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Research Article

Seasonal Biochemical Changes in the Muscles of Fresh water Fish *Wallago attu* (BL)

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Abstract

Freshwater fish *Wallago attu* collected from Krishna River near Audumber. The seasonal changes in the biochemical contents of the muscles were analyzed. Protein level in the muscles is ranges between 13.1394 ± 0.0286 to 19.03597 ± 0.0862. There was a gradual increase in protein from November to June (16.0948 ± 0.0578 to 19.03597 ± 0.0862), followed by slight decrease from August to October (16.0090 ± 0.04369). Maximum level of Protein was found in June and lowest content found in the month of October. Glycogen occurs in a very minute quantity in the fishes. In present fish it ranges between 0.11054 ± 4.30614^{-3} to 0.67491 ± 4.2777^{-3}. Maximum level of glycogen was observed in the month of February and lowest value is observed in the month of October.. Ascorbic acid content in the fish shows two peak values in the months of March to June i.e. Breeding Season (0.3838 ±6.45495^{-3} to 0.44873 ±9.7259^{-3}) and October to December i.e. Spent Season (0.30965 ± 6.45495^{-3} to 0.42483 ± 0.01205). The lowest values are observed in the months of January to February (0.08602 ± 9.25122-3 to 0.10134 ± 7.3521^{-3}) and July to September (0.1338 ±5.61528^{-3} to 0.17057 ± 5.6153^{-3}). Lipid content in the muscles of present fish shows two peak values in the months of January (0.64413 ± 2.161^{-3}) and September (0.71911 ±3.34288^{-3}). Decreasing level of lipid content is observed from the month of February to June (0.19613 ± 2.82946^{-3} to 0.01858 ± 2.82946^{-3}) and October, November and December. The lowest value was observed in the month of October (0.011978 ± 2.16104^{-3})

INTRODUCTION

Fish provide a good source of readily digested high quality animal protein, fat, mineral and vitamins specially vitamin A, D and E. So, fishes have significant role in nutrition, income, employment and foreign exchange earning of the country. Fish muscle contains all the nutrient components that is required for human body maintenance. Fish and fish products are the most important sources of animal protein in the human diet. It comprises of all the ten essential amino acids in desirable quantity for human consumption. Fish protein is very rich in such amino acid as methionine, lysine and low in tryptophan compared to mammalian protein (Nowsad, 2007). Amino acids are important because animals require them in their diets for maintenance, growth, reproduction, and lactation. The metabolism of amino acids by the animal in their gastrointestinal tract can change the composition of the dietary amino acids. Enrichment, impoverishment, or changes of the proportional quantities of the amino acids absorbed into the circulation can occur (Williams 1995).

Fish have rich source of essential nutrients required for supplementing both infant and adult diets (Abdullahi *et al.*, 2001).

The consumption of fish and fish products is recommended as a means of preventing cardiovascular and other diseases and greatly increased over recent decades in many European countries (Cahu *et al.,* 2004). Besides these fishes are good source which possess immense antimicrobial peptide in defending against dreadful human pathogens (Ravichandran *et al.,* 2011). Reports from various sources (Anon, 2001 and Conquer and Holub, 2002) noted that fish oils significantly lower blood pressure, protect against blood vessel constriction, thrombosis and heart arrhythmia. Several biochemical composition and nutritive values and seasonal variation in the chemical composition of fish tissues associated with reproductive cycle were reported by (AL-Badri *et al.,* 1991and Al-Mhanawi, 2001).

Proteins have multiple functions in the body. First, proteins are necessary for the growth and maintenance of tissues. This includes growth of embryos and developing young animals, as well as replacement of worn-out cells such as in the blood, gastrointestinal tract, and skin (Williams, 1995). Fish protein produces a good influence on the assimilation of magnesium, phosphorous and iron. The protein seems important roles in primitive organisms for ionic balance and in moving up the evolutionary scale (Thilsted and Roos, 1999).

Glycogen is a vital source of muscle energy of live animal and it is utilized during muscular action and stored up during rest. Glycogen in different tissues shows remarkable difference. The lipids are the most important biochemical compounds of fish (Akpınar, 1986 a). Fish store the lipids in various organs; particularly in muscles and liver. On the contrary, the mammals store in adipose tissue. Generally, fish lipids are known to contain n-3 series unsaturated fatty acids which reduce the level of serum triglyceride and cholesterol. As a result of this sudden heart attacks ratio and the risk of thrombosis, which is mainly the reason for heart attacks are reduced. Some researchers reported that the n-3 fatty acids facilitate some cancer treatments such as breast tumors (El-Sayed *et al.,* 1984; Konar *et al.,* 1999). In addition to the clear benefits of fish lipids in treatments, it is observed that due to lack of these essential fatty acids causes some symptoms to appear, such as slow growth, deformation of tail fin, faded and fatty liver, skin depigmentation and being shocked in case of stress (Ackman and Eaton, 1976).

