THE USE OF SEAWEED MEAL IN FEEDING COMMON CARP (*Cyprinus carpio* L.)

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Summary

Two experiments were made. In experiment 1, four diets containing 0, 5, 15 and 25% washed seaweed meal were prepared to study the effects of incorporating seaweed meal instead of equivalent amounts of berseem leaf meal in fish feeds on growth performance and feed utilization of common carp. The results showed that average daily gain (ADG), specific growth rate (SGR%), dry matter (DM) and ether extract (EE) of the carcasses were decreased ($p<0.05$) with the increasing level of seaweed meal in the feeds. Inclusion of 5% seaweed meal in the diet gave the best feed conversion ratio (FCR) among all diets, however, protein productive value (PPV) and energy utilization (EU) were decreased ($p < 0.05$) with increasing level of seaweed meal in the diet.

In experiment 2, washed seaweed meal was either steam cooked or sprayed with NaOH (0.5% or 1% NaOH) and incorporated in the diets at the level of 25% instead of equivalent amount of berseem leaf meal. The results showed that steam cooked seaweed gave the best ($p < 0.05$) growth performance, FCR and protein efficiency ratios, PER and PPV, for other treatments in descending order were NaOH treated seaweed, washed seaweed and unwashed seaweed
(**Key Words**: Seaweeds, Common Carp, Berseem Leaf Meal, Fish Feeds)

Introduction

Seaweeds have been used for many years in human nutrition and largely as a vitamin additive and feeding stuff for ruminants (Hegazy, 1974), poultry (Assar et al., 1972) and fish (Venkatesh and Shetty, 1978). In Egypt seaweeds are spread over a wide area of the coast and represent a handicap in maintaining a good standard of cleanness in a number of resorts. Therefore the efficient use of the seaweeds in animal nutrition may be considered one way of paying a part of the expenses of cleaning the coastal areas. El-Shazly (1955) studied the chemical composition of some species of seaweeds spread over the shores of Alexandria, and reported that its chemical analysis seems to be comparable to berseem hay.

The present work is an attempt to study the effect of using different levels of seaweeds in the diets on growth performance and feed utilization of common carp (*Cyprinus carpio L.*). Furthermore, different treatments for improving the quality of seaweeds were also tested.

Materials and Methods

Experimental fish

Common carp (*Cyprinus carpio L.*). fingerlings weighing an average 0.92 g/fish were obtained from the experimental Fish Farm, Faculty of Agriculture, University of Alexanria. Fish were fed for 7 days on a basal diet as adaptation period and the unhealthy fish were removed from the experimental aquaria and replaced with other healthy fish. Twenty five fingerlings of fish were killed at the beginning of the experiment and kept frozen at −20℃ for analysis.

Preparation of seaweeds and berseem meals

Fresh marine seaweeds was collected on March, 1989 from Anfoushi "Alexandria sea cost". The seaweeds was washed with tap water several times in order to get rid of associated

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salts and sand, and air dried for 48 hours. Seaweed was divided into four portions: one portion was left without treatment and the rest were subjected to three treatments. The 2nd and 3rd portions were treated with 0.5% or 1.0% sodium hydoroxide (NaOH) by adding one litre of the solution to 1 kg of seaweed. The 4th portion was cooked in an autoclave for 20 min, under normal pressure. Berseem leaves were collected fresh and dried at 60℃ for 48 hrs. The seaweed was oven dried at 60℃ for 48 hrs. The dried materials were ground and passed through 1.0 mm seive in a laboratory mill and kept in plastic bags.

Chemical composition of berseem leaves, unwashed seaweeds and treated or untreated washed seaweeds are shown in table 1.

