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GROWTH RESPONCE OF HYBRID TILAPIA, *Oreochromis niloticus* X *Oreochromis auraus,* FINGERLINGS TO DIETS SUPPLEMENTED WITH DIFFERENT LEVELS OF CARAWAY SEEDS

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ABSTRACT

Four experimental isonitrogenous (33% crude protein) and isoenergitic diets were formulated to contain 0, 0.5, 1.0 and 2.0 % of dried caraway seeds meal (CSM) in order to study the effects of different levels of CSM on growth, survival, feed and nutrient utilization, attraction activity, nutrient digestibility, body composition and cost-benefit analysis of hybrid tilapia, *Oreochromis niloticus* x *O. auraus,* fingerlings. Eight glass aquaria (each holds 96-L capacity) were used in duplicates. Ten fish (stocking rate of 104 fish /m^3) of the same average weight (13 g/fish) were stocked in each aquarium. Fish were fed daily at a rate of 3 % of the body weight, three times daily, six days a week for 112 days. Fish were weighed biweekly and feed amounts were adjusted on the basis of the new weight. Feces were collected daily during the last two weeks to determine apparent digestibility coefficients.

Results indicated that no significant differences ($P>0.05$) were observed in digestibility of dry matter, crude protein, ether extract and nitrogen free extract among fish fed all the tested diets. Fish fed 0.5% CSM was significantly higher ($P<0.05$) in body weight, weight gain and SGR than those fed the control diet. However, growth performance parameters of fish fed CSM levels of 1 and 2% were insignificant ($P>0.05$). Fish fed 0.5% CSM diet was the best supplemented level for FCR, PER, PPV%, ER%, feed waste %, palatability index and profit index in comparison to the control diet and other tested CSM levels. Body composition did not affect by using various levels of CSM.

Keywords: Feeding attractants, caraway seeds, hybrid tilapia, fingerlings, performance

INTRODUCTION

Many attempts have been undertaken in order to improve the utilization of diet nutrients using several growth promoters feed additives from different sources (Ibrahim *et al.*, 1998). Using dietary supplementation has greatly increased although feed additives contain chemical components, hence the accumulative effect of these components induced deterrent effects on human health (Salem and El-Mahdy, 2001). Therefore, the using of natural feed additives is been important to minimize these adverse effects.

Some vegetables, herbs, edible plants and seeds are used as tonics and restoratives (Abd El-Latif *et al.*, 2004). Several studies in animal nutrition showed that adding some spices or medicinal and aromatic plants to diets of sheep, goats, rabbits, chicken, cows and buffaloes had favorable effects on live weight gain, feed intake, feed efficiency and nutrient digestibility (Hanafy, 1995; Karaly, 1995; Gaber *et al.*, 1996; Mir *et al.*, 1998; Youssef *et al.*, 1998; Aboul-Fotoh *et al.*, 1999; Allam et al ., 1999; El- Ayek *et al.*, 1999 and El-Saadany *et al.*, 1999). The most recent studies showed successful use of

spices and natural herbs in fish nutrition including marjoram, basil, licorice roots, black seeds, peppermint and fenugreek seeds (Abd El-Maksoud *et al.*, 2002; Abd Elmoneim *et al.*, 2002; Sakr 2003; Shalaby *et al.*, 2003; El-Dakar *et al.*, 2004a, b, and c and Shalaby, 2004).

Caraway is another member of the group of aromatic, umbelliferous plants characterized by carminative properties, like anise, cumin, dill and fennel. It is grown, however, less for the medicinal properties of the fruits, or so-called 'seeds,' than for their use as flavoring in cookery and confectionery (Abo Zeid, 1989). Caraway seeds may contain 3% to 7% essential oil (Murray *et al.*, 1991). Caraway is distributed throughout the northern and central parts of Europe and Asia, though where it occurs in this country it is only considered a naturalized species, having apparently escaped from cultivation (Murray *et al.*, 1991).The present study aimed to investigate the effect of different levels of caraway seeds meal on growth performance, feed and protein conversion, nutrient retention efficiencies, feeding attraction, nutrient digestibility and cost-benefit analysis of hybrid tilapia, *O. niloticus* x *O. auraus*, fingerlings.

