Journal of Animal and Veterinary Advances 9 (19): 2517-2521, 2010
ISSN: 1680-5593

The Effect of Different Treatments of Rapeseed Meal on Nitrogen Digestibility and Metabolizable Energy in Broilers and Chicks Performance

[1]M.T. Mirakzehi, [1]A. Tahmasbi and [2]S. Ghazi
[1]Department of Animal Science, Excellence Center for Animal Science,
Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran
[2]Department of Animal Science, Faculty of Agriculture, Razi University, Kermanshah, Iran

Abstract: Two experiment were done to measure the effects of physical, chemical and enzymatic treatments of Rapeseed Meal (RSM) on Nitrogen (N) digestibility and True Metabolizable Energy (TME) in broilers and broiler chicks performance. In experiment 1, a precision fed-assay was used in which different RSM samples containing untreated RSM treated with autoclave, Hydrochloric acid (HCl), sodium hydroxide (NaOH) and Grindazyme GP were precise-fed (25 g) to male broilers (49 days old). Precision-fed assay indicated that N-digestibility and TME of all treated RSM were similar to untreated RSM ($p>0.05$) with the exception of autoclave treated RSM which was lower ($p<0.05$). On the basis of results of experiment 1 experiment 2 was designed to investigate the optimum level of RSM treated with Grindazyme GP on performance, breast, abdominal fat, pancreas, liver and gizzard weight for broiler chicks. Experimental diets were based on soybean meal (control diet) which was replaced by 0, 10, 15, 20, 25 and 30% enzyme treated RSM (0.03%). Over all live weight gain and feed intakes of all diets containing treated RSM were similar to control diet ($p>0.05$) but the broilers on 0, 25 and 30% RSM had significantly ($p<0.05$) better feed conversion ratio compared to the 20% level of RSM. Finally, the data suggest that up to 30% inclusion of enzyme treated RSM could be recommended for practical diet formulation.

Key words: Rapeseed meal, enzyme treatment, precision-fed assay, performance, broiler

INTRODUCTION

Rapeseed Meal (RSM) contains high quality protein but its use in diets of monogastric animals particularly poultry has been limited by the relatively high level of fibre, resulting in low energy yield and less than optimum protein utilization (Slominski and Campbell, 1990). RSM is a rich source of the sulfur amino acids, methionin and cystine. Also characterized as having a lower metabolizable energy level than that of protein sources such as soybean meal. The lower Apparent Metabolizable Energy (AME) is at least partially due to the higher fibre content of the meal but this does not appear to account for all of the differences (National Research Council, 1994). Nutritive value of RSM is limited by the presence of some antinutritive factors including the indigestible Non-Starch Polysaccharides (NSP). The major NSP components found in RSM are pectic polysaccharides, cellulose and xylans which are predominantly found in hull fraction (Meng and Slominski, 2005). The content of anti-nutrients as glucosinolates, aromatic choline esters, phytate and dietary fibres, restricts the use of RSM in feeding sensitive animals. The negative effects of the anti nutrients can be reduced or eliminated by plant breeding, proper processing or a combination of breeding and processing (Jensen *et al*., 1995; Liu *et al*., 1995). Several methods have been proposed in this connection e.g., ammoniation, autoclaving, changes in desolventization conditions, dehulling etc., each with its merits and demerits (Zeb *et al*., 2002). A considerable amount of canola meal (CM; the oil free residue of low glucosinolate, low erucic acid rapeseed), a coproduct of the canola oil extraction industry is available for use in animal feeds (Ahmad *et al*., 2007). Modern double zero varieties have low contents of both glucosinolates and erucic acid and such a variety was used in the present study. The presence of NSP may adversely affect the performance of broiler chicks fed high levels of RSM (Bedford, 2000). Efforts have been made to improve the availability of nutrients and Metabolizable Energy (ME) content from different ingredients through enzyme supplementation. Meng *et al*. (2005) found that multicarbohydrase enzymes are effective in depolymerizing cell wall polysaccharides of soybean meal, canola meal and peas. The present study

Corresponding Author: Mohammad Taher Mirakzehi, Department of Animal Science, Faculty of Agriculture, Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran

was conducted to evaluate the effects of different treatments of RSM on Nitrogen digestibility, AME and TME in broilers. This study reports results of first experiment that generated to second experiment (performance trial).

