Effect of Replacing Fishmeal with *Spirulina* sp. on some Biological Parameters of Common Carp *Cyprinus carpio* L.

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Abstract. This study was designed to investigate the effect of different replacement levels of fishmeal with *Spirulina* sp. on growth performance and some blood parameters of common carp *Cyprinus carpio* L., the trail was conducted for 105 days and for this purpose 200 fingerlings common carp. Mean initial weight was 32.7g. The fish were acclimated to laboratory conditions and fed with control pellets (32% crude protein) prior to the feeding trials for 21 days. Five experimental diets were used and *Spirulina* replaced fishmeal protein from the standard diet at 0% (T1), 5% (T2), 10% (T3), 15% (T4) and 20% (T5) levels. No differences observed among the treatments in the Liver index, Gonadosomato index were 6.489, 5.680, 5.339, 4.009 and 3.770 for the (T3), (T4), (T5), (T2) and (T1) respectively, results of statistical analysis showed no significant ($P<0.05$) different among all treatments but the higher value of GSI and Liver index found in T3.

Key words: *Spirulina,* fishmeal, replacement, liver index, gonadosomato index

Introduction

One of the biggest problems facing the utilization of fish nutrition, in many aquaculture operations today, feed accounts more than half of the variable operating cost (1). Therefore, the potential use of unconventional foodstuffs such as algae, for substitution the high cost food stuffs such as fishmeal is very important. Algae have attention as a possible alternative protein source for cultured fish, particular in tropical and subtropical developing countries where algae production rates are high and their higher protein, vitamins and essential fatty acids contents (2). Microalgae are comprised of all the microscopic organisms, which are suspended in water and include small plants (phytoplankton). *Spirulina* is a cyanobacterium that has been commercially cultivated for more than 10 years due to its high nutritional content; e.g. protein, amino acid, vitamin, minerals, essential fatty acid and b- carotene (3). *Spirulina* can be considered a nutritional supplement that has various health benefits for humans, and a feed supplement for animals having economic benefits. Mu *et al*. (4) and Nandeesha *et al*. (5) indicated that *Spirulina* could be used as an effective partially or completely replacement for fishmeal in formulated aqua feeds.

However, there has been no clear data to indicate whether the effects of *Spirulina* additives for nutrient utilization can be beneficial for growth and whether there is an effect on total counts of bacteria in rearing water and fish intestine and some biological parameters. As a result, the present study should provide information for the preparation of the pellet feed to maximize the health of fish in term of liver and gonadotropin index, and the microbial load of rearing water and fish intestine of the common carp.

Materials and Methods

This experiment work of this study was conducted in the Fish Laboratory for the department of Animal Production, Faculty of Agricultural Sciences, University of Sulaimaniya, Iraq.

Experimental Diet

Five practical diets were formulated based on the proximate composition of the feed ingredients. Diet 1 (Control diet free of *Spirulina*), diets 2, 3, 4 and 5 contained 5, 10, 15 and 20% dried *Spirulina* respectively by the replacement of fish meal on an equivalent protein basis. Composition and proximate analysis of algae and different experimental diet diets were shown in table 1. The 500g of premium sinking *Spirulina* wafers, these top quality-sinking wafers are rich in *Spirulina* suitable for all herbivorous fish such as pleco's and catfish as well as shrimps and snails. Their chemical composition as labeled in the below table (2).

Table 1: The structure of experimental diet.

	Basis on 100 kg				
Spirulina	0%	5%	10%	15%	20%
Fishmeal	24.2	21.7	19.2	16.8	14.2
Wheatbran	35	35	35	35	35
Soybean	20	20	20	20	20
Broken Rice	20.3	17.8	15.3	12.7	10.3
Vitamin	0.5	0.5	0.5	0.5	0.5
Calculated chemical composition					
Crude Protein %	32	32	32	32	32
Crude Fat %	6.7	6.4	6.0	5.7	5.4
Fiber %	7.6	7.6	7.5	7.5	7.5

Table 2: The structure of *Spirulina* used as labeled: Suitable for all herbivorous fish such as pleco's & catfish as well as shrimps & snails

Composition	Percent
Crude Protein	34
Crude Fat & Oils	6
Fiber	5
Ash	10
Vitamin A	24000lU(Per KG)
Vitamin D	2600lU
Vitamin E	280lU
Vitamin C	550mg/kg

Fish and feeding regime

Common carp *Cyprinus carpio* fingerlings with an average weight 32.7g were brought from a local aquarium fish supplier located in kut, in mid of Iraq and acclimatized in plastic aquaria for three weeks before to be used in the experiment. Fish were randomly allocated on the aquaria (7/aquarium). Each treatment was represented in four aquariums (4 replicates). A feeding regime of 3% body weight per day was employed throughout the experiment. The amount of food was calculated and readjusted weekly according to change in the body weight and distributed in three equal portions for 84 days.

