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Evaluation Of Crude Lipid And Carbohydrate Content In Exotic Major Carps With Relation To Their Age.

Rajesh[1], Shishir K. Verma[2]
1(University Department Of Zoology, Lnmu, Darbhanga, Bihar, 846004)
2(University Department Of Zoology, Lnmu, Darbhanga, Bihar, 846004)

Abstract
Proximate content of fish varied widely from species to species and within the same species from one individual to another individual. This individual variation is normally due to some factor such as size, age, season, sex and geographical location. The fat includes a mixture of saturated and unsaturated fats. Compared to carbohydrates and protein fats provide more than twice the amount of calories. Lipids are the heterogenous group of compound, extracted with solvent of low polarity. Carbohydrates are fundamental source for energy, the breakdown of protein, and to shield the body from poisons. Many researchers recorded that the exotic major carps are the good source of crude lipid and carbohydrates. The present study relates to crude lipid and carbohydrates in three species of exotic major carps i.e. ***Silver carp (Hypopthalmichthys molitrix), Common carp (Cyprinus carpio) and Grass carp (Ctenopharyngodon idella)*** *with related to their age in Darbhanga region, Bihar from March 2019 to Feb 2020 period. It is recorded that with advancing age the weight of Silver carp* ***(969.57±3.07)*** *increases more than the Grass carp* ***(836.78±1.86)*** *and Common carp* ***(683.33±2.11).*** *lipid content in all the three carps are increases with increases in age or weight of the carps. Maximum lipid content at the age of 16 months of different fishes are* ***6.1±0.49, 5.9±1.06*** *and* ***4.0±1.06 (per 100 gram)*** *of common cap, grass carp and silver carp respectively. Reverse trend was recorded for the carbohydrate content in fishes with advancing age. Carbohydrate content decreases with advancing age. Maximum carbohydrate content was recorded at early stage of life. Maximum carbohydrate content was recorded in common carp* ***(3.50±1.07)****, grass carp* ***(3.07±1.21)*** *and silver carp* ***(1.57±1.29)****.*

Keywords: *Crude lipid, Carbohydrate, Advancing age, Exotic carps, Calories.*

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I. Introduction

Studies on nutritional value of fishes, since a long time, has been a topic of extensive studies and abundant information are available on this account at national and international level. However, it also deserves special mentions that the biochemical profile viz. a nutritional value of fish is absolutely dependent on quality of food taken up by the individual fish. One of the recent work points out that the proximate composition changes as per age, sex, accessibility of food, climate, season, body area and the phases of development (Chaijan *et al.,* 2010). The work highlights the significance of the present work. In this back drop, three exotic carps viz. Silver carp, Grass carp and Common carp were selected for analysis of the proximate content being cultured in Darbhanga district, North Bihar.

Dahl *et al*., (2006) pointed out "Fish as food is now well recognized as the most significant dietary supplement for quality of protein, lipid and minerals". Consequently, per capita consumption of fish increased tremendously all over the Globe. The overall scenario reflects that whole fisheries sector is tremendous pressure to cope with the individual demand ratio.

From human consumption point of view that the best fats are those that contain essential fatty acids. So named, because without them we die (Larson, 2004). Essential fatty acids are poly unsaturated and grouped in omega-6 EFAs and Omega-3 EFAs. Both the groups have little difference in them molecular structure that make them act differently inside the body system. We do need both these EFAs but in certain ratio (Simopoulus, 1991).

With the recognition of benefits of EPA and DHA during 1970s, a number of papers have came up with therapeutic recommendation for fish consumption (Conor,2000; Digiacomo *et al.,* 1989; Levine, 1997; Kalmiju 1997; Yehuda *et al*., 1996; Edward, 1998 and Hibbelu, 1998).