MATERIALS AND METHODS

This work was carried out at Wet Lab., Fish Resources and Aquaculture Department, Faculty of Environmental Agricultural Sciences, Suez Canal University, El-Arish, North Sinai, Egypt. Wet lab was designed as a closed system (recirculating system). Eight aquaria (60x40x50 cm, 96 L, net water volume), two aquaria per treatment, were arranged in series and received recirculating filtered water at 0.5 litter/min. Water leaving aquaria was allowed to enter in a sedimentation basin where solids were removed.

The water was then passed into a biological filter using water pump (100 L/min), where bacteria detoxify ammonia and nitrite into nitrate.

The biological filter was followed by a reservoir tank ($1m^3$) in order to regulate water level of each aquarium using overflow tubes. Two blowers were used for aeration through air stones.

Fingerlings of hybrid tilapia *O. niloticus* x *O. auraus* were obtained from a private fish farm at El-Fayoum Governorate, Egypt. After arrival, all fish were kept for one week in fiberglass tanks (600-L capacity) to alleviate stresses during transportation and to be adapted to the new conditions.

Ten fish, stocking density of 104 fish per cubic meter, of the same initial weight (13 g/fish) were selected and randomly distributed into each experimental aquarium. Fish were fed the control diet for two weeks, during this period healthy fish of the same weight replaced the dead ones. Fish were reared in 27.5±2 °C, 6.55±0.5 mg l^{-1}, 8.7±0.2 and 12/12 h Light/Dark for temperature, dissolved oxygen, salinity, pH and photperiod, respectively.

Temperature and salinity were measured daily using S-C-T meter model YSI-33 and pH was measured by pH meter model Jenway, 3060.

Four experimental diets were formulated to contain 0, 0.5, 1.0 and 2 % caraway seeds meal (CSM) which was obtained from Medicinal and Aromatic Plants Company, El-Fayoum Governorate, Egypt. All the experimental diets contained similar percentages of fish meal, meat meal, soybean meal and oil.

Ingredients composition of the diets is presented in Table (1).

The experimental diets were prepared by mixing dry ingredients with water and were pelleted using a meat mincer with a 1.5-mm diameter. The pellets were air dried and stored at -20 °C until use. Fish were fed the experimental diets at a rate of 3% of the body weight daily, at three times a day (900, 1200 and 1500), six days a week for 112 days. Fish were weighed biweekly and feed amounts were adjusted on the basis of the new weight.

Table 1: Ingredients composition (%) of the experimental diets.

Ingredients	Diet No			
	1	2	3	4
Fish meal, herring meal[1] 72% CP	20.0	20.0	20.0	20.0
Meat meal[2], 54% CP	10.0	10.0	10.0	10.0
Soybean meal[3], 48% CP	26.0	26.0	26.0	26.0
Wheat milling by-products[4]	34.0	33.5	33.0	32.0
Caraway seeds meal (CSM)	0.0	0.5	1.0	2.0
Linseed oil[5]	6.0	6.0	6.0	6.0
Vitamin and minerals premix[6]	4.0	4.0	4.0	4.0
Total	100	100	100	100

1. **Herring fish meal, Revisen, Co, Denmark.**
2. **Sabi Co., Italy.**
3. **Kafer El-Zayyate Extracted OilsCo., Kafer El-Zayyte, Egypt.**
4. **East Delta milling Co., El-Arish, North Sinai, Egypt.**
5. **El-Mahala El-Kobra Extracted Oil Co., Egypt.**
6. **Vitamins and minerals premix each 1kg contained: 10.000.000 IU, 1.100.000 IU, 1.000 mg, 400 mg, 600 mg, 1.200 mg, 4.50 mg, 6500 mg, 6500 mg, 1200, 50 mg, 80 mg, 325 mg, 50 mg, 175 mg, 120 mg, 15 mg, 35 mg, 1.250 mg 31.25 mg, 50 mg, 500 mg and 125 mg of vitamin A, D3, E, B_1, B_2, B_6, B_{12}, K_3, C, inositol, biotin, d-pantotheonic acid, folic acid, choline Hcl, cobalt, iron, manganese, copper, zinc, selenium, iodine, and BHT, respectively. Meal vegetable and calcium carbonate upto 1000g. New Gellemix, Gelleni Co., Italy.**

