

Replacing Soybean Meal (SBM) by Canola Meal (CM) : The Effects of Multi-enzyme and Phytase Supplementation on the Performance of Growing and Laying Quails

B. Z. Sarıççek*, Ü. Kılıç and A. V. Garipoğlu

Department of Animal Science, Faculty of Agricultural, University of Ondokuzmayıs, 55139 Samsun Turkey

ABSTRACT : In this research, the possibilities of using canola meal (CM) in place of soybean meal (SBM), and also the effects of multi-enzyme and phytase supplementation on the performance of quails were investigated. For this purpose, soybean meal (44% CP), canola meal (37% CP), phytase (produced from *Pemphora luci*) and multi-enzyme (β -glucanases, pectinases, cellulases and hemicellulases) were used. CM was used supplying 0, 25 and 50% of CP from SBM and each of the phytase and multi-enzyme blends were added to the each level. This study was conducted with 675 day old quails (*Coturnix coturnix Japonica*) in 9 groups with 3 replicates including 25 birds (mixed sex) per replicate. Nine isocaloric and isonitrogenous diets were prepared. The effects of enzymes and CM levels were studied with a 3 \times 3 \times 3 factorial arrangement for three CM levels (0, 25 and 50%), three treatments (without enzyme, phytase enzyme and multi-enzyme) and three replicates. While the 25% CM level did not affect the liveweight gain 50% CM level decreased the liveweight gain ($p < 0.05$). Multi-enzyme addition to the 50% CM group increased the liveweight gain compared to the other groups ($p < 0.05$). CM levels and enzyme supplementation had no effect on feed consumption, feed conversion ratio, dressing percentage, viability, tibia ash content, Ca and P contents of tibia ash, viscera weight, gizzard weight and length of growth period. While heart weight and liver weight were not affected by CM levels, but they were affected by enzyme supplementation. CM levels and enzyme supplementation did not affect final liveweight, feed consumption, feed conversion ratio, egg yield, egg weight, shell weight and shell index during laying period. The increase in the CM level lightened the colour of the yolk ($p < 0.05$). (*Asian-Aust. J. Anim. Sci.* 2005, Vol 18, No. 10 : 1457-1463)

Key Words : Canola Meal, Soybean Meal, Phytase Enzyme, Multi-enzyme, Quail, Performance

INTRODUCTION

Soybean meal (SBM) has been extensively used as a vegetable protein source in compound feeds. In recent years, the possibilities of using canola meal (CM) in place of SBM has emerged as a topic of increasing concern to the researchers. This concern has been due to the fact that SBM is expensive and currently is not available for commercial use to the poultry industry. However, it is known that a decrease can be occurred in performance of layers and broilers when the higher amounts of CM used in place of SBM. This decrease is attributed to the presence of erusic acid, glucosinolate, phytic acid and various phenolic compounds in CM (Bell, 1993). In monogastrics, the negative effects of glucosinolates are related to abnormalities which occurred in thyroid metabolism. Weights of thyroid and liver were linearly related to the amount of glucosinolate ingested by the monogastrics (Bourdon and Aumaitre, 1990). Metabolizable energy (ME) content of CM is lower than that of SBM. Conversely, the crude fiber (4-6%), nonfiber polysaccharides (13-16%) and phytic acid (4%) contents of CM are higher compared to the SBM (Slominski and Campbell, 1990). The higher amounts

of these substances in CM impede the digestibilities of cell wall and the other nutrients (Bell, 1993).

Phytic acid found in vegetable feed sources affect the protein and amino acid digestibilities negatively by preventing the activities of the proteolytic enzymes such as pepsin/trypsin (O'Dell and deBorland, 1976). Furthermore, phytic acid has a higher P content and chelating ability and so phytate form of phytic acid diminishes the availability of Ca and P (Pointillart, 1991).

Monogastric animals can not make use of phytin phosphorus due to lacking of phytase enzyme in their digestive systems and consequently phytin phosphorus is mostly excreted in the faeces. Therefore, it is suggested that phytase enzyme can be used in order to alleviate the negative effect of phytic acid (Chesson, 1993). Phytase addition has been shown to increase Ca availability probably due to the increase in P availability (Schoner et al., 1994; Ravindran et al., 1995).

