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Proximate composition and its seasonal variations of the muscle tissue of *Channa striata* from Krishna river, Andhra Pradesh

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Abstract
The present study was conducted to determine the nutritive value in terms of proximate composition and seasonal variations in muscle of *Channa striata* from river Krishna, Andhra Pradesh, India. The bio-chemical composition such as protein, fat, ash and moisture content in the muscle tissue of fish has been carried out during 2021-22 to know the seasonal changes in relation to reproductive biology. This fish has excellent sources of high quality proteins and nutrients with medicinal value. The composition of protein, fat, moisture and ash contents showed variations in their abundance in different seasons in both females and males. The highest content of protein 24.3±2.2% in south west monsoon and lowest (20.4±2.1%) recorded in North East monsoon in case of females and males was 25.2±2.4% and lowest (22.3±2.2%). The highest content of fat content was 5.4±0.4% was observed in North East monsoon and the lowest (4.3±0.4%) in case of females and males was 5.5±0.3% and lowest 3.6. The highest moisture 83.8±6.4% and was observed in south west monsoon and minimum 80.2 recorded in summer in case of females and males was highest 84.2±6.3% and lowest recorded 80.4 in summer. The ash content was highest 2.19±0.06% in post monsoon and lowest 1.61 in summer in case of females and also males was highest 2.25±0.063% and lowest 1.65 in summer.

Keywords: *Channa striata*, proximate composition, reproductive biology

Introduction
Fish and fishery products are vital source of food for mankind all over the world due to its high quality proximate composition. It's also contains the most important nutrition components and serves as a source of energy for human beings and their domestic animals [1]. The fish products utilized dietary supplement to the farming of pig, chicken and other domestic animals has considerably increased their weight and quality meat [2]. The consumption of fishery products is preventing cardiovascular and other diseases [3]. In the throughout globe, majority of the nutrients recommend that human beings should consume fishery products daily [4, 5]. Regularly eating fish can reduce the risk of cancer and other related diseases [6, 7], lesser risk of Alzheimer's diseases [8] and prevent the cardiovascular diseases [9] and other nutritional supplements. Besides this, fishery products are good source of nutrients which possess immense antimicrobial peptide in defensive against dreadful human pathogenic diseases [10].

Fish flesh is easily digestible because it contains long muscle fibbers [11]. Fish plays a major role in human nutrition and its bioactive compounds [12]. Importance of fishes as a source of high quality fat, balanced diet and easily digestible protein [12]. Information of the proximate composition of fishery products are essential to estimate their energy value in terms of commercial products [13]. According to Love, 1980 [14] the composition of fish is 70 to 80% water, 20 to 30% protein and 2 to 12% lipid. In different environmental conditions, the composition of the fish may differ in relation to water quality, food and feeding conditions, and state of other conditions [15-17] and also biological variables [18]. Ravichandran *et al*., [19] studied nutritive composition of some edible fin fishes. The present study deals with the monthly variation in the proximate composition of murrel *C. striata*, protein, fat, moisture and ash contents in muscle tissue are investigated with respect to different seasons like south west

monsoon (June, July, August and September), Post-monsoon (includes October and November), north east monsoon (December, January and February) and summer (March, April, May) in relation to reproductive biology. These values are useful references for consumers in order to choose fish, based on their nutrition quality in different seasons and months.

Materials and Methods

Fish sampling are collected from 3 stations of the River Krishna, Guntur district of Andhra Pradesh and they are Station-STI: Amravati-Its located 16°34'50.36"N Latitude and 80°2I'10.65"E Longitude. Station-STII: Venkatapalem-Its located 16°31'01.67"N Latitude and 80°33'31.71 "E Longitude. Station-STIII: Seethanagaram, near Prakasam barrage-Its located 16°30'00.76"N Latitude and 80°36'01.99"E Longitude with the help of fisherman. Then the samples were placed in ice-box and were immediately brought to the laboratory for further analysis.

Sample preparation

The fish *C. striata* was washed with running tap water and the excess water was removed with blotting paper. The length and weight was recorded. Non-edible portions of fish were removed immediately to avoid decomposition. The muscle was washed, dried and powder for various analyses.

