

## EFFECT OF VARIOUS FOOD DEPRIVATION REGIMES ON BODY COMPOSITION DYNAMICS OF THAILA, CATLA CATLA

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**Abstract:** The study examined the body composition response with relation to stress induced by different food deprivation regimes. At least a group of five fingerlings of catla were subjected to food deprivation protocols of 0 (control), 15, 30 and 45 days in indoor laboratory aquaria after being acclimatized. Body composition was analyzed by standard procedures. Results revealed that % water and % ash (dry wt) increased while % dry weight, % organic weight, % fat, % protein and % ash (wet wt) decreased significantly.

*Key words:* food deprivation, body composition, Catla catla

### INTRODUCTION

Studies on fish starvation are important for better understanding of the growth biology of fish in wild state <sup>1</sup>. Many species of fish are subjected to a natural starvation period during part of the year and have developed an ability to survive without food <sup>2</sup>. In these species which have been studied the strategy to adapt to dietary deprivation varies considerably. Some fish utilize muscle protein as a major energy source rather than stored glycogen which is maintained by gluconeogenesis <sup>3</sup>, but other conserve body protein at the expense of their fat and glycogen stores <sup>4,5</sup>.

Fish body composition is influenced by several factors i.e. morphological, physiological and environmental and is therefore, a good indicator of condition, which is often assessed from a measure of the deviation of the mass of an individual fish from average mass for length of population <sup>6</sup>.

During starvation essential processes are maintained at the expense of accumulated energy reserves which of course, results in the progressive depletion of body tissue <sup>7</sup>. Starvation results in tissue hydration <sup>2,8,9,10</sup>. This plays a role in the

limitation of the loss or even the maintenance of wet body weight during starvation <sup>2</sup>.

Starvation results in significant decrease in lipid contents of the carcass and viscera. Following depletion of liver lipid stores, lipid contained in perivisceral adipose tissue is utilized along with apaxial muscle glycogen. In fishes, lipid is stored in the liver, viscera, and muscles. Lipids are broken down early in starvation, and often constitute the main energy source for maintenance of fish during over wintering starvation. Lipid depletion during starvation has been demonstrated in rainbow trout <sup>11</sup>.

Metabolic rate of fishes may decrease during food restriction <sup>2,8</sup>. Energy expenditure during starvation of fish can be reduced by decreased locomotion activity <sup>12</sup>. The present study is among a series to investigate the effect of starvation on body composition of *Catla catla* as it is a good indicator of fish's condition in an attempt to correlate with stress physiology, an important science for aqua-culture. Parallel studies looked into the effect of similar food deprivation protocols on other commercial food fishes of Pakistan <sup>13,1</sup>. The main reason for studying the effect of food deprivation protocols on body composition parameters is that the stress response of fishes is species-specific <sup>14</sup>.

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## MATERIALS AND METHODS

Catla used for the experiment were collected from “Govt. Fish seed Hatchery, Muzaffargarh” and were transported live in plastic containers and were maintained in glass stock tanks prior to experimentation. Fish were brought to the Laboratory and acclimatized in the experimental aquaria (36”x12”x15”) for 10 days. Mean temperature of the aquaria was (25°C±2°C). All other parameters of water quality like dissolved oxygen (D.O) and pH were kept constant throughout the study.

Prior to experimentation, at least four groups of fishes were made. They were transferred to separate experimental aquaria and kept individually at a natural photo-thermal regime. After acclimation for 10 days to a mean experimental temperature during which time they were trained to feed regularly on commercial fish diet. The first group used as controlled was *ad libitum* for 45 days. Three experimental groups of fish were subjected to starvation regime of 15, 30 and 45 days (Table 1). At the end of experimental period, the fish were killed, weighed and measured. The fish were dried at 65°C to a constant weight in an electric oven (Memmert 200-Germany) and re-weighed.

Table 1: Principle characteristics of experimental protocol

Temperature (°C)	Mean Fish Size (Cm)	No. of Fish	Starvation Level (days)
25±2	L = 12.6±3	13	0 (control 45 feeding)
25±2	L=13.2±3.3	13	15
25±2	L = 13.5±3	13	30
25±2	L=12.3±2.5	13	45

To calculate ash content in each individual of the group of fish, 50-100 mg of sample was taken in preweighed, heat resistant china clay crucible and heated in muffle furnace (RJM-1000 China) for 24 hours at 550°C and reweighed after cooling.

Percent ash was calculated by the method of Salam and Davies <sup>6</sup>.

The fat contents were estimated using the dry tissue by dry extraction method in which a mixture of 1:2 chloroform and methanol was used following the method of Bligh and Dyer <sup>15</sup>, and Cui and Wootton <sup>16</sup>.

The protein content was calculated by difference from the mass of other main constituents like ash, fat and water following, Caulton and Bursell <sup>17</sup>, Salam and Janjua <sup>18</sup>.

Carbohydrates do not form a major component of fish and are usually present in negligible amount <sup>19,17,20</sup>. No attempt was made to estimate this constituent.

