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Skeleton to Muscle Ration in *Labeo rohita* Fed on Conventional and Combinations of Formulated Feed

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Abstract
Fishes have fewer bones and as they are adapted to aquatic environment all bones reflect an adaptation for swimming. A fish is any aquatic vertebrate animal that is typically ectothermic, covered by scales. A fish's skeleton is composed of cartilage or bone. Basically, the skeleton provides a foundation for the body and the fins, encases and protects the brain and the spinal cord, and serves as an attachment for muscles. It contains three principal segments: skull, vertebral column, and fin skeleton. The meat or flesh covering the fish's muscular system is quite simple. All vertebrates, including fish, have three major types of muscles: smooth (involuntary), cardiac (heart), and striated (skeletal). Functionally, there are two kinds: voluntary and involuntary. In fish, the smooth muscles are present in the digestive tract, the air bladder, the reproductive and excretory ducts, the eyes, and other organs. The striated muscles run in irregular vertical bands, and various patterns are found in different types of fish. These muscles compose the bulk of the body and are functional in swimming by producing body undulations that propel the fish forward. The muscle segments, called myomeres, are divided into an upper and a lower half by a groove running along the midbody of the fish while striated muscles are also attached to the base of the fin spines and rays of fish body. In present study, experimental fish *Labeo rohita* was fed on conventional feed and combinations of formulated feed to access skeleton to muscle ratio.

Keywords
Skeleton, muscle, *Labeo rohita*

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INTRODUCTION
Aquaculture, beyond doubt, is the fast-growing food producing sector in the world. The important role of aquaculture is providing aquatic animal protein to make up for the shortfall in capture fisheries, and its socio-economic role in providing livelihood opportunities and economic security, particularly for the less developed regions of the world, is now being strongly recognized globally. The intensification of fish production made it essential to develop complete and supplemental favorable essential amino acid profile diets for use in aquaculture. Traditionally, fishmeal is preferred as dietary protein source for many farmed fish. They are considered most viable alternatives to replace fish feed for economic fish production. However, the threat of disease has now become a primary, constrain and risk to the growth of the aquaculture sector,

significantly impeding both economy and socio-economic development in regions dependent on aquaculture and fisheries.

Fishes have fewer bones and as they are adapted to aquatic environment all bones reflect an adaptation for swimming. A fish is any aquatic vertebrate animal that is typically ectothermic, covered by scales. A fish's skeleton is composed of cartilage or bone. Basically, the skeleton provides a foundation for the body and the fins, encases and protects the brain and the spinal cord, and serves as an attachment for muscles. It contains three principal segments: skull, vertebral column, and fin skeleton. The meat or flesh covering the fish's muscular system is quite simple. All vertebrates, including fish, have three major types of muscles: smooth (involuntary), cardiac (heart), and striated (skeletal). Functionally, there are two kinds: voluntary and involuntary. In fish, the smooth muscles are present in the digestive tract, the air bladder, the reproductive and excretory ducts, the eyes, and other organs. The striated muscles run in irregular vertical bands, and various patterns are found in different types of fish. These muscles compose the bulk of the body and are functional in swimming by producing body undulations that propel the fish forward. The muscle segments, called myomeres, are divided into an upper and a lower half by a groove running along the midbody of the fish while striated muscles are also attached to the base of the fin spines and rays of fish body.

The success of commercial aquaculture operations depends on a variety of factors relating to the fields of biology, engineering and economics. One key biological component is the availability of suitable diets that are efficiently digested and provide the required nutrients for optimum growth (Mokolensang *et al*.,2003). Use of supplementary feed has become inevitable for the success of fish culture. In order to get maximum fish yield from confined water, it is essential to use supplementary feed along with fertilizer and organic manure. Supplementary feeding is known to increase the carrying capacity of culture systems and can enhance fish production by many folds (Devaraj *et al*., 1976). It also offers the best means of fish production within the shortest possible time in the ponds. Attempts have been made to understand the gross level of nutrient requirements viz., proteins, lipids, carbohydrates, vitamins and minerals for Indian major carps (De-Silva and Gunasekera, 1991; Balogu *et al*., 1993; Saeed*, et al* 2005).

Extensive survey of literature shows that no work has been carried on skeleton to muscle ratio in freshwater fish and also in other vertebrates; hence work is pioneer in this area.