Estimation of proximate composition

Moisture, Fat and Ash content were determined according to AOAC [20] and Protein by the method of Micro- Kjeldahl by Pearson [21]. For each analysis of proximate composition, triplicate samples were used. All of the chemicals used in this work were high purity GR grade.

Results and Discussion

The proximate composition and its seasonal variations of Protein, Fat, Moisture and Ash in muscle of freshwater fish *C. striata* were recorded in one year (June 2021-May 2022) from river Krishna has presented (table no-1 & 2 and Fig.1 to 4). The protein percentage values of the fish *C. striata* ranged between 20.4 and 24.3 in case females and males goes to 22.3 and 25.2. The average values with standard deviation of the fish were 22.36±2.2% in females and 23.5±2.5% in males. The fat percentage values of the fish ranged between 4.3 and 5.4 in case females and males goes to 3.6 and 5.5. The mean values with standard deviation of the fish were 4.83±0.5% in females and 4.71±0.5% in males. Moisture percentage values of the fish ranged between 80.2 and 83.8 in case females and males goes to 80.4 and 84.2. The mean value with standard deviation of the fish was 82.09±5.9% in females and 82.10±5.8% in males. Ash percentage values of the fish ranged between 1.61 and 2.19 in case females and males goes to 1.65 and 2.25. The mean value with standard deviation of the fish was 1.90±0.06% in females and 1.90±0.05% in males. The results of freshwater fish clearly indicate that there are some minor differences in the proximate composition of the male and female species. These differences preclude the possibility of making any such generalization which may be applicable to murrel fishes. Biochemical constituents and these changes were attributed to factors like food quality, breeding and environmental conditions. The data on the biochemical constituents *i.e*. Moisture, Protein, Fat and Ash in the muscle of *C. striata* showed little bit fluctuations in different months of observations during the study period for one complete year (June 2021 to May 2022).

Protein

Proteins are regarded as fundamental compounds of living things. Amino acids are the end product of digestion of protein which are used in making new protoplasm and cells. It is the most important macromolecules of organisms [22]. Proteins' in Greek means something of primary importance. It is having various functions in living organisms. They act as structural compound of membrane. It functions as components of enzymes and hormone. In the present study highest percentage of protein recorded in both sexes is started in June may be due to the maturing stage of egg condition. Low percentages of protein was marked in the post-spawning period, in which the fishes collected are mostly in spent, recovering and different stages. High values of muscle protein contents in fully mature stages of fishes indicated that the need of muscle protein. Low protein content in muscle of fish in the post-spawning may be attributed to the transfer of muscle protein towards development of gonads. The protein content of *C. striata* female showed variations according to certain levels changes recorded and the values are ranged between 20.4 to 24.3%. The mean values with standard deviation of fish species 22.36±2.2%. Ahmed *et al*., [23] reported that the nutrient composition of selected fishes and the protein values from 15.6 to 18.5%. Mustafa *et al*., [24] recorded 17.86 to 18.5±0.92% protein values in muscle of *P. sophore*. The protein content shows a strong correlation with spawning and breeding.

During late July there is a gradual enhancement of gonads weight and muscle protein also gradually increased in this study. During late-October there is a sharp decline in the weight of the gonad in both female showing spawning time [25]. The gonado-somatic index show a gradual increase till they attain the maturity peak in the month of August and then onwards these values gradually decrease [26]. But, Ravisankar and Aravindkumar [27] observed that the protein values were high during pre-spawning and low at the time of spawning period. The maximum protein values during south west monsoon months (June and July) can attribute to the fact that food material is very abundant in the monsoon and early pre-monsoon months and as such fish have a chance to fed more on the available protein food. Maximum protein values recorded in present study, south west monsoon coincided with a period of intense feeding perhaps with more in the post-monsoon. After spawning fish recovers to compensate the energy through vigorous feeding activity. A fall of protein percentage may be attributed to a fall in the rate of feeding because of scarcity of food material due to turbidity and other ecological factors during that months. Medford and MacKay [28] recorded that the muscle protein of northern pike, *Esox lucius* is high before spawning and low after spawning. This could be attributed that these constituents might have been utilized for spawning and gonadal development. Jafri [29] also reported same relationship in cat fish *Mystus seenghala*. Abdullahi *et al*., [30] reported that the protein content in fish might vary with the species due to certain factors such spawning, food availability and environmental conditions. Njinkoue *et al*., [31] reported that fish muscle protein content changes was little with season. Tzikas *et al*., [32] recorded seasonal variation in the biochemical composition mackerel *Trachurus mediterraneus* muscle.

