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THE NUTRITIVE VALUE OF CANOLA SEEDS AS A FEED INGREDIENT FOR TILAPIA (*OREOCHROMIS NILOTICUS*) *INGERLINGS*

(With 5 Tables)

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القيمة الغذائية لبذور نبات الشلجم كأحد مكونات علائق أصبعيات البلطي النيلي

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اجرى هذا البحث لدراسة القيمة الغذائية والهضمية لبذور نبات الشلجم وكذلك دراسة امكانية استخدامها فى تغذية أصبعيات البلطي النيلي كمصدر للبروتين في العليقة لتحل جزئيا محل كسب فول الصويا أو مسحوق السمك . تم تحليل هذه البذور كيميائيا لاستبيان محتواها من بعض العناصر الغذائية وكذلك محتواها من الأحماض الامينية الأساسية . كما أجريت تجربة هضم لمدة خمسة وعشرون يوما منها أسبوعان كفترة تمهيدية لأسماك البلطي لاستبيان مدى استساغه هذة البذور وكذلك هضميتها بالنسبة لهذا النوع من الأسماك. وتم أيضا إجراء تجربة تغذية لمدة ١٢ اسبوعا منها أسبوعان تمهيديان لدراسة تأثير إحلالها جزئيا (٢٥، ٥٠%) محل كلا من بروتين كسب الصويا ومسحوق السمك في علائق أصبعيات البلطي على معدلات النمو والكفاءة الإنتاجية لهذه الأسماك . وقد أظهرت النتائج ما يلي:
تحتوى هذه البذور على ٢٤,٥، ٣٨,٧، ١١,٤، ٠,٣٥، ٠.٤٠% من البروتين الكلى- المستخلص الإيثيرى- الألياف الخام – الكالسيوم والفسفور الكلى على الترتيب. يحتوى بروتين هذه البذور على ٧,٢٤, ٣,٣٢, ٤,٢١, ٨,٥٣, ٧,٠٦, ١,٨٧, ٤,٦٤, ٥,٤٣, ١,٧٨, ٥,٥٨ من الأرجينين، الهستيدين ، الأيزوليوسين ، ليوسين ، لايسين ، مثيونين ، فينيل ألانين، ثريونين ، تربتوفان ، والفالين على التوالى. معامل الهضم بالنسبة للمواد العضوية- البروتين الكلى – المستخلص الإيثيرى- الألياف الخام – المحتوى الخالى من الازوت – الطاقة الكلية – الكالسيوم والفسفور الكلى على الترتيب كان ٧٨,١٦- ٧٧,٤٣ -٨١,٣٢- ٧٤,٤٦ - ٧٣,٥٥- ٧٨,٢٣- ٥٧,١٤- ٥٢,٥٠. أظهرت تجربة التغذية أنه من الممكن احلال بروتين مسحوق بذور الشلجم محل ٥٠% من بروتين كسب فول الصويا و٢٥% فقط من بروتين مسحوق السمك دون أن يكون لذلك تأثيرا معنويا على معدلات النمو والكفاءة الإنتاجية للأسماك.

SUMMARY

The proximate composition, essential amino acids profile, acceptability, digestibility of roasted whole canola seeds (WCS) and possibility of its inclusion in Tilapia (*Oreochromis niloticus)* fingerlings diets were studied. Results of chemical analysis on dry matter basis were 24.5, 38.7, 11.4, 0.35, 0.40 % for CP, EE, CF, Ca, total P % respectively and 5453 K cal / kg (GE). Essential amino acids % of its protein were 7.24, 3.32, 4.21, 8.53, 7.06, 1.87, 4.64, 5.43, 1.78, and 5.58 for arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine rspectively. A pilot experiment durated for 25 days on 50 tilapia fish in which full-fat canola seeds were fed as a sole dietary ingredient revealed digestible coefficient (DC) of 78.16, 77.43 , 81.32, 74.46, 73.55, 78.23, 57.14 and 52.50 % for organic matter (OM), CP, EE, CF, NFE, GE, Ca and P, respectively. To study the possibility of partial replacing of dietary protein by WCS protein, an experiment was done to investigate the growth performance traits as well as some nutrients utilization of tilapia (*oreochromis niloticus*) fingerlings fed on diets in which (25 and 50%) of both SBM and FM protein were replaced by WCS protein. The results demonstrated that groups of fish fed on diets in which 25 and 50% of SBM protein were replaced by WCS protein revealed no significant differences in weight gain, feed conversion and protein efficiency ratio compared with fish fed on the control diet. On the other hand fish fed on diet in which 25% of FM protein was replaced by WCS protein recorded significant improvement in the same parameters, however higher level of replacement (50%) showed significant negative effects on the same traits compared with fish fed on the control diet.