Organic contents were determined by subtracting ash content from dry body weight.

Minitab was used for all statistical analysis log transformation and arcsine transformation was used where required to stabilize the variances <sup>21</sup>. The data was subjected to one way ANOVA.

## RESULTS

The summary of the results is given in Table 2.

### Water Content

There was highly significant effect of starvation on percent water content (df = 3, 43, n = 46, f = 20.09, P <0.001\*\*\*). There was a trend of increase in water contents with increase in number of days of starvation. A rapid increase was observed between 0-30 days, and the rate of increase slowed down between 30-45 days of starvation.

There was highly significant effect of starvation on percent dry weight (df = 3, 43, n = 46, f = 19.88, P <0.001\*\*\*). Percent dry weight showed the opposite trend with water contents.

## Lipid Content

There was highly significant effect of starvation on lipid content (% dry wt) ( $df = 3, 43, n = 46, f = 263.77, P < 0.001^{***}$ ). There was trend of decrease in lipid content (% dry wt) with increase in number of days of starvation. A rapid decrease was observed between 0-15 days, and the rate of decrease slowed down between 30-45 days of starvation.

There was highly significant effect of starvation on lipid content (% wet wt) ( $df = 3, 43, n = 46, f = 30.20, P < 0.001^{***}$ ). The decrease in lipid content (% wet wt) followed the similar trend as % dry weight.

## Protein Content

There was significant effect of starvation on the protein (% dry wt) ( $df = 3, 26, n = 46, f = 3.59, P < 0.1^*$ ). A rapid decrease was observed between 0-30 days, and the rate became constant between 30-45 days of starvation.

There was significant effect of starvation on the protein (% wet wt) ( $df = 3, 26, n = 46, f = 20.45, P < 0.001^*$ ). A rapid decrease was observed between 0-30 days, and the rate of decrease slowed down between 30-45 days of starvation.

## Organic Content

There was highly significant effect of starvation on organic content (% dry wt) ( $df = 3, 43, n = 46, f = 498.22, P < 0.001^{***}$ ). A gradual decrease in organic content (% dry wt) was observed till 45 days of starvation. There was highly significant effect of starvation on organic content (% wet wt) ( $df = 3, 43, n = 46, f = 21.40, P < 0.001^{***}$ ). There was a trend of decrease in organic content (% wet wt) with increase in number of days of starvation. A rapid decrease

was observed between 0-30 days, and the rate of decrease slowed down between 30-45 days of starvation.

## Ash Content

There was highly significant effect of starvation on the ash contents (% dry wt) ( $df = 3, 43, n = 46, f = 295.95, P < 0.001^{***}$ ). A gradual increase in ash content (% dry wt) was observed till 45 days of starvation.

There was highly significant effect of starvation on ash contents (% wet wt) ( $df = 3, 43, n = 46, f = 12.6, P < 0.001^{***}$ ). Ash content (% wet wt) remained constant upto 15 days. A well marked decrease was observed between 15-30 days of starvation and remained almost constant between 30-45 days of starvation.

## DISCUSSION

Food deprivation has diverse effects on tissue and plasma components; the duration of deprivation has an important influence on the way in which energy reserves are utilized and metabolic processes are altered<sup>12,22,23</sup>. The effect of food deprivation on the use of reserve protein, lipid or glycogen as a metabolic fuel seems to be species-specific<sup>5,23</sup>. Two principal groups of fish have been identified on the basis of their metabolic response to starvation; (1) those that use primarily muscle protein as the principal fuel, e.g. eel, *Anguilla anguilla* L.<sup>24</sup>, carp, *Carassius auratus* L.<sup>25</sup>, plaice, *Pleuronectes platessa* L.<sup>27</sup> (2) those that use primarily lipids, e.g. pike, *Esox lucius* L.<sup>11</sup>, *Rutilus rutilus*, L.<sup>22</sup>. However, such a distinction is artificial as endogenous and exogenous factors may influence the choice of metabolic fuel.

In the present study body composition revealed that the quantity of fat decreased progressively as the number of days of starvation increased. When the body composition of starved fish was compared with the control fish, it was observed that there was a significant decrease in

fat content after 45 days. (Fig. 1, Table 2). Similar findings are reported by Wieser<sup>12</sup> on juveniles of *Luerciscus cephalus*, *Chalcolburnus chalcoides mento*, *Scardinius erythrophthalmus* and Ali<sup>1</sup> for *Ctenopharyngodon idella* (Val.). Many investigators are of the view that the first effect of starvation is the mobilization of lipids<sup>26</sup> for *Cyprinus carpio*; Niimi<sup>27</sup> for *Micropterus salmoides*; Larson and Lewander<sup>28</sup> for *Anguilla anguilla*; Stirling<sup>29</sup> for *Dicentrarchus labrax*; Ince and Thrope<sup>5</sup> for *Esox lucius*). Bull and Metcalfe<sup>4</sup> found that periods of food deprivation imposed on juvenile Atlantic Salmon in winter significantly reduced fat level in comparison to control fish.

