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Original Article

Utilization of Some Med Oreochromis Niloticus ical Plants as Feed Additives for Nile Tilapia, *Oreochromis Niloticus,* Feeds

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Abstract

There is an interesting in using of medical and aromatic plants or spices as feed additives in fish diets instead of chemical products to avoid side effects and achieve organic aquaculture. Feeding experiment was conduced to evaluate the growth of Nile tilapia fingerlings fed nine diets containing different levels (0, 0.5 or 1%) of dried marjoram leaves (DML), caraway seed meal (CSM), chamomile flowers meal (CFM) and fennel seed meal (FSM) as feed additives. A total number of 270 Nile tilapia fingerlings with an average initial weight (2.5g/fish) were randomly distributed into 27 glass aquaria (70L), in triplicate. Results indicated significant ($P<0.05$) differences in the final body weight, weight gain, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV%) between fish fed diets containing (0.5 or 1%) of all tested feed additives and the control diet. Fish that fed diets contained 1% level of DML, CSM, CFM and FSM were superior in growth, feed conversion ratio and protein efficiency as compared to those fed 0.5% level. The proximate composition of whole fish body showed that no significant differences ($P>0.05$) among all fish groups fed experimental and control diets. It was concluded that, diet containing 1% CSM was economically superior to other tested diets. It saved about 21% of feeding cost per unit fish.

Key Words: Nile tilapia, Feed additives, Marjoram, Caraway, Chamomile, Fennel, Growth, *Feed conversion*.

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Introduction

There is a large number of feed additives available to improve fish growth performance. Some of these additives used in feed mill are chemical products especially hormones and antibiotics which may cause unfavorable side effects. World Health Organization encourages

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using of medicinal herbs and plants to substitute or minimize the use of chemicals through the global trend to go back to the nature. Attempts to use the natural materials such as medicinal plants could be widely accepted as feed additives to enhance efficiency of feed utilization and animal productive performance (Mohamed, et al. 2003). Platel, et al. (2002) found that medicinal herbs are desirable for stimulating digestion, and had the highest stimulatory influence particularly on bile secretion and pancreatic enzymes activity. In other way, olfactory feed ingredients enhance growth through their ability to act as feeding enhancers for fish to eat more feed than in normal (Adams, et al. 1988). In this concern, Harada, (1990) stated that caraway has strong attractant effect depending on its concentration used. The most recent studies showed successful using of spices and natural herbs in fish nutrition including marjoram, licorice roots, black seeds, peppermint, caraway seed, fennel seed and fenugreek seeds (Abdel-Monem, et al. 2002; Sakr, 2003; Shalaby, et al. 2003; El-Dakar, et al. 2004a&b; El-Dakar, 2004; Shalaby, 2004; El_Dakar, et al. 2007 and El_Dakar, et al. 2008). A comparison between these plants is needed to determine the nutritional potential of each and its possibility to be used in the commercial fish feed industry.

The present study was conducted to evaluate four medical plants; dried marjoram leaves (DML), *Majorana hortensis* L., caraway seed meal (CSM), *Carum carvi* L., chamomile flowers meal (CFM), *Matricaria chamomilla* L. and fennel seed meal (FSM), *Foeniculum vulgare*, at two supplemented Levels (0.5 or 1.0%) and study their effects on growth performance, feed conversion, feed utilization and body composition of Nile tilapia, *Oreochromis niloticus*.

Materials and Methods

This work was carried out at the Wet Fish Lab., Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh, Egypt.

Experimental fish

Tilapia fingerlings, *Oreochromis niloticus*, were collected from Moassasa farms, Tolompate 7, Kafr El-Sheikh, Egypt. Fish were placed in a fiberglass tank and randomly distributed into experimental aquaria to be adapted to the experimental conditions until starting the experiment. Fish were fed the control diet for two weeks, during this period healthy fish at the same weight replaced died ones.

