ISSN 1682-8356
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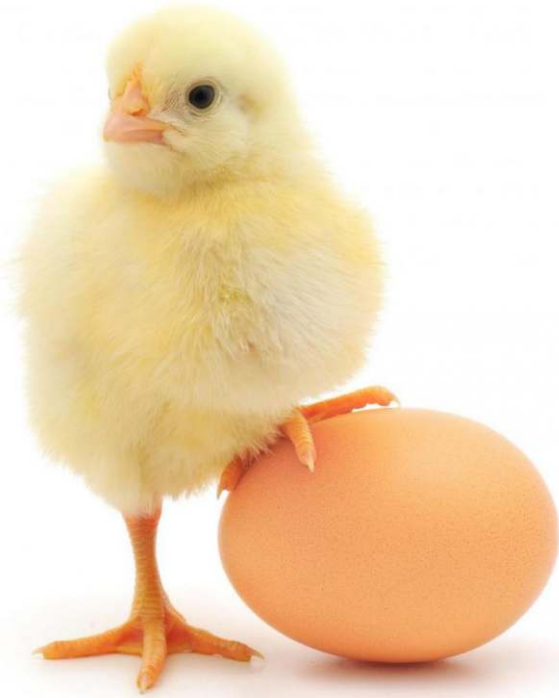

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 10 (10): 782-785, 2011
ISSN 1682-8356

Evaluation of Canola Meal from Biodiesel Production as a Feed Ingredient for Broilers†

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Abstract: This study was conducted to evaluate canola meal from biodiesel production as a feed ingredient for broilers. One-d-old commercial strain male broilers were randomly assigned to experimental diets with 0, 5, 10, 15, 20 and 25% canola meal. Diets were formulated to meet digestible amino acid requirements for periods of 0-14 d and 15-28 d. Each dietary treatment was replicated 6 times. Body weight and feed consumption were measured at 14 and 28 days of age. The results indicated that no significant (p>0.05) effect of canola levels was observed on feed intake, BW gain, feed conversion ratio, or mortality during the experimental period compared with control diets of soybean meal. Therefore, canola meal can be a valuable protein supplement for broilers when considered on a digestible amino acid basis. In this study, 25% canola was incorporated into broiler diets on a digestible amino acid basis without any negative effects on bird performance.

Key words: Canola meal, broilers, biodiesel, performance

INTRODUCTION

Canola was developed by altering rapeseed in two ways, including reducing the levels of glucosinolates, which contribute to the sharp taste in mustard and licosenic and erucic acids, two fatty acids not essential for human growth. Canola Meal (CM) contains low levels of erucic acid (<2%) in the oil portion and low levels of glucosinolates (<30 µmol/g) in the meal portion (Hickling, 2001). Canola meal has an excellent balance of amino acids but has lower amino acid digestibility than soybean meal (Zuprizal *et al.*, 1992). Shires *et al.* (1983) found that heating CM to 100°C with or without steam improved feed intake and growth in broiler chicks. However, previous work has shown that the nutritive value of CM is limited by the presence of a number of antinutritive factors, including indigestible nonstarch polysaccharides (Kocher *et al.*, 2000; Slominiski and Campbell, 1990; Bell, 1993; Dale, 1996).

In addition to the rapid increase in corn used for production of ethanol, increasing amounts of vegetable oils and inedible animal fats are being used in the production of biodiesel fuel. Because canola produces approximately three times more oil per acre than soybeans, there is a growing interest in the production of canola oil in many areas of the United States as a feedstock for biodiesel. It can possibly be grown as a winter crop in the southern U.S. followed by corn or soybeans. Thus, there may be a great increase in the amount of canola meal available for use in poultry diets in the southern U.S. broiler production area. The objective of this study was to evaluate the use of a canola meal produced as a result of extraction of the oil for biodiesel fuel production in diets for growing broilers.