An inverse relationship between body lipid and water content occurs due to the replacement of catabolized lipid by an equal volume of water. Similar findings are made by Denton and Yousef<sup>31</sup>; Miglavs and Jobling<sup>10</sup>, Quinton and Blake<sup>26</sup> Love<sup>2</sup> pointed out that during starvation, body weight is maintained by water uptake to compensate for organic matter losses. Numerous studies have demonstrated a rise in water content in several fish species during starvation<sup>33,34,27,35,8,9</sup>. In the present study similar trend was observed. The amount of water seems to be inversely related with the quantity of fat inside the body of fish. When compared the water content, it was found that maximum quantity of water was present in starved fish and the minimum in control group (Fig. 1, Table 2). Similar trend was documented in *Esox lucius* L., *Cirrhinus mrigala* and *Ctenopharyngodon idella* (Val.)<sup>6,13,1</sup>.

During starvation it was observed in the present study that there was significant decrease in protein content with different food deprivation protocols. A gradual decrease in protein content (% wet weight) which is largely due to inverse relationship of protein with water in starving fish is well documented<sup>6</sup>. This response is different from the grass carp<sup>1</sup> in which no change in protein contents (% dry weight) was observed. This is in confirmation with the results that the effect of food deprivation on the use of reserved protein, lipid or glycogen as a metabolic fuel seems to be species-specific<sup>5,23</sup>.

A gradual increase in ash contents (% dry weight) was observed during starvation after 45 days as compared to control group in the present study which agrees with the studies of grass carp<sup>1</sup>. There was significant change in ash contents which is different from the response of other species<sup>13,1</sup>. Herrera and Munoz<sup>36</sup> in *Sardia pilchardus* and Phillips and Livingstone<sup>37</sup> in *Salvelinus fontinalis* reported that total ash content increased during starvation for all these species which is in conformity of our results.

It was observed in the present investigations that dry content and organic content decreased during starvation, when compared with control fish. Minimum quantity of organic content and dry content were recorded in fish starved for 45 days. Organic content and dry content decreased due to the utilization of the body constituents as an energy source during starvation Table 2. Similar results were reported for other species by various workers<sup>13,1</sup>. Love<sup>7</sup> reported that although fatty and non fatty fish have different distribution of reserve lipid, both respond to starvation in a similar way in that much of the lipid, whether in liver or muscle drawn upon before the protein is utilized, any reserve of carbohydrate are used first of all. Thus due to change in body component during starvation, change in organic content and dry contents is also expected.

It is concluded that, fish body tried its best through physiological and biological means to buffer the effect of starvation on its body composition. This biochemical strategy to maintain body composition during periods of starvation may be an adaptation to seasonal periods of fasting that many fish experience as part of their natural life cycle<sup>9</sup>. It is further concluded that the response of the different species of the fish in relation to the stress induced by starvation is different. Therefore further studies are required to see this response in all commercially important fish species of Pakistan to draw a complete picture.

Table 2: Effect of starvation on proximate body composition of Thaila, *Catla catla*.

Body Composition Parameters	Control	Starvation (days)		
	0	15	30	45
Water content (%)	78.84 $\pm$ 8.18	83.78 $\pm$ 2.73	90.11 $\pm$ 0.76	91.85 $\pm$ 1.39
Dry content (%)	20.45 $\pm$ 7.93	16.88 $\pm$ 2.79	9.88 $\pm$ 0.76	8.13 $\pm$ 1.38
Organic content				
% Wet weight	14.50 $\pm$ 6.10	10.53 $\pm$ 1.68	5.88 $\pm$ 0.47	4.69 $\pm$ 0.79
% Dry weight	70.89 $\pm$ 0.69	62.45 $\pm$ 0.79	59.50 $\pm$ 1.46	57.77 $\pm$ 0.72
Ash content				
% Wet weight	6.15 $\pm$ 2.40	6.34 $\pm$ 1.12	3.99 $\pm$ 0.38	3.44 $\pm$ 0.62
% Dry weight	29.14 $\pm$ 0.72	37.27 $\pm$ 1.56	40.45 $\pm$ 1.46	42.28 $\pm$ 0.84
Lipid content				
% Wet weight	5.70 $\pm$ 2.24	3.60 $\pm$ 0.68	1.72 $\pm$ 0.59	1.31 $\pm$ 0.24
% Dry weight	26.89 $\pm$ 0.73	21.31 $\pm$ 1.32	19.54 $\pm$ 0.76	16.17 $\pm$ 0.85
Protein content				
% Wet weight	9.28 $\pm$ 3.60	6.94 $\pm$ 1.07	4.36 $\pm$ 0.91	3.38 $\pm$ 0.57
% Dry weight	43.97 $\pm$ 0.83	39.59 $\pm$ 3.54	41.89 $\pm$ 5.85	41.89 $\pm$ 1.37

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