Experimental facilities

270 fish with an average initial body weight of 2.5g/fish were randomly stocked into 27 aquaria (70 liter each) and supplied with air stones for aeration. Fresh tap water was stored in fiberglass tanks for 24h with aeration for dechlorination before use. One third of aquaria water was replaced daily. Water temperature ranged between 26.5-27.5ºC. Photoperiod was 14hr per day using florescent light. Fish feces and feed residue were removed daily by siphoning.

Experimental diets

Nine experimental diets were formulated to contain 0 (control), 0.5 and 1% of DML, CSM, CFM and FSM (Table 1). Each diet was fed to three randomly assigned aquaria. The dry ingredients were finely grounded and mixed by a dough mixer for 20 minutes for homogeneity. Oil was gradually added while mixing. After homogenous mixture was obtained, 40ml water per hundred g diet was slowly added to the mixture according to Shimeino, et al. (1993). The diets were cooked on the water evaporator for 20 minutes, then pelleted through fodder machine and the pellets were air dried. The diets collected, tagged and stored in refrigerator at 4°C.

Fish were fed the experimental diets at a rate of 3% of live body weight per day divided into two meals, six days a week for 12 weeks. Fish were weighed biweekly to adjust the amount of feed per day on the basis of the new weight of fish.

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

Ingredients	Diets No.								
	1 Control	2	3	4	5	6	7	8	9
Herring fish meal	15	15	15	15	15	15	15	15	15
Yellow corn	35	35	35	35	35	35	35	35	35
Soybean meal	30	30	30	30	30	30	30	30	30
Wheat bran	12	11.5	11	11.5	11	11.5	11	11.5	11
Sunflower oil	5	5	5	5	5	5	5	5	5
Vitamins and minerals premix*	3	3	3	3	3	3	3	3	3
Dried marjoram leaves**	---	0.5	1	---	---	---	---	---	---
Caraway seed meal	---	---	---	0.5	1	---	---	---	---
Chamomile flowers meal	---	---	---	---	---	0.5	1	---	---
Fennel seed meal	---	---	---	---	---	---	---	0.5	1
Total	100	100	100	100	100	100	100	100	100

* Vitamins and minerals premix (Product of HEPOMIX) each 2.5kg contain: 12.000.000 IU Vit.A; 2.000.000 IU Vit. D3 ; 10g Vit. E ; 2g Vit. K3 ; 1g Vit. B1 5g Vit. B2;1.5g Vit. B 6 ; 10g Vit.B12; 30g Nicotinic acid ; 10g Pantothenic acid ; 1g Folic acid; 50g Biotien; 250g Choline chlorid 50%; 30g Iron; 10g copper; 50g Zinc; 60g Manganese; 1g Iodine; 0.1g Selenium and Cobalt 0.1g (Local market)

** Dried marjoram leaves (DML), Caraway seed meal (CSM), Chamomile flowers meal (CFM)Fennel seed meal (FSM).

Chemical analysis

The chemical analyses of ingredients, diets and fish samples were analyzed according to AOAC, (1990) for dry matter, crude protein, ether extract, crude fiber and ash. Gross energy (GE) contents of the ingredients, experimental diets and fish samples were calculated by using factors of 5.65, 9.45 and 4.22 kcal/g of protein, lipid and carbohydrates, respectively (NRC, 1993) .

Measurements of water parameters

Water samples were analyzed for dissolved oxygen (Oxygen meter model 9070), pH (A digital pH-meter), nitrite, nitrate, phosphate, alkalinity and hardness (Commercial kits, Hach International Co., Cairo, Egypt). Values of water quality parameters were 26-28ºC, 7.12-8.0, 5.32-6.16mg/L, 0.22-0.27mg/L, 2-4mg/L, 2-5mg/L, 122-132mg/L and 290-310mg/L for temperature, pH, DO, NO_2, NO_3, PO_4, alkalinity and hardness, respectively.

