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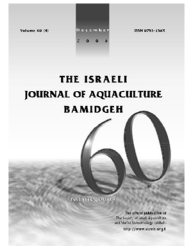

Canola Meal as an Alternative Protein Source in Diets for Fry of Tilapia (*Oreochromis niloticus*)

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Key words: tilapia fry, canola meal, growth, feed conversion ratio, alternative protein source

Abstract

Canola meal was used to replace fishmeal protein in diets for fry of tilapia (*Oreochromis niloticus* L. 1758) at rates of 0 (control), 10%, 20%, 30%, 40%, and 50%. The diets contained approximately 30% crude protein and 3000 kcal/kg digestible energy. The fry were fed 90 days and the growth, feed conversion ratio, protein efficiency ratio, hepatosomatic index, renosomatic index, and body composition were determined. The final weight (5.12 g) and feed intake (7.99 g) of fry fed the 10% diet did not significantly differ from those of the control. Weight gains declined beyond this replacement level, probably because of increased levels of antinutritional factors, particularly glucosinolates. Whole body percentages for moisture, crude lipid, crude protein, and ash were unaffected by the dietary treatment. Results indicate that protein from canola meal can replace up to 10% of protein from fishmeal in diets for tilapia fry.

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Introduction

Fishmeal is one of the most expensive ingredients in prepared fish diets. Nutritionists have tried to use less expensive plant protein sources to partially or totally replace fishmeal. Canola is a variety of rapeseed, specifically bred to contain much lower levels of deleterious components such as erucic acid and glucosinolates. The cost of canola meal is less than half that of premium quality fishmeal on a per kilogram protein basis (Forster, 1999) and generally lower than that of soybean meal, a major alternative protein source currently used in aquafeeds (Sajjadi and Carter, 2004). In 1993, the global amount of protein from canola was higher than that of other oilseed meals, except soybeans (Lim et al., 1998).

The amino acid profile of canola meal protein is similar to that of herring meal protein and superior to soybean meal protein (Thiessen et al., 2004). As with most plant protein sources, canola meal contains antinutritional factors that may restrict growth performance and protein utilization of fish. The major antinutritional factors include fiber, oligosaccharides, phenolic compounds, phytic acid, and glucosinolates (Thiessen et al., 2004).

Canola and rapeseed meals have been used in fish diets with variable success. Canola meal is a suitable protein replacement for salmonids because of its relatively high protein content (38%) and digestibility (Cheng and Hardy, 2002). However, replacement of soybean meal by rapeseed meal at dietary levels above 15% resulted in poor growth and feed utilization of tilapia, *Oreochromis mossambicus* (Davies et al., 1990). The main objective of our study was to evaluate canola meal as a partial replacement for fishmeal in feeds for tilapia (*Oreochromis niloticus* L.) fry by examining feed intake, growth, feed conversion ratio, somatic indices, and body composition.

Materials and Methods

Experimental diets. Five experimental diets were prepared by replacing 10%, 20%, 30%, 40%, and 50% of the fishmeal protein in the control diet by canola meal protein (Table 1). In preparing the diets, dry ingredients were ground to small particle size in a mill and thoroughly mixed. Water was added to obtain a 25% moisture level. Diets were passed through a mincer with a 0.4 mm sieve The spaghetti-like strands were dried (20°C) for 16 h in a convection oven. After drying, the diets were broken into 1 mm pellets and frozen (-20°C) until use. The diets contained approximately 30% crude protein and 3000 kcal/kg digestible energy, based on feedstuff values reported by NRC (1993). Protein content was determined by the Kjeldahl method, fat by the chloroform-methanol extraction method (Bligh and Dyer 1956), and ash and moisture by standard methods (AOAC, 1990). Digestible energy value was calculated from published values for the diet ingredients (NRC, 1993).

Fish and experimental conditions. Tilapia fry (*Oreochromis niloticus* L. 1758) were obtained from the aquarium unit of the Egirdir Fisheries Faculty. The feeding trial was conducted in 18 glass aquaria (70 x 30 x 40 cm) and run in triplicate. At the beginning of the experiment, 25 fish (avg wt 1.21±0.02 g) were randomly stocked into each aquarium. Water temperature (27±2°C) and dissolved oxygen (6.57±0.05 mg/l) were measured daily. pH (7.2±0.2), NO_2 (0.15±0.008 mg/l), and NO_3 (8.86±1.21 mg/l) were recorded weekly. Water parameters remained well within the optimum for tilapia throughout the trial (Hepher and Pruginin, 1981).