The carbohydrates present in vegetable feed ingredients are simple sugars, cell contents and cell wall polysaccharides. Among the cell wall polysaccharides known as nonstarch polysaccharides (NSP) are celluloses, pectins and oligosaccharides (Hyghebert and Grote, 1995). SBM (19.2%) and CM (46.1%) are rich in NSP (Choct, 2002). NSPs can not be degraded enzymatically in the digestive systems of the birds due to the lacking of enzymes

* Corresponding Author: B. Zehra Sarıççek. Tel: +90-362-457-60-20/11-58, Fax: +90-362-457-60-34, E-mail: bzehra@omu.edu.tr
Received November 11, 2004; Accepted March 18, 2005

Table 1. Grower and laying diet composition and calculated nutrient composition

Ingredient	Grower diets			Laying period diets		
	50% SBM- 50% CM	75% SBM- 25% CM	100% SBM-0% CM	50% SBM- 50% CM	75% SBM- 25% CM	100% SBM- 0% CM
Corn	47.57	52.5	54	52.5	55.1	56
SBM	18.45	27.7	36.9	14	21	28
CM	24.3	12.15		18.45	9.24	
Fish meal	2.9	2.19	2	2.62	2.25	2.14
Vegetable oil	4.03	2.93	3.01	4.75	4.31	4.45
Limestone	0.8	1.37	1.54	5	5.45	5.7
DCP	1.35	0.56	1.7	2.08	2	2.86
L.Lysine	0	0	0		0.05	
DL.Met			0.25			0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vit. ¹	0.25	0.25	0.25	0.25	0.25	0.25
Min. ²	0.1	0.1	0.1	0.1	0.1	0.1
Total (%)	100	100	100	100	100	100
Analysed and calculated nutrient composition						
ME (kcal/kg)	3,000.2	3,000.2	3,000	3,000.1	3,000.3	2,999.9
Dry matter (%)	87.75	87.50	87.14	86.17	87.16	86.10
Crude protein (%)	24.00	24.00	24.00	20.00	20.00	20.00
Ether extract (%)	6.63	5.37	5.36	6.54	6.13	6.47
Crude fiber (%)	4.20	3.85	2.12	3.55	3.16	2.38
Ash (%)	6.82	6.92	7.76	10.53	11.76	12.01
Nitrogen free extract (%)	46.09	47.36	47.90	45.55	46.12	45.24
Lysine (%)	1.34	1.32	1.32	1.08	1.11	1.07
Methionine (%)	0.71	0.54	0.63	0.58	0.45	0.58
Calcium (%)	1.03	0.93	1.17	2.63	2.69	2.92
Available phosphorus (%)	0.85	0.62	0.74	0.89	0.82	0.91

¹ Provides per kg of diet: 6,000 IU vitamin A, 2,000 IU vitamin D₃, 35 mg vitamin E, 2.0 mg vitamin K₃, 1.0 mg vitamin B₁, 3.0 mg vitamin B₂, 30 mg niacin, 7.5 mg calcium D-pantotenat, 2.0 mg vitamin B₆, 10 µg vitamin B₁₂, 0.75 mg folic acid, 0.075 mg D-biotin, 0.63 mg endox D dry.

² Provides per kg of diet: 100 mg Mn, 80 mg Fe, 80 mg Zn, 8 mg Cu, 0.2 mg Co, 0.15 mg Se, 300 mg Coline chloride, 1.0 mg I.

* Calculated to meet or exceed the requirements of broiler starter, grower diet (NRC, 1994).

degrading the NSPs in their digestive systems (Choct, 2002). β -glucans and pentosans decrease the digestions and absorptions of the nutrients due to their effects on the intestinal viscosity (Ikegami et al., 1990).

Most of the recent studies focus on the effects of the bacterial and fungal enzymes used in cereal based diets. These enzymes are effective in degrading of the complex compounds such as β -glucans and arabinoxylans (Bedford and Classen, 1992; Campbell and Bedford, 1992).

A study (Campbell et al., 2001) showed that supplementation of the feeds with carbohydrase enzyme complex composed of β -glucanases, pectinases, cellulases and hemicellulases has led to beneficial effects on the phytate, NSP, oligosaccharide, protein and ME contents.

