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Effect of various dietary fats supplementation on the liver glycogen, protein and digestive enzymes activities in striped murrel, *Channa striatus*

Rajesh Dayal[1], Prem Prakash Srivastava[1,2,*], Joykrushna Jena[1], Sudhir Raizada[1], Akhilesh Kumar Yadav[3], Anita Bhatnagar[4], Shipra Chowdhary[1]

[1]ICAR- National Bureau of Fish Genetic Resources, Canal Ring Road, Teli Bagh, Lucknow – 226 002, Uttar Pradesh, India .[2](Present address): ICAR - Central Institute of Fisheries Education, Panch Marg, Off Yari Road, Mumbai-400 061, Maharashtra, India. [3]Aquaculture Research Training Unit, ICAR - National Bureau of Fish Genetic Resources, Chinhat, Faizabad Road, Lucknow-227105, Uttar Pradesh, India.[4]Department of Zoology, Kurukshetra University, Kurukshetra-139 119, Haryana, India.

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ABSTRACT

A 84-days experiment was conducted to observe the effects of different feeds rich with various types of fats on selected biochemical parameters of *Channa striatus* grow-outs. There were seven treatments (F1, L3HUF; F2, H3HUF; F3, MUSOL; F4, LINOL; F5, MIXOL; F6, SATOL and F7, NATFO), fed to fish (avg. wt., 27.36 ± 0.09 to 32.54 ± 0.41 g). Results showed that the variation in liver glycogen content was recorded on addition of different fat content in the diet. Activity of intestine protease recorded significantly ($p<0.05$) on addition of various fat content in the diet. It is found that the variation in intestine amylase varied significantly ($p<0.05$) in F1, F3 and F5 feeding trials. Intestine lipase varied significantly on addition of various fat content in all the feeding trials except in NATFO. The intestine cellulase was very poor in this fish and does not varied significantly ($p > 0.5$) on addition of different fat content in the diet. In case of F1 and F2 there was no activity recorded till end. Results suggests that dietary fat has direct role in the alteration of biochemical parameters especially intestinal lipase which showed drastic variation in the activity in this species of aquaculture importance.

1. INTRODUCTION

Channa striatus, is a highly priced air-breathing freshwater fish and are in great demand as food fish due to their appealing flavour [1], few muscular spines, medicinal importance [2-6] and air-breathing nature [4] that facilitate high density culture and easy transport in live condition to the markets. Murrel adapts well to hypoxic water-bodies and hence can be cultured in high stocking densities. The striped murrel (*C. striatus*) culture is widely popular in Thailand and on limited scale in India, Philippines and Taiwan [4, 7] due to non-availability of seed. Striped murrel breeds in ponds and rivers a little prior to or with the onset of monsoons [7-9] and their spawning season extends throughout the monsoons [10]. The tissue glycogen content estimated by many authors like Johnston and Goldspink [11] in crucian carp; Driedzic and Short [12] in rainbow smelt; Diwan *et al*. [13]; Peres and Oliva-Teles [14] in European seabass and Bakthavatsalam and Reddy [15] in climbing perch. Similarly studies dealing with effect of feeding various lipids through diets on the muscle protein and intestinal protease in fish tissues have been reported by many authors [16-19].

The gut enzyme profile is the indicator of nutrient digestibility and utilization. Giri *et al*.[20] studied a very high activity of a-amylase, indicated that *Clarias batrachus* was able to digest the starch efficiently and concluded that study indicates that dried viscera of fish and chicken can be used as alternate animal protein sources for *Clarias batrachus* juveniles without affecting nutrient digestibility and can be used as a replacer of expensive fish meal in the diet. The relatively high carbohydrase activity in *Clarias* has been observed by earlier worker [21]. Fish amylases [22] appear to be molecularly closely related and to have characteristics comparable to mammalian amylases.

* *Corresponding Author*
Email:ppsicar @ gmail.com,
Fax : 91-22 26361573; ph: 91-22-26361446

Non-specific protease, trypsin, chymotrypsin, amylase and lipase were assayed by Lundstedt *et al.* [23] in *Pseudoplatystoma corruscans* (Teleostei: Siluriformes). Gaye-Siessegger *et al*.[24] investigated the influence of different dietary protein/ carbohydrate ratios on activities of enzymes involved in the amino acid metabolism as well as on growth performance and body composition of Nile tilapia (*Oreochromis niloticus*). The activities of both enzymes Aspartate aminotransferase (ASAT) and Alanine aminotransferase (ALAT) in the liver were significantly higher in fish with a higher protein gain. Measuring the activities of enzymes involved in the amino acid metabolism provide more information about the metabolic utilized dietary protein. Dietary proteins affect the activities of enzymes involved in carbohydrate metabolism in fish [25-27]. Cellulose digestibility in grass carp, *Ctenopharyngodon idella* and in goldfish, *Carassius auratus* has been reported [28]. The cellulolytic activity was measured both qualitatively and quantitatively. It was found that the ability of different strains in degrading cellulose varies within a wide range in tilapia and grass carp [29]. The stomachs of 148 elasmobranch and teleost fishes representing 35 families and 62 species were examined by viscometry for cellulase activity. Sixteen species of Georgia estuarine fish and the freshwater fish, *Ictalurus punctatus* (Rafinesque) showed some cellulase activity. Elasmobranchs and teleosts captured in Florida Bay, Florida, and over the continental shelf off Georgia lacked cellulase activity. Cellulase activity in fishes is probably produced by microflora of the alimentary tract[30]. The present study was taken to study the impact of dietary fat on carbohydrate, protein and lipid metabolites and on related enzymes of these metabolites in this carnivore fish, *Channa striatus*.