Fish were fed *ad libitum* for 90 days. At the end of the trial, five fish from each aquarium were sacrificed by decapitation, homogenized in a blender, and stored at -20°C for subsequent protein, fat, ash, and moisture analysis. Growth performance and feed efficiency were calculated as follows: wt gain (g) = final body wt (g) - initial body wt (g), specific growth rate (SGR; %/day) = (ln

Table 1. Composition of diets containing various percentages of canola meal as a replacement for fishmeal protein.

	Protein replacement level (%)					
	Control	*10*	*20*	*30*	*40*	*50*
Ingredient (%)						
Fishmeal (61.9% protein)	24.23	21.81	19.39	16.96	14.54	12.12
Canola meal (36% protein)	-	4.17	8.33	12.50	16.66	20.83
Soybean meal (36% protein)	25.91	25.91	25.91	25.91	25.91	25.91
Wheat flour	20.20	20.20	20.20	20.20	20.20	20.20
Corn flour	15.00	15.00	15.00	15.00	15.00	15.00
Corn starch	12.18	10.04	7.62	5.20	2.79	0.36
Oil	0.24	0.62	1.28	1.95	2.60	3.27
Vitamin mix[1]	1.00	1.00	1.00	1.00	1.00	1.00
Mineral mix[2]	0.10	0.10	0.10	0.10	0.10	0.10
Cr_2O_3	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.14	0.15	0.17	0.18	0.20	0.21
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Chemical analysis (%)						
Dry matter	89.55	89.00	89.02	89.71	89.75	89.93
Moisture	10.45	11.00	10.98	10.29	10.25	10.07
Crude protein	29.14	29.29	29.42	28.91	29.44	29.11
Crude fat	4.95	4.97	4.81	4.88	4.93	4.70
Crude fiber	2.51	2.60	3.25	3.40	4.21	4.35
Crude ash	8.35	8.39	8.07	8.00	7.45	7.78
Digestible energy (kcal/kg)	3000	3000	3000	3000	3000	3000

[1] per kilogram premix: 4,000,000 IU vitamin A, 480,000 IU vitamin D_3, 2400 mg vitamin E, 2400 mg vitamin K_3, 4000 mg vitamin B_1, 6000 mg vitamin B_2, 4000 mg niacin, 10,000 mg calcium D pantothenate, 4000 vitamin B_6, 10 mg vitamin B_{12}, 100 mg D-biotin, 1200 mg folic acid, 40,000 mg vitamin C, 60,000 mg inositol.
[2] per kilogram premix: 23,750 mg manganese, 75,000 mg zinc, 5000 mg copper, 2000 mg cobalt, 2750 mg iodine, 100 mg selenium, 200,000 mg magnesium.

final body wt - ln initial body wt)/days x 100, feed intake (FI) = daily feed intake (g) x 100/biomass (g), feed conversion ratio (FCR) = total feed intake (g)/wt gain (g), and protein efficiency ratio (PER) = wt gain (g)/protein fed (g). Somatic indices were calculated as hepatosomatic index (HIS) = 100 x liver wt (g)/body wt (g), viscerosomatic index (VSI) = 100 x viscera wt (g)/ body wt (g), and renosomatic index (RSI) = 100 x kidney wt (g)/body wt (g).

Statistical analysis. One-way analysis of variance (ANOVA) was used to compare growth rate, feed utilization, SGR, somatic indices, and body composition among treatments. All data were analyzed using SPSS computer program (SPSS, 2000). Duncan test was used to determine the differences among treatment means.

Results

Growth performance and feed efficiency are given in Table 2. Somatic indices and body composition did not significantly differ among groups (p>0.05). Survival was 100% in all treatments.

Discussion

There was an inverse relationship between tilapia growth and the dietary level of canola meal. There are few reports on the use of canola meal in fish diets with which to compare, and opinions vary regarding the level of canola meal that can be used without causing growth reduction. Rapeseed meal (28% protein) successfully replaced 50% of dietary fishmeal in diets for common carp (Dabrowski and Kozlowska, 1981) while good growth was obtained in juvenile tilapia (*Sarotherodon mossambicus*) with a diet containing 41.8% rapeseed meal (Jackson et al., 1982). On the other hand, an inclusion limit of 15% rapeseed meal has been suggested for diets for tilapia (*Oreochromis mossambicus*) fry (Davies et al., 1990) and canola meal cannot successfully replace soybean meal in commercial diets for young rainbow trout at 13.5% of the diet or greater without sacrificing growth (Hilton and Slinger, 1986). Reduced growth in young rainbow trout was probably due to an imbalance in the amino acid composition or reduced protein (amino acid) digestibility of the canola meal (Hilton and Slinger, 1986).