Fat

Fats are essential nutrient to the body for the supply of energy and other metabolic activities. Greater amount of calories could be given to the body with lesser amounts of fat, carbohydrates and proteins. Fats are not completely digested as compared to however carbohydrates and proteins. Sometimes slow digestion takes place in the case of a heavy fatty meal. Generally feeds are two types, on a diet with higher fat content and another with low fat content. The fat is ultimately broken down into fatty acids and essential fatty acids are ultimately supplied to the body requirement. Ahmed *et al*., [23] recorded the nutrient composition of indigenous and exotic fishes fat values of *P*. *sophore*, *P*. *ticto* and *X*. *cancila* are 2.28%, 3.56% and 2.76%. Mustafa *et al*., [24] observed 5.59±0.88%, 5.88±0.92%, 5.65±0.95% fat values in *P*. *sophore from* different stations in Bangladesh. Nahid *et al*., [33] stated that the fat value in muscle of *X*. *cancila* is 4.66%. Bogard *et al*., [34] reported the nutrient composition of different fishes and Siddique *et al*., [35] also reported the fat values of *Puntius sarana* and *Puntius sophore* are 3.69% and 5.80%. Mustafa *et al*., [36] studied on nutritional abilities of *Hilsa ilisha* and *P*. *sarana* are 9.49±0.54% and 9.0±1.09%. Begum *et al*., [37] reported the muscle fat value of *P*. *sarana* is 9.00±1.09%. Maria Zaman *et al*., [38] recorded the nutrient levels of selected fish species of the fat value and Sarojnalini and Sarjubala Devi [39] studied on nutritive values of *Puntius sophore* and Bijayalakahmi *et al*., [40] recorded total lipid content of Puntius *sophore* is 2.34±0416%. During mature stage the muscles contain lows fat. Thus it is observed that fat content of muscle is less in the months during spawning. The highest content of fat was during the post-monsoon and north east season. Almost all the fishes will be at this low metabolic rate due to low temperatures and hence the accumulation of energy mostly in the form of fat [12]. Ravishankar and Arivind Kumar [27] observed that the muscle of *Samostroma bacaila* contains high fat values during pre-spawning and low at the time of spawning. Fats are considered to be the most important constituent of fish organisms as reserve energy [41]. Prabhakara Rao *et al*., [42] also recorded fat levels in r*ohu* (*Labeo rohita*) and *channa* (*Channa striata*). Ecological factors are influenced the proximate composition particularly fat content of selected fishes [43].

Moisture

Fish muscle are very delicate and, quality depends such as season, sex, length & weight, size, food & feeding habits, maturity, environmental factors, topography and physiological composition. The amount or percentage of water within a fish's muscle is known as moisture content. Basic components of fish muscle are water, protein, fat, vitamins and ash. Among these, water constituent is more in fishes and other aquatic animals, making 70-80% weight of most organisms is due to water. Water is spread each and every portion of cell and a medium to transport nutrients, cytoplasmic reactions for maintenance of cell and transfer in to chemical energy. The Seasonal and monthly variations in the moisture content in muscle of *C. striata* was observed in relation to reproductive biology. The moisture values are ranged between 73.43-78.86%. Ahmed *et al*., [23] studied on nutrient composition of exotic fishes of Bangladesh, in that they reported the moisture values of *P*. *sophore*, *P*. *ticto* and *X*. *cancila* are 75.63%, 75.02% and 79.57%. Mustafa *et al*., [36,] find out moisture values in *P*. *sophore* and Hilsa *and* Maria Zaman *et al*., [38] recorded moisture content of *P*. *sophore* is 75.71±0.84. Bijayalakahmi *et al*., [40] studied the moisture value of *P*. *sophore* is 78.95 to 81.34 ±0.257%. In present study highest moisture values were observed in August 2021 during spawning period of south monsoon season. The results of the present study revealed that changes in moisture content in the muscles of *C.striata* could be attributed to changes in moisture level and to spawning time.