During the last two weeks, uneaten feed was removed from aquaria by siphoning after being weighed daily to calculate voluntary feed intake, feed waste % and palatability index. Every morning of the last two weeks, feces were collected by siphoning and separated from water, weighed and stored at -20° C for analysis. Voluntary feed intake was determined according to Kaushik (2000). Apparent digestibility coefficients (ADC) were determined using the direct method according to Lovell (1989). Ingredients, diets, feces and fish samples were analyzed according to AOAC (1990) for dry matter, crude protein, ether extract, crude fiber and ash. Cost-benefit analysis (incidence cost, IC and profit index, PI) for CSM inclusion in diets of tilapia fingerlings were calculated according to New (1985).

Analysis of variance (ANOVA) was carried out according to Snedecor and Cochran (1982) using a completely randomized design (CRD). Differences were subjected to Duncan's Multiple Range-Test (Duncan, 1955) at a 0.05 significance level. All statistical tests were preformed using the MSTAT-C (1988) software.

RESULTS AND DISCUSSION

Diets:-

Results indicated that caraway seeds meal (CSM) was rich in carbohydrates, ether extract and crude fiber, it contained 26.10, 22.54 and 22.87%, respectively (Table 2). Most of spices and medicine herbs may consider as nonnutritive feedstuff due to their small amounts that used in fish diets (Abd El-Maksoud *et al.*, 2002; Abd Elmonem *et al.*, 2002; Shalaby *et al.*, 2003; Abd-El-Latif *et al.*, 2004 and El-Dakar *et al.*, 2004 a, b,c). All experimental diets were isonitrogeneous (33% CP) and isocaloric (446-452 kcal/100 g diet, GE).

Table 2: Chemical proximate analysis of the experimental diets.

Item	CSM[1]	Diet No.			
		1	2	3	4
Dry matter	93.98	92.82	92.90	92.87	92.92
% of DM basis					
Crude protein	18.92	33.55	33.64	33.70	33.73
Ether extract	22.54	8.59	9.05	9.45	10.01
Crude fiber	22.87	6.52	6.67	6.83	7.03
Nitrogen free extract	26.10	42.79	42.14	41.64	40.81
Ash	9.62	8.55	8.50	8.38	8.42
Digestible protein[2] %	-	27.78	28.14	28.54	28.03
Calculated gross energy[2] *kcal /100g*	320	446	448	450	452
Digestible energy[2] *kcal /100g*	-	349	343	361	345

1- Caraway seeds meal
2- Calculated from ADC of protein and energy presented in Table (3).
3- calculated according to NRC (1993) by using factors of 5.65, 9.45 and 4.2 kcal per gram of protein, ether extract and nitrogen free extract, respectively.

Apparent digestibility coefficients:

Statistical analysis showed that no significant differences (P>0.05) were observed in digestibility of dry matter, crude protein, ether extract, nitrogen free extract and energy among fish fed all the tested diets (Table 3) Digestible protein slightly increased with diets containing CSM (diets 2, 3 and 4) than the control diet. However, digestible energy was affected by inclusion CSM in the tested diets.

Table 3:Apparent digestibility coefficients (ADC) of the experimental diets containing different levels of caraway seeds.

Item	Diet No			
	1	2	3	4
Dry matter	69.86±2.28	68.75±0.91	70.05±1.50	69.68±2.05
Crude protein	82.82±0.92	83.64±0.91	84.70±1.29	83.11±1.41
Ether extract	82.76±0.06	83.11±1.41	83.71±0.89	82.08±0.03
Crude fiber	23.05±0.37	22.90±1.13	23.00±0.71	23.39±0.45
NFE	58.07±0.69	56.36±0.42	58.00±0.33	57.25±0.69
Energy	78.20±0.75[ab]	76.50±0.17[b]	80.11±1.73[a]	76.23±1.23[b]

***Values in the row having a common superscript letter are not significantly different (P>0.05).**
*** Standard error of the means derived from the analysis of variance.***

The highest DP and DE were found with diet containing 1% CSM. These results parity agree with those obtained by Sakr (2003) who found that anise seeds gave similar percentages of apparent digestibility coefficients for DM, CP, EE, NFE and energy when were added at 0, 0.5, 1 and 2% in hybrid tilapia diets.