Key words: *Canola seed, nutritive value, digestibility, inclusion rate, tilapia, diets*

INTRODUCTION

The limited feed resources encounters many problems in Egypt as well as in countries of similar conditions. The gap of animal feeds in Egypt which were already evaluated by 4 – 6 million tons of concentrate feed mixtures represents about 3 – 4 million metric tons of TDN (El-Shinnawy, 1990). Consequently, the average consumption of meat and meat products is reduced to 12 g/Capita/day as compared by the universal corresponding average, 28 g/Capita/day (FAO, 1991).

Since aquafeeds generally represent the largest single cost item of most semi-intensive and intensive farming operations, usally accounting between 30 and 60 % of total farm production costs (Chong, 1992), so, the selection of feed ingredients for use within an aquafeed will play a major role in dictating its ultimate nutritional and economic success for a farmed fish or shrimp (Tacon, 1992).

Commercial tilapia diets contain variable but high contents of protein (25-50%) most of which is usually supplied by soybean and fish meals (El- Banna et al., 1994). Because of the complementary relationship between the nitrogenous feedstuffs and cereals, soybean meal (SBM) the universally accepted as the most important protein supplement in livestock feeds, are becoming increasingly expensive and sometimes inadequate. Fish meal (FM) quality and prices are variable, and the global supply is declining despite the increasing demand (Higgs et al., 1995), a situation which encouraged many researchers to fined other alternative protein sources that can replace both ingredients in animal diets.

Successful attempts to replace SBM in a particular manner by other vegetable protein supplements as corn gluten (Hepher, 1988; El-Banna et al., 1994), sunflower, cottonseed and linseed protein (Abdul-Aziz et al., 1999) in fish diet and nigella meal (Radwan et al., 2001) for poultry. Substituting FM by other animal protein sources as milk or whey powder (Meske et al., 1977), feather and meat meal (Tiews et al., 1976), poultry by-products (Osman, 1988) in fish diets, meat and bone meal (Abdel-Hafeez et al., 1995) in poultry diets, or by vegetable protein source as SBM (Pantha, 1982; Hossain and Jauncey, 1989) for fish diets and Nabila et al. (1993) in poultry diets, were investigated.

Canola seeds, the desert cultivated oil-bearing seeds, may offer a fairly cheap, non conventional protein supplement as a partial substitute for the traditional nitrogenous feedstuffs. Higgs et al. (1995) reported that rapeseeds or canola seeds are highly available commodities and less costly per unit protein and canola protein products are protein potentially excellent alternatives for finfish diets. Whole canola seeds (full fat seeds) were evaluated successfully as alternative protein supplement for broilers (Nwokolo and Sim, 1989), layers (Chprian and Sim, 1991), fattened lambs (Betit et al., 1997 and 1999), and ostrich (Brand et al., 1998). On the other hand, whole canola seeds (WCS) could be used as energetic feedstuff and omega - 3 fatty acids (FAs) source. Cherian and Sim (1991) demonstrated an increase in omega - 3 FAs content of eggs, embryos, and chicks of laying hens fed diet contained 16% WCS.

Moreover, the use of WCS as a source of omega - 3 FAs in rations for turkeys was assessed in 12-week-old Nicholas heavy turkeys by Ajuyah et al. (1993). They repoted that dietary C18: 3 – omega from WCS was readily absorbed and converted to its longer chain metabolites (C20: 5 omega - 3, C22: 5 omega – 3,and C22: 6 omega – 3) prior to tissues deposition.

Canola meal (defattened seeds) was evaluated for fish feeding in particular substitution to FM or SBM (Davies et al., 1990; Lim et al., 1997; Abdul-Aziz et al., 1999; and Soares et al., 2000).

The digestibility of whole canola seeds by tilapia and the effect of its inclusion in tilapia diets were not recorded in the available literature. Therefore, the present study was designed to investigate the digestibility of WCS when fed as a sole dietary ingredient to tilapia. Also, the tilapia performances was assessed when fed on diets in which SBM or FM was substituted by WCS at levels of 25 or 50 % on crude protein equivalent basis.

