu + T_i + e_{ij}$

Where Y_{ij} = represents the j^{th} observation (experimental unit) taken under treatment i.

μ = overall mean

T_i = treatment effect

e_{ij} = random error

RESULTS AND DISCUSSION

Dry Matter Intake

Dry matter intake during the starter, finisher and the entire experiment period are presented in Table 3. The total and daily DM consumption during the starter phase were not affected by 25% substitution of SBM by RSM, but intake significantly ($P<0.001$) decreased as the replacement level increased beyond 25%. Replacing SBM with RSM up to 50% during the finisher and the entire experiment period did not hampered DM intake, but 75 and 100% significantly ($P<0.001$) reduced intake. Reduction in feed intake beyond 25% during starter, but at 50% during finisher phase and the entire experiment period might be mainly due to the high fiber contents of RSM. At early age, activities of pancreatic enzymes that digest fiber is less, and its activity increases with increasing age of the chick (Maiorka *et al*., 2006). As a result, fibrous materials are relatively rapidly digested and leave the intestine, which allows the birds to consume more feed at later age. This might have allowed the birds to consume more feed during the finisher as compared to the starter phase with increasing level of RSM. However, the fact that feed intake linearly decreased beyond 50% substitution of RSM for SBM indicates the effect of high level of RSM in addition to the fiber content of the diet. Higher level of RSM is known to decrease feed intake because of the bitter and stringent taste of its constituent glucosinolates derivatives such as sinigrin, gluconapin, and progoitrin that are known to decrease palatability (Shahidi and Naczk, 1992, Mawson *et al.*, 1993). Furthermore, enzymatic hydrolysis of progoitrin, gluconapin and glucobrassicanapin in Brassica forms toxic compounds like nitrile and goitrin which reduces feed intake (Ciska and Kozlowska, 1998).

According to Bell (1989) increased tannin content in RSM decreases digestibility of the energy and protein. Previous studies, such as Montazer-Sadegh *et al*. (2008) during starter phase, Khan *et al.* (1998), Maroufyan and Kermanshahi (2006), Thanaseelaan *et al.* (2008), and Ghorbani *et al*. (2009) during finisher and entire experiment, reported a reduction in broilers feed intake at a lower percentage of RSM inclusion (16, 9.25, 15, 20 and 15 %, respectively) as compared to the present experiment. Kermanshahi and Abbasi (2006) evaluated the effect of graded levels (0, 15 and 30%) of RSM substitution for SBM and found 30% reduction in feed intake. The difference in the level at which RSM inclusion hampered intake could be due to the differences in the anti-nutritional factor contained in the meals used. On the other hand, Amsalu (1997) reported that broiler starter and finisher chicks can tolerate higher level (25%) of RSM (Tower variety) inclusion in the diet without any detrimental effects on performance. In agreement with the present experiment, Nassar *et al.* (1985) also noted significant decrease in feed intake of broilers when canola meal replaced the entire protein source ingredient in the diet. Similarly, Tadelle *et al.* (2003) reported decreased body weight in broilers when NSC is entirely replaced with RSM, but recommended up to 90% replacement of NSC by RSM for practical diet formulation.

Table 3. Effects of replacing soybean meal with graded levels of rapeseed meal on dry mater and nutrient intake during starter, finisher and the entire experiment period (dry matter basis)

	Treatments						
Intake	T1	T2	T3	T4	T5	SEM	SL
Starter phase							
Total DM (g/bird)	1499.4^{a}	1456^{a}	1367.5^{b}	1302.1^{c}	1108.4^{d}	37.4	***
Daily DM (g/bird/day)	53.5^{a}	52^{a}	48.8^{b}	46.5^{c}	39.6^{d}	1.33	***
ME (kcal/bird/day)	169.5^{a}	164.1^{a}	153.1^{b}	145^{c}	122.3^{c}	4.4	***
Protein (g /bird/ day)	12.15^{a}	11.7^{a}	11.0^{b}	10.3^{c}	8.7^{d}	0.3	***
Finisher Phase							
Total DM (g/bird)	3107^{a}	2951.2^{a}	2967^{a}	2569^{b}	2065^{c}	106	***
Daily DM (g/bird)	110.95^{a}	105.4^{a}	105.9^{a}	91.7^{b}	73.75^{c}	3.79	***
ME (kcal/day/bird)	369.5^{a}	348.7^{a}	347^{a}	294.4^{b}	235.5^{c}	13.5	***
Protein (g /bird/ day)	23.1^{a}	21.7^{a}	21.5^{a}	18.4^{b}	14.6^{c}	0.85	***