MATERIALS AND METHODS

Birds and dietary treatments: A supply of solvent extracted canola meal was obtained from a biodiesel producer. The product was analyzed for crude protein, amino acids, fat, fiber, ash, calcium and phosphorus by commercial laboratories specializing in these assays. The corn and soybean meal used in the study was also analyzed for crude protein and amino acids in the same commercial laboratory. Digestible amino acid coefficients were those reported by Ajinomoto Heartland Lysine.

The nutrient recommendations from a leading poultry breeder (Aviagen) were used in formulation to meet digestible amino acid requirements as these were shown to support maximum early growth (Yan *et al.*, 2010). Diets were formulated for periods of 0-14 d (Table 1) and 15-28 d (Table 2) to contain 0, 5, 10, 15, 20 and 25% canola meal. Diets were fortified with complete vitamin and trace mineral mixes from commercial sources. A pellet binder was added to all diets to facilitate pelleting. Diets from 0-14 d were pelleted using a CPM Laboratory Model pellet mill with a 1/8" die while diets fed from 15-28 d were pelleted using a CPM Master Model pellet mill with a 3/16" die (California Pellet Mill Company, Crawfordsville IN).

Management of experimental bird husbandry: Male chicks of a commercial broiler strain (Cobb 500) were

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Table 1: Composition (g/kg) and calculated nutrient analysis of diets for 0-14 days of age. Nutrient values in bold italic were at minimum specified level

Ingredient	A	B	C	D	E	F
Canola meal	0.00	50.00	100.00	150.00	200.00	250.00
Yellow corn	558.49	543.94	529.39	511.37	488.02	464.68
Poultry oil	21.59	26.64	31.69	37.31	43.82	50.33
Soybean meal	376.84	336.88	296.92	260.03	227.86	195.69
Ground limestone	5.32	4.97	4.62	4.28	3.96	3.63
Defluorinated phosphate	20.55	20.25	19.97	19.65	19.32	18.98
Sodium chloride	3.10	3.06	3.00	3.00	3.03	3.07
Sodium bicarbonate	0.33	0.51	0.69	0.83	0.91	0.98
MHA-84[1]	3.22	2.98	2.73	2.46	2.14	1.82
L-Threonine	0.36	0.36	0.37	0.33	0.22	0.12
L-Lysine HCl	1.70	1.91	2.12	2.24	2.22	2.20
Vitamin premix[2]	5.00	5.00	5.00	5.00	5.00	5.00
Mintrex P_Se[3]	1.00	1.00	1.00	1.00	1.00	1.00
Pel-Stik[4]	2.50	2.50	2.50	2.50	2.50	2.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ME kcal/kg	3041.50	3041.50	3041.50	3041.50	3041.50	3041.50
Crude protein %	23.42	23.37	23.32	23.39	23.63	23.87
Calcium %	1.00	1.00	1.00	1.00	1.00	1.00
Available P %	0.50	0.50	0.50	0.50	0.50	0.50
Sodium %	0.25	0.25	0.25	0.25	0.25	0.25
Chloride %	0.25	0.25	0.25	0.25	0.25	0.25
d Met	0.56	0.55	0.55	0.54	0.52	0.51
dLys	***1.21***	***1.21***	***1.21***	***1.21***	***1.21***	***1.21***
dTSAA	***0.86***	***0.86***	***0.86***	***0.86***	***0.86***	***0.86***
dTrp	0.24	0.23	0.23	0.24	0.24	0.25
dThr	0.77	0.77	0.77	0.77	0.77	0.77
dIle	0.84	0.83	0.82	0.81	0.81	0.81
dHis	0.52	0.53	0.53	0.53	0.53	0.54
dVal	***0.92***	***0.92***	***0.92***	0.93	0.94	0.95
dLeu	1.70	1.69	1.67	1.65	1.65	1.65
dArg	1.38	1.35	1.33	***1.32***	***1.32***	***1.32***

[1]Methionine hydroxy analogue calcium salt. Novus International, St. Louis MO 63141.

[2]Provides per kg of diet: vitamin A 7715 IU; cholecalciferol 5511 IU; vitamin E 16.53 IU; vitamin B_{12} 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; menadione 1.5 mg; folic acid 0.9 mg; choline 1000 mg; thiamin 1.54 mg; pyridoxine HCl) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg.