2. MATERIALS AND METHODS

2.1 Experimental fish

Air breathing shakehead striped murrel, *Channa striatus* (Bloch, 1793) was selected for present study owing to its aquacultural importance. The brooders of experimental fish *Channa striatus* were procured from local fish markets (Mawaiya Fish market, Kalli fish market, Bara Birwa Fish Markets in Lucknow and Fish markets in District Barabanki) in Lucknow and Barabanki and were hatchery bred at National Bureau of Fish Genetic Resources, Lucknow. The broodstock fish were segregated according to the size to prevent cannibalism and were kept in 36 plastic pools (capacity: 300 L) with continuous supply of oxygen. Treatment of 10 ppm formalin was given to brood fishes to disinfect from pathogens. Hidings (Shelter) were provided within the aerated tanks and acclimatized to laboratory conditions for a period of 15 days and were fed *ad-libitum* twice a day with laboratory made egg custard and live fry / fingerlings of common carp.

2.2 Experimental Unit

Circular, plastic pools were used for the present experiment with two replicates of fingerlings reared in these plastic pools during the entire experiment. The plastic pools of 300 L capacity were thoroughly washed and arranged accordingly to provide almost uniform environmental conditions for all experimental groups, in the wet laboratory (hatchery) at NBFGR, Lucknow. Damaged PVC pipes and broken earthen vases were kept within each of the pool for providing shelter and hides and to prevent cannibalism within the group. Each pool was filled with 100 L of water and the pools were covered with plastic sheets to provide darkness since, it is nocturnal feeder. Continuous and uniform aeration was provided in each of the tank using 1 HP air blower. The air was passed to the pools through Carborandom aerator stones, connected with small, individual plastic tubes which were in turn connected with blower with regulator. Water quality was analysed and monitored uniformly throughout the experimental period to avoid the drastic changes. The experimental tubs were cleaned manually and through siphoning every alternate day in order to remove fecal matter and unutilized feed. Approximately 30-40% volume of chlorine free bore-well water was used to replace the siphoned water.

2.3 Experimental Design

The Completely Randomized Block Design (CRBD) was followed for the experiment with two replicates in each treatment.

2.4 Rearing and maintenance

Five hundred sixty fishes were randomly distributed in seven distinct experimental groups having two replicates. The experimental fishes (*Channa striatus*) were hatchery produced fry from NBFGR, Lucknow. The fishes were bred artificially at NBFGR as per the requirement in every breeding season of 2009 to 2011. The brood fishes were procured from local fish market (Maviya Fish market, Lucknow). The matured fishes were fed for two weeks in controlled laboratory conditions under laboratory made rich diet containing 40% protein and 10% lipid (Fat) contents for proper maturity. Following the standard breeding protocols [31] the fry were produced. Feeding experiments were conducted for 12 weeks to record various biochemical parameters in the serum/tissue. Temperature, free CO_2 and dissolved oxygen were monitored on regular basis and other water quality parameters were analysed fortnightly.

2.5 Experimental Diets

Six isocaloric and iso-nitrogenous experimental feeds (Table-1) were made using different oils viz. Pure Omega – 3 HUFA (PUROL) in two concentrations (Low concentration of Omega – 3 HUFA and High concentration of Omega – 3 HUFA), Mustard oil (MUSOL), Linseed oil (LINOL) and Mixed oil (MIXOL) and saturated oil (SATOL) were used as per desired concentrations. In the case of MIXOL the two sources (MUSOL AND LINOL) were mixed in desired ratio of 11:1 w/w. The basal ingredients were Soybean meal, Starch soluble, Casein, Carboxy methyl cellulose, Papain and vitamin and mineral mixture. All the six feeds were rich in Omega – 3 HUFA.

Table 1: Ingredients composition (w/w) of feeds for *Channa striatus*.

Feed Ingredients	F-1 L3HUF	F-2 H3HUF	F-3 MUSOL	F-4 LINOL	F-5 MIXOL	F-6 SATOL	F-7 NATFO
Soybean meal	41.0	41.0	41.0	41.0	41.0	41.0	-
Starch Soluble	25.0	25.0	25.0	25.0	25.0	25.0	-
Casein	20.0	20.0	20.0	20.0	20.0	20.0	-
Carboxy Methyl Cellulose	2.0	2.0	2.0	2.0	2.0	2.0	-
Papain	0.5	0.5	0.5	0.5	0.5	0.5	-
Vitamin & Mineral Mix.*	3.5	3.5	3.5	3.5	3.5	3.5	-
Omega – 3 HUFA	0.5	1.0	-	-	-	-	-
Saturated Oil	7.5	7.0	-	-	-	8.0	-
Mustard Oil	-	-	8.0	-	4.0	-	-
Linseed Oil	-	-	-	8.0	4.0	-	-
Live Fish/ Natural Food	-	-	-	-	-	-	100.0

L3HUF = Low Omega – 3 HUFA; H3HUF = High Omega – 3 HUFA; MUSOL = Mustard Oil; LINOL = Linseed Oil; MIXOL = Mixed Oil (Mustard Oil : Linseed Oil :: 1 : 1 w/w) ; SATOL = Saturated Oil (vegetable ghee); NATFO = Natural Food (live fish).

