POTENTIAL FOR IMPROVED UTILIZATION OF CANOLA MEAL USING EXOGENOUS ENZYMES

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ABSTRACT

The use of exogenous enzymes to enhance the nutritive worth of canola meal has been investigated. Protease, carbohydrase and phytase enzymes, when tested individually, showed 3%, 10%, and 7% improvement in chick growth and 2%, 5% and 4% improvement in feed to gain ratio, respectively. The data indicate a potential for the development of an effective "cocktail" of enzymes for practical poultry feeding.

INTRODUCTION

Canola meal contains a high quality protein but its use in diets of rapidly growing monogastric animals has been limited by the relatively low available energy and available amino acid values (Bell, 1994). Similarly, canola meal contains an exceptionally high content of phosphorous (1.1-1.2%) but since a high portion of the phosphorous is present as phytate (0.7-0.8%) the overall phosphorous availability is low. The objective of the present study was to explore the potential for improving the nutritive worth of canola meal by the use of exogenous protease, carbohydrase and phytase enzymes.

EXPERIMENTAL

Protease Study. Several protease preparations were screened in in vitro studies for their ability to hydrolyze canola meal protein. Proteases G and D were identified as being superior (25.7% and 20.9% increase relative to pancreatin acting alone) and were further tested in semipurified canola meal (55%) diets (20% protein, 3050 kcal energy) fed to broiler chicks (8 replicates of 5 birds per treatment). Protease G resulted in a 3% improvement in chick growth and a 2% improvement in feed to gain ratio (Table 1).

In a subsequent study (data not shown) with a conventional wheat-based diet (22% protein, 3050 kcal energy), the total replacement of soybean meal by canola meal resulted in reduced body weight gain of broiler chicks by 7% which, however, was less pronounced (3% reduction) when protease G (0.02%) was incorporated into the canola diet. The protease enzyme supplementation at a higher inclusion rate (0.05%) tended to decrease feed intake and body weight gain but showed an improvement in feed to gain ratio of 12%.

Table 1. Performance of broiler chicks fed canola meal diets with (0.02%) and without protease supplementation.

Enzyme	Feed Intake (g)	Weight Gain (g)	Feed/Gain Ratio
None	545.6	367.7	1.48
Protease G	548.4	379.2	1.45
Protease D	544.4	366.3	1.48

Note: Mean values of three feeding trials of which two showed significant ($P < 0.05$) improvement in broiler performance following protease G addition.

Carbohydrase Study. Eight carbohydrase enzyme preparations were tested in an in vitro system (Slominski et al., 1993) (Table 2). Three of the enzymes: carbohydrase F,G and H with the highest activity towards cell wall polysaccharides were further evaluated in vivo.

Table 2. Carbohydrase activity as determined following incubation of canola meal with selected enzyme preparations.

Carbohydrase	A	B	C	D	E	F	G	H
Activity (mg soluble carbohydrate mg^{-1} enzyme)	3.1	3.8	3.8	4.1	4.6	7.2	6.0	6.4

Carbohydrase G showed greatest improvement (9.6%) in performance when incorporated into a semipurified canola meal (55%) diet (20% protein, 3050 kcal energy) and fed to broiler chicks (Table 3).

Table 3. Performance of broiler chicks fed semipurified canola meal diets with (0.05%) and without carbohydrase supplementation.

Enzyme	Feed Intake (g)	Weight Gain (g)	Feed/Gain Ratio
None	540.0	352.0	1.53^{a}
Carbohydrase F	543.6	361.8	1.50^{ab}
Carbohydrase G	558.8	381.6	1.46^{b}
Carbohydrase H	544.4	357.0	1.52^{a}

Phytase Study. Experiments in which pH and temperature were varied indicated that maximum activity of phytase enzyme, as determined by phosphate release (Hartland and Hartland, 1980), occurred at pH 5.2 and 55°C. At 40°C (body temperature of a bird) the release of phytate-P was significantly lower with maximum yield (67%) at pH 5.2. At pH 7.0 (normal intestinal pH of a bird), however, the phytase showed no activity. In addition, the canola phytate appeared to be linked to other components of the meal since an eight fold increase in enzyme concentration did not result in increased phytate hydrolysis (Table 4). These in vitro data indicate that phytase enzyme is effective in

hydrolyzing phytate only in the upper portion of the gut (ie., crop, proventriculus and gizzard where the pH is more optimal for enzyme activity) and that only a small portion of canola phytate is available for immediate hydrolysis.

Table 4. Release of phytate P on incubation of canola meal with increased concentration of phytase at 40 °C and pH 5.4 for 60 min.

Enzyme conc. (mg g^{-1} meal)	0.25	0.50	1.00	1.50	2.00
Available P (% of total)	12.6	14.1	15.7	16.2	16.6

The in vitro data were confirmed in a subsequent in vivo experiment in which leghorn chicks were fed semipurified canola meal diets containing four levels of phytase (Table 5). The overall improvement in bird performance was evident at the 100 ppm enzyme dose. There was, however, a lack of response with increased inclusion rates of this enzyme.

Table 5. Performance of leghorn chicks fed semipurified canola meal diets varying in supplemental phytase enzyme level.

Item	Phytase level (ppm)			
	0	100	200	400
Feed Intake (g)	195.7[b]	201.3[ab]	204.3[a]	204.4[a]
Weight Gain (g)	86.2[b]	91.7[a]	92.9[a]	93.0[a]
Feed/Gain Ratio	2.3[a]	2.2[b]	2.2[b]	2.2[b]

Research is underway to determine the synergistic effects and dose responses of carbohydrase, protease and phytase enzymes in improving the nutritive worth of canola meal.

REFERENCES

Bell, J.M. (1993). Factors affecting the nutritional value of canola meal: A review. *Canadian Journal of Animal Science*, **73**, 679-697.

Hartland, B.F. and Hartland, J. (1980). Fermentative reduction of phytate in rye, white and whole wheat breads. *Cereal Chemistry*, **57**, 226-229.

Slominski, B.A., Guenter, W. and Campbell, L.D. (1993). New approach to water-soluble carbohydrate determination as a tool for evaluation of plant cell wall degrading enzymes. *Journal of Agricultural and Food Chemistry*, **41**, 2304-2308.