Lipid is the third significant constituent in fish muscle. Fats are significant for building block in skin, body oils and chemicals. It protects and cushions inner organs, conveys fat-dissolvable nutrients all through the body, helps fix harmed tissue and battle diseases. Variety in the fat substance is a lot more extensive than that of protein. Fat substance are variable in different species as well as in various organs. Fish with fat substance as

low as 0.5% and as high as 18-20% are normal. The fat in fish contains a bigger segment of Omega 3 and other unsaturated fats that are more grounded than the soaked fat of red meat (Das *et al*., 2010).

According to Jobling *et al.,* 2008 and Turchini *et al.*2009; Fish diet has a major impact on the chemical composition of fish tissues and especially on the fatty acid (FA) composition of the fish lipids. Some environmental factors such as Temperature, water quality, season and some internal factors such as size and age of the fish also affects the fatty acid composition of fish. The impact of diet on the FA composition in fish tissue has been examined in numerous farmed and wild fish species explained by Grigorakis *et al.*, (2002), Alasalvar *et al*., (2002) and Jensen *et al.*, (2007).

It is the fundamental fuel source and metabolic introduction for the consuming of fat. Carbohydrates are fundamental for energy, the breakdown of protein, and to shield the body from poisons. Glucose frames part of the monosaccharide. Glucose powers the body's synthetic cycles. Polysaccharides are made out of monosaccharide atoms. They are called complex sugars and are found in natural product, vegetables and grain that are important for the fundamental supplements.

Carbohydrates can be assembled into two classifications: basic and complex. Straightforward starches are sugars while complex carbohydrate comprise of starch and dietary fiber. Carbohydrate gives around 4 (kcal = kilocalories = Calories) per gram (with the exception of fiber) and is the energy that is utilized first to fuel muscles and the cerebrum.

II. Materials And Methods

Procurement Of Fish:

All the three exotic major carps under study were procured from local fish culture ponds in every month. In order to ensure that every month, the fishes were cultured in the same habitat and same feeds were available. The size of fishes, obviously varied every month with their growth. Fishes were transported alive to the Toxicology Laboratory, Department of Zoology, L. N. Mithila University, Darbhanga, Bihar. To determine proximate composition differences between species, different groups were managed and analyzed separately during the experiment. Study was divided into two parts i.e. morphometric analysis and proximate analysis.

Fish samples of Common carp (***Cyprinus carpio***), Grass carp (***Ctenopharyngodon idella***) and Silver carp (***Hypophthalmichthys molitrix***) were collected on a monthly basis from Local fish Fish pond (Sonki barki pokhar) Darbhanga, Bihar from March 2019 to Feb 2020 period.

Morphometric Measurement:

Divider and measuring board, having graduations in millimeter have been used for various measurements. Eighteen morphometric characters were studied following the standard procedures described Appa Rao (1966), as well as Dwivedi and Menezes (1974).

A total of 36 specimens of Silver carp from five month old to sixteen month old ranging in size from 24.2-55.9 cm in total length (TL) and 369.1±2.32 to 1762.8±4.36g in weight were used for the experiment as shown in table 1. In the start of experiment (March 2019) the age of Silver carp was five old months and total weight of experimented sample was 885g.

Similarly, 36 specimens of Grass carp (Table 2) and Common carp (Table 3) from 16.4 to 55.2cm and 18.3 to 58.1cm in total length (TL) with 215.5± 1.01g to 1542.6±2.01g and 201.8±1.6 to 1264.2±2.02g of weight respectively, were used for experiments (Table 2 and 3). In the start of experiment (March 2019) the age of Grass carp and Common carp was five months old and total weight of experimented sample was 512.1 and 495.6g respectively.

Average weight of samples:
Silver carp > Grass carp > Common carp
969.57±3.07 > 836.78±1.86 > 683.33±2.11

Estimation Of Crude Lipid:

Crude lipid was estimated by continuous Soxhlet extraction technique by using petroleum ether (40-60°C B.P.) as solvent. Finely dried sample of fish flesh (2g) was placed in fat extraction thimble and placed in a clean, dry pre-weighed beaker to which 80 ml petroleum ether was added. This beaker was placed in the Soxhlet assembly for the extraction of fat for 2-3 hours. After extraction the beaker was removed and kept in hot air oven (100°C) allowing the traces of solvent to evaporate. It was then transferred to a Desiccator, cooled and reweighed. The difference between the weight gave the quantity of crude fat extracted from the sample. The result was expressed in percent on dry weight basis.

