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**Original Article**

# Body Composition and Fatty Acid Profile of Carps under the Influence of Ammonium Nitrate and Feed Supplementation

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## ABSTRACT

Aquaculture plays a significant role in the food requirements of an increasing population. Fertilization, composition of diet and its feeding rates affect the fish meat quality. **Objectives:** To observe the body composition and fatty acid profile of carps towards rice polish and maize gluten supplementation in ammonium nitrate fertilized ponds. **Methods:** Two earthen ponds containing total 55 fishes were selected with each pond stocked with Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Mori (*Cirrhinus mrigala*) at the final ratio of 2:1:1 respectively. Ammonium nitrate and rice polish was the feed in pond 1 while ammonium nitrate and maize gluten were the feed in pond 2. **Results:** Proximate analysis of fish meat samples showed that *Labeo rohita* showed maximum moisture contents in $P_1$ (78.51%) and minimum in $P_2$ (77.27%) in *Hypophthalmichthys molitrix*. Maximum crude protein was recorded as (17.93%) in *L. rohita*, under $P_2$ whereas minimum crude protein was observed in $P_1$ (16.81%) in *L. rohita*. *C. mrigala* remained well-known with minimum fat contents (1.71%) in $P_2$ but maximum (1.96) in *Labeo rohita* in $P_2$. *H. molitrix* gave the major ash contents of (1.85%) in $P_1$ as compared to other experimental fish species. Highest position of carbohydrate contents in $P_1$ was occupied by *H. molitrix*. The most abundant fatty acids recovered were monounsaturated fatty acids (37%) followed by polyunsaturated fatty acids (33%) and saturated fatty acids (29%). **Conclusions:** The body composition and fatty acid profile of carps varies depending upon their diet and feeding rate.

## INTRODUCTION

For the food need of increasing population, aquaculture plays a significant role. Protein production from aquaculture is much more efficient than other protein producing animal production systems. Aquaculture can be defined as crop production in aquatic medium either plant or animal. Aquaculture is source of higher quality protein supply but also improves economic status of rural people in developing countries [1]. Protein is important dietary requirement of human nutrition. Fish is important source of animal protein in human nutrition. Besides protein, fish flesh also contains minerals viz. iodine, phosphorus, copper, iron and vitamin A and D in required concentration. Fish provides healthy diet because it has low carbohydrates [2]. Fish meat is quite useful and different from other meat sources as it is a source of low energy food as well as provides significant level of polyunsaturated fatty acids, high amounts of proteins and long muscle fibers [3]. Body composition is defined as the investigation of water, fat, protein and ash contents. Carbohydrates and non-protein components are also investigated but these are present in very small quantity. The water contents are 70-80%, protein are 20-30% while fats are 2-12% in live fish. These compounds vary considerably from species to species depending upon its physical stage, sex, size,

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feeding and seasonal activity [4]. In modern hasty life, people are more conscious about health than past. Nutritionists are now emphasizing on product quality than the growth of animal. Incorporation of essential fatty acid (EFA) in our daily diet is essential for normal growth and development [5]. Fish and also other see foods are a potential source of white meat for humans as their useful effects are found in coronary heart diseases prevention. This role is particularly due to fats content of fish, which has the ability to convert fatty dienoic acid into useful tetraenoic, pentaenoic and hexaenoic acids. The profile of lipids vary among different species and may even differ between different tissues and organs of same species. While the nature of fatty acids either in form or in neutral lipid form is different in among species based on different water environments [6]. Lipids components in the fish have a potential impact on the preservation period and nutritional value of the fish products. So food scientists and nutritionists need the data of lipid profile and composition of fatty acid to help them in formulation of dietary plan, nutrients labeling and product development and processing [7]. Carps are the rich source of oleic acid, linoleic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). PUFA in carps range from 11.6-15.7% of total fatty acid composition to 32.3-34.5%. Freshwater fish are unique in the variety of fatty acids of which they are composed and degree of unsaturation [8, 9]. Naturally, a great diversity of food is present in water ecosystem to provide nutrition to fish. This food includes both plants and animals. But in pond culture, artificial or supplementary feed is also given to take the best yield of fish. Supplementary feeding increases the carrying capacity of pond and fish yield is increased to many folds. It is also a way to get the best means of fish production in minimum possible time. The quality and quantity of feed taken by fish has great influence upon fish activity, maturation, efficiency of feed conversion and proximate composition of fish [10]. Fertilization of pond by organic and inorganic fertilizers has become very important to increase productivity of fish. Carbon, nitrogen and phosphorus in proper ratios required to raise the economy of fish pond [11]. Inorganic fertilizers added to fish ponds stimulate and maintain the natural productivity by increasing density and population of zooplankton and phytoplankton for fish growth. Therefore, in fertilized ponds, increased fish production can be attributed to increased primary productivity. Inorganic fertilizers are more favorable in fish culture because they have lower loading rates and oxygen demand and higher nutrient content[12].