TABLE 1. CHEMICAL ANALYSIS OF BERSEEM LEAF MEAL AND SEAWEED MEAL

(%)	Berseem leaf meal	Seaweeds meal				
		Unwashed	Washed			
			Without treatment	0.5% NaOH	1% NaOH	Cooked
DM	91.9	91.9	84.75	86.87	86.95	88.81
CP	25.42	19.87	18.57	18.57	18.17	16.42
CF	15.76	14.07	16.15	15.11	14.92	14.40
EE	4.22	6.14	5.43	5.62	5.46	5.13
Ash	10.02	15.05	9.61	10.17	10.73	11.04
N.F.E.	44.58	45.11	48.94	50.53	50.72	53.01

Experimental facilities

Two types of aquaria (Glass Jars and Plastic Tanks) were used in the present study:

a- glass jars:

8 glass jars were used for rearing the fish in the 1st experiment. Each measured 100 × 30 × 40 cm with a capacity of 120 L and each was allowed to contain 105 L of fresh water only.

b- plastic tanks:

Twelve circular palstic tanks of 38.5 cm diameter and 37 cm height were used in the 2nd experiment. Each tank contained 35 L.

Both glass jars and plastic tanks were filled with tap water which was stored two days before using. Supplemental aeration was provided continuously through air stones by using an air pump.

Experimental diets

Experiment (1):

Four experimental diets were formulated to contain 0, 5, 15 and 25% dried seaweed meal which replaced an equivalent amount of berseem leaf meal. The experimental diets were isonitrogenous and isocaloric. Ingredients composition and chemical analyis (%) of the experimental diets are shown in table 2. The wet mixture of each diet was passed through a commercial meat mincer to produce spaghetti like strands called pellets which were air dried and broken into particles of 0.3 mm diameter and 2 mm length.

Experiment (2):

Six test fish diets were formulated to contain the following:

1) berseem leaf meal containing diet, 2) unwashed seaweeds meal containing diet, 3) washed seaweeds meal containing diet. 4) cooked washed seaweeds meal containing diet. 5) 0.5% NaOH-treated washed seaweeds meal containing diet and 6) 1% NaOH-treated washed seaweeds meal containing diet. All diets were isonitrogenous and isocaloric. Ingredients composition and the chemical analysis (%) of the tested diets are presented in table 3.

Feeding regime:

Each diet was fed to fish in two glass jars (Exp. 1) or two plastic tanks (Exp. 2) at random. The glass jars and the plastic tanks were cleaned

TABLE 2. COMPOSITION (%) AND CHEMICAL ANALYSIS (%) OF THE DIETS USED IN THE EXPERIMENT 1

Feed ingredients (%)	Diet No.			
	1	2	3	4
Fish meal	10.0	10.0	10.0	10.0
Soybean	17.0	17.0	17.0	17.0
Berseem leaf meal	30.0	27.0	21.0	15.0
Washed seaweed meal	00.0	5.0	15.0	25.0
Wheat miling by products	35.7	33.7	29.5	25.7
Corn oil	4.0	4.0	4.0	4.0
Bone meal	2.0	2.0	2.0	2.0
Vitamin premix (PFizer)	0.3	0.3	0.3	0.3
Mineral mixture	1.0	1.0	1.0	1.0
Chemical analysis (%):				
DM%	88.6	88.8	89.6	89.2
% on DM basis				
CP	28.8	28.3	28.5	28.9
EE	4.5	5.0	5.4	5.8
CF	5.1	5.3	6.3	7.0
Ash	12.6	14.2	15.6	16.7
NFE	49.0	47.1	44.2	41.6
Energy (Mcal/kg)	4.1	4.1	4.0	3.9