MATERIALS AND METHODS

Balance experiment: All animal handing were approved by The Razi University Animal Care and Use Committee. The samples of RSM used in the study was purchased from a Nazgol oil extraction Co. in Kermanshah, Iran. Test materials were untreated RSM, treated with autoclave (30 min at 121°C), treated with Hcl (0.44 molar), treated with NaOH (0.25 molar) and treated with Grindazyme GP (0.3 g kg^{-1}, 36000 Ug^{-1} xylanase and 15000 Ug^{-1} β-glucanase). The protein content (N×6.25) of each meals was 38%.

The technique of Sibbald (1976) was used to determine the Nitrogen digestibility and AME, TME contents of each rapeseed sample. About 42 adult male broilers (49 days old) were used in a completely randomized design. About 5 replicate groups (7 bird $group^{-1}$) of male broilers (Ross strain) were individually housed in raised wire cages (70, 60 and 30 cm) equipped with individual feeders and self drinking systems. Briefly, each sample was precision-fed (25 g $bird^{-1}$) following a 28 h fast. During the next 48 h, the excreta from each bird were collected. The excreta samples were frozen, freeze-dried, weighed and ground. These samples were stored for subsequent dry matter, gross energy and Nitrogen measurement. Pooled excreta from 7 birds fed 50 mL of a 50% glucose solution (25 g of dry glucose) were used to determine the endogenous excretion of energy and Nitrogen.

Growth experiment: The growth experiment was conducted to compare the growth performance of broiler chicks fed several diets of RSM by same level of Grindazym GP (0.03%). Cages constructed for this purpose were (L, W, H) 120, 60 and 60 cm with wooden floor and steel wire walls. About 144 days old mixed sex Ross broiler chicks were divided randomly into 6 groups each replicated 4 times (6 chicks/cage). The experiment was of 6 weeks (7-42) duration. A standard commercial starter diet was fed to chicks to 7 days of age before they were placed on the experimental diets. Six diets were used during the study. First diet did not contain RSM while diets 2-6 contained 10, 15, 20, 25 and 30% treated RSM (0.3 g kg^{-1} DM Grindazym GP), respectively. The RSM level in the diets was increased by replacing RSM instead of soybean meal. All diets met the National Research Council (National Research Council, 1994) recommendations. Data on composition of the diets are shown in Table 1. The diets were formulated to be iso-energetic and iso-nitrogenous. Feed and water provided *ad libitum*. The birds in each replicate were weighed as a group each week. Mortality was recorded as it occurred. About 1 bird from each replication and from each treatment was slaughtered and dressed at the end of experiment.

Chemical analysis: Nitrogen of feed and excreta samples was determined by the Kjeldahl method using a Automatic Kjeldahl 1030 Nitrogen Analyser. Gross Energy (GE) of feed and excreta was determined by bomb calorimetry using a Parr 1720 adiabatic calorimeter.

Calculations: The AME values of the RSM samples were calculated using the following formula:

Table 1: Composition (%) of experimental diets used in experiment

	Percentage of RSM in the diet					
Ingredients (%)	0	10	15	20	25	30
Corn	57.23	55.40	54.29	53.74	49.60	46.25
Soybean meal	30.00	20.00	15.00	10.00	5.00	-
Rapeseed meal	-	10.00	15.00	20.00	25.00	30.00
Fish meal	3.04	4.05	4.52	5.00	5.00	5.00
Corn gluten feed	4.50	5.00	5.45	5.62	8.65	11.35
Soy oil	2.30	2.88	3.25	3.35	4.50	5.33
Di-calcium phosphate	1.00	0.84	0.66	0.49	0.45	0.33
Oyster shell	1.20	1.10	1.10	1.07	1.07	1.01
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Mineral premix	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Hcl-lysin	-	-	-	-	-	-
Dl-methionin	-	-	-	-	-	-
Grindazym	0.03	0.03	0.03	0.03	0.03	0.03
Calculated analysis						
ME (kcal kg^{-1})	2950.00	2950.00	2950.00	2950.00	2950.00	2950.00
Cp (%)	21.18	21.18	21.18	21.18	21.18	21.18