A schematic representation has been presented as follow:
2 g of Pre dried (moisture free) sample is taken into extraction thimble

Put the sample into extraction thimble
A boiling flask (pre weighed) is kept on heating mantle
Anhydrous ether was added in boiling flask and reweight it (up to level of siphon's tube)
Boiling flask, soxhlet flask and condenser assembled
Extraction is allowed in soxhlet extractor at a rate of 5-6 drops per second for about 4 hour by heating (rate of extraction is regulated by controlling heat)
Boiling flask with extracted fat is dried in an air oven at 100ºC for 30 minutes
Cool it in dessicator and weight the flask

$$\%\ of\ fat\ on\ dry\ weight\ basis = \frac{\text{g of fat in sample}}{\text{g of dried sample}} \times 100$$

Calorific value = % of crude lipid × 9.45

ESTIMATION OF CARBOHYDRATE:

Estimation of carbohydrate was done by Anthrone reagent method.

Procedure:

1g of fish tissue sample is taken in boiling tube.
The sample was added with 0.5ml of 2.5N HCl and placed in boiling water for 3hrs allowing it to hydrolysed
Cool at room temperature
Neutralized it with solid sodium carbonate until effervescence cease
Made the volume 100ml by adding distilled water and centrifuged
The supernatant is collected and 0.2 to 1ml of this supernatant is taken for analysis.
0.2-1ml of working standard is added to the supernatant
1ml of water serve as blank
Made up the volume to 1ml in al tubes with distilled water
4ml of Anthrone reagent is added
Cool rapidly and read the green to dark green colour at 630 nm

Calculation: standard graph was drawn by taking the concentration of glucose on X axis and spectrophotometer reading on Y axis. From the graph the concentration of glucose in the sample was calculated.

Calorific value = % of carbohydrate × 4

III. Results And Discussion

Morphometric Analysis:

Morphometric analysis of the present exotic carps like Silver carp, Common carp and Grass carp were made at the following parameters:

a. Age
b. Weight
   i. Weight of head and tail
   ii. Weight of body part
c. Weight of sample taken for present experiment.

The findings have been presented in table 1 (Silver carp), table 2 (Grass Carp) and table 3 (Common carp). The table 1, depicts that first sample of the Silver carp (Five months old) measured about 369.1±2.32 g having a length of 24.2 cm. At the end of experiment (sixteen months old) fish weighed 1762.8±4.36g with a length of 55.9cm (Table 1). A total of 36 samples were studied during total study period (3 fish in each month).

Similarly, a total of 36 samples of Grass carp were sampled all through. The length of five month old Grass carp was tabulated as 16.4cm having weight of 215.5±1.01. The same fish on attainment of 16 months of age weighed around 1542.6±2.01g with a length of 55.2cm (Table 2).

Again, 36 samples of Common carps were taken for experiment having a length of 18.3 cm with a weight of 201.8±1.6g at the age of 5 month old. The total length and weigh of Common carp in 16 months age was 58.1cm and 1264.2±2.02g respectively (Table 3).

Tables 1, 2 and 3, also depicts the average weight of the fish taken for analysis of the proximate content of all the three fish.

Estimation Of Crude Lipid:

The results of lipid content in present fishes have been presented in Table 4. The maximum lipid content was recorded in Grass carp as 7.81±1.48 in 16 month old fish followed by Common carp being (7.5±0.42). At the attainment of adulthood (16 months old) the Silver carp exhibited maximum lipid content (5.4±1.12). At the age of 5 months, when the present fish usually show a low biochemical profile, the lipid content was recorded as 3.2±1.12, 4.4±0.41 and 4.51±1.01 in Silver carp, Common carp and Grass carp respectively (Graph 1). This indicates an increase of 2.2g in Silver carp, 3.1 in Common carp and 3.3 in Grass carp on attainment of adulthood (16 months). This also indicates an increase of 0.25g of lipid per month.