MATERIALS and METHODS

1- Analytical procedures:

Proximate analysis of roasted WCS and other dietary ingredients as well as fecal samples were done according to AOAC (1990). Gross energy (GE) content was determined by bomb calorimeter according to Nijkamp (1969) and (1971). Essential amino acids profile of WCS were obtained after acid hydrolysis (24 hours in 6N HCL at 110° C) using an amino acid analyzer (Modle, 120c analyzer Backman) according to the method described by Cross et al. (1975). Tryptophan was measured separately according to Matheson (1974) at Faculty of Agriculture, Cairo university, Egypt, central laboratory (Tables 1 and 2).

Table 1: Essential amino acid profile as a percentage of whole canola seeds protein

Amino acid	% of WCS protein
Arginine	7.24
Histidine	3.32
Isoleucine	4.21
Leucine	8.53
Lysine	7.06
Methionine	1.87
Phenyl alanine	4.64
Threonine	5.43
Tryptophan	1.78
Valine	5.58

Table 2: Chemical composition of the used feed ingredients (dry matter basis)

Ingredients Analyzed tems	Whole canola seed	Soybean meal (44 %)	Yellow corn	Fish meal (72%)	Wheat bran
Crude protein %	24.5	44.2	9.8	71.9	13.2
Gross energy (Kcal / Kg)	5453	4178	3882	5072	3702
Ether extract %	38.7	1.9	3.8	8.4	3.1
Crude fiber %	11.4	5.9	2.7	0.6	11.2
Ca %	0.35	0.28	0.03	2.49	0.15
TP %	0.40	0.63	0.31	1.92	1.22

2- Digestibility study:

Whole canola seeds was roasted for 30 minutes as described by Teleb et al. (1992) for soybean roasting to destroy any toxic substances which may be present in the raw seeds, then the seeds were finely ground. The digestibility of seeds when used as the sole dietary ingredient was then determined using 50 tilapia fingerlings (Oreochromis niloticus) with an average weight of 30 ± 1.5 g. They were randomly stocked as 2 replicates in two glass aquaria (180 L) each of 25 at Fish Culture Research Station, El-Kanater El-Khiria, Kalubia, Egypt. During the experimental period, water temperature, pH, and dissolved oxygen were maintained within the optimum levels for tilapia (Hepher, 1988), and the tap water was treated by antichlor reagent (Boyed, 1979).

Fish were starved for 48 hours before the beginning of the experiment, then acclimatized gradually to the finely ground WCS for a period of 2 weeks. WCS was fed at a rate of 3 % of live body weight (LBW). During the fecal collection period which lasted for 10 days the fecal samples were collected using siphoning technique (Abdel-Ghany, 1993). Chromic oxide was added at a level of 0.5 % to WCS as an indicator and measured in the fecal samples (Furukawa and Tankahara, 1966).

3- Experimental Study:

The efficiency of partial substitution of both SBM and FM (at 25 and 50% on an equivalent crude protein basis) by WCS in tilapia (Oreochromis niloticus) diets were experimentally evaluated using a total of 400 tilapia fingerlings of average 28.75 g LBW. Fish were allocated into 5 equal groups, 80 / each and distributed in 5 fiber glass water tanks of one cubic meter capacity, and maintained for two weeks acclimatization period before starting a 10-week trial. For the first and second groups, the WCS replaced 25 and 50 % of the SBM protein while for the third and fourth ones, it replaced the FM at the same replacement

percentages but the 5th group was considered as control and fed on a WCS - free diet. The dietary ingredients were chemically analyzed for the different nutrients (Table 2) and the five diets were formulated on iso-nitrogenous and semi-iso-caloric basis (Table 3) to fulfill the nutrient requirements for tilapia (NRC, 1993). Fish was weighed bi-weekly to adjust the daily feed accordingly to a rate of 3 % of LBW and the amount of feed was offered twice a day at 9.00 am and 3.00 pm. and at the end of the experiment the body weight gain (BWG), feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated.

Table 3: Physical and chemial composition of the experimental diets

Diet / Ingredient	Substitution %				Control
	Soybean meal		Fish meal		
	25	50	25	50	
Physical composition					
F M (72%)	20	21	15	10	20
SBM (44%)	20	13	26	30	25
Canola seeds	11	22	15	28	0
Yellow corn	24	14	15	6	27
Wheat bran	20	26	25	22	20
Corn oil	1	0	0	0	4
Vitamin mix*	2	2	2	2	2
Mineral mix**	2	2	2	2	2
Chemical composition					
C.P %	30.92	31.00	30.74	30.78	**30.81**
G.E (Kcal/Kg)	4216.3	4313.7	4237.1	4334.7	4225.4
EE %	8.61	11.76	8.71	12.94	7.62
CF %	5.44	6.70	6.53	7.64	4.57
Ca %	0.60	0.60	0.53	0.46	0.58
AP %	0.44	0.45	0.44	0.41	0.42
Methionine %	0.66	0.68	0.60	0.55	0.65
Lysine %	2.08	2.14	2.04	2.05	2.04

*Each Kg of the formulated vitamin mix. contains 4000000 I.U. Vit. A, 8000 I.U. Vit.D, 1000 mg Vit E, 1000 mg Vit.K, 10 g Vit. C, 2000 mg Vit. B_1, 1000 mg Vit.B_2, 100 mg Vit.B_6, 3 mg Vit.B_{12}, 500 mg folacin, 5000 mg pantothenic acid, and 5000 mg niacin.