There is no study related to use of CM as a protein source in quails. This present study was aimed to determine the possibilities of replacing SBM with CM and also the effects of the enzymes such as phytases and multi-enzymes (β -glucanases, pectinases, cellulases and hemicellulases) used for increasing the availabilities of these protein sources on the growth rates and yields of the quails. In a previous study conducted with broilers 25, 50, 75 and 100% of the

crude protein contributed by SBM were substituted with crude protein from CM and highest performance was obtained for 25% substitution level. The substitution ratios of 75 and 100% caused a decrease in performance. For this reason, in this study it was aimed to determine the effects of 0, 25 and 50% levels in quails' performances.

MATERIALS AND METHOD

Six hundredseventyfive day-old quails (*Coturnix coturnix japonica*) were used in this study. SBM (CP, 44%) and CM (CP, 37%) were used as vegetable protein source. The enzymes used in this study are phytase derived from *Peniophora lucii* (Ronozyme PC ct, Roche, 2,500 FYT/g) and multi-enzyme complex (RonozymeTM VP, Roche, 50 FBG/g) composed of β -glucanases, pectinases, cellulases and hemicellulases.

This study was conducted in 9 groups with 3 replicates and 25 birds (mixed sex) per replicate. Nine isocaloric and isonitrogenous diets were prepared. The effects of enzymes and CM levels were studied with a 3×3×3 factorial arrangement for three CM levels (0, 25 and 50%), three

Table 2. The effects of enzyme supplementation for different CM levels on performance of quails

Groups	6-41	6-41	6-41 day FCR	Tibia ash (%)	P % of tibia ash	Ca % of tibia ash
	days live weight gain	days feed consumption				
0% CM (control)	150.41±1.45 ^c	761.63±25.85	5.06±0.16 ^a	55.29±0.81 ^{ab}	15.68±0.83	27.94±1.97
0% CM multi	143.16±3.26 ^{abc}	738.03±3.47	5.16±0.13 ^{ab}	52.15±0.95 ^{abc}	16.02±0.75	29.68±1.63
0% CM phytase	151.14±1.52 ^c	760.19±10.72	5.03±0.09 ^a	55.60±2.40 ^{ab}	15.88±0.43	29.01±0.99
25% CM (control)	144.21±4.25 ^{abc}	751.17±6.36	5.22±0.11 ^{ab}	52.22±0.83 ^{abc}	17.22±0.32	28.77±0.56
25% CM multi	142.04±4.33 ^{abc}	753.69±10.32	5.31±0.12 ^{ab}	52.59±1.21 ^{abc}	16.72±0.34	27.02±1.07
25% CM phytase	137.54±0.99 ^{ab}	739.31±6.63	5.38±0.02 ^{ab}	53.90±0.70 ^{abc}	16.55±0.36	31.31±1.16
50% CM (control)	132.58±0.99 ^a	740.75±8.32	5.59±0.10 ^b	51.64±0.93 ^{bc}	17.38±0.32	30.85±2.70
50% CM multi	147.01±8.56 ^{bc}	755.24±24.23	5.16±0.19 ^{ab}	55.83±0.95 ^a	16.55±0.41	29.31±0.82
50% CM phytase	138.63±0.41 ^{abc}	749.34±23.29	5.41±0.17 ^{ab}	53.46±1.05 ^{abc}	16.04±1.11	27.76±1.93
SEM	1.25	5.19	0.04	0.21	0.20	0.52
F	2,545	4,170	2,059	2,044	0.970	0.811

^{a, b, c} Mean values within a column indicated with different superscripts are significantly different ($p < 0.05$).

treatments (without enzyme, phytase enzyme and multi enzyme) and three replicates. In rations CM was used in amounts supplying 0, 25 and 50% CP supplied by SBM used as vegetable protein source and each of the treatment groups were supplemented with phytase (1.5 kg/ton) and multi-enzyme (1 kg/ton) complexes.

This study consisted of two stages, namely growth and laying periods. The quails were fed with broiler grower feed during first week and afterwards experimental diets (3,000 kcal/kg, 24% CP) were given to the quails up to 42nd day (Table 1). The quails were housed in wooden cages (75 cm×75 cm×50 cm) during the growth period and afterwards taken to the laying cages. The experimental diets and water were provided *ad libitum*. Fluorescent lights provided 24-h illumination and sawdust was used as litter material. Liveweights and feed intakes were recorded at weekly intervals throughout growth period. One male and one female from each of the replicates of each group (totally 6 quails for a group) sacrificed by cervical dislocation at the end of the growth period. The carcasses and edible organs were removed and weighed.