In general, the average lipid content in present fish (5 to 16 months) was recorded to be maximum in Common carp (6.1 ± 0.49), followed by Grass carp (5.9±1.06) and Silver carp (4.0±1.06) (Table 4 and Graph 1).

Barros *et al*., (2000) and Yildirim *et al*., (2003) examined that the fat contents are associated closely to gained weight and inversely linked with moisture content of the body. Bumb, (1992) concluded that availability of food in different season affect the biochemical composition of fish particularly fat.

Gokee *et al*., (2004) and Sargent, (1995) concluded that the fat content increase as fishes gain weight and change in reproductive cycle. Renata and Waldemar, (2018) classified the Grass carp as medium fat fish having low calorific value among Siberian sturgeon, big headed carp and wels catfish. According to Sinclair and Duncan (1972) lipid is the most reserve food materials in fishes. Barros *et al*., 2000 and Yildirim *et al*., 2003 concluded that fat content are associated closely to gained weight and inversely linked with moisture content of the body. Choudhary *et al*., (2018) reported variation in proximate content in Common carp and Silver carp and valuated that variation could be due to certain factors such as different habitat, availability of food and water quality.

Kumar in 1992, recognized that fishes are the excellent food source for human beings for centuries and is preferred as a perfect diet not only due to its excellent taste and high digestibility but also because of having higher lipids proportions of unsaturated fatty acids, essential amino acids and minerals for the formation of functional and structural proteins.

Studies on growth performance of exotic carps (Silver carp, Common carp and Grass carp) and also the nutritional values of these fishes was extended by Singh *et al.,* (2013). They recorded 73.78-74.2% moisture, 17.1-17.64% protein, 2.24-2.4% crude fat and 6.1-6.3% of ash in Silver carp. In Grass carp and Common carp, they recorded 73.33-74.15 and 73.64-74.08% moisture, 17.38-18.12 and 17.5-18.24% protein, 2.29-2.35 and 2.1-2.16 crude fat, 6.1-6.4 and 6.0-6.4% of ash respectively.

Estimation Of Carbohydrates:

The findings have been presented in Table 5 and Graph 2. In contrast to the previous findings the carbohydrate content in fish was recorded be highest in the month of March at the 5 months. The carbohydrate level decreases with increase in age of the fish. The maximum level in all the three fish was recorded as 6.98±2.02, 4.56±1.12 and 2.31±1.98 in Grass carp, Common carp and Silver carp respectively (Table 5 and Graph 2). The value decreases to 1.25±0.88, 2.48±1.25 and 0.5±0.91 in all the three fishes mentioned above. The findings suggest that the fish, Silver carp, on attainment adulthood (16 months) exhibit minimum level of carbohydrate followed by Grass carp (1.25±0.88g) and Common carp (2.48±1.25g). This indicate that the adult Common carp have maximum carbohydrate content (4.56±1.12) (Table 5 and Graph 2).

An average of the carbohydrate content in present fish (5-16 months of age) is recorded as 3.50±1.07, 3.07±1.21 and 1.57±1.29 in Common carp, Grass carp and Silver carp respectively. The lowest value to carbohydrate is seen in case of Silver carp (Table 5) on attainment of 16 months. Thus in general, the data suggest that value of carbohydrate gradually decreases with increase in weight of fish (carps).

Unlike lipid contents all the three species exhibit a higher level of carbohydrate during early stages of life i.e. five to eight months (March, April, May and June) thereby a steady fall is observed (Table 5 and Graph 2). The average gain of carbohydrate content per month has been tabulated to be 0.15g (Silver carp), 0.17g (Common carp) and 0.47g (Grass carp) respectively. This may be mentioned that the present fishes exhibit a gain of 0.025g, 0.04g and 0.31g (Silver carp, Common carp and Grass carp respectively) during early stages of present study (Five to Eight months old). But the same fish with advancing age show a minimal gain of 0.12g, 0.10g and 0.14g (Silver carp, Common carp and Grass carp respectively) during later stages of present study (Nine to Sixteen months old).