TABLE 3. COMPOSITION (%) AND CHEMICAL ANALYSIS (%) OF THE DIETS USED IN THE EXPERIMENT 2

Feed ingredients (%)	Diet* No.					
	1	2	3	4	5	6
Fish meal	10.0	10.0	10.0	10.0	10.0	10.0
Soybean meal	17.0	17.0	17.0	17.0	17.0	17.0
Berseem leaf meal	30.0	15.0	15.0	15.0	15.0	15.0
Seaweeds	00.0	25.0	25.0	25.0	25.0	25.0
Wheat miling by-products	35.7	25.7	25.7	25.7	25.7	25.7
Corn oil	4.0	4.0	4.0	4.0	4.0	4.0
Bone meal	2.0	2.0	2.0	2.0	2.0	2.0
Vitamin premix (PFizer)	0.3	0.3	0.3	0.3	0.3	0.3
Mineral mixture	1.0	1.0	1.0	1.0	1.0	1.0
Chemical analysis (%):						
DM%	88.8	88.5	88.2	88.8	88.2	88.0
% on DM basis						
CP	28.9	28.7	28.2	28.2	28.0	27.4
EE	2.5	5.0	4.9	5.3	4.5	5.0
CF	5.2	7.2	6.9	6.4	5.7	5.6
Ash	12.6	17.1	13.6	17.2	17.6	14.4
NFE	50.8	42.0	46.4	42.9	44.2	47.6
Energy (Mcal/kg)	4.0	3.9	4.0	3.9	3.9	4.0

* Diet 1 berseem leaf meal containing diet.
2 unwashed seaweeds meal containing diet
3 washed seaweeds meal containing diet.
4 0.5% NaOH treated washed seaweeds meal containing diet.
5 1% NaOH treated washed seaweeds meal containing diet.
6 cooked washed seaweeds meal containing diet.

daily to prevent accumulation of feces and unused feed to reduce algal growth and were refilled with the same source of water to the same volume. Water in each aquarium was partially changed once every three days. Each jar or tank was stocked with ten carp fingerlings. Fish were fed the experimental diets twice daily at 9 a.m and 1 p.m for 14 weeks (98 days). Feed intake as a percent of live bodyweight was 10% for the first 28% days, 8% for 14 days, 6% for 14 days and 4% for the final 42 days.

Fish were weighed at 14 days interval and the amount of feed was readjusted according to fish weight. At the end of the experiment, fish were killed and stord at −20℃ for analysis of whole carcass.

Analytical methods:

Chemical analysis of feeds and fish carcasses were determined according to the official methods of AOAC (1975).

Statistical analysis:

Statistical analysis of the experimental results were conducted according to Snedecor and Cochran (1967) and Duncan (1955).

Results and Discussion

Experiment (1):

Effect of level of washed seaweed on growth performance, carcass composition and feed utilization of common carp are shown in table 4. The final weight and average daily gain of carp fingerlings were significantly ($p < 0.05$) decreased by increasing the level of washed seaweed in the diet. A similar trend was obtained with the specific growth rate (SGR %/fish/day), however, the differences were not significant. The present results are in agreement with Erdem (1983) who found no significant differences in live body weight gain between the groups of mirror carp fed 3, 6 or 9% seaweeds. Mona Taher (1986) reported that increasing the level of seaweed in the diets decreased body weight gains of broiler chicks. Assar (1972) and Tomova et al. (1981) found that the body weight of broiler chicks was

TABLE 4. EFFECT OF DIFFERENT LEVELS OF WASHED SEAWEED MEAL ON GROWTH PERFORMANCE, CARCASS COMPOSITION AND FEED UTILIZATION OF COMMON CARP (EXPERIMENT 1)

Item	% of seaweed meal			
	0	5	15	25
Growth performance:				
Initial weight (g)	0.92	0.91	0.92	0.92
Final weight (g)	3.04	2.88^{b}	2.53^{c}	2.22^{d}
Average daily gain, ADG*	21.63^{a}	20.10^{a}	16.43^{b}	13.27^{c}
Specific growth rate (%)	1.22	1.18	1.03	0.90
Carcass composition:**				
Dry matter (DM) (%)	23.22^{a}	21.47^{b}	21.45^{b}	20.05^{be}
Crude protein (CP) (%)	58.68	59.26	59.18	58.62
Ether extract (EE) (%)	30.13^{a}	29.49^{a}	28.05^{bc}	27.26^{c}
Ash. (%)	11.19^{d}	11.25^{c}	12.77^{b}	14.12^{a}
Feed Utilization:				
DM intake (g)***	7.23	6.03	6.81	6.24
Feed conversion ratio	3.41	3.06	4.23	4.80
Protein efficiency ratio	1.02	1.02	0.83	0.73
Protein productive value	15.80^{a}	14.04^{b}	12.10^{c}	9.90^{d}
Energy utilization	11.64^{a}	11.29^{b}	8.80^{c}	6.90^{d}

* ADG = mg/day/fish.