Laying period lasted up to 126th day. The experimental diets (3,000 kcal/kg, 20%CP) were given to the quails during this period (Table 1). Three male and 10 female quails were allocated to each replicate. Sixteen-hour illumination was provided daily throughout the laying period, and feed and water were given *ad libitum*. Eggs from each of the groups were collected and weighed separately every day.

Eggs of the each replicate were collected and weighed in last 3 days of a 28 day-period. Then, quality tests were made at 3 eggs from each replicate (9 eggs from each replicate for one period and totally 27 eggs from each replicate for three periods). Shape indices were determined by using a digital callipers. At the end of this period egg yields, internal and external egg characteristics (egg weights, egg widths, length and shape indices, shell weights,

shell thicknesses, white and yolk weights, yolk colours), feed intake and feed conversion rates (FCR), liveweights and liveweight gains were determined.

Dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and crude ash (CA) contents were determined according to the AOAC (1984).

Statistical analysis

The data on the characteristics obtained during growth and laying periods were subjected to statistical analysis for interpretation of results by using analysis of variance technique with factorial design (3 CM levels×3 enzyme treatments×3 replicates). Treatment means were compared by using the Duncan multiple range test. Statistical analyses were made by using SPSS pocket program.

RESULTS

Growth period

The effects of using CM in amounts supplying 0, 25 and 50% CP supplied by SBM and also phytase enzyme and multi-enzyme addition on liveweight gain, feed consumption, feed conversion ratio, tibia ash, phosphorus and calcium of tibia ash content were summarized in Table 2.

The highest and lowest live weight gain (LWG)s were recorded in control groups of (100% SBM) (150.41 g) and 50% CM group (132.58 g). ($p < 0.05$), respectively. While multi-enzyme and phytase enzyme supplementation had no effect in 0% CM and 25% CM groups, multi enzyme addition to the 50%CM increased LWG compared to the control group ($p < 0.05$).

Feed consumption was not affected by CM levels and enzyme supplementation. Feed conversion ratio were not different between 25% CM and 0% CM groups. There is a significant difference between 0% CM and 50% CM groups in terms of feed conversion ratio ($p < 0.05$). Enzyme supplementation did not effect the feed conversion ratio.

Table 3. The effects of enzyme supplementation for different levels of CM on carcass compositions of quails

Groups	Dressing percentage (%)	Viscera length (cm)	Viscera (W/LW %)	Heart (W/LW %)	Liver (W/LW %)	Gizzard (W/LW %)	Mortality (%)
0% CM control	66.31±0.55 ^a	61.17±3.18	5.39±0.52	1.20±0.02 ^a	2.98±0.41 ^{ab}	2.66±0.28	2.66±0.45 ^b
0% CM multi	67.76±0.32 ^{ab}	62.17±0.33	5.62±0.26	1.29±0.05 ^{ab}	2.53±0.11 ^a	2.75±0.16	2.66±0.41 ^b
0% CM phytase	68.19±0.42 ^{ab}	68.50±0.50	6.04±0.25	1.21±0.02 ^a	3.15±0.10 ^{ab}	2.71±0.06	1.33±0.46 ^a
25% CM control	67.75±0.59 ^{ab}	68.00±1.26	5.62±0.20	1.25±0.02 ^{ab}	3.41±0.26 ^b	2.89±0.22	4.0±0.47 ^c
25% CM multi	67.91±1.06 ^{ab}	65.00±2.29	5.90±0.47	1.30±0.04 ^{ab}	2.97±0.24 ^{ab}	2.94±0.13	2.66±0.48 ^b
25% CM phytase	67.33±0.93 ^{ab}	63.00±1.76	5.73±0.41	1.33±0.03 ^b	2.97±0.30 ^{ab}	2.80±0.08	2.66±0.40 ^b
50% CM control	67.74±0.41 ^{ab}	65.00±2.78	5.46±0.46	1.31±0.05 ^{ab}	2.74±0.07 ^{ab}	2.90±0.13	1.33±0.89 ^a
50% CM multi	66.04±0.75 ^a	66.00±3.33	6.23±0.43	1.20±0.02 ^a	2.82±0.12 ^{ab}	3.27±0.29	4.0±0.92 ^c
50% CM phytase	67.89±0.20 ^{ab}	65.17±2.83	6.42±0.42	1.29±0.02 ^{ab}	3.14±0.05 ^{ab}	3.05±0.22	1.33±0.86 ^a
SEM	1.21	0.76	0.01	0.07	0.06	0.13	0.17
F	1.91	2.32	0.76	1.22	1.75	2.35	0.66

^{a, b, c} Mean values within a column indicated with different superscripts are significantly different ($p < 0.05$).