It has been already mentioned that carbohydrate content is utilize mainly for immediate energy requirement. As fishes grow in size to become adult, their energy requirement also increases simultaneously consuming more carbohydrate reserves. Thus the reason of low carbohydrate profile in all the present species during adult condition may be attributed to high energy utilization.

Carbohydrate content of fish is affected by some environmental and physiological factors like seasons and feed intake. Seasonal differences in the availability of food and changes in the reproduction cycle have considerable effect on the tissue biochemistry of the fish, particularly fat (Bumb, 1992). Bumb (1992) also analyzed the variation of carbohydrate content with feed intake and found that intensive feeding in *Ambassis commersoni* coincides with the occurrence of high carbohydrate content in the muscle of fish.

Table 1. Weight and morphometric details of Silver carp sampled during March 2019 to Feb 2020.

Months (2019-20)	Age (in months)	Weight of sample in g. (A)	Weight of head and tail in g. (B)	Body weight in g. (C=A-B)	No. of samples (D)	Weight of sample for experiment in g. (D×C)	Total length of fish sample in cm.
March	5	369.1±2.32	74.1	295	3	885	24.2
April	6	442.7±2.08	88.2	354.5	3	1063.5	26.1
May	7	548.2±2.58	102.2	446	3	1338	30.6
June	8	641.6±3.12	122.6	519	3	1557	32.5
July	9	756.3±2.58	140.3	616	3	1848	34.9
Aug	10	846.1±3.25	170.2	675.9	3	2027.7	36.2
Sept	11	948.7±3.48	196.9	751.8	3	2255.4	39.6
Oct	12	1068.3±2.58	226.4	841.9	3	2525.7	42.1
Nov	13	1210.5±3.45	265.6	944.9	3	2834.7	44.9
Dec	14	1376.4±3.78	301.3	1075.1	3	3225.3	48.1
Jan	15	1564.1±3.28	336.4	1227.7	3	3683.1	51.7
Feb	16	1762.8±4.36	382.6	1380.2	3	4140.6	55.9
Average		**969.57**±3.07	**200.57**	**760.59**	**3**	**2282.0**	**39.03**

Table 2. Weight and morphometric details of Grass carp sampled during March 2019 to Feb 2020.

Months (2019-20)	Age (in months)	Weight of sample in g. (A)	Weight of head and tail in g. (B)	Body weight in g. (C=A-B)	No. of samples (D)	Weight of sample for experiment in g. (D×C)	Total length of fish sample in cm.
March	5	215.5±1.01	44.8	170.7	3	512.1	16.4
April	6	305.4±1.25	58.8	246.6	3	739.8	19.1
May	7	415.5±1.36	80.8	334.7	3	1004.1	23.3
June	8	520.1±2.36	99.8	420.3	3	1260.9	26.7
July	9	626.7±1.08	120.2	506.5	3	1519.5	30.1
Aug	10	748.3±2.01	142.3	606.0	3	1818.0	34.8
Sept	11	880.1±2.33	168.6	711.5	3	2134.5	38.7
Oct	12	996.3±3.02	198.8	797.5	3	2392.5	42.2
Nov	13	1126.4±2.98	221.3	905.1	3	2715.3	46.6
Dec	14	1266.2±1.98	262.5	1003.7	3	3011.1	49.4
Jan	15	1398.3±1.87	301.2	1097.1	3	3291.3	52.1
Feb	16	1542.6±2.01	339.6	1203.0	3	3609.0	55.2
Average		**836.78**±1.86	**169.89**	**666.89**	**36**	**2000.68**	**36.21**

Table 3. Weight and morphometric details of Common carp sampled during March 2019 to Feb 2020.