*Vitamin and Mineral composition (Per 100 g); Vitamin A, 70000 IU; Vitamin D_3, 7000 IU; Vitamin E, 25mg; Nicotinamide, 100 mg; Cobalt, 15 mg; Copper, 120 mg; Iodine, 32.5 mg; Iron, 150 mg; Magnesium, 600 mg; Manganese, 150 mg; Potassium, 10 mg; Selenium, 1mg; Sodium, 0.59 mg; Sulphur (%), 0.72; Zinc, 96 mg; Calcium (%), 25.50; Phosphorus (%),12.5. From Agrivet Farm Care Division, GlaxoSmithKline Pharmaceuticals Limited (Mfg. by Sunder chemicals Pvt. Ltd., Chennai). Lot/ Batch No. SC7450

Proximate Composition (%) of different formulated feeds

	F1	F2	F3	F4	F5	F6
Protein	35.6±1.2	35.28±0.9	35.66±2.1	35.42±1.4	35.29±1.3	35.86±1.5
Carbohydrate	24.56±0.8	24.58±0.9	24.71±1.1	24.55±1.2	24.63±0.7	24.74±1.5
Fat	8.0±0.5	8.04±0.4	8.19±0.3	8.23±0.4	8.07±0.6	8.22±0.5
Ash	8.7±1.2	8.6±1.4	8.4±1.6	8.6±1.3	8.7±0.9	8.9±1.2
Gross Energy Kcal/100g)	460.25±30.2	458.59±25.5	457.62±34.2	458.22±31.6	457.65±31.2	459.31±30.4

The moist-feed were prepared by mixing the ingredients in a mixer (Prestige made) and then water was added to prepare a stiff dough. The dough was then kept for 30 minutes for proper conditioning followed by steaming for 20 minutes in a pressure cooker. Then the steaming dough was allowed to cool. The feed were packed in airtight containers, labeled and stored properly in a freezer (-20°C) until used. In addition to six dietary treatments seventh treatment was also kept (F7) where the fish were fed on natural food as control containing fingerlings of *Cyprinus carpio*.

2.6 Experimental system and animals

The experimental fishes (adult) procured from local market were acclimatized for Two weeks in controlled laboratory conditions and were fed with rich diet containing 50 % protein and 8% fat contents. After acclimation each experiment were conducted for 12 weeks to observe the retention of dietary Omega – 3 HUFA contents and their reflection in terms of deposition of nutrients into flesh. All the six diets and control feed were trialed in two replicates; accordingly 12 plastic pools (capacity 300 L) were used to assess the various serum biochemical parameters. The control fishes were fed with live fish/ natural food in two plastic pools (capacity 300 L). Hence, total 14 plastic pools were used in the study. In each replicate 40 fishes were stocked @ 2.5 liters per fish. Although the experimental fishes are air-breathing fishes yet, the plastic pools were aerated for avoiding accumulation of obnoxious wastes coming out of the fecal matter and release of nitrogen in the ambient water.

2.7 Feeding

The fishes were fed at 10% of body weight throughout the experimental period and the ration was calculated by accessing the increment in weight gain at interval of 14 days. The daily ration was divided into two parts; about one-third of total ration was given at 10:00 hours and the rest two thirds was fed at 18:00 hours.

2.8 Liver glycogen, Protease, Amylase, Cellulase enzyme

Estimation of liver glycogen was undertaken following the method of Dubois *et al.* [32], (1956). Muscle were extirpated and used for the estimation of muscle protein [33]. Intestine were processed for the determination of protease [34], amylase was estimated as per the method described by Sawhney and Singh [35], lipase and cellulase enzyme activity was estimated by the method given by Thimmaiah [36].

2.9 Statistical Analysis

Data were analyzed for the variance component using SPSS statistical package and also following the ANOVA with Snedecor & Cochran [37] and difference between the means were examined using Duncan's multiple range tests. The feeding trials were carried out in Random Block Design (RBD).

3. RESULTS

3.1 Analysis of Water quality parameters

Water quality parameters were analysed during experiment condition and recorded that water temp, pH, dissolved oxygen and total alkalinity values are: 20 - 24 °C, 6.8 - 7.5, 6.9 - 7.4 $mg.L^{-1}$ and 130 – 138 $mg.L^{-1}$, respectively (APHA [38].