Measurements of growth and feed utilization parameters

Body weight of fish in each aquarium was measured at the start and every two weeks during the experimental period (12 weeks). The measurements of growth performance such as average weight gain (AWG), specific growth rate (SGR) and survival rate (SR) were calculated. Meanwhile, the parameters of feed utilization included FCR, PER and PPV %, were estimated at the end of the experimental period, as follows:

AWG (g/fish)= [Average final weight (g) – Average initial weight (g).

SGR (%/day)= [Ln final body weight–Ln initial body weight] 100/days.

FCR= Feed Intake, dry weight (g)/Live weight gain (g).

PER= Live weight gain (g)/Protein intake (g).

PPV (%)=100[Final fish body protein (g) – Initial fish body protein (g)]/crude protein intake (g).

SR= % of live fish number.

Preliminary economical efficiency

Costs were as common commercial feeds in local markets during 2006. Costs of 1 kg of fish meal, soybean meal, wheat bran, yellow corn,

sunflower oil, vitamins and minerals premix, DML, CSM, CFM and FSM were 6, 1.5, 0.70, 1, 3.5, 10, 8, 5, 7 and 4LE, respectively

Statistical analysis

The obtained numerical data were statistically analyzed using SPSS, (1997) for one-way analysis of variance according to Snedecor and Cochran, (1967). When F-test was significant, least significant difference was calculated according to Duncan, (1955).

Results and Discussion

Chemical composition of ingredients and diets

Chemical composition of the feed ingredients and additives used in the experiment is presented in (Tables 2, 3). The highest crude protein content of tested feed additives was in FSM following by CSM. However, lowest values of CP were in CFM and DML. Most of spices and medicinal herbs may consider as nonnutritive feedstuff due to their small amounts that used in fish diets (El-Dakar, 2004). These results are in agreement with (Abdel-Maksoud, et al. 1999; Abdel-Maksoud, et al. 2002; Abdel-Monem, et al. 2002; Shalaby, et al. 2003 and El-Dakar, et al. 2004a&b). The experimental diets contained nearly similar levels of DM, CP, EE, CF, Ash, NFE, GE and P/E ratio (Table 3). The CP and GE contents were around 31.73% and 4.619 kcal/g diets, respectively. These values were within the range suggested by Jauncey and Ross, (1982) and NRC, (1993).

Table 2: The chemical analysis of items used in the experimental diets:

Ingredients	DM%	(On DM basis, %)						GE*** kcal/g
		OM	CP	EE	CF	Ash	NFE**	
Herring fish meal	94.25	94.42	71.95	14.84	0.91	10.98	1.32	5.523
Yellow corn	92.92	98.65	9.67	7.48	3.03	1.35	78.42	4.254
Soybean meal	89.89	92.12	45.87	1.49	8.70	7.88	36.06	4.564
Wheat bran	94.43	95.13	12.95	7.31	8.48	4.87	66.39	4.224
DML*	93.91	85.51	11.67	7.23	14.47	14.49	52.14	3.543
CSM	93.41	93.27	17.49	13.47	27.03	6.73	35.28	3.750
CFM	93.59	84.34	12.11	6.42	15.15	15.66	50.66	3.429
FSM	93.51	91.97	20.50	7.66	26.78	8.03	37.03	3.445

* DML (Dried marjoram leaves), CSM (Caraway seed meal), CFM (Chamomile flowers meal) and FSM (Fennel seed meal).
** OM, CP, EE, CF and NFE mean organic matter, crude protein, ether extract, crude fiber and nitrogen free extract, respectively.
*** Gross energy was calculated according to NRC (1993) by using factors of 5.65, 9.45 and 4.22 kcal per gram of CP, EE and NFE, respectively.