The biochemical composition of the whole body indicates quality of the fish. Therefore, biochemical composition of a species helps to assess its nutritional and edible value in terms of energy units compared to other species. The seasonal changes occur in the biochemical contents of fresh water fishes this indicates that biochemical constituents in any organism vary with the variation of environmental changes. Similarly, variation of biochemical composition of fish flesh may also occur within same species which depends upon the fishing ground, fishing season, age, sex and reproductive status of the individual. The spawning cycle and food supply are the main factors responsible for this variation (Love, 1980).

A number of workers have studied the depletive effects of maturation and spawning in the chemical composition of fish (Pandey *et al.,* 1976 and Kiran and Puttaiah, 2005). Number of workers studied on biochemical and histopathological changes under toxicity stress (Ganeshwade, 2012a, b and Ghanbahadur *et al.,* 2015). Some workers have studies seasonal variation in the biochemical composition of freshwater fishes (Jan *et al.,* 2012; Venkatesan *et al.,* 2013, Jaya and Shettu,2015 and Ganeshwade, 2020). *Wallago attu*, is a commercially important fish having high protein contents and taste. Therefore, the present work is an attempt to investigate the seasonal variations in the biochemical components of muscles of *Wallago attu*,

MATERIALS AND METHODS

The freshwater fish *Wallago attu (Bl)* were collected monthly from Krishna River during January 2013to Dec 2014 and were obtained from fisherman. They were brought in to the laboratory and then scarified for furthers studies. The muscle was removed from the dorsal of the body without scales, skin and pieces of bones. The tissue was processed for Protein, Glycogen, Ascorbic Acid and Lipid estimations. The protein was estimated as method described by Lowry *et al*., 1951. Glycogen was estimated by Anthrone Reagent Method (De Zawaan and Zandee, 1972), the total Lipids was estimated by Vanillin Reagent Method (Barnes and Black stock, 1973) and Ascorbic Acid by Roe J. H. ((1958).

RESULTS AND DISCUSSION

Seasonal biochemical changes in the muscles of *Wallago attu* are given in the Table No.1 and Graph No. 1-4. Protein level in the muscles is ranges between 13.1394 ± 0.0286 to 19.03597 ± 0.0862.

There was a gradual increase in protein from the month November to June (16.0948 ± 0.0578 to 19.03597 ± 0.0862), followed by slight decrease from August to October (16.0090 ± 0.04369). Maximum level of Protein was found in the month of June and lowest content found in the month of October.

Glycogen occurs in a very minute quantity in the fishes. In present fish it ranges between 0.11054 ± 4.30614^{-3} to 0.67491 ± 4.2777^{-3}. Maximum level of glycogen was observed in the month of February and lowest value is observed in the month of October. During breeding season, it goes on decreasing. It indicates that the glycogen content from the muscles is utilized for the process of spermatogenesis and oogenesis. After breeding season also fish suffers from heavy loss of energy and this will be getting from reserve food material i.e., Glycogen which is stored in liver and muscles. Again, from the month of October onwards its level is increases due to increased rate of feeding or due to availability of food in the surrounding habitat.

Ascorbic acid content in the fish shows two peak values in the months of March to June i.e., Breeding Season (0.3838 ±6.45495^{-3} to 0.44873 ±9.7259^{-3}) and October to December i.e., Spent Season (0.30965 ± 6.45495^{-3} to 0.42483 ± 0.01205). The lowest values are observed in the months of January to February (0.08602 ± 9.25122-3 to 0.10134 ± 7.3521^{-3}) and July to September (0.1338 ±5.61528^{-3} to 0.17057 ± 5.6153^{-3}).