MATERIALS AND METHODS

Formulation of feeds:

Fully grown earthworms of species *Eisenia faetida* of about 20 to 30 cm were collected. They were brought to the laboratory, washed, cleaned and weighed. Then they were sacrificed by introducing them in boiling water. Sacrificed earthworms were then squashed using mortar and pastel. Ingredients such as corn flour, milk powder, agar powder, turmeric powder, garlic paste, cumin powder and pepper powder were added. The mixture was boiled till it became semisolid mass. Then it was cooled to room temperature. After cooling vitamin mixture and cod liver oil was added. The mixture in semisolid form was kept in refrigeration at temperature 15^0C for 12 hrs. After 12 hours it was removed from refrigeration, brought to room temperature and then squeezed over polythene sheet and dried for 48 hrs. The dried nodules were crushed into small pellets. Pellets were sun dried to avoid fungal infection, weighted and stored in the bottles.

Experimental protocol

The fingerlings of freshwater fish *Labeo rohita* measuring about 4 to 5 cm in length were obtained from the Fish Seed Rearing Centre, Rankala, Dist. Kolhapur, unit of Department of Fisheries, Government of Maharashtra. After obtaining them, they were brought to the laboratory and acclimatized in rectangular glass aquaria of 36x12" with 60 liters capacity containing aerated water for seven days. During acclimatization adequate aeration was maintained and temperature was maintained from 28^0C to 30^0C. The fishes which survived during acclimatization were distributed randomly into five aquaria (10 in each) and labeled as per the feed combination. They were fed at the rate of 2% of total body weight. The feeding was done once in a day. The body weights and lengths were recorded at each time interval i.e.30, 45, 60, 75 and 90 days throughout the experimental period respectively.

Skeleton to muscle ratio (Davis and Gore, 1936):

After specific time intervals the fishes were weighed and then sacrificed for skeleton to muscle ratio. They were introduced in 4% KOH (Humason, 1962) for specific time interval so that the muscles get dissolved in KOH and only skeleton is left behind. The weight of skeleton was recorded from each group.

Calculation:

To obtain the skeleton to muscle ratio following recordings were taken into consideration:

1. Total body weight of fish (gm)
2. Total weight of skeleton (gm)

Total weight of body muscle is given by the formula,

Total weight of body muscle (g) = Total body weight – Total weight of skeleton

Formula:

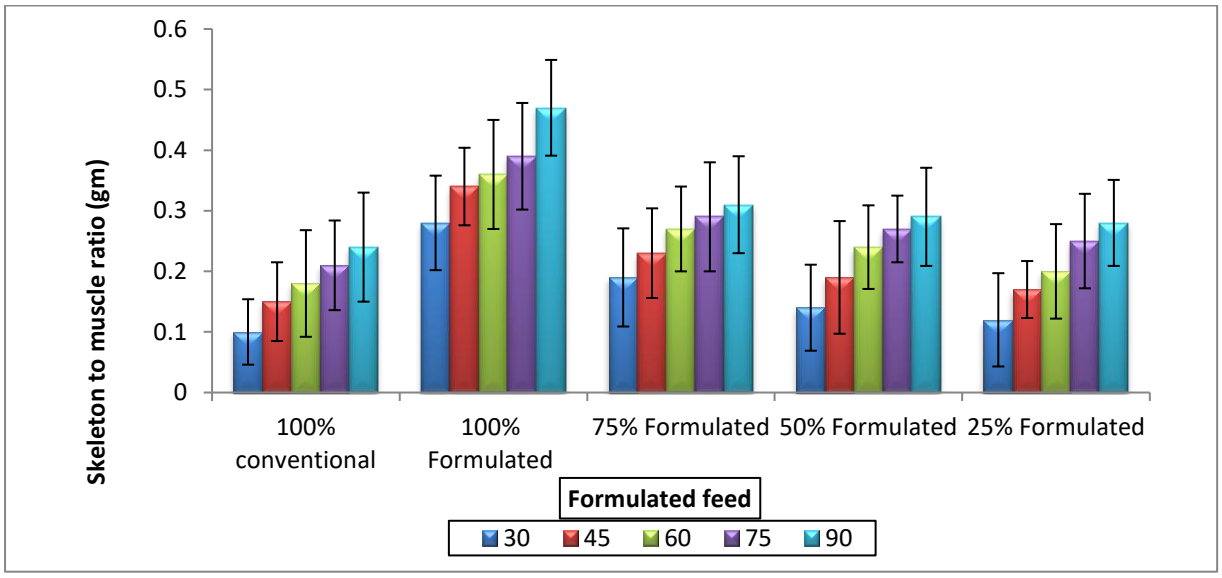
$$\text{Skeleton to muscle ratio (gm)} = \frac{\text{Total Weight of fish skeleton (gm)}}{\text{Total body weight (gm)}}$$