Table 3: Chemical proximate analyses of the experimental diets:

Items	Diets No.								
	1 Control	2	3	4	5	6	7	8	9
Dry matter	92.74	92.50	93.05	92.89	92.98	92.53	92.46	93.01	92.75
Crude protein	31.72	31.26	31.31	31.98	32.34	31.46	31.71	31.73	32.03
Ether extract	10.76	10.50	10.57	11.00	11.98	10.41	10.61	10.85	10.98
Crude fiber	4.14	4.22	4.28	4.31	4.42	4.12	4.28	4.36	4.59
Ash	9.90	10.39	10.61	9.91	9.99	10.50	10.93	9.92	10.30
Nitrogen free extract	43.48	43.63	43.23	42.80	41.27	43.51	42.47	43.14	42.10
Calculated energy values									
GE (kcal/g)*	4.64	4.60	4.53	4.65	4.70	4.60	4.59	4.64	4.62
ME (kcal/g)**	3.82	3.78	3.77	3.82	3.87	3.78	3.77	3.81	3.80
P/E ratio, mg/kcal***	68.32	67.96	68.18	68.73	68.79	68.44	69.15	68.40	69.27

* Gross energy was calculated according to NRC (1993) by using factors of 5.65, 9.45 and 4.22 kcal per gram of protein, lipid and carbohydrate, respectively.
** ME (Metabolizable energy) calculated using the value of 4.5, 8.1 and 3.49 kcal per gram of protein, ether extract and nitrogen free extract, respectively according to Pantha (1982).
*** P/E (Protein to energy ratio)= mg crude protein/kcal GE.

Growth performance and surviving

Figure (1) shows the comparison between growth rates of fish fed tested additives. It was clear that all tested feed additives gave a higher SGR than the control group. However, no significant differences ($P > 0.05$) were observed among fish fed different feed additives. Growth performance and survival rate of Nile tilapia fingerlings fed diets containing two levels of DML, CSM, CFM and FSM are shown in Table (4). Data showed that fish fed diets containing DML, CSM, CFM and FSM were significantly higher ($P < 0.05$) than those fed the control diet in final body weight, weight gain, and specific growth rate. The highest values were recorded at level 1% for all tested feed additives. However, differences in growth performance parameters of fish fed 0.5% levels of DML, CSM, CFM and FSM were insignificant ($P > 0.05$). These results are in agreement with those obtained by Abdel-Monem, et al. (2002); Sakr, (2003); Shalaby, et al. (2003); El-Dakar, et al. (2004a); El-Dakar, (2004) and Shalaby, (2004) who found that positive effect of spices including caraway, fennel seeds, marjoram and black seeds supplemented in tilapia diets on growth performance. El-Dakar, et al. (2004b) indicated that incorporating fennel seed meal in diets of Nile tilapia resulted in an increase of growth, feed conversion ratio and nutrients utilization efficiencies. Similar results were obtained with DML in Nile tilapia diets (Abdel-Maksoud, et al. 1999 and El-Dakar, et al. 2004a). In addition, Nile tilapia fed diets containing CFM recorded a significant ($P < 0.05$) increase in performance than those fed the control diet (Abdel-Wahhab, et al. 2001 and Abdel-Maksoud, et al. 2002). This enhancement in growth performance may be due to the presence of a mixture of essential fatty acids including linoleic, linolenic and arachidonic acids in supplemented medicinal feed additives which are essential for growth (Murray, et al. 1991 and Abdel-Latif, et al. 2004).

Using 1% level of tested additives was better than 0.5% supplemented level in improving growth parameters. The superiority of 1% may led us to believe that this level provide fish with proper concentration of effective compounds which have antibacterial, antifungal and antispasmodic effects. These results are in disagreement with those found by El-Dakar, et al. (2004b) who reported that 0.5% was the optimum inclusion level in Nile tilapia diets. The differences between two studies may be due to different experimental conditions.