**Each Kg of the formulated mineral mix. contains Ca 125 g , P 90 g, Fe 2500 mg, Cu 2000mg, Mn 6000 mg, I. 200 mg, Se 100 mg, Zn 4000 mg, and Na Cl 250g.

4- Statistical analysis:

The obtained data were statistically analyzed using one way ANOVA test (Snedecor and Cochran, 1989).

RESULTS and DISCUSSION

Chemical composition and digestibility study:

The proximate composition of roasted whole canola seeds demonstrated 24.5, 38.7, 11.4, 0.35, 0.40 for CP, EE, CF, Ca and total P % respectively and 5453.6 Kcal (GE) / Kg diet. Feeding on WCS as a sole dietary ingredient proved that it is highly acceptable and palatable for tilapia (*oreochromis niloticus*) fingerlings and the digestibility study of WCS demonstrated that digestion coefficient of OM, CP, EE, CF, NFE, GE, Ca and P, were 78.16, 77.43, 81.32, 74.46, 73.55, 78.23, 57.14 and 52.50% respectively (Table 4). Unfortunately, there is no available data concerning the digestibility of WCS in tilapia to justify our findings, however Bett et al. (1999) found that digestibility of ADF and NDF of WCS are significantly higher than those of SBM (60.11 Vs 46.84) and (54.19Vs 45.84) respectively, and there was no significant difference in the DM, CP, and GE digestibility of WCS and SBM in lambs. Generally, there is considerable variation in nutrients digestibility of various feedstuffs exists among fish species and under different environmental conditions (Lovell, 1977). Moreover, the digestibility of feed when used as a sole dietary ingredient usually differs than its digestibility when fed in a complete diet, besides, the results of nutrient digestibility in fish are usually contradictory due to the difference in methods used in collection of feed samples (Hanley, 1987) and there is a possibility that fish have the ability to select diet components (pick and expel) by their mouth before swallowing (Popma, 1982).

Table 4: Results of chemical analysis of feces and digestion coefficient of WCS nutrients in the digestibility Study using indicator* method.

Nutrients	OM** %	CP %	EE %	CF %	NFE %	GE (Kcal / Kg diet)	Ca %	P %
Chemical composition of WCS	88.7	24.5	38.7	11.4	14.1	5453.6	0.35	0.40
Chemical composition of feces	25.5	7.3	9.5	3.8	4.9	1540.3	0.15	0.19
Digestion coefficient of nutrients	78.16	77.43	81.32	74.46	73.55	78.23	57.14	52.50

* Cr_2O_3 (0.5 % in feed and 0.657 % in feces) was used as indicator and the digestion coefficient of nutrients was calculated according to the equation of Cho et al.(1982)

$$DC = 100 - \left(\frac{\text{Nutrient in feces}}{\text{Nutrient in feed}} \times \frac{\text{Indicator in feed}}{\text{Indicator in feces}} \times 100\right)$$

** OM = organic matter

Experimental Study:

The growth performance traits as well as the nutrients utilized by tilapia (*oreochromis niloticus*) fingerlings fed on dies in which WCS replaced (25 or 50%) of either SBM or FM protein are presented in (Table 5). Results demonstrated that groups of fish fed on diets in which 25 and 50% of SBM protein were replaced by WCS protein revealed no significant differences (p 0.05) in weight gain (22.4 and 20.8 vs 22.4), feed conversion (1.58 and 1.72 vs 1.60) and protein efficiency ratio (2.11 and 1.94 vs 2.12) compared with fish fed on control diet. Davies et al. (1990), found that the best results were achieved when 15% rapeseed meal replacing soybean meal while higher inclusion levels led to progressively poorer performance, on the other hand, Abdul-Aziz et al. (1999) found that fish fed on diets containing 25% soybean or rapeseed protein showed better live weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio and energy retention value than those fed on sunflower or cottonseed diets and the lowest values were observed with the linseed diet.