Table 2: Liver glycogen, protein and intestinal enzymes of *Channa striatus.*

Feed Parameters	Sampling Days (Day/ Weeks)	F1 (L3HUF)	F2 (H3HUF)	F3 (MUSOL)	F4 (LINOL)	F5 (MIXOL)	F6 (SATOL)	F7 (NATFO)
Liver glycogen (mg/100g)	**0**	80.2±4.2^{a}	81.0±3.1^{a}	80.5±7.8^{a}	80.2±5.6^{a}	81.3±6.1^{a}	80.6±4.9^{a}	80.0±7.4^{a}
	4	80.6±3.8^{a}	81.5±5.3^{a}	83.2±9.6^{b}	80.6±6.3^{a}	81.7±8.4^{a}	82.7±7.5^{a}	83.2±7.1^{b}
	8	82.7±7.4^{a}	83.6±6.0^{b}	86.4±4.7^{b}	80.4±6.3^{a}	84.4±5.6^{b}	83.3±6.2^{b}	84.1±8.2^{a}
	12	85.9±6.6^{b}	81.4±7.5^{a}	82.7±6.3^{a}	80.5±6.8^{a}	82.2±5.9^{a}	87.4±5.3^{b}	85.4±6.2^{b}
Liver protein (g/100g)	**0**	15.2±1.1^{a}	15.3±0.8^{a}	15.3±0.8^{a}	16.4±1.2^{a}	15.2±0.5^{a}	16.5±0.9^{a}	16.0±0.1^{a}
	4	16.1±1.2^{b}	16.1±0.7^{b}	16.1±0.4^{b}	16.5±0.7^{b}	16.5±0.2^{b}	16.2±0.6^{b}	16.5±0.5^{b}
	8	17.5±0.9^{b}	16.4±1.3^{b}	16.4±0.3^{b}	16.8±0.6^{b}	16.3±0.4^{b}	16.6±0.5^{b}	16.3±0.8^{b}
	12	15.4±1.1^{a}	16.6±0.6^{b}	16.6±1.1^{b}	16.3±0.9^{b}	16.7±0.8^{b}	16.3±0.7^{b}	16.2±0.7^{b}
Intestine Protease (Unit/mg protein)	**0**	1.4±0.08^{a}	1.2±0.01^{b}	1.3±0.04^{a}	1.2±0.02^{b}	1.4±0.03^{a}	1.1±0.01^{b}	1.1±0.04^{b}
	4	1.3±0.07^{a}	1.2±0.07^{b}	1.5±0.02^{a}	1.6±0.04^{a}	1.3±0.02^{a}	1.1±0.06^{b}	1.6±0.06^{c}
	8	1.2±0.04^{b}	1.3±0.09^{a}	1.2±0.09^{b}	1.5±0.05^{a}	1.2±0.04^{b}	1.3±0.08^{a}	1.4±0.03^{a}
	12	1.5±0.06^{a}	1.4±0.05^{a}	1.4±0.07^{a}	1.6±0.06^{c}	1.5±0.05^{a}	1.6±0.07^{c}	1.8±0.08^{d}
Intestine Amylase (Unit/mg protein)	**0**	0.40±0.01^{a}	0.42±0.01^{a}	0.44±0.02^{b}	0.41±0.04^{a}	0.42±0.01^{a}	0.41±0.05^{a}	0.32±0.01^{c}
	4	0.41±0.01^{a}	0.40±0.03^{a}	0.40±0.01^{a}	0.45±0.03^{b}	0.43±0.02^{b}	0.39±0.01^{a}	0.37±0.01^{d}
	8	0.47±0.03^{b}	0.39±0.03^{a}	0.49±0.01^{b}	0.42±0.02^{a}	0.49±0.03^{b}	0.38±0.01^{c}	0.38±0.01^{c}
	12	0.46±0.02^{b}	0.38±0.02^{c}	0.41±0.04^{a}	0.43±0.01^{a}	0.47±0.01^{b}	0.43±0.02^{a}	0.36±0.03^{c}
Intestine Lipase (Unit/mg protein)	**0**	0.35±0.01^{a}	0.32±0.01^{a}	0.35±0.02^{a}	0.33±0.04^{a}	0.32±0.01^{a}	0.30±0.02^{b}	0.28±0.01^{c}
	4	2.41±0.02^{a}	2.34±0.09^{b}	1.15±0.06^{c}	2.45±0.32^{a}	2.43±0.47^{a}	2.39±0.25^{a}	0.29±0.03^{d}
	8	2.47±0.01^{a}	2.32±0.08^{b}	1.78±0.04^{c}	1.88±0.19^{c}	1.96±0.55^{c}	1.88±0.14^{c}	0.28±0.04^{d}
	12	0.46±0.05^{a}	2.33±0.10^{b}	1.76±0.09^{c}	1.70±0.46^{c}	1.77±0.16^{c}	1.78±0.12^{c}	0.26±0.05^{d}
Intestine Cellulase (Unit/mg protein)	**0**	ND	ND	0.01±0.001^{a}	0.03±0.002^{b}	0.03±0.002^{b}	0.01±0.001^{a}	0.01±0.002^{a}
	4	ND	ND	0.01±0.002^{a}	0.01±0.001^{a}	0.02±0.001^{a}	0.01±0.002^{a}	0.01±0.001^{a}
	8	ND	ND	0.01±0.002^{a}	0.02±0.003^{a}	0.02±0.001^{a}	0.01±0.001^{a}	0.01±0.002^{a}
	12	ND	ND	0.01±0.003^{a}	0.02±0.004^{a}	0.03±0.002^{b}	0.01±0.001^{a}	0.01±0.002^{a}

Means in a given row having the same letter superscript are not significantly different at ($p < 0.05$) by ANOVA and Duncan's multiple range test.

3.2 Biochemical Analysis

3.2.1 Liver glycogen

The liver glycogen on day 0, week-4, week-8, week-12 recorded as 80.0±7.4 to 81.3±6.1 mg/100g, 80.6±3.8 to 83.2±9.6 mg/100g, 80.4±6.3 to 86.4±4.7 mg/100g and 80.5±6.8 to 87.4±5.3 mg/100g respectively. It is found that the variation in liver glycogen content was changing on addition of various fat content in the diet. Results are shown in Table-2 & Fig. 1.