Months (2019-20)	Age (in months)	Weight of sample in g. (A)	Weight of head and tail in g (B)	Body weight in g. (C=A-B)	No. of samples (D)	Weight of sample for experiment in g. (D×C)	Total length of fish sample in cm.
March	5	201.8±1.6	36.6	165.2	3	495.6	18.3
April	6	296.5±1.75	58.8	237.7	3	713.1	21.1
May	7	368.2±1.63	76.2	292.0	3	876.0	24.2
June	8	443.6±3.26	90.9	352.7	3	1058.1	27.5
July	9	519.7±1.96	110.3	409.4	3	1228.2	30.1
Aug	10	601.4±2.17	121.3	480.1	3	1440.3	33.4
Sept	11	694.3±1.88	140.2	554.1	3	1662.3	37.9
Oct	12	776.3±3.21	153.6	622.7	3	1868.1	42.1
Nov	13	882.6±1.81	171.2	711.4	3	2134.2	45.6
Dec	14	1012.8±1.96	188.1	824.7	3	2474.1	49.1
Jan	15	1138.6±2.25	202.2	936.4	3	2809.2	53.2
Feb	16	1264.2±2.02	220.1	1044.1	3	3132.3	58.1
Average		**683.33**±2.11	**130.79**	**552.54**		**1657.63**	**36.72**

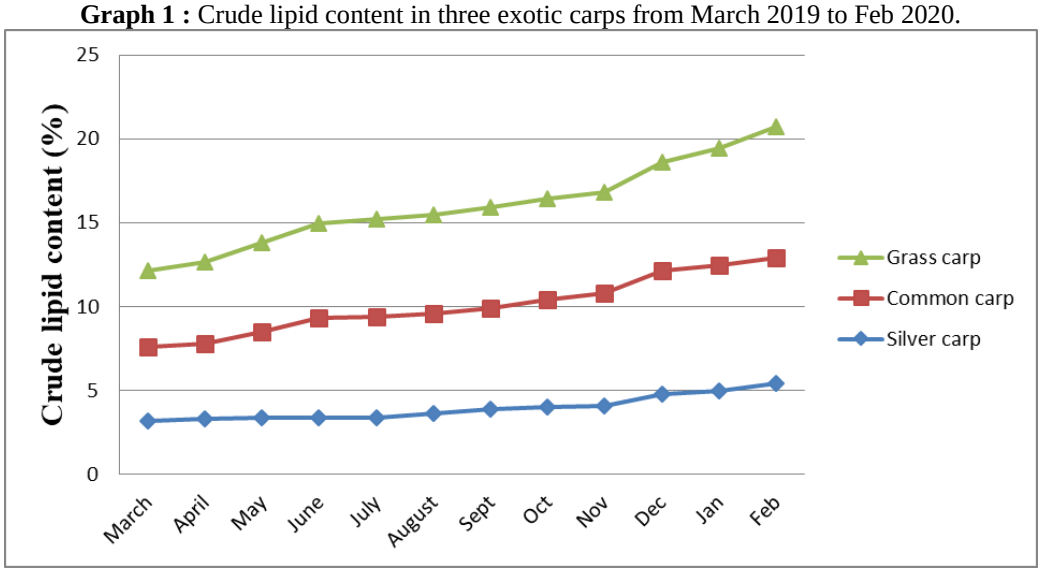
Table 5. Crude lipid content in exotic carps during March 2019 to Feb 2020 (Mean ± SE).

Months	Silver carp	Common carp	Grass carp
March	3.2±1.12	4.4±0.41	4.51±1.01
April	3.3±0.68	4.48±0.28	4.89±1.48
May	3.4±0.98	5.11±0.92	5.31±1.32
June	3.4±1.21	5.92±0.72	5.61±1.28
July	3.4±0.98	6.0±0.52	5.82±1.48
Aug	3.6±0.56	6.01±0.92	5.88±0.92
Sept	3.9±1.11	6.02±0.49	5.98±0.21
Oct	4.0±0.97	6.44±0.10	6.02±0.48
Nov	4.1±1.56	6.7±0.59	60.2±1.21
Dec	4.8±1.86	7.31±0.30	6.48±0.98
Jan	5.0±1.56	7.48±0.48	6.98±0.91
Feb	5.4±1.12	7.5±0.42	7.81±1.48
Average	**4.0±1.06**	**6.1±0.49**	**5.9±1.06**