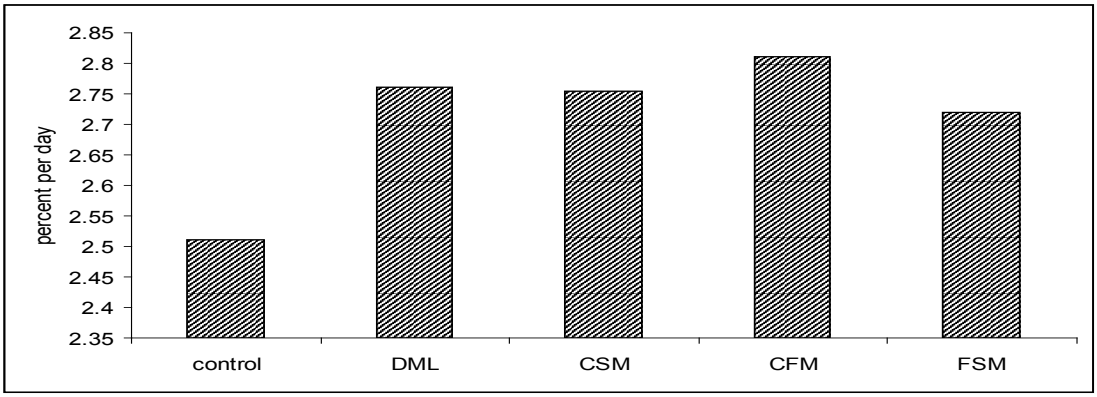

Fig. 1: Specific growth rate of fish fed tested feed additives where DML: dried marjoram leaves; CSM: Caraway seed meal; CFM: chamomile flowers meal and FSM: fennel seed meal.

Table 4: Growth performance parameters of Nile tilapia fed different experimental diets:

Diets No.	Feed additive*	%	Initial Wt. g/fish	Final Wt. g/fish	Gain (AWG) g/fish	SGR %/day	Survival %
1	Control	0	2.53	20.83^{e}	18.30^{e}	2.51^{c}	100
2	DML	0.5	2.50	24.34^{cd}	21.84^{cd}	2.71^{ab}	100
3		1.0	2.50	26.49^{abc}	23.99^{abc}	2.81^{ab}	100
4	CSM	0.5	2.52	23.95^{d}	21.43^{d}	2.68^{b}	90
5		1.0	2.55	27.34^{ab}	24.79^{ab}	2.83^{ab}	100
6	CFM	0.5	2.59	26.33^{abc}	23.74^{abc}	2.76^{ab}	100
7		1.0	2.54	27.97^{a}	25.43^{a}	2.86^{a}	100
8	FSM	0.5	2.52	23.77^{d}	21.25^{d}	2.67^{b}	90
9		1.0	2.51	25.70^{bcd}	23.19^{bcd}	2.77^{ab}	100

Superscript with different letters in the same column are significantly (P<0.05) different.
* DML (Dried marjoram leaves), CSM (Caraway seed meal), CFM (Chamomile flowers meal) and FSM (Fennel seed meal).

Survival rate of the experimental fish groups was within the normal range. It recorded 100% for all fish groups except those fed diet containing 0.5% CSM and 0.5% FSM levels which gave 90% survival rate for both (Table 4).

Feed intake and feed utilization

Data of feed utilization (Table 5) showed that fish fed DML, CSM, CFM and FSM were significantly differences (P <0.05) in feed intake, feed conversion ratio and protein utilization. Each of 1% level of all tested feed additives showed higher feed intake followed by 0.5% level of all tested feed groups. Such results were parallel to that of periodical body weight changes. Values of FCR, PER and PPV% were nearly similar within fish groups fed different additives and increase significantly (P <0.05) comparing with fish fed control diet. These results indicate that adding 1% CSM, CFM and DML improved the feed conversion ratios. This improvement may be due to the effect of their chemical constituents such as antioxidant, antibacterial and antifungal activities on performance stimulation and metabolism (Abdel-Maksoud, et al. 1999). In addition, these effective components have a strong stimulating action on bile secretion as well as antispasmodic and anti-inflammatory effects (Murray, et al. 1991).