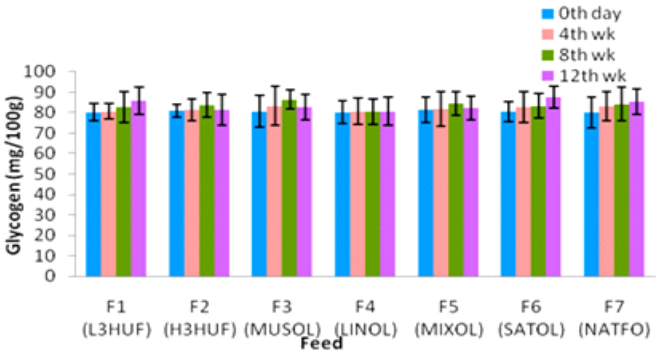

Fig. 1: Glycogen contents in the livers of *Channa striatus* fed with various fats.

3.2.2 Liver Protein

The liver protein on day 0, week-4, week-8, week-12 recorded as 15.2±0.5 to 16.5±0.9 g/100g, 16.1±0.4 to 16.5±0.7 g/100g, 16.3±0.4 to 17.5±0.9 g/100g and 15.4±1.1 to 16.7±0.8 g/100g respectively. Results are shown in Table-2 & Fig. 2.

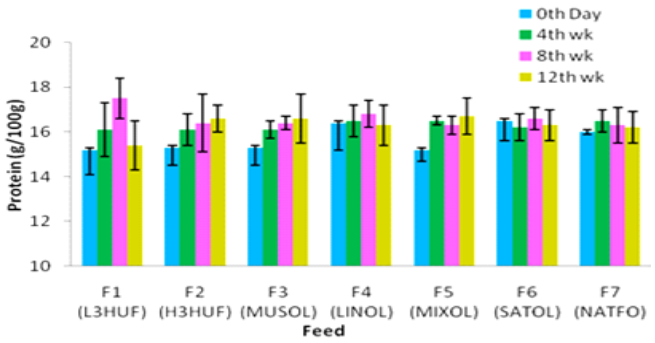

Fig. 2: Protein contents in the livers of *Channa striatus* fed with various fats.

3.2.3 Intestine Protease

The intestine protease on day 0, week-4, week-8, week-12 recorded as 1.1±0.01 to 1.4±0.08/mg protein, 1.1±0.06 to 1.6±0.04/mg protein, 1.2±0.04 to 1.5±0.05/ mg protein and 1.4±0.05 to 1.8±0.08 / mg protein respectively. It is found that the variation in intestine protease does not varied significantly on addition of various fat content in the diet. Results are shown in Table-2 & Fig. 3.

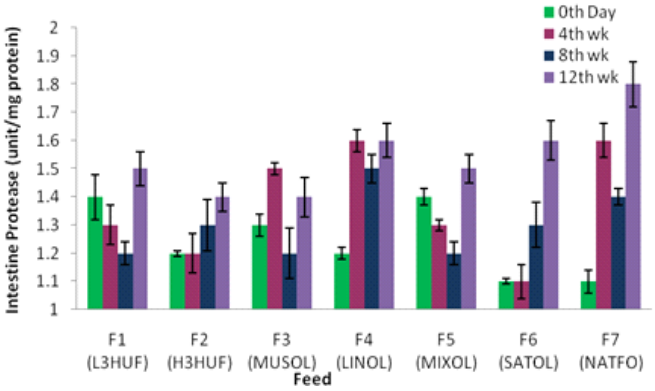

Fig. 3: Protease activity in the intestine of *Channa striatus* fed with various fats.

3.2.4 Intestine Amylase

The intestine amylase on day 0, week-4, week-8, week-12 recorded as 0.32±0.01 to0.44±0.02 /mg protein, 0.37±0.01 to 0.45±0.03 / mg protein, 0.38±0.01 to 0.49±0.03 / mg protein and 0.36±0.03 to 0.47±0.01 / mg protein respectively. It is found that the variation in intestine amylase does not varied significantly on addition of various fat content in the diet. Results are shown in Table-2 & Fig. 4.

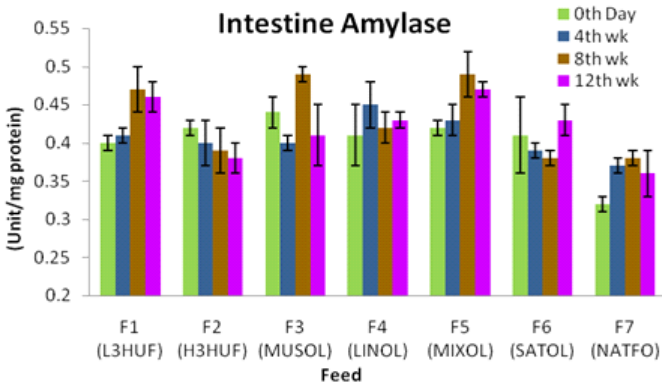

Fig. 4: Amylase activity in the intestine of *Channa striatus* fed with various fats.

3.2.5 Intestine Lipase

The intestine lipase on day 0, week-4, week-8, week-12 recorded as 0.28±0.01 to 0.35±0.01/ mg protein, 0.29±0.03 to 2.45±0.32 / mg protein, 0.28±0.04 to 2.47±0.01 / mg protein and 0.26±0.05 to 2.33±0.10/ mg protein respectively. It is found that the variation in intestine lipase varied significantly on addition of various fat content in the diet. Results are shown in Table-2 & Fig. 5.