AME = [(feed intake×gross energy$_{diet}$) - (excreta output × gross energy$_{excreta}$)]/feed intake. The TME contents of the RSM samples were calculated based on equation of Sibbald (1976) as follows:

$$TME = [(EI-EO)/FI]+(FEL/FI)$$

Where:

EI = Gross energy intake (kcal)
EO = Gross energy output (kcal)
FI = The feed intake of the feedstuffs (25 g)
FEL = Fasting energy loss (kcal) from the feed deprived birds

The true Nitrogen digestibility values of the RSM samples were calculated using the following formula:

True Nitrogen digestibility = N of feed (g) - N of excreta (g)+fasting N loss/N of feed (g)

Statistical analysis: Both studies were set up as completely randomized designs and all data were analysed using a 1-way ANOVA (SPSS, 1999). Means were separated by using Duncan's multiple range tests. The level of significance was set at $p<0.05$.

RESULTS AND DISCUSSION

Over the experimental period the general health of all birds was observed carefully in both precision-fed assay and growth experiment. Results of precision-fed assay are shown in Table 2. Results showed that TME values ranged from 2565.49-2461.34 (cal g^{-1}). Also, results showed that values of AME and TME for all treatments with the exception of acid treatment were significantly different ($p<0.05$) compared with autoclave treatment. Data of N digestibility showed that there were significant differences ($p<0.05$) between untreated and enzyme treated compare to autoclave treated of RSM.

However, autoclave, HCl and NaOH treated RSM had a no significant differences ($p>0.05$). The least values of AME and TME was obtained for autoclave treated RSM. Parsons *et al.* (1992) reported that excessive heat treatment can reduce protein quality due to decrease in amino acid content and availability. Araba and Dale (1990) reported that the protein solubility in potassium hydroxide solution of soybean meal autoclaved at 121°C for longer than 10 min was <70% and the weight gain of chicks fed a diet containing that soybean meal was lower than for these autoclaved for 5 and 10 min with prolonged or elevated heating, basic amino acids such as lysine, undergo a Maillard reaction making them less available for growth (Wiryawan and Dingle, 1999).

Data of Table 2 showed that the AME, TME and N digestibility of HCl and NaOH treated RSM was similar and no differences ($p>0.05$) among both treatment and untreated RSM was noted.

It seems rather likely that the disruption of polypeptides structure (Denaturation) because of wet heating in autoclave for 30 min was responsible for the observed differences.

Slominski and Campbell (1990) reported that enzymatic treatment of RSM resulted to well-being digestibility of fibre part that included lignin and other Non-starch polysaccharides. Total NSP content of 17.9% for canola meal (Slominski and Campbell, 1990) have been reported.

The sugar profiles confirmed that the main polysaccharides of canola meal, soybean meal and peas are pectic polysaccharides with uronic acids, arabinose and galactose residues predominating (Bach, 1997). Meng *et al.* (2005) suggested that further improvements in nutrient utilization could be achieved using combinations of carbohydrases each differing in their substrate preference and mode of action to target various structures of cell wall polysaccharides.

Grindazym GP is an appropriate combination of carbohydrase enzymes (xylanase and β-glucanase) that were added to the RSM samples and diets in both experiment.

Supplementation of multiple carbohydrase preparations may partially depolymerize the NSP of canola meal, thereby improving protein digestibility (Kocher *et al.*, 2000).

Meng *et al.* (2005) reported that combination of carbohydrase enzymes are effective in degrading cell wall structure, leading to the release of oil, the major contributor to the TME$_n$ value. This could have contributed to some improvements in TME and N digestibility observed in the precision-fed assay when enzyme treatment was used.

Table 2: Available energy and nitrogen digestibility in broilers fed different samples of treated RSM

Factors	Untreated RSM	Enzyme treated RSM	Autoclave treated RSM	HCl treated RSM	NaoH treated RSM	SEM
AME (cal g^{-1})	1769.81^{a}	1839.41^{a}	1192.26^{b}	1570.58^{ab}	1735.25^{a}	25.9
TME (cal g^{-1})	2495.00^{a}	2565.49^{a}	1918.34^{b}	2296.66^{ab}	2461.34^{a}	25.9
Nitrogen (N) digestibility (%)	52.81^{a}	63.04^{a}	13.63^{b}	42.43^{ab}	43.77^{ab}	1.69