## METHODS

To evaluate the impact of ammonium nitrate and feed supplementation on body composition and profile of fatty acids of carps, two earthen ponds were selected. Each pond had the dimensions of 25 × 8.5 × 1.5m (length × width × depth) and was located at Fisheries Research Farms, University of Agriculture, Faisalabad. To disinfect the ponds and to stabilize its pH, liming with calcium oxide was done. Each pond contained total 55 fish. Among which 15 were Silver carps (*Hypophthalmichthys molitrix*), 25 Rohu (*Labeo rohita*) and 15 were Mori (*Cirrhinus mrigala*). Pond 1 was treated with ammonium nitrate and rice polish and pond 2 with ammonium nitrate and maize gluten. The feeding rate was 0.3 gN/100gm of fish body weight daily. Supplementary feed was given on daily basis while the fertilizer was applied on weekly basis. At the end of experimental period, final harvest was done and the nine fish samples from each experimental pond were collected. Samples were analyzed for the proximate composition of experimental fish species in terms of moisture, crude protein, total fats, total ash and carbohydrates by using reported the techniques [13] to study the effect of fertilization and supplementary feeds on the meat quality of *Hypophthalmichthys molitrix*, *Labeo rohita*, and *Cirrhinus mrigala*. Head, viscera, bones, fins, scales and tails of these fishes were removed and only their flesh was used for analysis. Fatty acid profile of each fish species was analyzed. Saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids profiles were analyzed by performing the gas chromatography.

## RESULTS

The results of proximate body composition of carps are given in Table 1. In this study, the highest moisture content was observed in the *L. rohita* flesh (77.98%) and lowest moisture content was in the flesh of *H. molitrix* (77.50%). The flesh of *H. molitrix* (17.39%) showed the highest protein contents and lowest protein contents were found in the *C.mrigala* flesh (17.36%). While highest fat contents were found in the meat of *L. rohita* (1.89%) and the lowest fat content were shown by *C. mrigala* (1.78%). The highest contents of ash were found in the *H. molitrix* (1.74%) and lowest were observed in the meat of *L. rohita* (1.40%). The highest carbohydrate contents of *Hypophthalmicthys molitrix* was observed as 1.43 and lowest 1.36% in *L. rohita* .

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**Table 1:** Body composition of carps under the influence of inorganic fertilizer and supplementary feed under two experimental ponds

| Variables | Labeo rohita | | Cirrhinus mrigala | | Hypophthalmicthys molitix | | F-value | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pond 1 | Pond 2 | Pond 1 | Pond 2 | Pond 1 | Pond 2 | Treatment (T) | Species (S) | T×S |
| Moisture | 78.51 | 77.44 | 77.98 | 77.67 | 77.73 | 77.27 | 8.892* | 1.883$^{NS}$ | 1.255$^{NS}$ |
| Crude protein | 16.81 | 17.93 | 17.03 | 17.70 | 16.87 | 17.90 | 25.000** | 0.005$^{NS}$ | 0.547$^{NS}$ |
| Fats | 1.81 | 1.96 | 1.85 | 1.71 | 1.77 | 1.89 | 1.161$^{NS}$ | 2.531$^{NS}$ | 5.887* |
| Ash | 1.36 | 1.45 | 1.74 | 1.56 | 1.85 | 1.64 | 14.805** | 62.469** | 14.155** |
| Carbohydrates | 1.51 | 1.22 | 1.39 | 1.36 | 1.54 | 1.31 | 1.687$^{NS}$ | 0.067$^{NS}$ | 0.298$^{NS}$ |