Table 4. The effects of enzyme supplementation for different levels of canola meal on performance of quails

Groups	L Period finish LW	L period LWG	FCR g feed/g LWG	Feed consumption: number	Egg yield quail/d, %	Egg weight	Shell weight	Yolk colour	Indices
0% CM- % 100 SBM control	230.99±4.20	53.36±1.84 ^{ab}	4.46±0.28	3,196.43=89.93	83.50±3.41	10.64±0.22	1.22±0.05	4.64±0.22 ^b	80.17±1.68
0% CM multi	227.06±8.85	57.31±7.80 ^{ab}	4.50±0.13	3,254.52=172.06	81.68±3.87	10.88±0.52	1.25±0.09	4.67±0.29 ^{bc}	81.10±0.57
0% CM phytase	231.20±4.86	54.33±5.71 ^{ab}	4.35±0.09	3,118.15=131.27	82.14±2.88	10.77±0.11	1.14±0.05	4.00±0.11 ^a	81.07±0.64
25% CM control	235.05±3.47	64.00±2.40 ^{ab}	4.59±0.19	3,202.47=114.13	80.23±0.38	10.73±0.14	1.25±0.09	3.90±0.29 ^{abc}	79.11±0.17
25% CM-% 75SBM multi enzyme	228.09±10.57	56.58±8.08 ^{ab}	4.52±0.16	3,104.83=140.68	81.58±3.51	10.84±0.07	1.23±0.04	4.44±0.19 ^{ab}	79.91±1.28
25% CM phytase	232.10±8.13	65.29±3.78 ^b	4.37±0.08	3,203.65=2.27	86.03±3.14	10.79±0.17	1.23±0.05	4.75±0.59 ^c	78.25±1.14
50% CM control	226.39±5.71	61.22±3.50 ^{ab}	4.96±0.50	3,608.04=330.30	84.84±2.17	10.94±0.13	1.24±0.02	3.70±0.11 ^a	80.06±1.24
50% CM multi	229.09±4.01	48.86±1.96 ^a	4.79±0.20	3,288.83=57.45	79.60±2.31	11.24±0.07	1.23±0.05	4.30±0.11 ^{ab}	79.45±0.38
50% CM phytase	224.72±1.57	57.10±1.13 ^{ab}	4.65±0.08	3,162.66=87.31	79.51±1.17	10.81±0.20	1.18±0.01	4.09±0.22 ^{ab}	79.39±1.24
SEM	0.98	1.54	1.57	0.76	50.64	0.92	0.07	0.09	0.310
F	1.351	2.424	4.269	3.509	1.280	2.729	1.347	0.667	0.310

^{a, b, c} Mean values within a column indicated with different superscripts are significantly different ($p < 0.05$).

There was no effect of using CM in place of SBM on tibia ash content.

While the phytase supplementation to the 0% CM group decreased the tibia ash content ($p < 0.05$), the multi-enzyme supplementation to the 50% CM group increased the tibia ash content ($p < 0.05$).

Tibia P content in 0% CM group (15.68%) is lower than those in 25% CM (17.22%) and 50% CM (17.38%) groups, but differences were not significant. Enzyme (phytase and multi) addition did not affect the tibia P contents.

There were no differences among the 0% CM (27.94%), 25% CM (28.77%) and 50% CM (30.85%) groups in terms of tibia Ca contents. Tibia Ca contents were not affected by enzyme (phytase and multi) addition.

Viability were not affected by CM levels and enzyme supplementation.

The effects of different CM levels and enzyme supplementation on carcass characteristics were presented in Table 3.

Dressing percentages, heart weights (LW %), liver weights (LW %), viscera lengths, viscera weights (LW %), gizzard weights (LW %) and mortality rates were not affected by CM levels and enzyme supplementation.

Laying period

The effects of CM levels and enzyme supplementation on the egg yield and egg characteristics were given in Table 4.

CM levels and enzyme supplementation had no negative effect on initial and final liveweights as well as liveweight gains during laying period.

Feed consumptions, feed conversion rates, egg yields, average egg weights, shell weights and shape indices of the experimental groups were not significantly different.