3.2.6 Intestine Cellulase

The intestine cellulase on day 0, week-4, week-8, week-12 recorded as 0.01±0.001 to 0.03±0.002 /mg protein, 0.01±0.001 to 0.02±0.001/ mg protein, 0.01±0.001 to 0.02±0.003/mg protein and 0.01±0.001 to 0.03±0.002/ mg protein respectively. The intestine cellulase was very poor in this fish and does not varied significantly on addition of various fat content in the diet. In case of F1 and F2 there was no activity recorded. Results are shown in Table-2 & Fig. 6.

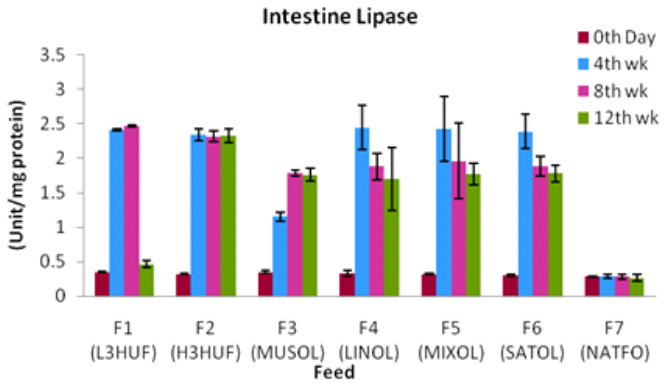

Fig. 5: Lipase activity in the intestine of *Channa striatus* fed with various fats.

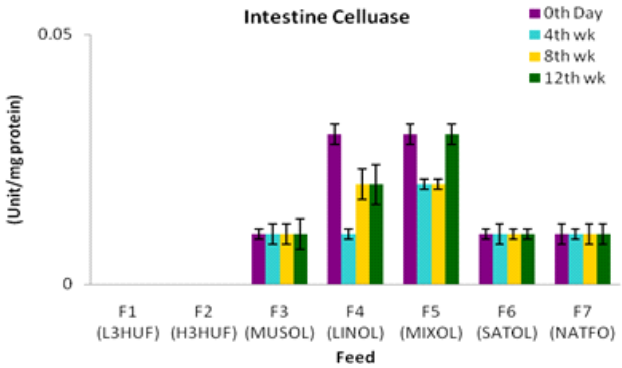

Fig. 6: Cellulase activity in intestine of *Channa striatus* fed with various fats.

4. DISCUSSION

Cortisol-induced changes in liver glycogen content of coho salmon, *Oncorhynchus kisutch* have been reported[39]. The intra-peritoneal implants of hydrogenated coconut oil alone or coconut oil containing cortisol at 1, 5, or 10 mg/fish exhibited dose-related increases in liver glycogen content and hepatosomatic index were significantly lower in the cortisol-treated groups at day 30 but not at day 15. The effect of endosulfan and its isomers on tissue protein, glycogen, and lipids in the fish *Channa punctatus* has been observed[40]. There was no significant change in liver glycogen in *Channa striatus*, in the present study, on feeding various graded levels of fat on day 0, week-4, week-8 and week-12. It is found that the variation in liver glycogen content was changing not in a fashion on addition of various fat content in the diet. Similar studies on the glycogen content estimated by many authors [11-15]. Digestive enzyme pattern of two stomachless filter feeders, silver carp, *Hypophthalmichthys molitrix* Val., and bighead carp, *Aristichthys nobilis* has been reported[41]. Influence of *Bacillus coagulans* CC1 on growth performance and digestive enzyme activites of *Catla catla* had been reported[42]. The intestine protease on day 0, week-4, week-8, week-12 recorded and it is found that the variation in intestine protease does not varied significantly on addition of various fat content in the diet.

Comparative study of α-amylase activity in three Cyprinid species of different feeding habits described by Al-Tameemi *et al*. [43]. The intestine amylase on day 0, week-4, week-8, week-12 recorded and it is found that the variation in intestine amylase does not varied significantly on addition of various fat content in the diet. Lipase activity in different tissues of four species of fish: rohu (*Labeo rohita*, Hamilton), oil sardine (*Sardinella longiceps*, Linnaeus), mullet (*Liza subviridis*, Valenciennes) and Indian mackerel (*Rastrelliger kanagurta*, Cuvier) have been dealt by Nayak *et al*. [44]. The intestine lipase on day 0, week-4, week-8, week-12 recorded and it is found that the variation in intestine lipase varied significantly on addition of various fat content in the diet. Effect of dietary phospholipid level and phospholipid:neutral lipid value on the development of seabass (*Dicentrarchus labrax*) larvae fed on compounded diet have also been reported[45]. Cellulase activity in rohu fingerlings were recorded by Saha and Ray [46] and the cellulase activity in fishes is probably produced by microflora of the alimentary tract[30]. Characterization of cellulase producing bacteria has been demonstrated from the digestive tract of tilapia, *Oreochromis mossambica* (Peters) and grass carp, *Ctenopharyngodon idella*[29]. The relatively high carbohydrase activity in *Clarias* has been observed by earlier worker [21]. Reports from Giri *et al*.[20] suggests a very high activity of a-amylase, indicated that *Clarias batrachus* was able to digest the starch efficiently and concluded that fish used alternate animal protein sources for *Clarias batrachus* juveniles. In the present study the intestine cellulase on day 0, week-4, week-8, week-12 recorded and showed that the intestine cellulase was very poor in this fish and does not varied significantly on addition of various fat content in the diet. In case of F1 (L3HUF) and F2 (H3HUF) there was no activity recorded. This may be due to the basic carnivore nature of the fish.