Table 5: Effect of WCS particular substitution to SBM and FM in Tilapia diet on growth performances of tilapia at the end of experimental period

Dietary treatment / Parameter	Substitution %				Control
	Soybean meal		Fish meal		
	25	50	25	50	
Initial BW (g) / fish	28.1 ±0.65	28.7 ±0.55	27.7 ±0.80	29.4 ±0.60	28.0 ±0.55
Final BW (g) / Fish	50.5^{a} ±0.30	49.5^{a} ±0.25	54.5^{b} ±0.35	49.0^{a} ±0.50	50.4^{a} ±0.40
Gain (g) / fish	22.4^{a} ±0.52	20.8^{a} ±0.42	26.8^{b} ±0.65	19.6^{c} ±0.30	22.4^{a} ±0.56
Feed intake (g)/ fish	35.37	35.97	38.36	35.28	35.8
FCR	1.58	1.72	1.43	1.80	1.60
PER*	2.11	1.94	2.52	1.99	2.12
Survival %	100	100	100	100	100

a, b, c: rows with different superscripts are significantly different at $P < 05$.

PER (protein efficiency ratio) = $\frac{\text{Weight gain (gm)}}{\text{Protein intake (gm)}}$

The fish fed on diet in which 25% of FM protein was replaced by WCS protein revealed significant increase (p 0.05) in weight gain (26.8 vs 22.4), feed conversion (1.43 vs 1.60) and protein efficiency ratio(2.52 vs 2.12), however higher level of replacement (50%)

negatively affected (p 0.05) the same growth parameters, weight gain (19.6 vs 22.4), feed conversion (1.80 vs 1.60) and protein efficiency ratio (1.99 vs 2.12). This negative effect could be explained on the basis that Tilapias in general are omnivorous fish with tendency to herbivorous side. Alkholy and Abdel-Malek (1972) reported that the microscopical examination of the alimentary tract contents of tilapias demonstrated that these fish were omnivorous, eating both vegetable and animal materials, however, plant components were the most predominant feed items for both sexes of tilapia 78.88% in males and 85.20 in females. Jauncey and Ross (1982) found that S. niloticus are omnivorous fed predominantly on phytoplanktons.

Moreover, Higgs et al. (1995) reported that canola seeds protein products are potentially excellent alternative for finfish diets. The essential amino acids % of its protein were 7.24, 3.32, 4.21, 8.53, 7.06, 1.87, 4.64, 5.43, 1.78, and 5.58 for arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, trytophan and valine respectively. These values were more or less comparable with EAAs profile for protein of full fat soybean seeds calculated on the basis of 38 % CP content, as the value reported in the NRC (1993) are 7.97, 2.82, 5.34, 8.61, 7.05, 1.37, 5.55, 4.37, 1.68 and 5.31 for the same amino acids in the same order respectively. Amino acid profile of canola protein indicated high nutritional quality for use, not only for livestock, but also in products for young and adult human being (Klockeman et al., 1997). The nutritive value and acceptable dietary concentration of canola meal as protein supplement in shrimp diet was evaluated by Lim et al (1997), who found that the canola meal comprised protein 150, 300, 450 g /Kg in a basal (practical) diet by replacement of one third, two thirds or all of menhaden meal protein. Shrimp fed on diets in which canola protein comprised protein 45 % and 30 % exhibited significant reduction in growth and feed intake compared with those fed on the basal diet. Percentage of survival and final whole body level of protein, minerals and thyroid hormones were not significantly affected by dietary treatment. In the same study, they suggested that channel catfish can be fed on diets containing up to 31 % canola meal without adverse effects on growth or body composition. The higher inclusion rate lowered the percentage live weight gain, possibly due to reduced palatability of the diet (Webster et al., 1997), adverse effect of phytate phosphorus source in canola meal which counter attacked by using phytase to concomitantly minimize phosphorus discharge and increase its availability for rainbow trout (Forster et al., 1999), or may be due to the

high sulphur content (1.14 %) of canola meal that has been reported to reduce growth performances as a result of Ca metabolism impairment, which can be partially alleviated by the addition of Ca to the diet (Summers, 1995). However, Soares et al. (2000) reported that replacement of 100 % protein from SBM by canola meal or inclusion of 43.12 % of canola meal, in isonitogenous, and of equal Ca and P diets for piavucu fry, produced better growth, protein efficiency and survival rate.

In conclusion the present work suggests that roasted WCS is highly acceptable and palatable dietary ingredient for Tilapias and promoted reasonable growth, when replaced soybean or fish meal meal at a level up to 50% of SBM and 25% of fish meal.

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