[3]Provides per kg of diet: Mn (as manganese methionine hydroxy analogue complex) 40 mg; Zn (as zinc methionine hydroxy analogue complex) 40 mg; Cu (as copper methionine hydroxy analogue complex) 20 mg; Se (as selenium yeast) 0.3 mg. Novus International, Inc., St. Louis MO 63141.

[4]Uniscope Inc., Johnstown CO 80534

obtained from a local hatchery where they had been vaccinated *in ovo* for Marek's disease and had received vaccinations for Newcastle Disease and Infectious Bronchitis post hatch via a coarse spray. Five chicks were assigned to each of 36 compartments in electrically heated battery brooders with wire floors. Each of the six diets was fed to six replicate pens of birds. For the first 14 d the birds were housed in the electrically heated brooders while for 15 to 28 d they were housed in unheated wire floor finishing brooders in a temperature controlled room. Test diets and tap water were available for *ad libitum* consumption. Fluorescent lights provided 24 hr of light daily. Care and management of the birds followed recommended guidelines (FASS, 2010). All procedures were approved by the University of Arkansas Institutional Animal Care and Use Committee.

Measurements: Birds were weighed by pen at 1, 14 and 28 d of age with feed consumed during each period determined. Mortality was checked twice daily; any bird that died or was removed to alleviate suffering was weighed to adjust feed conversion. Diets were analyzed for crude protein, calcium, total phosphorus and sodium content. The diets with 0 and 25% canola were analyzed for total amino acid content. All assays were conducted by commercial laboratories specializing in these assays.

Statistical analysis: Pen means were served as an experimental unit for statistical analysis. Data were subjected to analysis of variance using the General Linear Models (GLM) procedure of SAS (SAS Institute, 1991). Significant differences among or between means were separated by repeated t-tests using the

Table 2: Composition (g/kg) and calculated analysis of diets from 15 to 28 d of age. Nutrient values in bold italic were at minimum specified level

Ingredient	A	B	C	D	E	F
Canola meal	0.00	50.00	100.00	150.00	200.00	250.00
Yellow corn	628.67	616.87	596.77	575.99	552.61	528.57
Poultry oil	25.97	30.01	35.44	40.98	47.51	54.26
Soybean meal	304.67	264.27	231.21	198.76	166.59	134.50
Ground limestone	5.20	3.55	1.93	0.30	0.00	0.00
Defluorinated phosphate	18.27	17.96	17.62	17.28	16.93	16.59
Sodium chloride	3.04	3.00	3.01	3.04	3.08	3.11
Sodium bicarbonate	0.86	1.05	1.14	1.22	1.29	1.37
MHA-84[1]	2.65	2.40	2.08	1.76	1.44	1.12
L-Threonine	0.35	0.35	0.26	0.15	0.05	0.00
L-Lysine HCl	1.82	2.04	2.04	2.02	2.00	1.98
Vitamin premix[1]	5.00	5.00	5.00	5.00	5.00	5.00
Mintrex P_Se[1]	1.00	1.00	1.00	1.00	1.00	1.00
Pel-Stik[1]	2.50	2.50	2.50	2.50	2.50	2.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ME kcal/kg	3140.69	3140.69	3140.69	3140.69	3140.69	3140.69
Crude protein %	20.38	20.33	20.55	20.80	21.04	21.28
Calcium %	0.90	0.90	0.90	0.90	0.95	1.01
Available P %	0.45	0.45	0.45	0.45	0.45	0.45
Sodium %	0.25	0.25	0.25	0.25	0.25	0.25
Chloride %	0.25	0.25	0.25	0.25	0.25	0.25
d Met	0.49	0.47	0.46	0.45	0.43	0.42
dLys	***1.05***	***1.05***	***1.05***	***1.05***	***1.05***	***1.05***
dTSAA	***0.75***	***0.75***	***0.75***	***0.75***	***0.75***	***0.75***
dTrp	0.20	0.20	0.20	0.21	0.21	0.22
dThr	0.67	0.67	0.67	0.67	0.67	0.68
dIle	0.72	0.71	0.71	0.71	0.71	0.71
dHis	0.46	0.46	0.47	0.47	0.48	0.49
dVal	***0.80***	***0.80***	0.81	0.82	0.84	0.85
dLeu	1.53	1.52	1.52	1.51	1.51	1.51
dArg	1.17	***1.15***	***1.15***	***1.15***	***1.15***	***1.15***