^{a,b,c,d,} Means with in a row with different superscripts are significantly different from each other; *** P<0.001; g = gram; % = percent; DM = Dry Matter; SEM= standard error of mean; SL= significant level; RSM = rapeseed meal; SBM = soybean meal; SL = Significant Level; T1= ration where 0% of SBM substituted by RSM; T2= ration where 25% of SBM substituted by RSM; T3= ration where 50% of SBM substituted by RSM; T4= ration where 75% of SBM substituted by RSM; T5= ration where 100% of SBM substituted by RSM.

Dry matter intake increased throughout the experiment in all treatments but, the increase in T_4 and T_5 was at a lower rate than the other treatments. The reduction in total weekly dry matter intake in T_5 started as early as the 2nd week compared to T_4 which is relatively maintained at least up to the 4th week.

Body Weight Gain

The final weight, total and daily body weight gains per bird during the starter, finisher and entire experimental period are shown in Table 4. Final weight, total and daily body weight gains during starter, finisher and the entire period was not significantly affected up to 25% replacement of RSM for SBM. However, at 50, 75 and 100% substitution levels, body weight gains were significantly reduced.

Table 4. Effects of replacing soybean meal with graded levels of rapeseed meal on body weight gain of broiler chick during starter, finisher and the entire experiment period

	Treatments						
Parameters	T1	T2	T3	T4	T5	SEM	SL
Starter phase							
Initial BW (g)	43.6	43.46	43.47	43.2	44.1	0.17	ns
Final BW (g)	606.6^{a}	592.87^{a}	529^{b}	499^{b}	398^{c}	19.9	***
Total BWG (g/bird)	563.6^{a}	549.5^{a}	485.6^{b}	455.8^{b}	353.9^{c}	20.2	***
ADG (g/bird/day)	20.1^{a}	19.62^{a}	17.3^{b}	16.3^{b}	12.64^{c}	0.72	***
Finisher phase							
Final BW (g)	1616^{a}	1601.67^{a}	1453^{b}	1275.5^{c}	901.1^{d}	67.6	***
Total BWG (g/bird)	1009^{a}	1008.8^{a}	924^{b}	776.5^{b}	503.1^{c}	49.4	***
ADG (g/bird/day)	36.04^{a}	36.03^{a}	33^{b}	27.7^{c}	18^{d}	1.76	***

^{a,b,c,d,} Means with in a row with different superscripts are significantly different from each other; P<0.001; *** P<0.001; ADG = average daily gain; BW= body weight; g= gram; SEM= standard error of mean; SL= significant level; ; RSM = rapeseed meal; SBM = soybean meal; SI = small Intestine, SL = Significant Level; wt = weight; T1= ration where 0% of SBM substituted by RSM; T2= ration where 25% of SBM substituted by RSM; T3= ration where 50% of SBM substituted by RSM; T4= ration where 75% of SBM substituted by RSM; T5= ration where 100% of SBM substituted by RSM.

Similar to the present study, Kermanshahi and Abbasi (2006) reported lower body weight gain in broilers when the diet contained 50% SBM replacement by RSM. Arena and Penz (1988), recorded reduced weight gain at 22.5 and 30% inclusion in a total diet of broilers, respectively. Bogedanov and Robako (1986) studied the comparative effects of low and high glucosinolates RSM on broiler performance at 20% level of inclusion. At this level, high glucosinolates RSM feeding resulted in growth depression, but feeding low glucosinolates RSM did not exert such effect, indicating that high glucosinolate RSM should be included in the rations of broilers at a lower level. The final body weight recorded in the present experiment in T1 (control) and T2 (25% replacement) are higher than that reported by Tadelle *et al.* (2003) for broilers fed diet in which RSM replaced NSC, but at higher level body weight of broilers in the present study is lower than reported by these authors indicating that replacing RSM for SBM is more deleterious than replacing RSM with NSC at higher level.

Body weight increased in all treatments throughout the experiment, but the increase in T4 and T5 was at a slower rate, indicating depression in growth rate as the level of RSM increased in the diet. The reduction in body weight observed at high level of RSM substitution for SBM may be due to the anti-nutritional effects of glucosinolate and high level of tannin on feed intake and their direct effect on body weight gain by depressing thyroid gland metabolism (Kralik *et al*., 2003).