Growth performance and surviving:-

No mortality was found in all experimental fish groups fed different levels of CSM (Table 4). Data in Table (4) show the growth performance, feed and nutrient efficiencies of hybrid tilapia fed diets containing different levels of CSM. Results showed that fish fed 0.5% CSM (diet 2) was significantly higher ($P<0.05$) in body weight, weight gain and SGR than those fed the control diet. However, growth performance parameters of fish fed CSM levels of 1 and 2 (diets 3 and 4, respectively) were insignificant ($P>0.05$).

The positive effect of CSM in hybrid tilapia diets was supported by Abd Elmonem *et al.* (2002); Sakr (2003); Shalaby *et al.* (2003); El-Dakar *et al.* (2004 a, b and c) and Shalaby (2004). Incorporating fennel seeds meal in diets of Nile tilapia resulted in an increase of growth, feed conversion ratio and nutrients utilization efficiencies (El-Dakar *et al.*, 2004c). Similar results were obtained with seeds of fenugreek in Nile tilapia diets (Shalaby, 2004). This enhancement in growth performance may be due to the presence of vitamin F (a mixture of essential fatty acids including linoleic, linolenic and arachidonic) in supplemented medicinal feed additives which have been essential for growth (Murray *et al.*, 1991 and Abd El-Latif *et al.*, 2004).

Moreover, Henry and Emery (1986) demonstrated the metabolic rate increase by 25% when chili sauce and mustard sauce were added to a meal.

The activity of beta-glucuronidase significantly increased in the colon, intestine and liver of rat fed seeds of fenugreek at 2 g/kg body weight when compared to an untreated control group. In addition, Devasena and Menon (2003) reported that supplementation of fenugreek seeds in the diet inhibits colon carcinogensis by modulating the activities of beta-glucuronidase and mucinase group.

Feed and nutrient utilization:

Feed intake (Table 4) was lower for fish fed diets containing CSM at all levels except fish fed dietary 0.5% CSM (diet 2). The increasing feed intake as affected by adding CSM may confirm the results obtained by Abd Elmonen *et al.* (2002); Sakr *et al.* (2003); Shalaby *et al.* (2003); Abd El-Latif *et al.* (2004); El-Dakar *et al.* (2004 a) and Shalaby (2004). There were significant differences ($P<0.05$) in protein and energy utilization among fish fed diets containing CSM and the control diet. Fish fed 0.5% CSM diet was the better supplemented level for FCR, PER, PPV and ER in comparison to the control diet and other tested CSM levels. The seniority of dietary caraway seeds in improving these parameters may be due to its of contains essential oil and effective components contents. The aroma of the essential oil of CSM is mostly dominated by carvone (50 to 85%) and limonene (20 to 30%);

the other components carveol, dihydrocarveol, α- and β-pinene, sabinene and perillyl alcohol) are of much minor importance (Murray *et al.* 1991).

The effective components have a strong stimulating action on bile secretion as well as an antispasmodic and anti-inflammatory effect (Murray *et al.*, 1991).

Platel *et al.* (2002) found that spices are desirable for stimulating digestion, and had the highest stimulatory influence particularly on bile secretion and pancreatic enzymes activity. In another way, olfactory feed ingredients enhanced growth through their ability to act as feeding enhancers by fish to eat more feed than in normal (Adams *et al.*, 1988).

In this connection, Harada (1990) stated that caraway was strong attractants of spices for oriental wetherfish and cumin for yellowtail; however, their attractive effect depending on their concentration used.

Table 4: Growth rate, feed conversion and nutrient efficiencies utilization of hybrid tilapia fingerlings fed diets containing different levels of caraway seeds.