ASH

The concentration of minerals and trace elements that are contribute for the total ash contents in fish and other aquatic organisms. Its depending on their food quality and feeding habits, water quality parameters, ecological conditions and sex of the fish [12] and also season, environment, ecosystem and size of the fish [44,45]. Ash content in the muscle of marine fishes was generally higher than that of freshwater fishes [46]. Ash concentrations increased marginally at mature and clearly after spawning of the fish. The high total ash content was found in the present study post monsoon. Love [14] reported that generally fish contains 0.5 to 5% of ash in their muscle tissue. Ahmed *et al*., [23], stated on nutrient composition of the ash values of *P*. *sophore*, *P.ticto* and *X*. *cancila* are 3.56%, 3.34% and 2.02%. Mustafa *et al*., [36] recorded 0.88±0.37%, ash values in *P*. *sophore* and Maria Zaman *et al*., [38] worked on nutrient contents of some fish species of the ash value of *P.sophore* is 4.31±1.08. Begum *et al*., [37] recorded the ash value of *P*. *sarana* is 2.02±0.25% and Mustafa *et al*., [36] studied on nutritional qualities of *Hilsa ilisa* and P. *sarana* the ash values are 2.27±0.16% and 2.02±0.24%. Panchakshari *et al*., [46] observed biochemical observations of *Lates calcarifer*. Storage is also influence the ash content changes in the muscle tissue [47].

The intensity of feeding, quality of natural food and quantity of natural food consumed by fish and may impact on the protein and fat content in the muscles [48]. Luzia *et al*., [49] stated that differences in fat content in muscle of fish collected in different seasons. Seasons may also impact on the muscle of rainbow trout was reported by Skałecki *et al*., [50]. Skałecki *et al*., [51] studied the effect of the season on fat content in muscle tissue in perch. In the autumn season contained significantly more fat (0.29%) than those caught in the spring (0.11%) [52]. In the present study protein highest recorded in the south west monsoon and fat recorded highest in the north east monsoon.

In the present investigation the protein content of muscle has been showed to fluctuate in relation to the maturation and spawning and similar findings recorded by Jafri and Khawaja [53]. It also indicates that the protein varies directly with the fat and inversely with the moisture. Piska and Warghray [54] stated that the seasonal variations in the protein content are well marked and conspicuous correlation with maturation, spawning and feeding activity of *A*. *mola*. The high content pre-spawning may due to the more energy required for the maturation. Low value of protein is due to energy utilized after spawning. Piska *et al*., [55], Ravisankar Piska and Aravinda Kumar [27] also reported similarity in muscles of *S*. *bacaila*. Rahman *et al*., [56] reported the snakehead *C*. *striata* have medicinal value and used to treat wounds, boosting energy and antimicrobial and antifungal ability. Further the fish have bioactive components, therapeutics and nutrition supplements.

Table 1: Variations of biochemical composition of muscle. *C. striata* (females)

Seasons	Months 2021-2022	Protein	Fat	Moisture	Ash
South West Monsoon	June	22.9	5.1	81.5	1.75
	July	23.5	4.9	82.6	1.87
	August	24.3	4.3	83.8	1.99
	September	23.8	4.5	83.4	2.03
Post Monsoon	October	22.8	4.8	83	2.12
	November	21.5	5.2	82	2.19
North East Monsoon	December	20.4	5.4	82.1	2.01
	January	21.5	4.9	82.3	1.96
	February	21.2	4.6	82.2	1.81
Summer	March	21.8	4.5	80.2	1.79
	April	22.3	4.6	81.5	1.61
	May	22.4	5.2	80.5	1.75
	Min.	20.4	4.3	80.2	1.61
	Max.	24.3	5.4	83.8	2.19
	Avg.	22.36±2.2	4.83±0.5	82.09±5.9	1.90±0.06