Yolk colour was found different between 50% CM and 0% CM levels ($p < 0.05$) but enzyme supplementation did not affect yolk colour.

DISCUSSION

Growth period

Liveweight gains decreased due to the increase in CM level from 0% to 50% ($p < 0.05$). This decrease can be attributed to the presence of high amounts of fibre and nonstructural polysaccharides (NSP) in CM. Newkirk and Classen (2002) reported an increase in LW and LWG when the CM replaced 20% of the SBM and a decrease when the CM replaced 40% of the SBM in ration. Kocher et al.

(2001) and Bedford and Morgan (1995) recommended not to use CM above 35% and 21% levels, respectively. In our previous study we obtained the best performance when we used the ratio of 25:75 CM to SBM compared to the 0:100, 50:50, 75:25 and 100:0 ratios. Several researchers reported that use of high CM levels in rations caused decreases in the performances of the broilers and layers (Slominski and Campbell, 1990; Bell, 1993).

Phytase supplementation to the rations caused numerical increases in the LWG. This study is consistent with some studies which indicated that phytase supplementation affect performance positively (Guenter et al., 1997; Kocher et al., 2000). This case can be attributed to the positive effects of phytase enzyme on phytates and proteins.

Multi-enzyme and phytase enzyme supplementation to the 50% CM group increased the LWG. This result is consistent with the findings of Slominski and Campbell (1990) who reported that multi-enzyme supplementation improved the quality of CM. Furthermore, Campbell et al. (2001) showed that phytase, B-glucanase, pectinase, cellulase and hemicellulase supplementation improved the protein and ME values of the CM based diets.

CM addition to the diets decreased the feed consumption for all the inclusion levels. This lowered feed consumption appears to be related to the presence of antinutritional factors in CM. This finding is supported by several studies (Newkirk and Classen, 2002). Also, Bourdon and Aumaitre (1990) reported that glucosinolates found in CM had deleterious effects on feed intake and liver enlargement.

There were numerical decreases in feed consumption due to the multi-enzyme and phytase supplementation. Bedford and Morgan (1995) reported that xylanase and α -alkaline supplementation to the soybean-canola meal caused a decrease in feed consumption and an increase in FCR in broilers. While some studies are consistent with these findings (Kocher et al., 2000) the others not (Leeson et al., 1987; Borcea et al., 1996).

FCRs and LWGs in 50% CM group are lower than the other groups. This may be caused by the fact that quails can not utilize the fibrous parts of the CM. Changes in FCR and LWG with changing CM level are similar to the results of some studies (Leeson et al., 1987).

Enzyme supplementation did not effect the FCR significantly. This finding is consistent with those of Kocher et al. (2001) and Borcea et al. (1996). However, phytase and carbohydrase supplementation and phytase supplementation have been shown to improve the FCR (Simbaya et al., 1996; Shim et al., 2004).

There were no differences among the experimental groups in terms of viability. This finding confirms the results of Kocher et al. (2001).

Tibia ash contents were not affected by the replacement of SBM with CM at various levels and enzyme supplementation. However, Sebastian et al. (1996) and Broz et al. (1994) reported that phytase supplementation to the SBM based diets increased the tibia ash content.

Tibia Ca and P contents were not affected by CM levels and enzyme addition. However, Sebastian et al. (1996) and Broz et al. (1994) reported that phytase addition increased the tibia ash and Ca contents. Furthermore, Shim et al. (2004) reported that phytase supplementantion increased the phosphorus content of bone. Guenter et al. (2001) and Schoner et al. (1994) reported that enzyme supplementation can be required if the canola based diets used. In this study available P contents decreased due to increases in CM levels of experimental diets (Table 1).

Dressing percentages were not different between the different CM levels in quails' rations. Kocher et al. (2002) reported that different CM levels did not affect dressing percentages.

Enzyme supplementation appeared to have not influenced the dressing percentage. Kocher et al. (2001) reported an increase in dressing percentage due to the enzyme supplementation.

Viscera weight and viscera length were not significantly affected by CM levels and enzyme supplementation. This observation is inconsistent with other observations that viscera weight and viscera length increase due to the increased consumption of indigestible fibrous parts and NSPs in CM (Shires et al., 1987; Kocher et al., 2001).

There were no differences among the treatment groups in terms of hearth weight, liver weight and gizzard weight.