Diets containing different levels of rapeseed and canola meal did not result in noticeable differences in body levels of moisture, protein, fat, and ash in rainbow trout (Yurkowski at al., 1978), chinook salmon (Higgs et al., 1982), and tilapia (Davies et al., 1990). These findings agree with our results concerning body composition. In addition, hepatosomatic, viscerosomatic, and renosomatic indices were unaffected by the dietary canola meal level.

In our study, growth, feed intake, and FCR of fish in the control and 10% diet groups significantly differed from the other groups (p<0.05). It may be that phenolic compounds in the diets containing a higher ratio of canola meal affected palatability. Enhanced phenolic compounds, including sinapine and tannins, influence the quality of canola meal added to aquaculture diets (Webster et al., 1997). Tannin may reduce protein digestibility, while sinapine and glucosinolates probably reduce the palatability of canola meal (Webster et al., 1997).

The FCR increased as the amount of canola meal increased. This may be related to the increasing amount of crude fiber in the diet as the amount of canola meal increased. Fiber can induce a faster passage rate, reducing the opportunity for digestion and increasing endogenous nitrogen loss through abrasive action or binding endogenous protein (Liang, 2000). In tilapia, increased dietary fiber caused reduced growth (Shiau and Kwok, 1989) and lower protein efficiency (Teshima et al., 1987). The decreasing growth in our study may be due to the increasing level of crude fiber, together with phenolic compounds that reduce the palatability of canola meal.

In conclusion, up to 10% of the fishmeal protein in tilapia fry diets can be replaced by canola meal protein. Higher levels of canola meal may be possible with supplementation of a dietary enzyme that breaks down the structure of crude fiber or application of some process to decrease the crude fiber level of canola meal.

Table 2. Growth, feed efficiency ratios, and somatic indices of tilapia fry fed diets containing different levels of canola meal for 90 days.

	Protein replacement level (%)					
	Control	*10*	*20*	*30*	*40*	*50*
Growth						
Initial mean wt (g)	1.21±0.03	1.23±0.03	1.20±0.03	1.22±0.03	1.23±0.03	1.22±0.03
Final mean wt (g)	$5.32±0.01^{a}$	$5.12±0.22^{ab}$	$4.71±0.28^{bc}$	$4.40±0.05^{cd}$	$4.44±0.09^{cd}$	$4.11±0.07^{d}$
Wt gain (g)	$3.98±0.09^{a}$	$3.76±0.20^{a}$	$3.37±0.30^{ab}$	$3.12±0.10^{b}$	$3.13±0.11^{b}$	$2.86±0.12^{b}$
Specific growth rate	$1.65±0.02^{a}$	$1.59±0.06^{a}$	$1.52±0.06^{ab}$	$1.43±0.03^{bc}$	$1.43±0.02^{bc}$	$1.35±0.03^{c}$
Feed efficiency						
Feed intake (g)	$7.98±0.05^{a}$	$7.99±0.02^{a}$	$7.23±0.34^{b}$	$7.13±0.11^{b}$	$7.18±0.07^{b}$	$7.27±0.07^{b}$
Feed conversion ratio	$2.01±0.06^{b}$	$2.13±0.12^{b}$	$2.16±0.10^{b}$	$2.29±0.11^{ab}$	$2.30±0.05^{ab}$	$2.55±0.14^{a}$
Protein efficiency ratio	$1.71±0.05^{a}$	$1.61±0.09^{a}$	$1.58±0.07^{ab}$	$1.51±0.07^{ab}$	$1.48±0.03^{ab}$	$1.35±0.07^{b}$
Somatic indices						
Hepatosomatic index	2.44±0.19	2.47±0.30	2.30±0.21	2.56±0.26	2.43±0.37	2.43±0.05
Renosomatic index	0.38±0.01	0.33±0.04	0.37±0.01	0.37±0.03	0.37±0.05	0.39±0.03
Viscerosomatic index	11.65±0.32	12.15±0.32	11.53±0.21	11.85±0.40	12.26±0.37	12.41±0.18
Body composition (%)						
Moisture	71.08±1.83	72.92±1.44	72.85±1.05	71.25±2.03	72.94±1.39	72.27±0.64
Dry matter	28.92±1.83	27.08±1.44	27.15±1.05	28.75±2.03	27.06±1.39	27.73±0.64
Crude protein	18.59±0.25	18.33±0.45	18.09±0.67	18.04±0.20	18.25±0.34	18.01±0.67
Crude lipid	3.93±0.18	3.42±0.32	3.59±0.66	3.04±0.04	3.61±0.19	3.07±0.13
Crude ash	2.90±0.26	2.75±0.13	2.40±0.28	2.32±0.21	2.31±0.19	2.22±0.16

Values in a row with different superscripts differ significantly ($p<0.05$).