Lipid content in the muscles of present fish shows two peak values in the months of January (0.64413 ± 2.161^{-3}) and September (0.71911 ±3.34288^{-3}). Decreasing level of lipid content is observed from the month of February to June (0.19613 ± 2.82946^{-3} to 0.01858 ± 2.82946^{-3}) and October, November and December. The lowest value was observed in the month of October (0.011978 ± 2.16104^{-3})

Jan *et al.,* (2012) studied seasonal variation in the protein content of the muscles of *Schizothorax esocinus* and observed highest protein content was observed in summer season and lowest in winter season. During spawning, muscle protein started declining gradually due to its transfer in to ovaries to meet energy requirement of fish. Jyotsna *et al.,* (1995) also reported that protein content during spawning season changes due to change in the endocrine system that monitors supply of nutrients to gonads from all parts of body including liver and muscles. Proteins get accumulated in gonads when fish matures and at the time of spawning the gonadal elements get released either as eggs or milt carrying the protein along with them and protein declines. During the post spawning period, especially with the commencement of the recovery period normal life is resumed and this is marked with an increase in protein content (Jan *et al.,* 2012). During autumn season the protein content declines as protein for germ building is mobilized from muscle as reported by Sivakami *et al.,* (1986). In this period gonadal development starts so the food that fish eats utilizes for making gonads.

The highest value of muscle protein is observed in summer season as gonads of fish are in the recovery stage and without any gonadal elements; the food that is consumed by the fish is used in the building up of the muscle. These observations confirm the earlier findings of Bruce (1924). Similar observations observed in the freshwater fish *Wallago attu,* during present investigation. Ashashree *et al.,* (2013) studied seasonal changes in protein muscles in *Mystus cavasius* and observed protein levels of muscle ranged from 0.42±0.01 to 5.27±0.04, being maximum in December and minimum in July. Langer *et al.,* (2013) reported low protein level during winter (Dec- Jan) and Monsoon (July-August) and increase in the protein content during spring (Feb-April) and post-monsoon (August-October) in the muscles of *Paratelphusa masoniana.* Venkatesan *et al.,* (2013) reported protein level in the muscles of female decreased from stage II-VI as the maturation of ovaries advanced and in male protein content decreased from the stage I-V, indicating utilization of protein for the development of testis. Similar observations made by Love and Robertson (1967) and Iles (1974). They reported that protein synthesized and accumulated in the somatic tissues during pre-maturation period would be utilized for gamete formation in addition to the growth of fish.

Normen (1962) reported that the stage of gonads may play a great role in the biochemical composition of a fish. Hence, the observation made here is in agreement with Kiran & Puttaiah (2005) and Shendge *et al.,* (2012). The proteins in the flesh of fish are important for the tissue building activity of those who consume them. Protein cycle does not show any relationship with intensity of feeding. Low value of protein content in winter or post-monsoon season may be a consequence of greater utilization of protein for energy requirements in the season.

Glycogen content in the muscles of *Wallago attu, shows* steady decrease from the month Jan to October. Highest level was observed in the month of Jan and Feb and lowest level was observed in the month of October. Glycogen is a vital source of muscle energy of live animal and it is utilized during muscular action and stored up during rest (Pawar and Sonawane, 2014). Glycogen level drastically decreased from the month of Jan to October in the fish *Wallago attu*. During post-spawning its level decreases due to its utilization for to meet energy demand. During the present work it is observed that in the summer its level is more and it goes on decreasing in advancement of maturity. In post-spawning season its level is very low because it is utilized as a source of energy. Venkatesan *et al.,* (2013) reported muscle carbohydrate content in the female showed a general decline from the stage I-VI with the advancement of maturation. However, it decreased only slightly in male indicating utilization of carbohydrate to a lesser extent with the advancement of maturation. Pawar and Sonawane (2014) observed low level of muscle glycogen in the month of November and December in *Garra mullya.*

Somvanshi (1987) reported percentage of fat in muscles of *Garra mullya*. She observed maximum fat percentage in July in females and November in males. This indicates high values were observed during pre-spawning and spawning months and low during the post-spawning months. Langer *et al.,* (2013) studied on seasonal fluctuations in the proximate body composition of *Paratelphusa masoniana*. They observed two peaks in the muscle lipid content in the months of March (5.49 ± 0.381) and September (5.85 ± 0.46) and stated high lipid content was observed in spring and post-monsoon and this could be due to active feeding and optimum availability of food as an algal blooms and planktons. Similar result was observed in the *Wallago attu.* There was also decline in the lipid content during spawning period and this is possibly due to mobilization of lipid as an energy source to meet the high energy demands during the act of ovulation and spawning on one hand and due to low feeding intensity and low availability of food items on the other. Reduction in the amount of lipid content in the muscles for the development and maturation of gonads has been well discussed by Langer *et al.,* (2008) and Samyal *et al.,* (2011).