Table No.01: Skeleton to muscle ratio of *Labeo rohita* fed on conventional and combinations of formulated feed:

Duration in days	100% Conventional fish feed	100% Formulated fish feed	75% Formulated fish feed	50% Formulated Fish feed	25% Formulated fish feed
30	0.10±0.054	0.28±0.065**	0.19±0.088***	0.14±0.074***	0.12±0.057***
45	0.15±0.078	0.34±0.064***	0.23±0.090***	0.19±0.088***	0.17±0.079**
60	0.18±0.081	0.36±0.074**	0.27±0.070*	0.24±0.090***	0.20±0.080**
75	0.21±0.071	0.39±0.093**	0.29±0.069*	0.27±0.055*	0.25±0.081***
90	0.24±0.077	0.47±0.047*	0.31±0.078***	0.29±0.078***	0.28±0.071***

(Value expressed is mean of n (n=5); ±: SD)
***P<0.05, **P< 0.01, ***P< 0.001, NS – Non-Significant**

Figure No.01: Skeleton to muscle ratio of *Labeo rohita* fed on conventional and combinations of formulated feed:



DISCUSSION

As the aquaculture industry grows, the need for specialized feeds designed for particular production situations is also increasing. To date, nutritionists and feed manufacturers have concentrated their efforts on determining which of the wide variety of feedstuffs available to the feed industry may be used to produce lower cost aquaculture feeds. Fish farming and aquaculture industries take part in contributing fish protein to large Asian population (Ravenhalt, 1982).

The ability of any fish to digest a given diet and absorption of its nutrients depends on the presence and the quality of digestive enzymes. Although several on-farm feeds are in use in aquaculture, commercial fish feeds manufactured on the basis of proper understanding of digestive physiology of fish are yet to be established for most of the cultured species. As protein utilization is fundamental to growth, proteases have an important role to play in the larval fish as in the adult. The digestive proteases of different species showed variations (which may

influence their digestive capability and feeding habits. De Silva and Anderson (1995) reported amylase increase in rainbow trout fed on high carbohydrate. Dabrowski et al. (1992) reported ten-time higher amylase in the charr *Salvelinus alpinus*, as the feeding was high protein content (65-70%). Other factors than starch can influence the amylase activity in fishes as the degree of gut stuffing the nutritional condition (Munilla-Morán and Stark, 1990), the feeding habit, the age (Munilla-Morán and Stark, 1990; Kuz'mina, 1996), the structural complexity of the carbohydrate (NRC,1993), the temperature and season of the year (Kuz'mina et al., 1996). It is important to consider that higher contents of starch impair the carbohydrate hydrolysis. Fishes are assumed to consume fat-rich food. Thus, the occurrence of lipase in the digestive tract of fishes is justified (et al., 1995). Thus, amylase, protease and lipase activity are related to the feeding habits of fish.

Extensive survey of literature shows that no work has been on skeleton to muscle ratio in freshwater fish and also in other vertebrates', hence our work is pioneering in this area.

CONCLUSION

Aquaculture is an important income-generating sector of many economies with considerable prospects for job creation, poverty alleviation, community development, and food security. It provides fish for domestic markets and for international markets. The domestic market improves national food security, and production for international markets creates employment, provides income, and brings in foreign exchange; thereby indirectly contributing to national food security.

Fish need energy and essential nutrients for maintenance, movement, normal metabolic functions and growth. Fish can obtain their energy and nutrients from natural food in ponds, from feed supplied by the farmer or from a combination of both sources. The feed requirements of fish vary in quantity and quality according to their feeding habits and digestive anatomy as well as their size and reproductive state. So, the variation in nutrient content of feed is important because of the effects it can have in meeting nutritional requirements.

From the overall results it can be concluded that, the fishes from combinations of formulated feed group were having best skeleton to muscle ratio

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