[1]As given in Table 1

LSMEANS option of SAS. Mortality data were transformed to $\sqrt{n+1}$ prior to analysis; data are presented as natural numbers. All statements of statistical significance are based on ($p<0.05$).

RESULTS AND DISCUSSION

The effect of dietary treatments on feed intake, BW gain, feed conversion ratio and mortality during 1 to 14 d and 15-28 d are presented in Table 3 and 4 respectively. No significant effect of canola meal level was observed on feed intake, BW gain, feed conversion ratio, or mortality during the experimental period compared with control diets of soybean meal. The results indicate that 25% canola meal can be used in broiler diets without any negative effects on broiler growth performance when diets were formulated on a digestible amino acid basis and fed in pelleted form.

Variable results have been reported for usage of canola meal. Hickling (2001) recommended a maximum inclusion level of 15% canola meal in diets typically fed to broilers. Perez-Maldonado *et al*. (2003) concluded that for chicken meat production, up to 20% of either solvent extracted or solvent extracted and extruded canola meal can be used during the starter phase when formulated on a digestible amino acid basis. Ahmad *et al*. (2007) reported that canola meal can be used up to 20% of the

Table 3: Effect of dietary canola meal levels on growth performance of 14-d-old male broilers (means of six pens of 5 birds per pen)

Canola meal (%)	Feed intake (g/bird)	Weight gain (g)	Feed conversion ratio (g:g)	Mortality (%)
0	539	484	1.230	6.67
5	509	465	1.221	0.00
10	535	482	1.207	3.33
15	511	478	1.183	3.33
20	520	477	1.214	3.33
25	497	462	1.219	3.33
SEM	15.0	12.0	0.017	3.22
p-value	0.24	0.56	0.430	0.85

Table 4: Effect of dietary canola meal levels on growth performance of 28-d-old male broilers (means of six pens of 5 birds per pen)

Canola meal (%)	Feed intake (g/bird)	Weight gain (g)	Feed conversion ratio (g:g)	Mortality (%)
0	2,202	1,498	1.513	13.33
5	2,159	1,473	1.516	0.00
10	2,198	1,518	1.495	3.33
15	2,222	1,528	1.492	6.67
20	2,205	1,526	1.489	3.33
25	2,142	1,503	1.472	6.67
SEM	53.0	34.0	0.025	3.54
p-value	0.81	0.80	0.730	0.17

starter (1 to 28 d) without having any adverse effects of broiler performance. Aftab (2009) considered that in low-ME broiler diets formulated on a digestible amino acid basis, canola meal can be safely incorporated up to 20% of the diet without any negative effect on the live performance parameters of broilers. These results are slightly lower than the current study. However, two studies showed that canola meal can be effectively used in broiler diets up to 30% without negatively affecting performance as long as the diets are formulated on a digestible amino acid basis (Newkirk and Classen, 2002; Ramesh *et al.*, 2006).

Canola meal is known to have a bitter flavor that may reduce feed intake due to the presence of sinapine (Clandinin, 1961). A reduction in feed intake has occurred in some studies with broilers consuming a CM-based diet (Classen *et al.*, 1991; Nassar and Arscott, 1986). The results do not agree with the present study which showed no significant difference in feed intake.

In the current study, the incorporation rate of canola meal can be added to 25% without any negative effects on broiler BW gain, feed intake, feed conversion ratio or mortality. However, different processing technologies and canola grade varieties may lead to different results. In conclusion, canola meal can be a valuable protein supplementation for broilers, in this study, 25% canola can be incorporated into broiler diet on a digestible amino acid basis and without any negative effects on bird performance.

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