The fish generally store lipids in their own liver and muscle tissues, but during the process of storage which tissues are important varies according to the fish species. It was reported that active fish stored their lipids in muscle tissues; but the fish inactive living at the bottom of water store their lipids in liver (Castell *et al.,* 1972). *Wallago attu* shows peak values of lipid in the month of January and August-September. According to the results, the amount of total lipid and fatty acid in muscle and liver has reached its maximum level in autumn; it has reached its minimum in spring. The decrease of lipid amount in this period with the increase of reproduction function, confirmed the opinion that the storing lipids have been consumed (Akpınar, 1987b) and nutrition period has been in summer and autumn. Ashashree *et al.,* (2014) reported muscle lipid reaches maximum in December (0.83 ± 0.09), January (1.05 ± 0.09) and minimum during July (0.35 ± 0.23). Similar results have been reported by Jorgensen, *et al.,* (1997) in different fishes.

Ascorbic acid content in *Wallago attu* shows two peak values in the months of March-June and October-December. The ascorbic acid plays an important role in detoxification of the foreign bodies or toxicants in metabolic process. The main site to synthesize the ascorbic acid is the liver. Ascorbic acid content in the muscles is less as compared to other tissues (Giroud *et al.,* 1938). It plays a role directly related to homeostatic mechanism and is essential for wound healing and regeneration (Padhi & Patnaik, 1978). Ascorbic acid act as an essential factor for normal growth in rainbow trout *Salmo gairdneri* (Tucker and Halver, 1986). In terrestrial animals the dietary ascorbic acid has role in the host defense system. Though the complete prevention of viral infection is not possible, high doses of ascorbic acid reduces potency of the viral diseases (Murata, 1975). During present investigation ascorbic acid in *Wallago attu* shows decreased level of content in pre-spawning and post-spawning period. During breeding season ascorbic acid content is reduces due to its utilization for the process of maturation of gonads. Some authors have observed that AA concentrated in female gonads is transferred to the oocyte during maturation and then quickly consumed during the first days of embryonic growth (Blom and Dabrowski 1995).

Ascorbic acid is a key antioxidant molecule having low molecular weight and an essential to fish and crustacean micronutrients (Brown and Lavens, 2001). This antioxidant is highly consumed from the tissues during oocyte maturation (Blom and Dabrowski, 1995). High concentrations of AA

Table No. 1: Seasonal variation in the biochemical components of the Muscles of *Wallago attu* (Bl) [Marathi Name – Valshivda, Pangat,]

Biochemical Compo. / Months	Protein	Glycogen	Ascorbic Acid	Lipid
January 2013	17.17927718 ±0.01011	0.364347194 $\pm1.711085679^{-3}$	0.086019827 $\pm9.251217306^{-3}$	0.644126725 $\pm2.161035978^{-3}$
February 2013	17.80135205 ±0.028601145	0.67490926 $\pm4.27771485^{-3}$	0.101336749 $\pm7.352122001^{-3}$	0.196128783 $\pm2.829460982^{-3}$
March 2013	17.84902063 ±0.801002259	0.376324794 $\pm4.527107598^{-3}$	0.383780772 $\pm6.454951239^{-3}$	0.149914258 $\pm6.89586364^{-3}$
April 2013	18.83814353 ±0.054141019	0.307596183 $\pm4.390305132^{-3}$	0.397259663 $\pm7.35212203^{-3}$	0.108179713 $\pm4.322072636^{-3}$
May 2013	18.85959438 ±0.028601127	0.276796639 $\pm4.306138107^{-3}$	0.411963907 $\pm7.352122007^{-3}$	0.044988424 $\pm3.18968645^{-3}$
June 2013	19.03596811 ±0.086199756	0.22660479 $\pm3.422171518^{-3}$	0.448724518 $\pm9.725943229^{-3}$	0.018580124 $\pm2.8294605^{-3}$
July 2013	18.11596464 ±\0.028601148	0.209208752 $\pm5.156967321^{-3}$	0.133808621 $\pm5.615275934^{-3}$	0.321803995 $\pm2.484184796^{-3}$
August 2013	16.0090137 ±0.043688968	0.168142693 $\pm3.857856579^{-3}$	0.117879024 $\pm7.352122001^{-3}$	0.520573608 $\pm3.189686011^{-3}$
September 2013	13.34434044 ±0.103452884	0.127361816 $\pm4.277714497^{-3}$	0.170569231 $\pm5.61527593^{-3}$	0.719107433 $\pm3.342877129^{-3}$
October 2013	13.13936557 ±0.028601145	0.110536139 $\pm4.306138206^{-3}$	0.309646874 $\pm6.45495122^{-3}$	0.01197805 $\pm2.161036317^{-3}$
November 2013	16.09481713 ±0.057795067	0.219475266 $\pm5.013023928^{-3}$	0.369689205 ±0.01023372	0.017636971 $\pm2.484184761^{-3}$
December 2013	18.29710522 ±0.059538017	0.358073213 $\pm5.227453572^{-3}$	0.424830121 ±0.012052772	0.176322558 $\pm3.241554646^{-3}$
Jan 2014	17.64881262 ±0.05022196	0.264248677 $\pm5.342863783^{-3}$	0.126456499 $\pm6.4549551216^{-3}$	0.127750149 $\pm3.56032675^{-3}$