5. CONCLUSION

On the basis of results it is observed that the various dietary fats impacted not only lipid related metabolites and enzymes but also modified the elements of carbohydrate (except cellulase activity) and protein metabolism and exhibits a direction that dietary fat has some direct role in the alteration of biochemical parameters of other metabolic system in this species of aquaculture importance.

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7. REFERENCES

1. Hossain MK, Latifa GA, Rahman MM. Observation on induced breeding of snakehead murrel *Channa striatus* (Bloch 1793). International Journal of Sustainable Crop Production. 2008; 3: 65-68.
2. Baie SH, Sheikh KA. The wound healing properties of *Channa striatus*– cetrimide cream-wound contraction and glycosaminoglycan measurement. Journal of Ethnopharmacology. 2000; 73:15-30.
3. Mat Jais AM, McCulloh R, Croft K. Fatty acid and amino acid composition in haruan as a potential role in wound healing. General Pharmacology.1994; 25 : 947-950.
4. Wee KL. The biology and culture of snakeheads *In*: Muir JF and RJ Roberts (eds). Recent advances in aquaculture West view Press Boulder Colorado USA. 1982; 180-211.
5. Zakaria ZA, Somchit MN, Sulaiman MR, Mat Jais AM. Preliminary investigation on the anti- nociceptive activity of haruan (*Channa striatus*) fillet extract with various solvent system. Pakistan Journal of Biological Science. 2004; 7(10): 1706-1710.
6. Zuraini A, Somchit MN, Solihah MH, Goh YM, Arifah AK, Zakaria MS, Somchit N, Rajion MA, Zakaria ZA, Mat Jais AM. Fatty acid and amino acid composition of three local Malaysian Channa spp. Fisheries and Food Chemistry. 2006; 97(4) : 674-678.
7. Chacko PI, Kurian GK. On the culture of Ophiocephalus marulius Hamilton in the Coimbatore and Salem Districts Madras. Proceeding of Indian Science Congress. 1947; 34(3) : 180.
8. Alikunhi KH. Notes on the bionomics breeding and growth of the murrel Ophiocephalus striatus (Bloch). Proceeding of Indian Academy of Sciences (B). 1953; 38(I) : 10-20.
9. Alikunhi KH. Fish culture in India. Farm bulletin Indian Council of Agricultural Research New Delhi.1957; p 20.
10. Parameshwaran S, Murugesan VK. Breedìng season and seed resources of murrels in swamps of Karnataka State. Journal of Inland Fisheries Society India. 1976; 8 : 60-67.
11. Johnston IA, Goldspink G. Study of the swimming performance of the Crucian carp Carassius carassius (L) in relation to the effects of exercise and recovery on biochemical changes in the myotomal muscles and liver. Journal of Fish Biology. 1973; 5(2) : 249–260.
12. Driedzic WR, Short CE. Relationship between food availability glycerol and glycogen levels in low-temperature challenged rainbow smelt Osmerus mordax. Journal of Experimental Biology. 2007; 210(16) : 2866-2872.
13. Diwan AD, Hingorani HG, Chandrasekhram Naidu N. Levels of blood glucose and tissue glycogen in two live fish exposed to industrial effluents. Bulletin of Environmental Contamination and Toxicology. 1979; 21 : 269-276.
14. Peres H, Oliva-Teles A. Effect of dietary lipid level on growth performance and feed utilization by European sea bass juvenile (Dicentrarchus labrax). Aquaculture. 1999; 179 : 325–334.
15. Bakthavatsalam R, Srinivasa Reddy Y. Intoxication effects of lidane (T-BHC) on the activities of aspartate aminotransferase (EC 2.6.1.1) and alanine aminotransferase (EC 2.6.1.2) of Anabas testudineus. Pesticide Biochemistry and Physiology. 1982; 18: 226-234.
16. Hemre GI, Sandnes. Effect of dietary lipid level on muscle composition in Atlantic salmon Salmo salar. Aquaculture Nutrition. 1999; 5(1) : 9–16.
17. Cahu C, Zambonino Infante J. Substitution of food by formulated in marine fish larvae. Aquaculture. 2001; 200(1-2) :161-180.
18. Morais S, Bell JG, Robertson DA, Roy WJ, Morris PC. Protein/lipid ratios in extruded diets for Atlantic cod Gadus morhua L Effects on growth feed utilization muscle composition and liver histology. Aquaculture. 2001; 203:101-119.
19. Bell JG, Henderson RJ, Tocher DR, Mcghee F, Dick JR, Porter A, Smullen RP, Sargent J. Substituting fish oil with crude palm oil in the diet of Atlantic salmon (Salmo salar) affects muscle fatty acid composition and hepatic fatty acid metabolism. Journal of Nutrition. 2002; 132 : 222-230.