Table 2: Variations of biochemical composition of muscle. *C. striata* (males)

Seasons	Months 2021-2022	Protein	Fat	Moisture	Ash
South West Monsoon	June	23.7	5.4	82.4	1.79
	July	23.8	5.1	83.1	1.65
	August	25.2	4.5	84.2	2.05
	September	25.1	4.7	83.8	2.14
Post Monsoon	October	24.2	4.9	82.9	2.1
	November	23.5	5.3	83.2	2.25
North East Monsoon	December	22.4	5.5	81.2	1.96
	January	22.3	4.6	81.5	1.85
	February	23.2	4.4	80.5	1.72
Summer	March	22.6	3.8	80.4	1.65
	April	23.5	3.6	81.5	1.84
	May	22.5	4.8	80.6	1.89
	Min.	22.3	3.6	80.4	1.72
	Max.	25.2	5.5	84.2	2.25
	Avg.	23.5±2.5	4.71±0.5	82.10±5.8	1.90±0.05

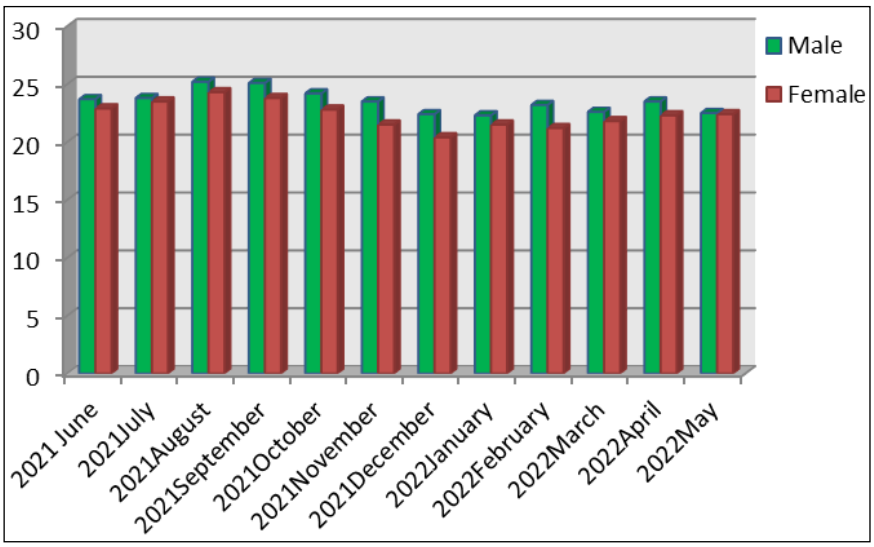

Fig 1: Protein content variations in muscle of male and female *C. striata*

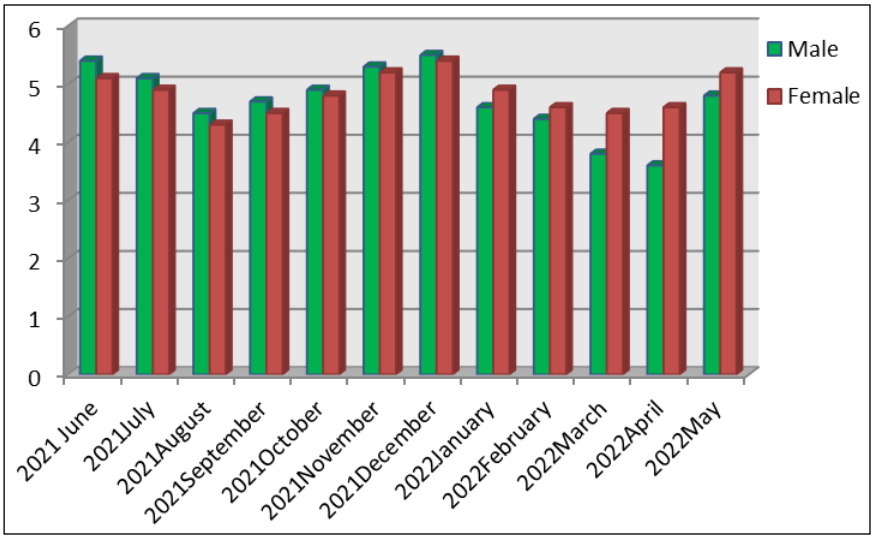

Fig 2: Fat content variations in muscle of male and female *C. striata*

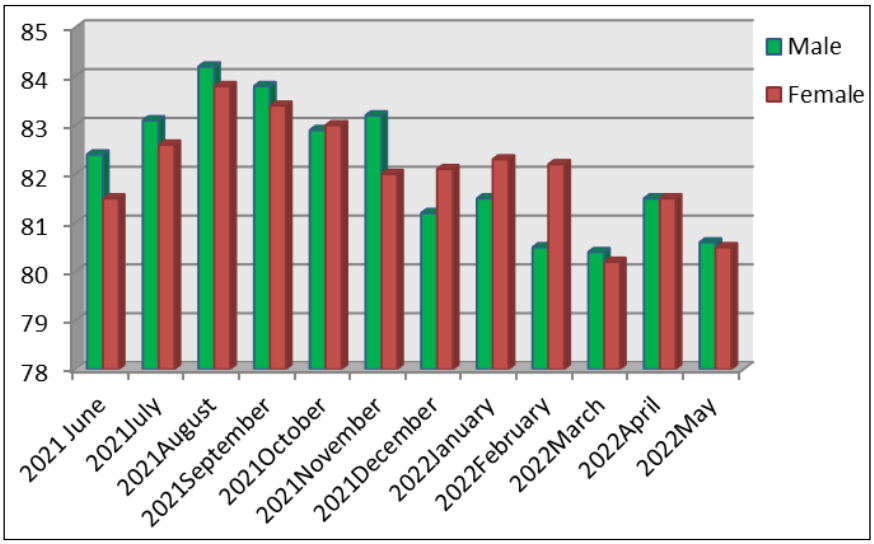

Fig 3: Moisture content variations in muscle of male and female *C. striata*

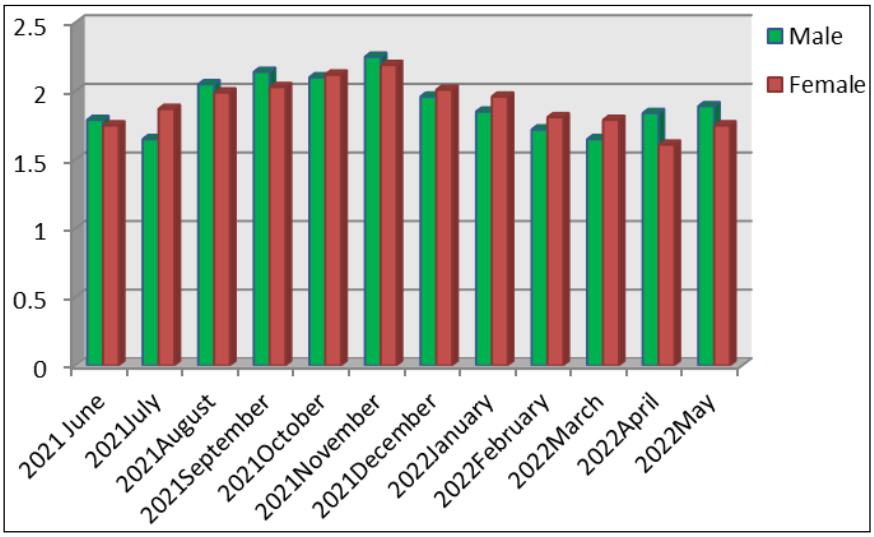

Fig 4: Ash content variations in muscle of male and female *C. striata*

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