The values are expressed in mg/100mg dry weight (Mean ± S.D.)

in fish ovaries have been reported by many authors (Sandnes, 1988). Ovary levels of AA vary during the reproductive cycle in the crucian carp, *Carmius carassius* (Seymour, 1981 a), in cod, *Gadus morhua* (Sandnes and Braekkan, 1981) and in sea trout, *Salmo trutta* (Sandnes, 1984). The overall high levels and seasonal variations of AA in ovaries have been suggested to reflect a requirement for AA in hydroxylation reactions in steroidogenesis in the ovarian follicle cells (Hilton *et al.,* 1979). Due to this during preparatory and post-spawning season its level is more in muscles while during breeding season they are transferred for maturation of gonads. According to Nandurkar (2013) ascorbic acid has a central position in curing the impaired condition occurred by the pathogenic attack and resists against the diseases in organisms. Different pollutants stress also has its impact on the concentration of ascorbic acid (Ali *et al.,* 1983 and Bhusari 1987). Ascorbic acid content increases during stress (Rao and Chinoy, 1986) and after metal intoxication indicating its role in detoxification process.

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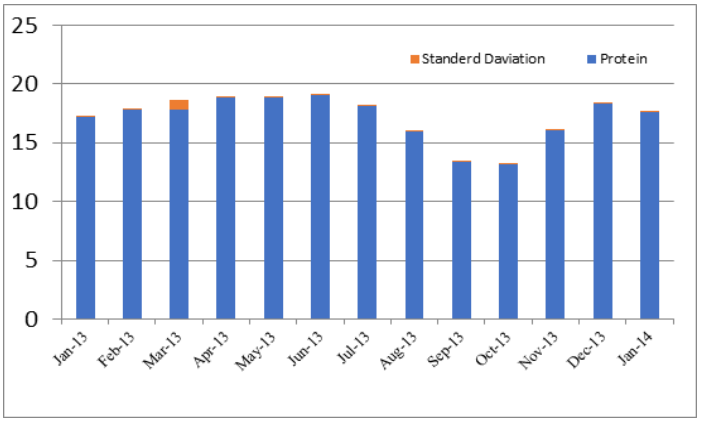
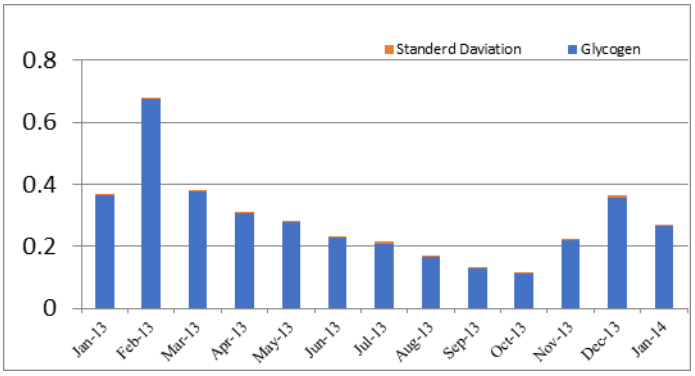
REFERENCES

Abdullahi SA, Abolude DS and Ega RA, 2001. Nutrient quality of four oven dried freshwater catfish species in Northern Nigeria. *J. Trop. Biosci.*, **1**(1): 70-76.

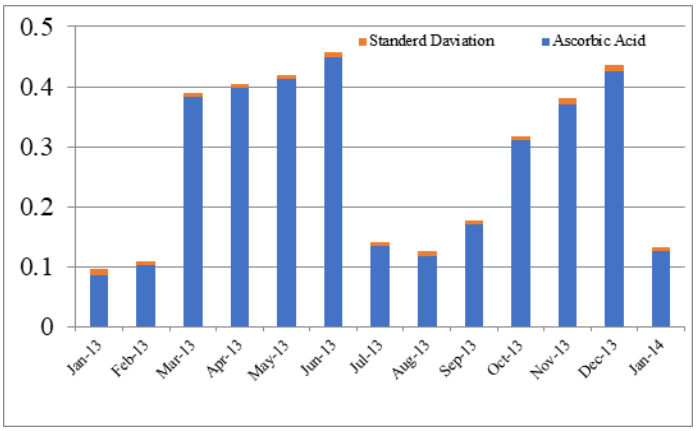
Ackman RG and Eaton CA, 1976. Fatty acid composition of the decapod shrimp, *pandulus borealis*, in relation to that of the euphasiid,