The fatty acid profiles of *Labeo rohita*, *Cirrhinus mrigala* and *Hypophthalmicthys molitrix*, are given in Tables 2-4. The fatty acids recovered were saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). The predominant fatty acids in three samples were 16:0 (SFA) and 18:1 n-9 (MUFA). Total saturated fatty acids content was 29% in all the samples. The majority of this group was comprised of 16:0, then 18:0 and 14:0. The monounsaturated fatty acids accounts for 37% of all fatty acids in all samples and the main fatty acid found among this group was 18:1 n-9 followed by the 16:1 n-7 and then 18:1 n-7. In case of polyunsaturated fatty acids, it comprised 33% of the total fatty acids and the main fatty acids of this group found was 18:2 followed by 22:6 and 20:5. The overall contents of fatty acids were higher in *Labeo rohita* compared to other two species. *Labeo rohita* showed 79% highly significant, 13% significant and 8% non-significant difference of total fatty acids (Table 2) followed by 79% highly significant, 8% significant and 13% non-significant in *Cirrhinus mrigala* (Table 3) and 75% highly significant, 8% significant and 17% non-significant in *Hypophthalmicthys molitrix* (Table 4).

**Table 2:** Fatty acid profile of meat of *Labeo rohita* from two experimental ponds

| Fatty acids | *Labeo rohita* | | | |
|---|---|---|---|---|
| | P1 | P2 | t-value | Prob. |
| 14:0 | 1.23±0.067 | 2.02±0.012 | -11.56** | 0.000 |
| 15:0 | 0.07±0.006 | 0.11±0.007 | -4.16* | 0.014 |
| 16:0 | 21.37±0.240 | 23.33±0.176 | -6.60** | 0.003 |
| 17:0 | 0.49±0.041 | 0.88±0.012 | -9.17** | 0.001 |
| 18:0 | 5.14±0.108 | 6.02±0.015 | -8.06** | 0.001 |
| 20:0 | 0.39±0.009 | 0.43±0.012 | -2.24 | 0.089 |
| 24:0 | 0.71±0.012 | 0.77±0.010 | -4.05* | 0.015 |
| 14:1 | 0.25±0.012 | 0.32±0.015 | -3.77* | 0.020 |
| 15:1 | 0.71±0.012 | 0.89±0.009 | -12.16** | 0.000 |
| 16:1(n-9) | 1.31±0.003 | 0.61±0.009 | 73.54** | 0.000 |
| 16:1(n-7) | 5.08±0.044 | 6.01±0.012 | -20.49** | 0.000 |
| 17:1 | 0.28±0.019 | 0.39±0.009 | -5.35** | 0.006 |
| 18:1(n-9) | 23.14±0.020 | 25.16±0.081 | -24.22** | 0.000 |
| 18:1(n-7) | 3.48±0.017 | 4.00±0.015 | -23.52** | 0.000 |
| 20:1 | 1.59±0.009 | 1.73±0.015 | -7.84** | 0.001 |
| 22:1 | 0.14±0.003 | 0.20±0.009 | -5.66** | 0.005 |
| 18:2 | 10.90±0.015 | 13.57±0.067 | -39.13** | 0.000 |
| 20:2 | 0.49±0.012 | 1.30±0.009 | -53.89** | 0.000 |
| 20:4 | 1.41±0.012 | 1.99±0.007 | -42.69** | 0.000 |
| 18:3 | 1.40±0.003 | 1.51±0.009 | -12.37** | 0.000 |
| 20:3 | 0.69±0.012 | 0.96±0.010 | -17.48** | 0.000 |
| 20:5 | 4.32±0.012 | 3.56±1.325 | 0.57 | 0.599 |
| 20:5 | 1.32±0.009 | 1.95±0.009 | -50.51** | 0.000 |
| 22:6 | 7.89±0.009 | 8.89±0.006 | -95.18** | 0.000 |

