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Algal Meal's Impact on the Fertilisation Abilities of Common Carp (*Cyprinus carpio* var. *communis*)

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ABSTRACT: *Spirulina* is a blue-green algae that contains upto 70% dry weight protein and is a good source of vitamins and PUFA. This study's goal was to evaluate the reproductive efficiency of Common carp fed with Spirulina supplemented diets at varied levels and to achieve the most effective supplementation of *S platensis* in feed. The experiment was set up in which 150 *C carp* fish were assigned randomly to follow treatments: T_1 = Spirulina 25g/kg, T_2 = Spirulina 50g/kg, T_3 = Spirulina 75g/kg, T_4 = Spirulina 100g/kg and T_0 = feed without supplementation as control in 3 replicates. The results showed that supplementation of Spirulina platensis affected reproductive parameters in common carp and better results were obtained at a dosage of 7.5% i.e. T_3.

Keywords: Algae, Fecundity, Feed, Gonadosomatic index, Spirulina.

INTRODUCTION

Fish is a low-cost and high-quality source of lean meat. One of the most critical elements determining cultured fish's capacity to express their genetic capacity for development and reproduction is nutrition (Kumar and Ram 2016). Successful reproduction needs sufficient resources to support the high energy requirements for gamete development and reproduction (Volkoff and London 2018). The sum of the body's energy reserves influences the onset of reproduction and this reproductive process is susceptible to various metabolic factors. Gonadotropin-releasing hormone expression and release are regulated by metabolic hormones and neuropeptides that act on the hypothalamus centre represent the the neuroendocrine system underlying the connection with relation to fertility and energy balance. Therefore, for the hypothalamus-pituitary-gonadal axis to fully activate throughout puberty and to function normally in maturity, sufficient bodily energy stores are required. In teleosts and other vertebrates, the hypothalamus–pituitary–gonadal axis regulates reproduction. Gonadotropin-releasing hormone, which controls pituitary gonadotropin production and release, as well as follicle-stimulating hormone and luteinizing hormone, are all produced by the pituitary. Gonadotropins act on the gonads to promote gonadal development through the release of sex steroid hormones. The brain and pituitary receive input from these steroids, completing the hypothalamic pituitary axis and regulating the reproductive cycle (Yaron *et al*., 2003; Zohar *et al*., 2010). As a result, the hypothalamic gonadotropin-releasing hormone is thought to be a key player in teleost reproduction control.

In general, a large amount of food favours reproduction, while a small amount of food prevents the efficient functioning of the reproductive system (Schneider, 2004). The physiological mechanisms that split energy into different tasks during energetic difficulties favour processes that aid in survival over processes that aid in the development, longevity and reproduction (Shahjahan *et al.,* 2014). Proteins, carbohydrates and lipids are the three different food classes that the body uses to provide energy for various physiological processes and physical activities. The ability of different fish species to use energy-producing nutrients varies greatly. This difference is due to their normal feeding habits, which can be categorized as herbivorous, omnivorous and carnivorous. There is a link between natural eating habits and the need for protein in the diet as a result. Compared to herbivorous and omnivorous species, some carnivorous species need more protein in their diet. Carnivorous species excel at converting dietary fat and protein into energy, while they struggle with doing the same with carbohydrates.

MATERIAL AND METHODS

A. Biochemical analysis of aquatic weeds

The Association of Official Analytical Chemists' methodologies were used to analyse the aquatic weeds for the proximate composition of several nutrients. Each determination was made three times. Fish meal was substituted with spirulina due to its high protein content AOAC (1990).

B. Diet formation and preparation (Elghany, 2003)

Five experimental diets (control and four treatment groups) with 30% crude protein were formulated. Each diet's dry ingredients were well combined and dough was prepared by mixing the mixture with distilled water (100ml/kg). The ingredients were thoroughly blended using kitchen blender to make a paste of each diet. Four diets with different Spirulina concentrations were prepared (Table 1). The diet control (C) had no Spirulina, similarly four treatment diets designated as T_1, T_2, T_3 and T_4 were formulated containing Spirulina at the rate of 2.5%, 5 % and 7.5% and 10% respectively in addition to the basal feed ingredients. Pelleting of diets was carried out by passing the blended mixture through hand pelletizer with 1mm diameter mesh. All the five diets were dried and stored separately in air-tight containers for further use as described by Elghany (2003).