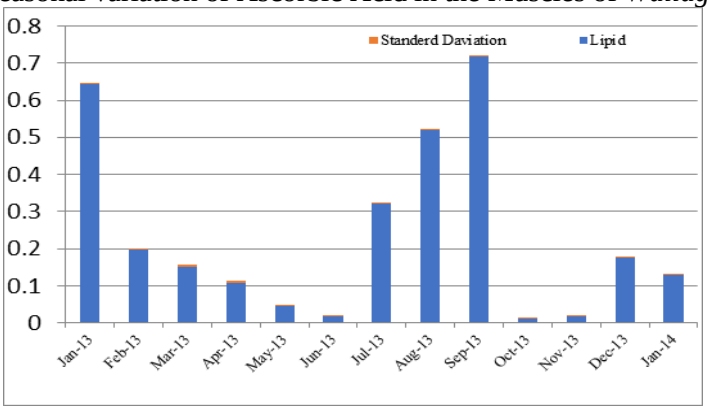
Graph No. 1: Seasonal variation of Protein in the Muscles of *Wallago attu* (Bl)



Graph No. 2: Seasonal variation of Glycogen in the Muscles of *Wallago attu*



Graph No. 3: Seasonal variation of Ascorbic Acid in the Muscles of *Wallago attu* (Bl)



Graph No. 4: Seasonal variation of Lipid in the Muscles of *Wallago attu* (Bl)

Meganyctiphanes noruegica. J. Fish. Res. Bd. Can., **33**: 1634-1638.

Akpınar MA, 1986 a, *Cyprinus carpio* L. (*Osteichthyes*:*Cyprinidae)* karaciğer yağ asitlerinin mevsimsel değişimi. *Doğa Tu. Bio.*, **10** (3): 232-239.

Akpınar MA, 1986 b. *Cyprinus carpio* L. (*Osteichthyes*: *Cyprinidae)* karaciğer ve kasındaki total lipid ve total yağ asidinin mevsimsel değişimi. *C.Ü. Fen-Edebiyat Fak., Fen Bil. Derg*., **4**: 33-42.

AL-Badri MEH, Yesser AKT and AL – Habbib FMK, 1991. The chemical composition and nutritive value of *Silurus triostegus* (Heckel 1843). *Marina Mesopotamica* **6**(1): 92 – 100.

Al-Mhanawi BHH, 2001. Effect of threelevels of protein on growth, food conversion effeciency and body composition of himri *Barbus luteus* juveniles. M. Sc. thesis, College of Agriculture, University of Basrah. 66 pp.

Anon, 2001. whats so healthy about seafood? A guide for seafood marketers. Fisheries research House. Deakin, Australian Capital Territory.

Ashashree HM, B Venkateshwarlu B and HA Sayeswara 2014. Impact of Seasonal Changes on Composition of Total Lipid Content in Muscle, Liver and Testes of Freshwater Male Fish *Mystus Cavasius* (Ham) From Bhadra Reservoir, Shivamogga, Karnataka, India. *International J. Sci. Res.* **3**(2):540-541.

Ashashree HM, M Venkateshwarlu and HA Sayeswara, 2013. Seasonal changes of protein in the tissues of male catfish *Mystus cavasius* (Ham) in Bhadra Reservoir, Karnataka, India. *International J. App. Bio. Pharma. Techn.*, **4**(4):264-267.

Barnes H and Blackstock J, 1973. Estimation of Lipid, Detailed investigation of the Sulpho -phospho vanillin method for total lipids. *J. Expt. Mar. Biol.Assoc*.**12**:103-118.

Bhusari NB, 1987. Alterations in the tissues ascorbic acid in the freshwater fish, *Barbus ticto* (Ham) due to endosulfan and ekalux. Proc. Nat. Symp. On Poll. And Pesticide Toxicol. And 8th annual session of acad. Of Environ. Biol. India, Held at University of Jammu (J and K) from Dec.10-12, pp 59-64.

Blom JH, Dabrowski K, 1995. Reproductive success of female rainbow trout (Oncorhynchus mykiss) in response to graded dietary ascorbyl monophosphate levels. *Biol Reprod*., **52**:1073–1080.