Laying period

Various CM levels and enzyme supplementation had no negative effects on final liveweight and LWG during laying period. Campbell et al. (2000) reported that use of carbohydrase enzyme containing β -glucanase and pectinase improved the NSP, phytate, oligosaccharide and protein levels in CM based poultry diets.

Feed consumption and FCR were not affected by CM levels and enzyme supplementation. While these results differ from some previous studies (Gomez et al., 1993; Broz et al., 1994) which reported that phytase supplementation decreased the feed consumption, they are consistent with other studies (Bustany and Elwinger, 1988; Hamilton and Proudfoot, 1993).

Egg yield, egg weight, shell weight and shape index were not significantly affected by inclusion of CM and enzyme supplementation. Gomez et al. (1993) reported that phytase supplementation to the SBM based diets improved the egg yield. In some studies it was reported that egg weight and shell weight were not affected by enzyme supplementation (Benabdeljlil and Arbaoui, 1994).

Yolk colour was significantly affected by increasing CM inclusion levels in the diet ($p < 0.05$) but not by enzyme supplementation. The change in yolk colour due to CM inclusion can be attributed to the decreasing of corn inclusion level in the ration.

It is concluded that CM can be used with a substituting ratio of 25% of the crude protein contributed by SBM in quail rations. Also, it was determined that the inclusion ratios above 25% can cause negative effects on growth and yield characteristics, and enzyme supplementation to the SBM-CM based diets has no significant effect.