**Table 3:** Fatty acid profile of meat of *Cirrhinus mrigala* from two experimental ponds

| Fatty acids | *Cirrhinus mrigala* | | | |
|---|---|---|---|---|
| | P1 | P2 | t-value | Prob. |
| 14:0 | 1.70±0.012 | 2.12±0.012 | -25.40** | 0.000 |
| 15:0 | 0.32±0.009 | 0.59±0.009 | -21.65** | 0.000 |
| 16:0 | 20.17±0.088 | 21.07±0.067 | -8.14** | 0.001 |
| 17:0 | 0.08±0.009 | 1.59±0.009 | -121.07** | 0.000 |
| 18:0 | 4.08±0.044 | 4.60±0.017 | -10.91** | 0.000 |
| 20:0 | 0.40±0.009 | 0.32±0.012 | 5.37** | 0.006 |
| 24:0 | 0.62±0.010 | 0.71±0.010 | -6.36** | 0.003 |
| 14:1 | 0.29±0.009 | 0.32±0.012 | -2.29 | 0.083 |
| 15:1 | 0.74±0.012 | 0.82±0.012 | -4.60* | 0.010 |
| 16:1(n-9) | 1.15±0.009 | 1.02±0.017 | 7.25** | 0.002 |
| 16:1(n-7) | 4.27±0.003 | 4.45±0.009 | -19.80** | 0.000 |
| 17:1 | 0.19±0.006 | 0.24±0.012 | -4.00* | 0.016 |
| 18:1(n-9) | 22.40±0.58 | 21.95±0.029 | 6.97** | 0.002 |
| 18:1(n-7) | 3.47±0.088 | 3.73±0.067 | -2.41 | 0.073 |
| 20:1 | 1.92±0.009 | 1.80±0.009 | 9.62** | 0.001 |
| 22:1 | 0.18±0.009 | 0.15±0.007 | 2.71 | 0.053 |
| 18:2 | 12.40±0.012 | 13.51±0.006 | -85.98** | 0.000 |
| 20:2 | 0.66±0.007 | 0.16±0.009 | 44.62** | 0.000 |
| 20:4 | 0.46±0.009 | 0.67±0.009 | -16.84** | 0.000 |
| 18:3 | 1.60±0.009 | 1.40±0.009 | 16.57** | 0.000 |
| 20:3 | 0.74±0.012 | 0.67±0.009 | 4.70** | 0.009 |
| 20:5 | 3.17±0.009 | 3.31±0.007 | -13.27** | 0.000 |
| 20:5 | 1.39±0.007 | 1.61±0.012 | -15.52** | 0.000 |
| 22:6 | 17.42±0.009 | 18.27±0.145 | -5.84** | 0.004 |

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**Table 4:** Fatty acid profile of meat of *Hypophthalmichthys molitrix* from two experimental ponds

| Fatty acids | *Hypophthalmichthys molitrix* | | | |
|---|---|---|---|---|
| | P1 | P2 | t-value | Prob. |
| 14:0 | 1.38±0.009 | 1.91±0.009 | -42.49** | 0.000 |
| 15:0 | 0.07±0.012 | 0.06±0.006 | 1.00 | 0.374 |
| 16:0 | 20.20±0.115 | 21.71±0.007 | -13.03** | 0.000 |
| 17:0 | 0.60±0.009 | 0.73±0.015 | -7.26** | 0.002 |
| 18:0 | 5.33±0.020 | 5.50±0.009 | -7.69** | 0.002 |
| 20:0 | 0.36±0.007 | 0.45±0.015 | -5.63** | 0.005 |
| 24:0 | 0.62±0.012 | 0.72±0.009 | -6.26** | 0.003 |
| 14:1 | 0.31±0.009 | 0.35±0.003 | -3.54* | 0.024 |
| 15:1 | 0.71±0.007 | 0.79±0.006 | -8.69** | 0.001 |
| 16:1(n-9) | 1.06±0.009 | 1.09±0.009 | -2.41 | 0.074 |
| 16:1(n-7) | 3.51±0.003 | 3.92±0.012 | -32.87** | 0.000 |
| 17:1 | 0.24±0.009 | 0.41±0.007 | -15.98** | 0.000 |
| 18:1(n-9) | 25.41±0.007 | 26.81±0.007 | -148.49** | 0.000 |
| 18:1(n-7) | 3.09±0.003 | 3.44±0.009 | -36.42** | 0.000 |
| 20:1 | 1.93±0.033 | 1.85±0.009 | 2.51 | 0.066 |
| 22:1 | 0.03±0.009 | 0.06±0.009 | -2.41 | 0.074 |
| 18:2 | 12.60±0.009 | 13.02±0.009 | -33.67** | 0.000 |
| 20:2 | 0.28±0.009 | 0.80±0.009 | -41.69** | 0.000 |
| 20:4 | 0.81±0.006 | 0.68±0.292 | 0.43 | 0.687 |
| 18:3 | 1.60±0.006 | 1.70±0.003 | -14.50** | 0.000 |
| 20:3 | 0.97±0.009 | 1.05±0.009 | -6.41** | 0.003 |
| 20:5 | 2.16±0.007 | 3.19±0.009 | -93.17** | 0.000 |
| 20:5 | 1.82±0.012 | 1.93±0.015 | -5.48** | 0.005 |
| 22:6 | 10.13±0.015 | 11.52±0.012 | -75.08** | 0.000 |