Brown MR, Lavens P, 2001. Critical review of the concentration, interactions with other nutrients and transfer of ascorbic acid in algae, crustaceans and fish. In: Dabrowski K (ed) Ascorbic acid in Aquatic Organisms. Status and Perspectives. CRS Press, USA, pp 167–189.

Bruce JR, 1924. Changes in the chemical composition of tissues of the herring in relation of age and maturity. *Biochemical J.*, **18**:469-485.

Cahu C, Salen P, de Lorgeril M, 2004. Farmed and wild fish in the prevention of cardiovascular diseases, Assessing possible differences in lipid nutritional values. *Nutr. Metab. Cardiovasc. Dis.*, **14**:34-41.

Castell JD, Sinnhuber RO, Wales JH and Lee DJ, 1972. Essential fatty acids in the diet of rainbow trout (*Salmo gairdnerii*): Growth, feed conversion and some gross deficiency symptoms. *J. Nutr.*, **102**: 77-86.

Conquer J and Holub BJ, 2002. Human health effects of docosahexanoic acid. P. 311- 329. In J. Shi, G. Mazza and M. L. Maguer (eds) Functional foods: biochemical and proccessing aspects. Vol. 2 CRC Press Boca Raton.

De Zwaan A and Zandee DI, 1972. Glycogen estimation with Anthrone reagent comp. *Biochem. physiol.* **43**B: 53-55.

El-Sayed MM, Ezzat K, Kandeel M and Shaban FA, 1984. Biochemicalstudies on the lipid content of *Tilapia nilotica* and *Sparatus auratus.* Comp. *Biochem. Physiol.*, **4**: 589-594.

Ganeshwade RM, 2012 a. Histopathological changes in the gills of *Puntius ticto* (Ham) under dimethoate toxicity. *Bioscan* **7**(3):423-426**.**

Ganeshwade RM, 2012 b. Biochemical changes induced by Dimethoate (Rogor 30%EC) in the gills of fresh water fish *Puntius ticto* (Hamilton). *J. Eco. Nat. Envi.*, **4**(7):181-185.

Ganeshwade RM, 2020. Seasonal biochemical changes in fresh water fish *Rohitee cotio* (Ham). Int *J. Biosci. Disc.*, **11**(1): 27-33.

Ghanbahadur AG, Ghanbahadur GR, Ganeshwade RM and SB Wagh, 2015. Effect of p^H on Nuvan Toxicity to *Rasbora daniconius. Inter. J.Trend. in Fish. Res.*, **4** (2): 8-13.

Giroud A, Leblond CP, Ratsimamanya R and Gerge 1938. The normal level of ascorbic acid. *Bull. Soc. Chem. Biol.*, **20**: 1079-1087.

Iles TD, 1974. The tactis and strategy of growth in fishs In F.R.H. Jones (Editor), sea Fiseries Research (John Wily New York): 331-345.

Jan Ulfat, M Shah, Tahila M and Showkat AG, 2012. Seasonal and monthly variations of protein content in the muscle of fish *Schizothorax esocinus*. *Rec. Res. Sci. Tech.*, **4**(7): 05-07.

Jaya K and Shettu N, 2015. Changes in the biochemical constituents of the freshwater fish, *Channa punctatus* (Bloch) exposed to the toxicity of cypermethrin. *J.Chem.Pharm.Res.*, **7**(9):695-697.

Jorgensen EH, Johansen SJS, Jobling M, 1997. Seasonal patterns of growth, lipid deposition and lipid depletion in andromous. *Arctic charr. J. fish Bio.*, **51**: 312-326.

Jyotsna K, Nilesh K, Verma PK and Fasihuddin MD, 1995. Distribution of Bio Constituents in Various Tissues during Pre and Post-Spawning Periods of

Channa striatus (Bloch). *J. Inland Fish. Soc. India*, **27**(2):14-17.**Kiran BR and ET Puttaiah, 2005.** Biochemical composition of *Chela untrahi* from Bhadra reservoir, India, *Geobios*, **32**: 93-95.

Konar V, Canpolat A and Yılmaz O, 1999. *Capoeta trutta* ve *Barbus rajanorum mystaseus*'un Kas Dokularındaki Total Lipid ve Yağ Asidi Miktar ve Bileşimlerinin Üreme Peryodu Süresince Değişimi, *Tr. J. Bio.*, **23**(3): 319-331.

Langer S, A Samyal and Y. Bakhtiyar 2008. Studies on ovarian development of *Macrobrachium dayanum* (Hend.) in relation to gonadosomatic index and hepatosomatic index. *Biosci. Biotechnol. Biores. Asia*, **5**(1): 289-284.