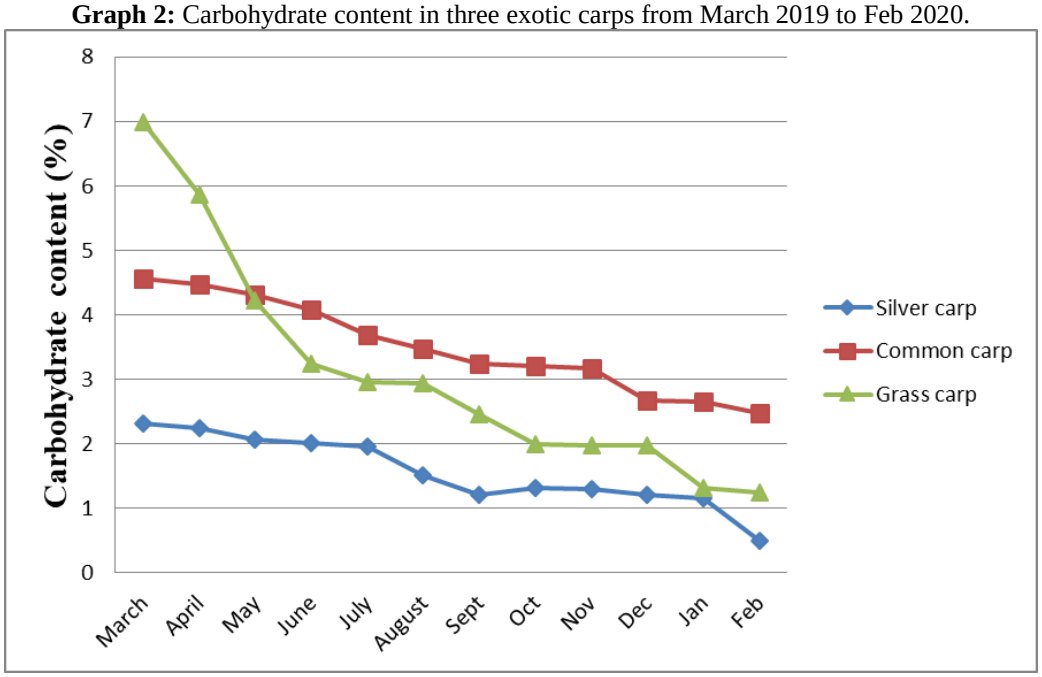
Table 6. Carbohydrate content in exotic carps during March 2019 to Feb 2020 (Mean ± SE).

Months	Silver carp	Common carp	Grass carp
March	2.31±1.98	4.56±1.12	6.98±2.02
April	2.24±1.80	4.48±1.54	5.87±1.58
May	2.06±1.89	4.32±1.21	4.22±1.21
June	2.01±1.56	4.08±1.24	3.25±1.08
July	1.96±1.26	3.68±0.86	2.96±1.12
Aug	**1.51**±1.89	3.47±0.98	2.94±1.04
Sept	1.21±1.12	3.24±0.98	2.46±0.98
Oct	**1.32**±0.98	3.21±0.43	1.99±1.56
Nov	1.30±0.61	3.18±1.21	1.98±0.88
Dec	**1.21**±0.68	2.68±1.02	1.98±1.11
Jan	**1.16**±0.76	2.66±0.98	1.31±1.10
Feb	0.5±0.91	2.48±1.25	1.25±0.88
Average	**1.57±1.29**	**3.50±1.07**	**3.07±1.21**

Graph 1 : Crude lipid content in three exotic carps from March 2019 to Feb 2020.



Graph 2: Carbohydrate content in three exotic carps from March 2019 to Feb 2020.