Experimental diets: The different feeding combinations (5 formulas of isoenergy diets, (Table 1) were prepared as follows:

T1: replacing fishmeal with 0% *Spirulina*, T2: replacing fishmeal with 5% *Spirulina*, T3: replacing fishmeal with 10% *Spirulina*, T4: replacing fishmeal with 15% *Spirulina*, T5: replacing fishmeal with 20% *Spirulina*.

Experimental system

The experimental facility consisted of 20plastic Aquaria (100 litters each). Each aquarium was supplied with aerated and dechlorinated tap water, which was stored in tanks for 24 hours and aerated by air pump (Model-Rina 301) during the experimental period. The water level was maintained to a fixed level by the addition of new well-aerated fresh water.

Biological parameters

Fish samples were scarified and soon the abdominal cavity was opened to remove, gonads and liver to be weighed at once. The gonad and liver indices were calculated as follow:

Gonadosomato index (GSI) % = Gonads weight (g)/ Body weight (g) x 100 (Lagler, 1956).

Liver index % = liver weight (g)/body weight (g) x 100 (Lagler, 1956).

Statistical analysis of data:

Analysis of variance was conducted using the general linear models (GLM) procedure of XLSTAT. Pro. 7.5 one way (ANOVA). Fisher's L.S.D test's was used to compare between means of the control and experiment treatments. The model of analysis was as follows:

$Yij = \mu + Ti + Eij$

μ = The overall mean.

Ti = The effect of treatment.

Eij= The random error.

Results and Discussion

In this experiment, the feed consisted of isonitrogenous and isocaloric feed in all treatments. Results at the end of experiment in the table (4) shows liver index 2.629, 2.585, 2.378, 2.140 and 1.140 for the T3, T2, T1, T5 and T4 respectively, there were no significant (*P>0.05*) differences treatments. Gonadosomato index 6.489, 5.680, 5.339, 4.009 and 3.770 for T3, T4, T5, T2 and T1respectively, when all treatments than control but differences among treatments were statistically no significant (P>0.05).

Table 3: Effect of replacing fishmeal with some biological parameters.

Treatments	Liver index	Gonadotropin index
T1	2.378 a	3.770 a
T2	2.585 a	4.009 a
T3	2.629 a	6.489 a
T4	1.931 a	5.680 a
T5	2.140 a	5.339 a

Mean values with different superscripts within a column differ significantly (P<0.05).

There is no information about the effects of dietary *Spirulina* meal on reproductive performance of carps; however, James *et al*. (9) reported that dietary *Spirulina* elevated red swordtail reproductive performance this agree with our results in high percent of GSI obtained in T3 as it contain the ration of *Spirulina*. Reproductive performance of yellow tail cichlid also increased with the dietary supplementation of *Spirulina* meal; the highest TEP and hatching rate was observed in the SP2.5 diet, but there were no significant differences among the *Spirulina* diets in terms of hatching rate, the reason for this elevation in reproductive performance is not fully understood, but previous studies have shown that reproductive performance can be modulated by dietary carotenoids, which may be mediated through various biological responses to the elevated dietary provision of provitamin A, protection from adverse lighting conditions, promoting chemotaxis of spermatozoa or antioxidant functions, an improvement in reproductive performance in response to elevated inclusion of dietary carotenoid

sources has been previously reported in gilthead seabream *Sparus aurata*, yellow tail *Seriolaquin queradiata* and rainbow trout *Oncorhynchus mykiss* (10).

For the role of dietary algae on body indices, Nakagawa and Montgomery (11) reported that there were no significant differences (P>0.05) in hepatosomatic index among the sea bream fed dietary *Ascophyllum* meal.

Fish fed the 8% *Spirulina* diet had four time's heavier gonads than fish fed the 1-3% *Spirulina* diets, possibly due to greater availability of protein and gonad stimulatory substances (9). Gonad weight reflects fecundity, fish receiving the *Spirulina*+ 300 mg E diet laid 50% more eggs than fish fed the control diet, indicating that an additive interaction exists between *Spirulina* and vitamin E. *Spirulina* contains fat soluble vitamins and β - carotene that might have interacted with the vitamin E, exerting an impact on gonad weight and fecundity in *C. auratus* (8, 9).

The effect of the three diet formulations on the liver index and the viscerosomatic index (VSI) during the feed trial was also negative, which meant that the liver decreased in size and the fish lost visceral fat during the feed trial (10). The VSI of fish fed the control diet was lower than that in the others (P<0.05), while no statistical differences between treatments were apparent in the HSI, lipid and energy values of the liver. The HSI values are similar to those recorded by Hung, Moore, for sturgeon fed high carbohydrate level, while the values reported by (11) are higher.

Finally, although the algal varieties varied in their proximate composition, their amino acid and fatty acid profiles suggest that they could be made into valuable ingredients for aquatic animal feeds. Based on the reported amino acid requirements of the species studied the algal products will be able to provide most of the essential amino acids (12).

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