Langer S, P Manhas, Y Bakhtiyar and Sheikh RG Singh, 2013. Studies on the Seasonal Fluctuations in the Proximate Body Composition of *Paratelphusa masoniana* (Henderson) (Female), a Local Freshwater Crab of Jammu Region. Adv. J. Food Sci. and Tech., **5**(8): 986-990.

Love RM and Robertson I,. 1967. Studies on the North Sea Cod IV. Effects of starvation to changes in the distribution of muscle protein fractions. *J. Sci. Fd. Agric.*, **18**:217-220.

Love RM, 1980. The Chemical Biology of Fishes, Vol. 2. New York: Academic Press.

Lowery OM, Rosenbrough NJ, Farr AC, Randall RF, 1951. Protein estimation with Folin Phenol Reagent. *J. Biol. Chem*. **193**:265-275.

Murata A, 1975. Virucidal activity of vitamin C: vitamin C for prevention and treatment of viral diseases. *Proc. First Intersec. Congr. IAMS, Sci. Cn. Of Japan.*

Normen JR, 1962.A History of Fishes. Ernest Bern Ltd., London, 2nd edition.

Nowsad AKM, 2007. Participatory Training of Trainers, Bangladesh Fisheries Research Forum, Mymensingh, Bangladesh.

Padhi SM and Patnaik BK, 1978. Changes in ascorbic acid content kidney following partial hepatectomy in the garden lizard *Calotes versicolor* (Daudin). *Ind. J. Expt. Biol.*, **16**: 1499.

Pawar SM and Sonawane SR, 2014. Seasonal variation in muscle glycogen and moisture content of *Garra mullya* and *Rasbora daniconius. Inter. j of Fauna and boil. Studies.* **1**(5):91-94.

Ravichandran S, Kumaravel K, Pamela Florence E, 2011. Nutritive Composition of Some Edible Fin Fishes. *Inter. J. Zool. Res*., **7**:241-251.

Roe JH,1967. Methods of Biochemical analysis Vol.5, (Ed. By Glick Inter. Science, New York) p-44.

Samyal A, Y Bakhtiyar, A Verma and S Langer, 2011. Studies on the seasonal variation in lipid composition of muscles, hepatopancreas and ovary of freshwater prawn, *Macrobrachium dayanum* (Henderson) during reproductive cycle. *Adv. J. Food Sci. Technol.*, **3**(3): 160-164.

Sandnes K and Braekkan OR, 1981. Ascorbic acid and the reproductive cycle of ovaries in cod (*Gadus morrhua*). *Comp. Biochem. Pliysiol.*, **70***A:* 545-546.

Sandnes K, 1988. The effect of vitamin C on reproduction in fish. Animal Nutrition Events, Roche Seminar on Vitamin Nutrition in Fish, Trondheim, august 1987.

Shendge AN, Pawar BA and Pandarkar AK, 2012. Variation in protein content of freshwater catfish *Wallago attu* (Ham) in relation to sex and maturity cycle. *J. of Expt. Zoo., India* **15**(1): 251-252.

Sivakami S Ayyappan S Rahman MF and Govind BV, 1986. Biochemical Composition of *Cyprinus carpio* (Linnaeus) Cultured in Cage in Relation to Maturity. *Indian J. Fish.*, **33**(1):180-187.

Somvanshi VS 1987. Seasonal changes in the biochemical composition of a Hill stream fish *Garra mullya* (Sykes), *Indian J. fish* **30**:55-60.

Thilsted SH and Roos N, 1999. Policy issues on fisheries in relation to food and nutrition security. Pp 61-69. In Ahmed, M., Delgado, C., Sverdrup-Jensen,S. and Santos, R.A.V. (eds). Fisheries policy research in developing countries: Issues, Prioritis and needs. *ICLARM conf. Proc.*60, 112p.

Tucker BW and Halver JE, 1986. Utilization of ascorbate-2-sulfate in fish. *Fish. Physiol. Biochem.*, **2**: 151-160.

Venkatesan V, V Gandhi and PU Zacharia, 2013. Observations on the utilization of the biochemical constituents during maturation of the butterfish *Scatophagus argus* (L.1766) from Palk Bay, South east coast of India. *Ind. J. Geo-Marine Sciences*, **42** (1):75-81.

Williams PEV, 1995. Digestible amino acids for non-ruminant animals: theory and recent challenges. *Animal Feed Sci. and Tech.*, **53**: 173-1 87.

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