20. Giri AN, Srivastava DK, Trivedi SP. Insecticide basathrin induced histoanatomical insult of ovarian tissue of Indian catfish Heteropneustes fossilis. Biological Memoirs. 2000; 26 : 20-24.
21. Fagbenro OA. Food composition and digestive enzymes in the gut of pond cultured Clarias isheriensis (Sydenham 1980) (Siluriformes: Clariidae). Journal of Applied Ichthyology. 1990; 6 : 91-98.
22. Krogdahl A, Hemre GI, Mommsen TP. Carbohydrates in fish nutrition: digestion and absorption in postlarval stages. Aquaculture Nutrition. 2005; 11:103-122.
23. Lundstedt LM, Melo JFB, Moraes G. Digestive enzymes and metabolic profile of Pseudoplatystoma corruscans (Teleostei: Siluriformes) in response to diet composition. Comparative Biochemistry and Physiology. 2004; 137B: 331-339.
24. Gaye-Siessegger, Focken U, Becker K. Effect of dietary protein/carbohydrate ratio on activities of hepatic enzymes involved in the amino acid metabolism of Nile tilapia Oreochromis niloticus (L). Fish Physiology and Biochemistry. 2006; 32 : 275–282.
25. Shimeno S, Hosokawa H, Masumoto T, Ando H, Yamanaka H, Ukawa M. Effect of lipid contents in soybean meal diet on growth feed conversion and body composition in juvenile yellowtail. Bulletin of Marine Science and Fisheries , Kochi University. 1995; 15: 51-57.
26. Shimeno S, Hosokawa H, Takeda M. Metabolic response of juvenile yellowtail to dietary carbohydrate to lipid ratios. Fisheries Science. 1996; 62(6) : 945-949.
27. Panserat S, Perrin A, Kaushik SJ. High dietary lipids induce liver glucose-6-phosphatase expression in rainbow trout (Oncorhynchus mykiss). Journal of Nutrition. 2002; 132:137-141.
28. Lesel R, Fromageot C, Lesel M. Cellulose digestibility in grass carp Ctenophyaryngodon idella and in gold fish Carassius auratus. Aquaculture. 1986; 54 :11-17.
29. 29. Saha S, Roy RN, Sen SK, Ray AK. Charaterization of cellulase-producing bacteria from the digestive tract of tilapia Oreochromis mossambica (Pet) and grass carp Ctenopharyngodon idella (Val). Aquaculture Research. 2006; 37 : 380-388.
30. Stickney RR, Shumway SE. Occurrence of cellulase activity in the stomach of fishes. Journal of Fisheries Biology. 1974; 6 : 779-790.
31. Sahoo SK, Giri SS, Sahu AK. Induced spawning of Asian catfish Linn): effect of various latency periods and SGnRHa and domperidone doses on spawning performance and egg quality. Aquaculture Research. 2005; 36(13): 1273-1278.
32. Dubois M, Gilles HA , Hamilton JK, Robers PA, Smith F. Colorimetric method for determination of sugars and related compounds Analytical Chemistry. 1956; 28 : 350-356.
33. Lowry OH, Rosebrough NJ, Farr AL, & Randall RJ. Protein measurement in the folin phenol reagent. Journal of Biological Chemistry. 1951; 193: 265-275.
34. Walter HE. Probionases : Methods with haemoglobin casein and azocoll as substrates In : Bergmeyer H U (Ed) Methods of Enzymatic Analysis Vol - V Verlag Chemic Weinheim. 1984; pp. 270-277.
35. Sawhney SK, Singh R. Introductory Practical Biochemistry Narosa Publishing House. 2000; 452 pp.
36. Thiammaiah SK. Standard Methods of Biochemical Analysis Kalyani Publishers India. 1999; 545 pp.
37. Snedecor GW, Cochran WG. Statistical methods IOWA State University Press Ames IOWA. 1967.
38. APHA. Standard Methods for the Examination of Water and Wastewaters American Public Health Association NW Washington DC. 1998.
39. Vijayan MM, Leatherland JF. Cortisol induced changes in plasma glucose protein and thyroid hormone levels and liver glycogen content of coho salmon (Oncorhynchus kisutch Walbaum). Canadia Journal of Zoology. 1989; 67: 2746-2750.
40. Murthy AS, Devi AP. The effect of endosulfan and its isomers on tissue Protein glycogen and lipid in the fish Channa punctatus. Pesticide Biochemistry and Physiology. 1982; 17: 280-286.
41. Bitterlich G. Digestive enzyme pattern of two stomachless filter feeders silver carp Hypophthalmichthys molitrix Val and bighead carp Aristichthys nobilis Rich. Journal of Fish Biology. 2006; 27(2): 103-112.
42. Bhatnagar A, Shashi R, Sudesh K. Isolation and Influence of Bacillus coagulans CC1 on growth performance and digestive enzyme activites of Catla catla. Journal of Nature Science and Sustainable Technology. 2012; 6(3) : 225-235.
43. Al-Tameemi R, Aldubaikal A, Salman NA. Comparative study of α-amylase activity in three Cyprinid species of different feeding habits from Southern Iraq. Turkish Journal of Fisheries and Aquatic Sciences. 2010; 10 : 411-414.
44. Nayak Jyotiranjan, Viswanathan Nair PG, Ammu K, Suseela Mathew. Lipase activity in different tissues of four species of fish: rohu (Labeo rohita Hamilton) oil sardine (Sardinella longiceps Linnaeus) mullet (Liza subviridis Valenciennes) and Indian mackerel (Rastrelliger kanagurta Cuvier). Journal of the Science of Food and Agriculture. 2003; 83(11): 1139–1142.
45. Cahu CL, Zambonino Infante JL, & Barbosa V. Effect of dietary phospholipid level and phospholipid: neutral lipid value on the development of sea bass (Dicentrarchus labrax) larvae fed a compound diet. British Journal of Nutrition. 2003; 90 : 21-28.
46. Saha AK, Ray AK. Performance of rohu Labeo rohita (Hamilton) fingerlings maintained on alternative feeding of plant and animal protein based diets. Acta Ichthyologica et Piscatoria XXVIII Fase. 1998; 1 : 3-13.

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