Item	Diet No.			
	1	2	3	4
Initial Wt. g/fish	13.23±0.04	13.11±0.13	13.05±0.06	13.07±0.07
Final Wt. g/fish	31.68±0.54^{b}	35.32±1.12^{a}	30.32±1.33^{b}	31.86±0.65^{b}
Gain g/fish	18.45±0.49^{b}	22.21±0.99^{a}	17.27±1.27^{b}	18.79±0.65^{b}
SGR[2] % /day	0.78±0.01^{b}	0.89±0.02^{a}	0.76±0.04^{b}	0.80±0.72^{ab}
Survival rate %	100±0.00^{a}	100±0.00^{a}	100±0.00^{a}	100±0.00^{a}
Feed intake g/fish	62.04±2.19^{a}	64.67±3.09^{a}	58.90±2.05^{a}	57.87±2.37^{a}
FCR[3]	3.12±0.03^{ab}	2.71±0.01^{b}	3.17±0.13^{a}	2.86± 0.23^{b}
PER[4]	0.96±0.01^{b}	1.10±0.01^{a}	0.94±0.04^{b}	1.04±0.08^{ab}
PPV[5] %	16.36±0.26^{b}	20.05±0.12^{a}	16.53±1.11^{b}	17.71±0.65^{b}
ER[6] %	10.76±0.57^{a}	13.03±0.36^{a}	10.74±1.21^{a}	11.35±0.96^{a}

***Values in the row having a common superscript letter are not significantly (P>0.05).**

1. **Standard error of the means derived from the analysis of variance.**
2. **Specific growth rate = 100 (Ln final weight-Ln initial weight) / days**
3. **feed conversion ratio =dry matter intake / gain**
4. **Protein efficiency ratio = weight gain / protein intake**
5. **Productive protein value = 100 (protein gain/protein intake)**
6. **Energy retention = 100 (gross energy gain / gross energy intake)**

Body composition:-

Results in Table (5) showed no significant differences (P>0.05) in moisture, crude protein, ether extract and ash content of Nile tilapia fed diets containing various levels of CSM. These data are in agreement with those published by Abd El-Maksoud *et al.* (2002); Abd Elmonem *et al.* (2002) and Shalaby *et al.* (2003) for other spices. Body composition characteristics of hybrid tilapia fed various levels of anise seeds were closer to the control group of fish and showing no adverse effect of the experimental diets on the dry matter, crude protein, ash and energy contents (Sakr, 2003). Similarly, Shalaby (2004) found that body composition of Nile tilapia did not affect by using of fenugreek seeds at different levels. In addition, several investigators have reported that ground seeds of fenugreek have hypoglycemic and hypocholesterolemic effect (Madar and Shomer, 1990; Matsuo *et al.*, 1996; Rashwan, 1998 and Saito *et al.*, 1999).

Table 5:Body composition[ns] of hybrid tilapia fingerlings fed diets containing different levels of caraway seeds.

Diet No	Dry matter %	% on DM basis		
(CSM levels)		Crude protein	Ether extract	Ash
Initial fish	20.96	62.73	16.01	21.26
1 (0.0%)	22.95±0.28	68.11±0.30	19.89±1.61	12.00±1.91
2 (0.5%)	23.47±0.16	69.63±0.42	20.89±1.03	9.48±1.46
3 (1.0%)	23.15±0.62	67.87±0.25	20.14±1.75	11.99±1.49
4 (2.0%)	22.75±1.22	68.05±0.33	19.90±2.33	12.05±3.66

ns means not significantly different (P>0.05).
** Standard error of the means derived from the analysis of variance.

Voluntary feed intake, feed waste and palatability index:

Voluntary feed intake, feed waste rate and palatability index of fish fed different levels of CSM are found in Table (6). Fish fed 0.5% CSM-diet was significantly higher (P<0.5) in VFI and palatability index than other diets.

Similar feed amounts were consumed by fish fed diets containing 0, 1 and 2% CSM. On contrast, feed waste rate decreased with 0.5% CSM-diet but not done with the other diets. Similar findings were obtained with anise seeds in hybrid tilapia (Sakr, 2003). The positive response of VFI and palatability index as affected by adding CSM supplementation was parley with the enhancements of growth performance and feed utilization. It may give approve to the critical role of the CSM additive in improving performance of tilapia. However, feed waste rate by CSM was lower than which obtained with leaves of marjoram (El-Dakar *et al.*, 2004a); leaves of basil (El-Dakar *et al.*, 2004b) and leaves of peppermint (Sakr, 2003).