** Carcass composition of fish at the start was: 16.50% DM, 56.70% CP, 28.27% EE and 15.03% ash.

*** Total dry matter intake per fish during the 98-days feeding period.

a,b,c,d Values in the same row bearing different superscripts are differ ($p < 0.05$).

adversely affected by feeding of seaweed at levels of 3 to 4% at the expense of the basal diet. The present results showed that the inclusion of 5% seaweed obtained similar results to control diets while increasing the level of seaweeds over 5 to 25% significantly decreased daily gain ($p < 0.05$). Similar results were obtained with Combs(1952) and Vankataraman et al. (1980) when seaweeds level reached 10% of the chicks diets.

Carcass DM, CP and EE were decreased by increasing the level of seaweed in the diet. The differences in DM% and CP% were not significant, however, the differences in EE% were significant ($p < 0.05$). Ash (%) was increased by increasing the level of seaweed. The present result generally are in agreement with the findings of several investigators (El-Deek et al., 1985 & Mona Taher, 1986) when studied the effect of seaweeds on the carcass composition in layer hens and broiler chicks respectively.

Average feed conversion ratio (FCR) was improved with the inclusion of 5% washed seaweeds in the diet and decreased with inclusion of the higher levels (15 and 25%). The differences in the feed utilization were significant ($p < 0.05$). Erdem (1983) reproted that the use of up to 9% seaweed in the diet had no effect on feed effeciency. Reduced efficiency of feed utilization associated with diets containing higher levels of seaweed was expected due to the presence of antinutritional factors known to influence the digestion and utilization of many nutrients. Assar (1972), Tomova et al. (1981) and Mona Taher (1985) recommended a maximum inclusion level of 5% seaweed in the diets of chicks.

Protein utilization in terms of protein efficiency ratio (PER%) and protein productive value (PPV%) were decreased by increasing the level of washed seaweed in carp diets. Differences in PER were not significant however, in PPV% were significant ($p < 0.05$) with increasing the level of washed seaweeds in the diet of carp fingerlings.

The lower protein and energy utilization obtained by increasing the level of washed seaweed in the diets of carp fingerlings could be explained that washed seaweed diluted the nutrient quality of the diet and increased of the toxic materials which aggravate at high levels of inclusion of seaweeds.

Experiment (2):

Effect of different treatments of seaweeds on growth performance, Carcass composition and feed utilization of common carp are shown in table 5. The results showed that higher growth performance was obtained when fish were fed diets with cooked washed seaweeds (diet 4). It was significantly higher ($p < 0.05$) than the other tested diets. NaOH-treated seaweed (diets 5 and 6) significantly ($p < 0.05$) increased the growth performance compared to those fed washed seaweeds (Diet 3). From the results obained, it could be concluded that washing and cooking were the optimum method for improving the quality of seaweeds used in carp diets followed by washing and treating with sodium hydroxide respectively. Mona Taher (1986) indicated that inclusion of 5% autoclaved seaweeds in the diets of chicks improved their growth rate. Also the results of Eman Labib. (1990) showed that treated Egyptian Mallow leaves with 1% NaOH improved their quality when fed to common carp.

The results of carcass composition of common carp fed on seaweeds treated with different treatments showed that inclusion of the seaweeds in the diet decreased DM% and EE% while CP% was increased. Ash content was increased in carp carcass when the diet contained unwashed seaweeds.

Feed conversion ratios (FCR) greatly improved with cooking of washed seaweeds followed by NaOH treated washed seaweeds, unwashed seaweeds and washed seaweeds, respectively. The differences were significant ($p < 0.05$). Protein effeciency ratio (PER) was improved with washed and cooked seaweeds followed by washed and treated with NaOH seaweeds, unwashed seaweeds, and washed seaweeds, respectively, however, the differences were not significant. Protein productive value (PPV%) was significantly ($p < 0.05$) higher when carp fed washed and cooked or washed and treated with 1% NaOH seaweeds than the unwashed or washed seaweeds respectively. Energy utilization (%) was significantly decreased ($p < 0.05$) by inclusion of seaweeds in the diet as compared with the control diet. However, treatment of washed seaweeds with 1% NaOH followed by cooked washed seaweeds and treated with 0.5% NaOH, respectively, improved significantly ($p < 0.05$) the energy utilization.