Carcass Yield Characteristics

The main carcasses characteristics of broilers are presented in Table 5. Pre-slaughter weight and dressed carcass weight were not influenced by up to 25% RSM replacement to SBM, but linearly decreased beyond 25% replacement of RSM for SBM. Absence of significant difference in dressing percentage is in line with the finding of Tadelle *et al.* (2003), who did not found statistically significant difference in dressing percentage between treatments in which RSM replaced NSC at a level of 0, 7, 14, 21, 28 and 35% in broiler diet. Eviscerated percentage linearly decreased with increasing levels of RSM as a substitute for SBM. The breast and drumstick-thigh percentages were also reduced in treatments receiving ration containing RSM as compared to the control. Therefore, the results indicated that RSM inclusion in broilers diet reduced saleable broiler carcass. The result of the present experiment is in accordance with that of Taraz *et al.* (2006), who reported that replacement of RSM with SBM at a level greater than 25% (7.5 % in diet) reduced carcass and whole weight of broiler chicks. Reduction in carcass can be attributed to the effects of the anti-nutritional factors of RSM on feed intake and broiler growth.

Table 5. Effects of replacing soybean meal with graded level of rapeseed meal on main carcass of broiler chicks.

	Treatments						
Parameter	T1	T2	T3	T4	T5	SEM	SL
Pre-slaughter wt (g)	1574.3^{a}	1515.8^{a}	1417.6^{b}	1202.2^{c}	887.8^{d}	67.6	***
Dressed carcass wt (g)	1337.4^{a}	1254.8^{a}	1128.9^{b}	948.7^{c}	748.4^{d}	59.3	***
Dressing % (sw)	84.8	82.7	79.6	78.9	76.4	1.08	ns
Eviscerated wt (g)	1022.6^{a}	922.8^{b}	842.4^{c}	664.9^{d}	487.9^{e}	51.4	***
Eviscerated % (sw)	64.9^{a}	60.8^{b}	59.4^{b}	55.3^{c}	55.1^{c}	1.07	***
Breast wt (g)	382.9^{a}	330.96^{b}	309.2^{b}	218.8^{c}	169.65^{d}	21.4	***
Breast % (sw)	24.3^{a}	21.8^{ab}	21.7^{bc}	18.2^{c}	19.12^{bc}	0.67	**
Drumstick -thigh wt (g)	328.3^{a}	313.1^{ab}	263^{b}	206.5^{c}	158.9^{d}	16.6	***
Drumstick-thigh % (sw)	20.8^{a}	19.1^{ab}	18.5^{bc}	17.2^{c}	17.9^{bc}	0.39	**

^{abcde} means with in a row with different superscripts are significantly different from each other; *** $P < 0.001$; ** $P < 0.01$; NS = Non Significant; g = gram; sw= slaughter weight; wt = weight; SEM= standard error of mean; SL = Significant Level; ; RSM = rapeseed meal; SBM = soybean meal; SI = small Intestine, SL = Significant Level; wt = weight; T1= ration where 0% of SBM substituted by RSM; T2= ration where 25% of SBM substituted by RSM; T3= ration where 50% of SBM substituted by RSM; T4= ration where 75% of SBM substituted by RSM; T5= ration where 100% of SBM substituted by RSM.

Similarly, Mushtaq *et al.* (2007) noted depression in breast weight due to 30% canola meal inclusion in broiler ration. Thanaseelaan *et al.* (2008) reported similar eviscerated and breast percentage of broilers in treatments consumed ration containing RSM at a level of 0, 5, 7.5, 10, 12.5 and 15% in replacement for groundnut cake.

Weight and percentage of organ parts are shown in Table 6. In the present study, weights of liver, gizzard, heart, lung, and kidney decreased when the substitution level of RSM for SBM increased beyond 25%. This result is in line with that reported by Taraz *et al.* (2006), in which replacement of RSM for SBM at 5.8, 11.58, 17.37 and 23.16% in broiler diet increased percentage of liver with increasing replacement levels. Kermanshahi and Abbasi (2006) also noted increased liver and gizzard percentage at 15 and 30% SBM replacement with RSM. Increased percentage of liver at the highest level of RSM replacement for SBM might be related to the liver damage and its hypertrophy caused by anti-nutritional factors of glucosinolate (Slominski and Campbell, 1990). A significant enlargement of liver and changes of plasma enzyme activities are indicative of damage to the bilary system of the chicks (Griffith *et al.*, 1980). An enlargement and haemorrhage lesion not only in liver but also in other organs of the birds fed RSM suggests the presence of an agent affecting the integrity of the vascular system (March *et al.*, 1978). The high fiber content of the diets containing higher levels of RSM might have attributed to the relatively higher weight of gizzard and the hypertrophy of this organ (Kermanshahi and Abbasi, 2006).