References

AOAC, 1990. *Official Methods of Analysis*, 15th ed. Assoc. Official Analytical Chemists, Arlington, VA.

Bligh E.G. and W.J. Dyer, 1959. Rapid method of total lipid extraction and purification. *Can. J. Brioche. Physiol.*, 37:911.

Cheng Z.J. and R.W. Hardy, 2002. Effect of microbial photoset on apparent nutrient digestibility of barley, canola meal, wheat and wheat middlings, measured *in vivo* using rainbow trout (*Oncorhynchus mykiss*). *Aquac. Nutr.,* 8:271-277.

Dabrowski K. and J. Godowsky, 1977. A study of the application of proteolysis enzymes to fish food. *Aquaculture*, 12:349-360.

Davies S.J., McConnell S. and R.I. Bateson, 1990. Potential of rapeseed meal as alternative protein source in complete diets for tilapia (*Oreochromis mossambicus* Peters). *Aquaculture*, 87: 145-154.

Forster I., Higgs D.A., Dosanjh B.S., Rowshandeli M. and J. Parr, 1999. Potential for dietary phytase to improve the nutritive value of canola protein concentrate and decrease phosphorus output in rainbow trout (*Oncorhynchus mykiss*) held in 11°C fresh water. *Aquaculture*, 179:109-125.

Hepher B. and Y. Pruginin, 1981. *Commercial Fish Farming, with Special Reference to Fish Culture in Israel*. John Wiley & Sons, New York. 261 pp.

Higgs D.A., McBride J.R., Markert J.R., Dosanjh B.S., Plotnikoff M.D. and W.C. Clarke, 1982. Evaluation of tower and candle rapeseed (canola) meal and bronowski rapeseed protein concentrate as protein supplements in practical dry diets for juvenile chinook salmon (*O. tshawytscha*). *Aquaculture,* 29:1-31.

Hilton J.W. and S.J. Slinger, 1986. Digestibility and utilization of canola meal in practical-type diets for rainbow trout. *Can. J. Fish Aquat. Sci*., 43:1149-1155.

Jackson A.J., Capper B.S. and A.J. Matty, 1982. Evaluation of some plant proteins in complete diets for tilapia *Sarotherodon mossambicus. Aquaculture*, 27:97-109.

Liang D., 2000. *Effect of Enzyme Supplementation on the Nutritive Value of Canola Meal for Broiler Chickens.* M.Sc. Thesis, Dept. Anim. Sci., Univ. Manitoba, Canada. 123 pp.

Lim C.P., Klesius H. and D.A. Higgs, 1998. Substitution of canola meal for soybean meal in diets for channel catfish (*Ictalurus punctatus*). *J. World Aquac. Soc*., 239:161-168.

NRC, 1993. *Nutrient Requirements of Fish*. Natl. Res. Council, Natl. Acad. Press, Washington, DC.

Sajjadi M. and C.G. Carter, 2004. Dietary phytase supplementation and the utilization of phosphorus by Atlantic salmon (*Salmo salar* L.) fed a canola meal-based diet. *Aquaculture,* 240:417-431.

Shiau S.Y. and C.C. Kwok, 1989. Effects of cellulose, agar, carrageenan, guar gum and carboxymethylcellulose on tilapia growth. *World Aquac.,* 20(2):60.

SPSS, 2000. *SPSS for Windows Base System User's Guide*, release 10.0. Chicago.

Teshima S., Kanazama A. and S. Koshis, 1987. Effect of feeding rate, fish size and dietary protein and cellulose levels on growth of *Tilapia nilotica*. *Mem. Fac. Fish., Kagoshima Univ.*, 36: 7-15.

Thiessen D.L., Maenz D.D., Newkirk H.L., Classen H.L. and M.D. Drew, 2004. Replacement of fishmeal by canola protein concentrate in diets fed to rainbow trout (*Oncorhynchus mykiss). Aquac. Nutr.,* 10:379-388.

Webster C.D., Tiu L.G., Tidwell J.H. and J.M. Grizzle, 1997. Growth and body composition of channel catfish (*Ictalurus punctatus*) fed diets containing various percentages of canola meal. *Aquaculture*, 150:103-112.

Yurkowski M., Bailey J.K., Evans R.E., Tabachek J.L., Ayles J.B. and J.G. Eales, 1978. Acceptability of rapeseed proteins in diets of rainbow trout *(Salmo gairdneri). J. Fish. Res. Board Can.*, 35:951-962.