It could be due to different edible parts which are rich in effective components of natural herbs and spices. In addition, the herbal leaves were more effectively than seeds, this may attribute to their content of vitamin C and beta-carotene.

Table 6:Voluntary feed intake (VFI), palatability index and feed waste percent of hybrid tilapia fingerlings fed diets containing different levels of caraway seeds.

Diet No	VFI[1]	Palatability index[2]	Feed waste[3]
(CSM)	g/fish/day	%	%
1 (0.0%)	8.64±0.35[b]	69.92±3.5[b]	30.08±1.70[b]
2 (0.5%)	10.10±0.14[a]	73.25±1.4[a]	26.75±1.51[a]
3 (1.0%)	8.30v0.39[b]	70.14±3.9[b]	29.86±0.23[b]
4 (2.0%)	8.48±0.18[b]	70.59±1.8[b]	29.41±0.64[b]

* Values in the column having a common superscript letter are not significantly different (P>0.05).
** *Standard error of the means derived from the analysis of variance.*
1-Voluntary feed intake = Introduced feed for fish based on 3% body weight– uneaten feed, according to Kaushik (2000).
2- Palatability index = 100 x (VFI/introduced feed).
3- Feed waste % = 100 x (Uneaten feed / introduced feed for fish).
(Voluntary feed intake, palatability index and feed wastes were calculated during the last two weeks.

Cost-benefit analysis:

Data in Table (7) show the effect of different levels of CSM as a feed additive in Nile tilapia diets. Incidence cost (IC %) of fish decreased by 87% and 93% from the control group for fish fed 0.5% and 2% CSM-diets, respectively.

Table 7:Cost-benefit analysis of hybrid tilapia fingerlings fed diets containing different levels of caraway seeds.

Item	Diet No.			
	1	2	3	4
Cost[1] per kg diet	2.74	2.75	2.77	2.79
Incidence cost[2]	8.55	7.45	8.78	7.97
Relative IC (%)	100	87	103	93
Profit index[3]	0.82	0.94	0.80	0.88
Relative PI (%)	100	115	97	107

1. Costs were as common commercial feeds in local markets during 2003. Costs of 1 kg of fishmeal, meat meal, soybean meal, wheat flour, linseed oil, CSM, and vitamin and minerals premix were 4, 2, 2.5, 1.5, 3, 4 and 10 LE, respectively.
2. Incidence cost = feed cost consumed / kg fish produced
3.Profit index = value of fish crop /cost of feed consumed

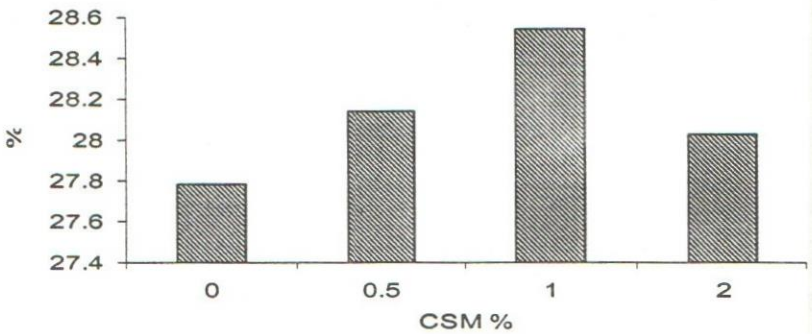

Fig (1). Digestible protein by fish fed diets containing different levels of caraway seeds meal