REFERENCES

- AOAC. 1990. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemists, Arlington, VA.
- Bedford, M. R. and H. Classen. 1992. Reduction of intestinal viscosity through manipulation of dietary rye and pentosanase concentration is affected through changes in the carbohydrate changes in the carbohydrate composition of the intestinal aqueous phase and results in improved growth rate feed conversion, *J. Nutr.* 122:260-269.
- Bedford, M. R. and A. J. Morgan. 1995. The Use of Enzymes in Canola-based Diets. In: 2nd European Symposium on feed enzymes. Noordwijkerhout, Netherlands. 125-131.
- Bell, J. M. 1993. Factors affecting the nutritional value of canola meal: A review. *Canadian J. Anim. Sci.* 73:679-697.
- Benabdeljilil, K. and M. I. Arbaoui. 1994. Effect of enzyme supplementation of barley-based diets on hen performance and egg quality. *Anim. Feed Sci. Technol.* 48:325-334.
- Borcea, F., A. Csuma and D. Grossu. 1996. The partial replacement of soybean meal with canola meal in broiler diets. *Archiva Zootechnica* 4:69-76.
- Bourdon, D. and A. Aumaitre. 1990. Low-glucosinolate rapeseeds and rapeseed meals: effect of technological treatments on chemical composition, digestible energy content and feeding value for growing pigs. *Anim. Feed Sci. Technol.* 30:175-191.
- Broz, J., P. Oldale, H. Perrin-Voltz, G. Rychen, J. Schulze and C. Simoes Nunes. 1994. Effect of supplemental phytase on performance and phosphorus utilization in broiler chickens fed a low phosphorus diet without addition of inorganic phosphates. *Br. Poult. Sci.* 35:273-280.
- Bustany, Z. A. and K. Elwinger. 1988. Whole grains, unprocessed rapeseed and β -glucanase in diets for laying hens. *Swedish J. Agric. Res.* 18:31-40.
- Campbell, G. L. and M. R. Bedford. 1992. Enzyme applications for monogastric feeds: a review, *Can. J. Anim. Sci.* 72:449-466.
- Campbell, L. D., D. Liang, B. A. Slominski and W. Guenter. 2001. Nutritive value of enzyme pre-treated canola meal, Proceedings International Symposium on rapeseed Science. April, 19-23. Wuhan, The People's Republic of China. pp. 334-342.
- Chesson, A. 1993. Feed enzymes. *Anim. Feed Sci. Technol.* 45:65-79.
- Choct, M. 2002. Non-starch polysaccharides: effects on nutritive value. In: *Poultry Feedstuffs: Supply, Composition and Nutritive Value*, pp. 221-235. (Ed. J. M. McNab and K. N. Boorman), CABI Publishing.
- Duncan, D. B. 1955. Multiple range and multiple F tests. *Biometrics*. 11:1-42.
- Gomez, S., C. Moj. ca and S. R. Fernandez. 1993. Effect of *Peniophora Lycii* phytase on nutrient utilization in laying hens. Mexico Agricultural Research Institute Roche Vitam. Mexico S.A. de C.V. <http://www.poultrscience.org/meet/91st/psabs5.pdf>
- Guenter, W., L. W. J. Nernberg and B. A. Slominski. 1997. Improved phosphorus availability in poultry fed wheat/canola meal-based diets supplemented with phytase enzyme. Proceeding of International Symposium on Rapeseed Science. April 19-23, Wuhan, The People's Republic of China, 315-327.
- Hamilton, R. M. G. and F. G. Proudfoot. 1993. Effects of dietary barley level on the performance of leghorn hens. *Can. J. Anim. Sci.* 73:625-634.
- Hyghebert, G. and D. Groote. 1995. The effect of specific enzymes on the Men-value and nutrient utilization of target feedstuff in broiler and layer diets. WPSA Proceedings, 10th European Symposium on Poultry Nutrition, October 15-19, Antalya, Turkey.
- Ikegami, S., F. Tsuchihashi, H. Harada, N. Tsuchihashi, E. Nishide and S. Imami. 1990. Effect of viscous indigestible polysaccharides on pancreatic-biliary secretion and digestive organs in rats. *J. Nutr.* 120:335-360.
- Kocher, A., M. Choct, M. D. Porter and J. Broz. 2000. The effects of enzyme addition to broiler diets containing high levels of canola or sunflower meal. *Poult. Sci.* 79:1767-1774.
- Kocher, A., M. Choct, L. Morrisrose and J. Broz. 2001. Effects of enzyme supplementation on the replacement value of canola meal for soybean meal in broiler diets. *Aust. J. Agric.* 52:447-452.
- Leeson, S., J. O. Atteh and J. D. Summers. 1987. The replacement value of canola meal for soybean meal in poultry diets. *Canadian J. Anim. Sci.* 67:151-158.
- Newkirk, R. W. and H. L. Classen. 2002. The Effects of toasting canola meal on body weight, feed conversion efficiency and mortality in broiler chickens. *Poult. Sci.* 81:815-825.
- O'Dell, B. L. and A. R. deBorland. 1976. Complexation of phytate with proteins and cations in corn germ and oilseed meal. *J. Agric. Food Chemist.* 24(4):804-808.
- Pointillart, A. 1991. Enhancement of phosphorus utilization in growing pigs fed phytate-rich diets by using rye bran. *J. Anim. Sci.* 69:1109-1115.
- Ravindran, V., W. L. Bryden and E. T. Komegay. 1995. Phytases: Occurrence, bioavailability, and implication in poultry nutrition. *Poult. Avian Biol. Rev.* 6:125-143.
- Schoner, F. J., P. P. Hoppe and G. Schwarz. 1991. Comparative effects of microbial phytase and inorganic phosphorus on performance and on retention of phosphorus, calcium and crude ash in broilers. *J. Anim. Physiol. Anim. Nutr.* 66:248-255.
- Schoner, F. J., G. Schwarz, P. P. Hoppe and H. Wiesche. 1994. Effect of microbial phytase on Ca-availability in broilers. Third Conference of pig and poultry nutrition. Halle, Germany, November 29-December 1:235-244.
- Sebastian, S., S. P. Touchburn, E. R. Chavez and P. C. Lague. 1996. Efficacy of supplemental microbial phytase at different dietary calcium levels on growth performance and mineral utilization of broiler chickens. *Poult. Sci.* 75:1516-1523.

- Shim, Y. H., B. J. Chae and J. H. Leel. 2004. Effects of phytase and enzyme complex supplementation to diets with different nutrient levels on growth performance and ileal nutrient digestibility of weaned pigs. *Asian-Aust. J. Anim. Sci.* 17:523-532.
- Shires, A. J., J. R. Thompson, B. V. Turner, P. M. Kennedy and Y. K. Goh. 1987. Rate of passage of corn-canola meal and corn-soybean meal diets through the gastrointestinal tract of broiler and white leghorn chickens. *Poult. Sci.* 66:289-298.
- Simbaya, J., B. A. Slominski, W. Guenter, A. Morgan and L. D. Campbell. 1996. The effects of protease and carbohydrase supplementation on the nutritive value of canola meal for poultry: In vitro and in vivo studies. *Anim. Feed Sci. Technol.* 61:219-234.
- 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.