Means within a row followed by different superscripts are significantly different at $p<0.05$

Table 3: Effect of feeding different levels of RSM on the performance of broiler chicks

Groups	Feed intake (g/chick day)	Weight gain (g/chick day)	Feed:Gain ratio
RSM-10	80.370^{a}	37.330^{a}	2.090^{ab}
RSM-15	76.580^{a}	35.610^{a}	2.130^{ab}
RSM-20	69.950^{a}	28.830^{a}	2.440^{b}
RSM-25	83.780^{a}	42.210^{a}	1.970^{a}
RSM-30	84.780^{a}	41.430^{a}	2.002^{a}
Control	91.415^{a}	47.160^{a}	1.900^{a}
SEM	6.083	2.635	0.028

Values with different superscripts in the same column are significantly different at $p<0.05$

Table 4: Effect of feeding different levels of RSM on organ weights of broiler chicks

Groups	Liver (g)	Gizzerd (g)	Heart (g)	Pancerase (g)	Breast muscle (g)	Abdominal fat (g)
RSM-10	24.750^{ab}	24.50^{a}	7.000^{a}	2.750^{a}	143^{ab}	35.00^{a}
RSM-15	26.000^{ab}	26.25^{a}	8.000^{a}	3.500^{a}	152^{abc}	47.25^{a}
RSM-20	20.750^{a}	23.00^{a}	7.000^{a}	3.250^{a}	102^{a}	29.25^{a}
RSM-25	28.750^{ab}	29.75^{a}	7.000^{a}	2.750^{a}	123^{ab}	35.00^{a}
RSM-30	32.250^{b}	25.75^{a}	9.000^{a}	2.750^{a}	185^{bc}	43.25^{a}
Control	28.750^{ab}	29.00^{a}	8.500^{a}	3.000^{a}	217^{c}	49.50^{a}
SEM	0.642	0.72	0.176	0.083	5.69	1.72

Values with different superscripts in the same column are significantly different at $p<0.05$

Data of feed intake, weight gain and feed conversion ratio is shown in Table 3. All dietary treatments did not influence feed consumption significantly ($p>0.05$) which ranged from 69.95 g/chick/day (20% RSM) to 91.415 g/chick/day (0% RSM). Body weight gain was not affected ($p>0.05$) by different levels of RSM. Most average daily gain in weight (47.16 g chick^{-1}) was recorded in the control group. However, this is not significantly ($p>0.05$) different from average daily weight gain in 20% RSM fed group (28.83 g chick^{-1}). Among the RSM fed groups, the highest weight gain per chick was noted for 25% RSM group. Lowest gain in weight (28.83 g chick^{-1}) was recorded in group fed on 20% RSM diet. Feed to gain ratio ranged from 1.9-2.44 among various dietary treatments and there were significant differences ($p<0.05$) between control, 25 and 30% RSM compare to 20% RSM. RSM levels did not affect the birds feed intake and weight gain. Similar results have been reported by Kocher *et al*. (2000) who observed no adverse affect of canola meal when it was added at 35% of the broilers diet. The results of growth performance were close to those obtained in a previous study by Zeb *et al*. (2002) which fed variously levels of RSM to broiler chicks.

Meng *et al*. (2005) reported that carbohydrase treatment resulted to elimination of the nutrient encapsulating effect of the cell wall polysaccharides and to some extent, reduction of intestinal viscosity. It assumed that beneficial effects of enzyme supplementation contributed to some improvements of broilers performance in high levels of RSM that observed in the current study. Tadelle *et al*. (2003) conducted a study to investigate the effect of dietary RSM cake levels on growth performance and indicated same results of weight gain. Less amount of feed conversion ratio related to higher weight gain by means of marked feed intake.

Mushtaq *et al*. (2007) reported that increase in dietary canola meal to 30% resulted in reduced performance only during 1-21 days only. The inclusion of RSM at 30% had no effect on performance of broilers and was similar to control group ($p>0.05$). Results of carcass organ weights of the slaughtered 6 weeks old birds are shown in Table 4. There were not significant differences ($p>0.05$) between control and other groups except for liver and breast muscle whose weight values were higher ($p<0.05$) in control group compared with the 20% RSM group. This observation is difficult to explain. It is interesting to note that the high level of RSM in 25 and 30% RSM groups not to have affected the weights of both organ.