Table 1: **Percentage composition of experimental diets.**

Ingredient		Inclusion rate (%)				
	Protein (%)	**Control (C)**	**T_1**	**T_2**	**T_3**	**T_4**
Fish meal (gm)	60	29	26.5	24	21.5	19
Mustard oil cake (gm)	45	22	22	22	22	22
Rice bran (gm)	13	25	25	25	25	25
Wheat flour (gm)	15	11	11	11	11	11
Vegetable oil (gm)	-	8	8	8	8	8
Vitamin & Mineral mixture (gm)	-	5	5	5	5	5
Spirulina (gm)	70	0	2.5	5	7.5	10
Total (gm)		100	100	100	100	100
Chemical composure						
Dry matter	-	89.5	90.4	90.5	90.6	89.5
Crude protein	-	30.3	30.7	30.8	30.9	30.3
Ether extract	-	8.05	7.71	7.45	7.11	8.05
Crude fiber	-	2.57	2.42	2.26	2.34	2.57
Ash	-	6.01	5.91	5.56	5.71	6.01

C. Experimental Site

The experiment was performed in the Faculty of Fisheries' Wet Laboratory, Rangil Gandersbal, India, during the course of 90 days from April 1 to June 1 of this year. The fish were raised in plastic containers after a 10-day acclimation period.

D. Experimental set-up and experimental fish

The experiment was carried out in the Fisheries farm Shuhama, India for 90 days 15 plastic circular tubs with a 80L capacity, covered with net. Initially, the tubs were cleaned and filled with a 4mgL^{-1} solution of potassium permanganate. The following day, fresh water was used to properly wash the tubs and flush them out. Common carp, *Cyprinus carpio* specimens with average weight of 50g procured from fish farm shuhama were utilised in the investigation.

150 fish were randomly assigned to each of the four different experimental groups. Three replicates were used in each group, according to a totally random design. In each plastic tub, 80L of chlorine-free canal water was filled with ten fish, with an initial average weight of 50±5 g. There was constant aeration available. To evaluate the growth, the body weight was taken at intervals of 15 days. Before weighing the fish, they were starved overnight.

E. Feeding

For the duration of the 60-day feeding trial, feeding was done at 5% of body weight. The daily diet was divided into two equal portions and given between 10:00 am and 6:00 pm.

F. Reproductive biology

Gonado-Somatic Index (GSI) (Desai, 1970)

In order to study the gonad somatic index, the weight of the each fish specimen and corresponding ovary were calculated to 0.001 g precision. The ratio was computed through formula given by (Desai, 1970).

$$\text{Gonado Somatic Index} = \frac{\text{Weight of gonads (g)}}{\text{Total weight of fish (g)}} \times 100$$

G. Fecundity Absolute fecundity

$$\text{Absolute Fecundity} = \frac{\text{No. of ova in the subsample} \times \text{Total Ovary weight}}{\text{Weight of subsample}}$$

For the estimate of absolute and relative fecundity, sub samples were obtained from the front, middle, and posterior areas of the ovary.

H. Relative fecundity

$$\text{Relative Fecundity} = \frac{\text{Absolute Fecundity}}{\text{Weight of fish}}$$

I. Statistical analysis

The data generated was analysed by appropriate statistical methods of Microsoft Excel and PAST for Windows (Version 20).

RESULTS AND DISCUSSION

In males, the highest mean ± S.D. value of 5.03±1.22 for gonadosomatic index (GSI) was recorded in treatment group (T_3) and the lowest mean ± S.D value of 3.88±1.9 for gonadosomatic index (GSI) was recorded in control group (T_0). No significant difference ($p>0.05$) was seen in gonadosomatic index (GSI) among various treatment groups.

In females the highest mean ± S.D value for gonado somatic index (GSI) recorded in treatment group T_3 (9.43±3.86) and the lowest mean ± S.D value for gonado somatic index (GSI) recorded in control group T0 (3.71±2.13). Significant difference ($p<0.05$) was seen in gonado somatic index (GSI) of females among various treatment groups.

The gonadosomatic index (GSI) is a key indication of an organism's overall health. It's a tool for calculating or measuring reproductive capacity. Reproduction is the most important step in a species life cycle as it affects the species survival and success. The gonado somatic index (GSI) is a good predictor of changes in a fish's nutritional and energetic status (Adams *et al.,* 1996). The proportion of a fish's gonad weight to body weight is known as the gonad somatic index (GSI). As the ovaries of gravid females rapidly grow in size shortly prior to spawning, the gonad somatic index (GSI) is particularly useful in determining days and seasons of spawning. During the present study, the highest mean gonad somatic index (GSI) for both male (5.03) and female (9.43) was recorded in treatment group (T_3) and the lowest mean gondo somatic index (GSI) value for both male (3.88) and female (3.71) was recorded in control group (T_0). The fact that Spirulina contains sizable amounts of protein, lipids, and fatty acids—the primary components of egg yolk—could account for the treatment group T_3's highest mean gonado somatic index (GSI) value. Additionally, the necessary fatty acids in it give spawning energy. Dahlgren (1980) showed that the lipids, essential fatty acids, and proteins included in fish diets affect the rate at which vitellogenesis develops and oocytes mature. The improvement in the reproductive efficiency of treatment group (T_3) may also be due to the fact that Spirulina has a good content of micronutrients (B group vitamins), which is in agreement with the findings of Coves *et al.* (1990) who explained the importance of B vitamins in elevating reproductive performance of fish. James *et al.* (2004) reported that female Xiphophorous helleri fed with 45% protein diets (animal and plant protein diets) had a greater ovary weight and gonado somatic index than those fed low protein diets (10-35%). Khanzadeh *et al.* (2016) also reported that the fish fed Spirulina platensis meal had greater gonad somatic indices than control. The outcomes of the current investigation concur with those of Guroy *et al.* (2012). Spirulina increased seed production in the golden tail cichlid (Pseudotropheus acei), gold fish (*Carrasius auratus*), swordtail (*Xiphophorous helleri*), and bassa fish (*Pangasius bocourti*), according to Vasudevan *et al.* (2011); James *et al*. (2006).