From the present results it could be concluded that cooking of washed seaweeds with autoclaving

TABLE 5. EFFECT OF DIFFERENT TREATMENTS OF SEAWEEDS MEAL ON GROWTH PERFORMANCE, CARCASS COMPOSITION AND FEED UTILIZATION OF COMMON CARP (EXPERIMENT 2)

Item	Treatments*					
	1	2	3	4	5	6
Growth performance:						
Initial weight (g)	1.55	1.56	1.55	1.55	1.55	1.56
Final weight (g)	3.79^{a}	3.44^{c}	3.06^{d}	3.54^{b}	3.53^{c}	3.75^{a}
Average daily gain (mg)	22.86^{a}	11.18^{d}	16.00^{c}	20.31^{b}	20.20^{b}	22.35^{a}
Specific growth rate (%)	0.91	0.81	0.69	0.84	0.84	0.89
Carcass composition:**						
Dry matter (DM) (%)	21.82^{a}	19.80^{c}	19.55^{c}	20.15^{bc}	20.62^{b}	20.00^{b}
Crude protein (CP) (%)	57.19^{b}	57.32^{b}	58.17^{a}	58.01^{a}	58.10^{a}	58.28^{a}
Ether extract (EE) (%)	30.50^{a}	27.75^{c}	29.45^{a}	28.87^{b}	29.00^{b}	28.73^{b}
Ash. (%)	12.31^{c}	14.93^{a}	12.38^{c}	13.12^{b}	12.90^{b}	12.99^{b}
Feed Utilization:						
DM intake (g)***	11.47	11.27	10.07	11.32	10.57	11.32
Feed conversion ratio	5.12^{d}	6.00^{b}	6.42^{a}	5.69^{b}	5.34^{c}	5.18^{d}
Protein efficiency ratio	0.68	0.58	0.54	0.61	0.65	0.70
Protein productive value	9.88^{a}	6.64^{d}	7.20^{cd}	8.40^{b}	9.10^{ab}	9.40^{a}
Energy utilization	7.73^{a}	5.30^{d}	5.29^{d}	6.30^{b}	6.80^{b}	6.60^{b}

* See = table 3.

** Carcass composition of fish at the start was: 16.50% DM, 56.70% CP, 28.27% EE and 15.02% Ash.

*** Total dry matter intake per fish during the 98-days feeding period.

^{a,b,c,d} Values in the same row bearing different superscripts are differ ($p < 0.05$).

or washing and treatment with 1.0% NaOH significantly improved protein and energy utilization of common carp.

Omar et al. (1989) found that dietary treatment with 1.5% NaOH increased the growth performance, feed and nutrient utilization (protein and energy) of common carp and Nile tilapia. They found that increasing the level of NaOH treatment of water hyacinth leaves resulted in a significant ($p < 0.05$) increase in the growth performance of carp and tilapias. Feed utilization were improved significantly ($p < 0.05$) with increasing the level of NaOH. They concluded that 4.0% NaOH was the optimum level of treatment. Studies on rainbow trout (Hilton and Atken- son, 1982) and *O. niloticus* (Anderson et al., 1984) have demonstrated that increasing fiber level in the diets has resulted in a significant reduction in feed digestibility and assimilation. The role of NaOH treatment in the present work was to decrease the fiber content of the washed seaweeds and increase the solubility of insoluble materials and this could help in increasing the digestibility and utilization of polysacchrides could be improved by cooking. Studies on rainbow trout (Smith, 1976) have demonstrated that cooked starch was better digested and assimilated than raw starch. Cooking the sugar cane bagasse (El-sayed, 1987) seemed, however, to have a negligible effect and resulted in poor performance with *O. niloticus*.

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