Table 5: Average of feed intake, feed conversion, protein intake, protein efficiency ratio and protein productive value (%) of Nile tilapia fed different experimental diets:

Diets No.	Feed additive*	%	Feed intake g/fish	FCR	Protein intake g/fish	PER	PPV %
1	Control	0	25.97^{c}	1.42^{a}	8.24^{d}	2.22^{d}	25.61^{b}
2	DML	0.5	27.26^{a}	1.25^{b}	8.52^{c}	2.56^{bc}	41.43^{a}
3		1.0	27.41^{a}	1.14^{bc}	8.58^{bc}	2.80^{ab}	41.26^{a}
4	CSM	0.5	26.78^{b}	1.25^{b}	8.56^{bc}	2.50^{c}	35.28^{a}
5		1.0	27.23^{a}	1.10^{c}	8.81^{a}	2.81^{ab}	33.83^{a}
6	CFM	0.5	27.50^{a}	1.16^{bc}	8.65^{b}	2.74^{abc}	36.30^{a}
7		1.0	28.47^{a}	1.12^{c}	9.03^{a}	2.82^{a}	41.53^{a}
8	FSM	0.5	26.73^{b}	1.26^{b}	8.48^{c}	2.51^{c}	40.57^{a}
9		1.0	27.11^{ab}	1.17^{bc}	8.68^{bc}	2.67^{ab}	41.13^{a}

Superscript with different letters in the same column are significantly (P<0.05) different.

Protein intake, protein efficiency ratio and protein productive value for fish fed diets containing DML, CSM, CFM and FSM were significantly higher (P <0.05) than those fed control diet. The increase in feed intake, protein efficiency and protein productive value due to adding two levels of DML, CSM, CFM and FSM are also recorded by Abdel-Maksoud, et al. (1999); Abdel-Wahhab, et al. (2001); Abdel-Monem, et al. (2002); Sakr, (2003); Shalaby, et al. (2003); El-Dakar, et al. (2004a); El-Dakar, (2004) and Shalaby, (2004). The comparison between fish fed the four tested feed additives in FCR and PER is shown in (Figure 2). No differances in FCR and PER among all tested spices.

Body composition

No significant differences (P >0.05) in DM, CP, EE, ash and energy contents of tilapia fed diets containing both levels of DML, CSM, CFM and FSM (Table 6). These data agreed with those published by Abdel-Wahhab, et al. (2001); Abdel-Maksoud, et al. (2002); Abdel-Monem, et al. (2002); Shalaby, et al. (2003) and El-Dakar, (2004) for other spices. Sakr, (2003) found that body composition characteristics of hybrid tilapia fed various levels of anise seeds were close to control group fish and showing no adverse effect of the experimental diets on the DM, CP, ash and energy contents. Similar findings were found by Shalaby, (2004) when used fenugreek seeds at different levels in Nile tilapia diets.

Preliminary economical efficiency

Data of preliminary economical efficiency, is shown in (Table 7), cleared that diets containing medicinal plants (DML, CSM, CFM and FSM) had lower incidence costs than the control diet. Diet containing 1% CSM had lowest feed costs for producing 1kg fish, it recorded 78.82% comparing with those fed the control diet, followed by 1% (CFM, DML and FSM), respectively. Previous studies showed that the use of spices in small amounts gave lower incidence cost and higher profit index of fish species (Abdel-Maksoud, et al. 1999; Abdel-Monem, et al. 2002; Sakr, 2003; Shalaby, et al. 2003; Shalaby, 2004; El-Dakar, 2004; El-Dakar, et al. 2004a&b and El-Dakar, et al. 2005). Improvement of preliminary 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 (Sakr, 2003; El-Dakar, et al. 2004a and El-Dakar, 2004).