CONCLUSION

In conclusion, the present studies indicate that precision-fed assay is a good model for evaluating feed enzymes and provide evidence that treatment of RSM with exogenous enzyme improved its nutritional value. The enzyme treated RSM may be used up to 30% of the diets without having adverse effects on the broilers growth performance.

REFERENCES

Ahmad, G., T. Mushtaq, M.A. Mirza and Z. Ahmed, 2007. Comparative bioefficacy of lysine from L-Lysine hydrochloride or L-Lysine sulfate in basal diets containing graded levels of canola meal for female broiler chickens. Poult. Sci., 86: 525-530.

Araba, M. and N.M. Dale, 1990. Evaluation of protein solubility as an indicator of over processing soybean meal. Poult. Sci., 69: 76-83.

Bach, K.K.E., 1997. Carbohydrate and lignin contents of plant materials used in animal feeding. Anim. Feed. Sci. Technol., 67: 319-338.

Bedford, M.R., 2000. Exogenous enzymes in monogastric nutrition: Their current value and future benefits. Anim. Feed Sci. Technol., 86: 1-13.

Jensen, S.K., Y.G. Liu and B.O. Eggum, 1995. The effect of heat treatment on glucosinolates and nutritional value of rapeseed meal in rats. Anim. Feed Sci. Technol., 53: 17-28.

Kocher, A., M. Choct, M.D. Porter and J. Broz, 2000. The effects of enzyme addition to broiler diets containing high concentrations of canola or sunflower meal. Poult. Sci., 70: 1767-1774.

Liu, Y.G., S.K. Jensen and B.O. Eggum, 1995. The influence of seed size on digestibility and growth performance of broiler chickens fed full-fat rapeseed. J. Sci. Food Agric., 67: 135-140.

Meng, X. and B.A. Slominski, 2005. Nutritive values of corn, soybean meal, canola meal and peas for broiler chickens as affected by a multicarbohydrase preparation of cell wall degrading enzymes. Poult. Sci., 84: 1242-1251.

Meng, X., B.A. Slominski, C.M. Nyachoti, L.D. Campbell and W. Guenter, 2005. Degradation of cell wall polysaccharides by combinations of carbohydrase enzymes and their effect on nutrient utilization and broiler chicken performance. Poult. Sci., 84: 37-47.

Mushtaq, T., M. Sarwar, G. Ahmad, M.A. Mirza, H. Nawaz, M.M.H. Mushtaq and U. Noreen, 2007. Influence of canola meal-based diets supplemented with exogenous enzyme and digestible lysine on performance, digestibility, carcass and immunity responses of broiler chickens. Poult. Sci., 86: 2144-2151.

National Research Council., 1994. Nutrient Requirements of Poultry. 9th Edn., National Academy Press, Washington, DC.

Parsons, C.M., K. Hashimoto, K.J. Wedekind, Y. Han and H.D. Baker, 1992. Effect of overprocessing on availability of amino acids and energy in soybean meal. Poult. Sci., 71: 133-140.

SPSS, 1999. SPSS for Windows User's Guide Release 10. SPSS Inc., Chicago.

Sibbald, I.R., 1976. A bioassay for true metabolizable energy in feeding stuffs. Poult. Sci., 55: 303-308.

Slominski, B.A. and L.D. Campbell, 1990. Non-starch polysaccharides of canola meal: Quantification, digestibility in poultry and potential benefit of dietary enzyme supplementation. J. Sci. Food Agric., 53: 175-184.

Tadelle, D., Y. Allemu, H.M. Moges and K. Fasil, 2003. Effect of level of rapeseed *Brassica carinata* cake in rations on broiler performance. Animal breeding for tropics and sub-tropics. Humboldth university of berlin http://www.lrrd.org/lrrd15/4/tade154.htm.

Wiryawan, K.G. and J.G. Dingle, 1999. Recent research on improving the quality of grain legumes for chicken growth. J. Anim. Feed. Sci. Technol., 76: 185-193.

Zeb, A., A. Sattam and A.B. Shah, 2002. Effect of feeding increased levels of heat processed rapeseed meal on performance of broiler chicks. Arch. Geflugelk., 66: 158-163.