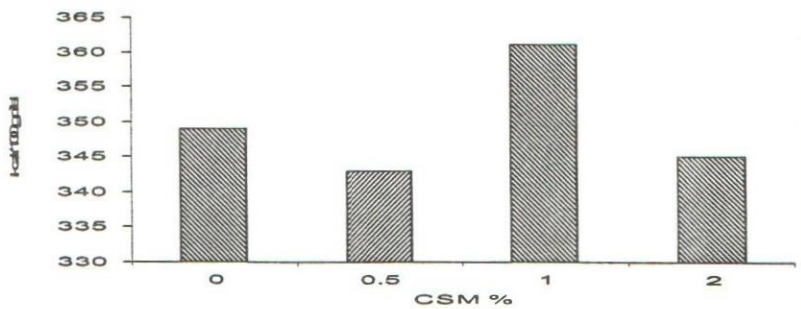

Fig (2): Digestible energy by fish fed diets containing different levels of caraway seeds meal 9

On contrast, profit index (PI %) increased by 115 and 107 % for fish fed 0.5 and 2% CSM-diets, respectively. However, fish fed 1% CSM-diet gave higher incidence cost and lower profit index than the other treatments.

Previous studies showed that the use of spices in small amounts gave lower incidence cost and higher profit index of fish species (Abd Elmonem *et al.*, 2002; Sakr, 2003; Shalaby *et al.*, 2003 and Shalaby, 2004). Improvement of economic efficiency of fish fed spices or medical and aromatic plants as feed additives may be due to their ability to reduce feed waste and organic matter in the culture environment which results in a good water quality (Mendoza *et al.*, 1997; Sakr, 2003 and El-Dakar *et al.*, 2004a).

Generally, the present study could recommend the safety and economically use of caraway seeds meal at 0.5 % level in tilapia diets.

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استجابة نمو اصبعيات البلطى الهجين للعلائق المحتوية على مستويات مختلفة من بذور الكراوية

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فى هذه الدراسة تم تحضير أربعة علائق تجريبية لتحتوى على صفر ، 0.5 ، 1.0 ، 2% مسحوق بذور الكراوية كإضافات غذائية وذلك لدراسة تأثيرها على معاملات الهضم الظاهري للعناصر الغذائية و النمو والاستفادة من الغذاء والعناصر الغذائية والنشاط الأنجذابى للأسماك والتركيب الكيماوى لجسم الأسماك وتحليل التكلفة / الربح لأسماك البلطى الهجين. وقد استخدمت ثمانية أحواض سعة كلا منها 96 لترا بواقع حوضين لكل معاملة. وتم تخزين عشرة أسماك (بوزن ابتدائي 13 جم/سمكة) فى كل حوض وكانت الأسماك تتغذى على العلائق التجريبية بمعدل 3 % من الوزن الحي يوميا على ثلاثة مرات لمدة ستة أيام فى الأسبوع. واستمرت التجربة لمدة 112 يوما وكانت الأسماك توزن كل أسبوعين ويتم تعديل كميات الغذاء على أساس الوزن الجديد. كما تم تجميع المخلفات وحفظها فى أخر أسبوعين من الدراسة لتقدير معامل الهضم الظاهري للعناصر الغذائية ودليل الاستساغة و النسبة المئوية لمخلفات الغذاء.

وتوضح النتائج أنه لم تسجل أى اختلافات معنوية بين المعاملات المختبرة فى معاملات الهضم الظاهري لكل من المادة الجافة والبروتين والمستخلص الاثيري والمستخلص الخالى من النيتروجين والطاقة وأن الأسماك التى تغذت على عليقه تحتوى على 0.5% من مسحوق بذور الكراوية كانت أفضل معنويا فى وزن الجسم والزيادة الوزنية ومعدل النمو النسبى عن تلك التى تغذت على العليقة الضابطة (الكنترول) على الرغم من أنه لم تسجل اختلافات معنوية فى كفاءة النمو للأسماك التى تغذت على علائق تحتوى على 1 ، 2% من مسحوق بذور الكراوية. وكانت الأسماك التى تغذت على 0.5% بذور الكراوية أفضل المجموعات المختبرة فى كل من معدل التحويل الغذائى والكفاءة النسبية للبروتين والقيمة الحيوية للبروتين وكفاءة احتجاز الطاقة ودليل الاستساغة ودليل الربحية. ولم يتأثر التركيب الكيماوى لجسم الاسماك بمستويات الاضافة فى العلائق.