Table 6. Effects of replacing soybean meal with graded level rapeseed meal on organ parts of broiler chicks

Organ wt and %	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
Liver wt (g)	38.07^{a}	37.08^{a}	33.6^{ab}	30.9^{b}	25.3^{c}	1.36	**
Liver % (sw)	2.42^{b}	2.45^{b}	2.37^{b}	2.57^{ab}	2.84^{a}	0.058	*
Spleen wt (g)	1.9	2.13	2.04	1.99	1.83	0.045	ns
Spleen % (sw)	0.12^{c}	0.14^{cb}	0.144^{cb}	0.17^{b}	0.21^{a}	0.008	***
Heart wt (g)	8.6^{a}	9.15^{a}	7.15^{b}	6.9^{b}	5.5^{c}	0.38	**
Heart % (sw)	0.54	0.6	0.5	0.57	0.62	0.016	ns
Lung wt (g)	7.84^{a}	8.02^{a}	7.5^{a}	5.13^{b}	4.7^{b}	0.43	**
Lung% (sw)	0.49	0.53	0.52	0.43	0.54	0.018	ns
Kidney wt (g)	8.65^{a}	7.59^{ab}	7.13^{b}	5.5^{c}	5.45^{c}	0.36	***
Kidney % (sw)	0.55	0.501	0.502	0.48	0.58	0.023	ns
Abdominal fat wt (g)	21.2^{a}	12.4^{b}	9.04^{c}	6.02^{d}	5.2^{d}	1.56	***
Abdominal fat % (sw)	1.35^{a}	0.82^{b}	0.67^{c}	0.64^{c}	0.43^{d}	0.08	***
Gizzard empty wt (g)	36.5^{a}	35.2^{ab}	33.8^{b}	32.8^{b}	29.7^{c}	0.68	**
Gizzard empty % (sw)	2.32^{c}	2.33^{c}	2.38^{c}	2.7^{b}	3.34^{a}	0.107	***

$^{a, b,c,d,;}$ means with in a row with different superscripts are significantly different from each other; *** P < 0.001; ** P < 0.01; * P < 0.05; NS = non significant; SEM= standard error of mean; SL= Significant Level; ; RSM = rapeseed meal; SBM = soybean meal; SI = small Intestine, SL = Significant Level; wt = weight; T1= ration where 0% of SBM substituted by RSM; T2= ration where 25% of SBM substituted by RSM; T3= ration where 50% of SBM substituted by RSM; T4= ration where 75% of SBM substituted by RSM; T5= ration where 100% of SBM substituted by RSM.

The weight and percentage of gastro-intestinal tracts (GIT) organs are given in Table 7. The percentage of esophagus, proventriculus and ceaca empty weight showed no significant difference among treatments, except that esophagus in T5 (100%) RSM replacement is lower than in the other treatments. The maximum and minimum mean value for length of crop and gizzard were noted in T_1 (0%) and T_5 (100%). The length of crop and gizzard were decreased as the graded level of RSM increased. Whereas the length of proventriculus, ceaca, large and small intestine did not influenced by inclusion of RSM in the ration. According to Naseem *et al*. (2006), there was no significant difference in small intestine length among broilers fed diet containing 0, 5, 10, 15 and 20% canola meal. In this study the percentage of GIT parts were increased and showed significant differences at higher level of RSM substitution for SBM, which could be attributed to high fiber content of RSM. As the level of fiber in poultry diet increases, the thickness of GIT organs also increases (Aderolu *et al.,* 2007; Jimenez-Moreno *et al*., 2009).

Table 4. Effects of replacing soybean meal with rapeseed meal on the Gastro-intestinal tracts (GIT) parts of broiler chicks.