A. Absolute Fecundity

The highest mean±S.D. value of 5888±643.7 for absolute fecundity was observed in treatment group (T4) and the lowest mean±S.D. value of 3632±749.3 for absolute fecundity was observed in control group (T0). Statistically it was seen that there was significant difference ($p<0.05$) between the absolute fecundity of various treatment groups.

B. Relative fecundity

The highest mean±S.D. value of 99±13.37 for relative fecundity was observed in treatment group T3 and the lowest mean±S.D. value of 69±13.08 for relative fecundity was observed in control group T_0. Significant difference ($p<0.05$) was seen in relative fecundity between various treatments groups.

The estimated number of eggs that will be laid during a spawning season is referred to as a fish's fecundity (Bagenal, 1957). Fecundity or reproductive potential is an important biological metric to consider when assessing the commercial potential of fish stocks (Gomez *et al.,* 2003). To understand the ability of fish populations to recover, accurate fecundity evaluation is necessary for effective fisheries management, including practical aquaculture (Tracey *et al.,* 2007). Fecundity and its relationship to female size makes it feasible to estimate egg output potential (Chondar, 1977), as well as the number of off springs that could be produced in a season and the reproductive capability of fish populations (Qasim and Qayyum 1963). In the study of fish biology and population dynamics, descriptions of reproductive techniques and assessments of fecundity are essential issues (Hunter *et al.,* 1992). Studies on reproduction, such as size at maturity, fecundity, reproductive season length, spawning behaviour and spawning fraction allow for the estimation of a fish's reproductive capacity. This data combined with estimations of egg production, allows for the calculation of spawning stock biomass (Saville, 1964; Parker, 1980; Laqsker, 1985). Even within a stock, fecundity is known to vary periodically, to change over time and to be proportional to fish size and hence age and condition (Kjesbu *et al.,* 1998). In both absolute and relative terms to body mass, larger fish produce more eggs. Fish size and condition are thus critical factors in determining population fecundity.

The absolute fecundity of Common carp in the present study ranged from 5888±643.7 to 3632±749.3. The relative fecundity varied from 99±13.37 to 69±13.08. To promote sexual development, reproduction, high-quality eggs, and larvae survival rates, the meals' essential fatty acids, alpha-tocopherol, ascorbic acid, and carotenoids were successful (Scabini *et al.,* 2011). James *et al.* (2006) found comparable outcomes in swordtail fish fed 8% spirulina. According to Bustamente and Ortega-salas (2002), the fecundity rate for three spotted gourami fish ranged from 8021 to 9104 eggs (2002). Furthermore, according to Guroy *et al.* (2012), feeding cichlid yellow tail (*Pseudotro pheusacei*) 2.5% spirulina resulted in the largest number of eggs laid and hatching rates, which was a significant difference from other treatments.

CONCLUSION AND FEATURE SCOPE

Gonado somatic index (GSI) of treatment group (T_3 @7.5% *Spirulina*) performed better than control (T_0) for both males and females. Fecundity was recorded in terms of absolute and relative fecundity. The absolute fecundity of common carp in the present study ranged from 5888±643.7 to 3632±749.3 and the relative fecundity varied from 99±13.37 to 69±13.08. *Spirulina platensis* has beneficial effects on the growth, reproduction and blood physiology of common carp (*Cyprinus carpio* var. *communis*) based on the results of the present study. Spirulina can replace upto 7.5% (T3) of fish meal in the diet of common carp without any adverse effects on growth. Currently, Spirulina production is directed towards its use as a feed additive at low inclusion levels. However, the present study demonstrates the feasibility of its use as a substitute source of protein in fish dietsss, giving arguments for intensification in Spirulina cultivation and its use in fish feeds.

Conflict of Interest. None.

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