IV. Conclusions

From the present studies, it is concluded that the weight of the Silver carp increases more than the weight of Grass carp and Common carp with advancing age of the carp. A direct relationship is recorded with the age of carp and lipid content that with increases in age the lipid content increases but a reverse trend is recorded with carbohydrate. Different researchers concluded that the carbohydrate is the fundamental source of energy and utilized to gain energy for performing different life activities in advancing age, whereas the lipid content is mainly utilized in breeding cycle so its content is stored in advancing age for completing their breeding cycles.

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References

[1]. Alasalvar, C., Taylor, K. D. A., Zubcov, E., Shahidi, F. And Alexis, M. (2002) Differentiation Of Cultured And Wild Sea Bass (Dicentrarchus Labrax): Total Lipid Content, Fatty Acid And Trace Mineral Composition. Food Chemistry, 79, 145-150.
[2]. Appa Rao, T. (1966). On Some Aspects Of The Biology Of Lactarius Lactarius (Schneider). Indian J. Fish. 13:334-349.
[3]. Chaijan, M., Jongjareonrak, A., Phatacharat, S., Benjakul, S. And Rawdkuen, S. (2010). Chemical Composition And Characteristics Of Farm Raised Giant Catfish (Pangasianodon Gigas) Muscle. Journal Of Food Sciene And Technology. 43: 452-57.
[4]. Choudhary, M.A., Fatima, S., Yasin, R., Samiullah, K., Mubarik, M.S., Malik, M.I., Fazal, R.M., Rauf, A., Draz, O. And Tabassum, M. (2018). Compararive Study Of Proximate Composition And Mineral Contents In Cyprinus Carpio And Hypopthalmichthys Molitrix Collected From River Sutlej. 13(2): 185-193.
[5]. Das, P., Sarma, D., Bisht, H. C. S And Singh, N. O. (2010). Proximate And Mineral Composition Of Some Selected Coldwater Fish Species. Coldwaterfisheries Management. Edited By: Debajit Sarma And P.C. Mahanta, Dcfr. 321–332.
[6]. Dwivedi, S.N. And Menzes, M.R. (1974). A Note On Morphometry And Ecology Of Brachiunius Orientalis (Bloch &Schenider) In The Estuary Of Goa. Geobios. 1:80-83.
[7]. Di Digiacomo, R. A. (1989). Fish Oil Dietary Supplementation In Patients With Raynauld's Phenomenon: A Double Blind Corbolled, Prospective Study.
[8]. Edward, R. (1998). Omega-3 Polyunsaturated Fatty Acid Level In The Diet And In Red Blood Cell Membrane Of Depressed Patients. Journal Of Effective Disorders, Vol 48, Pp: 149-155.
[9]. Grigorakis, K., Alexis, M. N., Tylor, K.D.A. And Hole, M. (2002). Comparison Of Wild And Cultured Gilthead Sea Breams (Sparus Qurata): Composition, Appearance And Seasonal Variation. Internationaljournal Of Food Science And Technology. Vol 37 (5): 477-484.
[10]. Hibbelu, J.R. (1998). Fish Consumption And Major Depression. The Concept, Vol, 351 (18): P-1213.
[11]. Jensen, K. N., Jacobsen, C., Nielsen, H. H. (2007). Journal Of Science, Food And Agriculture. 87: 710-718.
[12]. Jobling, M., Leknes, O., Seather, B. S. And Bendiksen, E. A. (2008). Determination Of The Fatty Acids In Fish Tissue And Food- Comparision Of Different Methods And Statistical Evaluation. Aquaculture, 281: 87–94.
[13]. Kalmiju, S. (1997). Dietary Fat Intake And The Risk Of Incident Dementia In The Rotterdam Study. Annuals Of Neurology. Vol. 42 (5), Pp: 776-82.
[14]. Kumar, D. (1992). Fish Culture In Un-Drainable Ponds. A Manual For Extension Fao Fisheries Technical Paper No. 235: 239.
[15]. Larson, H. R. (2004). Fish Oils: The Essential Nutrients Oil Of Pisces. Com/Fish Oil Nutrient Html.