Parameters	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
Esophagus empty wt (g)	2.49^{a}	2.41^{a}	1.98^{bc}	1.56^{c}	1.83^{bc}	0.106	**
Crop empty wt (g)	6.23^{bc}	7.56^{a}	4.97^{d}	6.56^{b}	5.57^{b}	0.26	***
Proventriculus empty wt (g)	8.25	8.66	7.84	7.23	6.69	0.98	ns
SI empty wt (g)	61.76^{ab}	67.1^{a}	62.8^{a}	56.7^{b}	45.1^{c}	2.12	***
Ceaca empty wt (g)	7.9	8.1	7.87	7.7	6.98	0.19	ns
LI empty wt (g)	3.56^{abc}	4.1^{a}	2.94^{c}	3.06^{bc}	3.6^{ab}	0.14	*
Esophagus length (cm)	7.2^{a}	6.35^{b}	6.9^{ab}	6.62^{ab}	5.62^{c}	0.166	**
Crop length (cm)	11.7^{a}	11.5^{a}	11.09^{a}	9.52^{b}	8.6^{b}	0.36	**
Proventriculus length (cm)	4.17	4.17	4.46	4.09	4.04	0.05	ns
Gizzard length (cm)	6.17^{a}	5.7^{abc}	6.03^{ab}	5.58^{bc}	5.3^{c}	0.106	*
SI length (cm)	191.6	217.7	197.7	201.3	190.16	3.5	ns
Ceaca length (cm)	18.47	17.6	17.91	17.93	17.3	0.34	ns
LI length (cm)	5.7	5.46	5.8	5.68	5.66	0.067	ns

^{abcde} means within a row with different superscripts are significantly different from each other; *** P < 0.001; **

P < 0.01; * P < 0.05 NS = non significant; g= gram; cm =centimeter; LI = large Intestine; RSM = rapeseed meal; SBM = soybean meal; SI = small Intestine, SL = Significant Level; wt = weight; T1= ration where 0% of SBM substituted by RSM; T2= ration where 25% of SBM substituted by RSM; T3= ration where 50% of SBM substituted by RSM; T4= ration where 75% of SBM substituted by RSM; T5= ration where 100% of SBM substituted by RSM.

Mortality and Morbidity of Chicks

There was no significant difference during starter, finisher and entire period in chicken mortality among treatments. During the feeding trial there are depressed and compacted chicken in T5. Mortality during the starter phase was low as compared to the finisher. This might be due to the sudden deaths encountered during finisher phase. Modern chicken has a small lung volume to body weight ratio causing an inability of the respiratory system to respond to the broilers elevated oxygen needs, which can lead to hypoxia and respiratory acidosis (Kiiskinen, 1985). The result is in line with that reported by Tadelle *et al.* (2003). Contrary to our observation, Mushtaq *et al.* (2007) reported that addition of canola meal at 30% of the diet increased mortality of chicks.

Economic Analysis

In this experiment the maximum net returns noted in chickens fed diet containing 25% RSM, as a substitution for SBM, followed by chickens fed diets with 50, 0, 75 and 100% RSM. Nascimento *et al.* (1998) and Naseem *et al.* *(*2006*)* reported decreased average diet cost with increasing dietary canola meal. Tadelle *et al.* (2003) also reported the highest net benefit at 28% inclusion level of RSM as a replacement for NSC. Decreased net income at higher level of RSM inclusion, regardless of its cheaper cost as compared to other ingredients is due to the adverse effects of RSM on feed intake, growth rate and feed conversion efficiency that resulted in lower body weight. In general, the results indicated that replacement of RSM for SBM beyond 25% hampered growth rate, reduced marketable carcass parts and resulted in enlargement of some edible and non edible carcass offal.

CONCLUSIONS:

The final weight, daily body weight gain and for the entire experiment period, as well as during the starter and finisher phases were not influenced up to 25% RSM replacement for SBM. However, at 50, 70 and 100% replacements, final weight, daily and total body weight gain of broilers was significantly reduced as compared to 0 and 25% replacement. Except dressing percentage, the other percentages for main carcass parts were significantly hampered by replacement of RSM for SBM. The edible and non edible organs show a tendency of linear reduction in weight as the level of replacement increased. Selling price of broilers based on body weight decreased with increasing level of RSM. In general, the results indicated that replacement of RSM for SBM beyond 25% hampered growth rate, reduced marketable carcass parts and resulted in enlargement of some edible and non edible carcass offal, but replacement at 25% has not affected growth. Therefore, Replacement of SBM by RSM up to 25% is recommendable. As a follow up work, we recommend assessments of different methods that could reduce anti-nuritional factor of RSM to raise its inclusion in poultry ration.

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