## DISCUSSION

Meat excellence is a crucial feature for accomplishing the food requirements in any population. Different factors including fertilization, composition of diet and also the feeding rates affect ecosystem of pond and eventually the quality and quantity of fish meat [14, 15]. In this study, to observe the body composition and fatty acid profile of carps towards supplementation of rice polish and maize gluten along ammonium nitrate fertilizer, two earthen ponds were selected. Each pond containing total 55 fishes was stocked with Silver carp (*Hypophthalmichthys molitrix*), Rohu (*Labeo rohita*) and Mori (*Cirrhinus mrigala*) at the respective ratio of 1:2:1. Pond 1 was treated with ammonium nitrate and rice polish while pond 2 was treated with ammonium nitrate and maize gluten. Then the samples were analyzed for the proximate composition of experimental fish species in terms of moisture, crude protein, total fats, total ash and carbohydrates. While the fatty acid profile of each fish species was analyzed by gas chromatography. The body composition of meat showed that *Labeo rohita* in pond 1 had maximum content of moisture (78.51%) and minimum (77.27%) was observed in pond 2 in *Hypophthalmichthys molitrix*. Highest crude protein (17.93%) was observed in *L. rohita* in pond 2 whereas lowest crude protein (16.81%) was found in *L. rohita* in pond 1. The results were confirmed by another study who reported higher moisture and protein contents in *L. rohita* [16]. Hassan *et al.*, also reported higher protein contents in *Labeo rohita* [14]. *C. mrigala* remained well-known with minimum fat contents (1.71%) in pond 2 but maximum (1.96%) in *Labeo rohita* in pond 2. *H. molitrix* gave the major ash contents of (1.85%) in pond 1 as compared to other experimental fish species. Lowest ash contents (1.36%) were observed in *L. rohita* in pond 1. Highest position of carbohydrate (1.54%) contents in pond 1 was occupied by *H. molitrix* while lowest (1.22%) in *Labeo rohita* in pond 2. Balaswamy *et al.*, also reported the same results [17]. The predominant fatty acids in all fish samples among all fatty acid groups were 16:0 (SFA) and 18:1 n-9 (MUFA) [18]. In group of saturated fatty acids, the major fatty acids found were 16:0 followed by 18:0 and 14:0 similar to the findings of Luczynska *et al.*, study [19]. 18:1 n-9 was the most prevalent fatty acid of monounsaturated fatty acids group that was followed by 16:1 n-7 and 18:1 n-7 [20]. In case of polyunsaturated fatty acids group, the abundant fatty acids founds were 18:2, 20:5 and 22:6. The results of this study are also correlated with two other studies who reported abundance of same fatty acids among polyunsaturated fatty acids group [21, 22]. A study involved the evaluation of fatty acid profile in pike perch showed that it was a potential source of polyunsaturated fatty acids and omega-3 oils [21]. Another study included evaluation of fatty acid profile of marine and freshwater fish that showed higher percentage of omega-3 series in marine fish and higher content of omega-6 series in fresh water fish [22].

## CONCLUSIONS

Diet composition and feeding rates affect the fish meat quality. The body composition and profile of fatty acids in carps varies depending upon their diet and feeding rate. Overall *Labeo rohita* showed higher moisture and protein content. *C. mrigala* had minimum fat contents and *H. molitrix* gave the major ash contents. *H. molitrix* had the major carbohydrate contents while their feed was ammonium nitrate and rice polish.

## Authors Contribution

Conceptualization: JR
Methodology: MAAT, RK
Formal analysis: SK, SM, SH
Writing-review and editing: JR, SK, SH, SM

All authors have read and agreed to the published version of the manuscript.

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## Conflicts of Interest

The authors declare no conflict of interest.

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