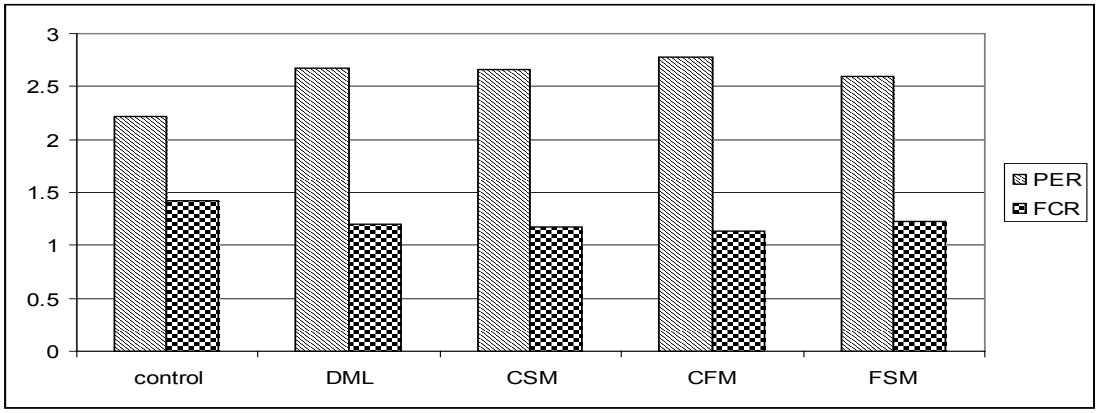

Fig. 2: Feed conversion and protein efficiency ratios of fish fed the tested feed additives where DML: dried marjoram leaves; CSM: Caraway seed meal; CFM: chamomile flowers meal and FSM: fennel seed meal.

Table 6: Body composition of fish fed different feed additives:

Diets No.	Feed additive*	%	Dry matter	Crude protein	Crude lipid	Ash	Gross energy**
	Initial fish		21.13	60.63	16.52	19.66	498.67
1	Control	0	26.01	62.74	21.07	16.17	553.59
2	DML	0.5	24.89	64.16	20.96	15.32	560.58
3		1.0	25.07	64.17	20.91	14.30	560.16
4	CSM	0.5	24.77	63.65	21.64	14.72	564.10
5		1.0	25.15	63.61	21.35	15.48	561.15
6	CFM	0.5	24.71	63.77	22.38	15.79	571.77
7		1.0	24.57	64.38	21.10	15.06	563.07
8	FSM	0.5	24.20	64.07	20.68	14.88	557.40
9		1.0	24.70	64.20	20.03	16.27	552.02

* DML (Dried marjoram leaves), CSM (Caraway seed meal), CFM (Chamomile flowers meal) and FSM (Fennel seed meal).
** Gross energy contents (kcal/100g) were calculated according NRC (1993).

Table 7: Cost of feed required to produce one kg gain of Nile tilapia fed the experimental diets:

Item	Diets No.								
	1	2	3	4	5	6	7	8	9
Cost of one ton of feed (LE)	2259	2296	2332	2281	2302	2291	2322	2276	2292
Feed cost relative to control	100	102	103	101	102	101	103	101	101
Feed intake g/fish	25.97	27.26	27.41	26.78	27.23	27.50	28.47	26.73	27.11
Total gain g/fish	18.30	21.84	23.99	21.43	24.79	23.74	25.43	21.25	23.19
Cost of one kg fish gain (LE)	3.21	2.87	2.66	2.85	2.53	2.65	2.60	2.86	2.68
Cost of one kg fish gain relative to control	100	89.41	82.55	88.79	78.82	82.55	81.00	89.10	83.49

LE means Egyptian pond, 1 USD equals 5.5 LE according to 2008 prices.

Conclusion

Using dried marjoram leaves, caraway seeds meal, chamomile flowers and fennel seeds meal at levels of 0.05 and 1% in tilapia diets have a positive response to growth performance, feed conversion, nutrient utilization, protein efficiency and economical efficiency. Under the experimental conditions, 1% of (DML, CSM, CFM and FSM) level was preferable as a feed additive to diets of Nile tilapia.

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