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STUDIES ON CHANGES OF SODIUM, POTASSIUM AND CALCIUM IN WHITE MUSCLES AND RED MUSCLES OF TWO SPECIES OF FISHES OFF JODIA COAST IN GULF OF KUTCH

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Abstract

The rise in sodium content is recorded in white muscles of the both the species during spawning period, it is related relation with the gonadal activities during breeding period and the active gametogenesis. Potassium content in white muscles of *E.tetradeptylum* gradually increase during beginning of spawning and spawning period and in case of *L.tade* potassium content in white muscles show increase trend during pre-spawning period and moderates level in found during spawning. The calcium content in white muscles of *E.tetradeptylum* show higher level during pre-spawning period and in case of *L.tade* the calcium level gradually increase during pre-spawning period. The sodium content in red muscles of both the species shows higher level during pre-spawning and spawning period but in case of *L.tade* sodium level significantly decrease during spawning period. The potassium content of *E.tetradeptylum* level increase during pre-spawning and spawning period and incase of *L.tade* potassium level decreases significantly during spawning and it shows higher level during post-spawning period. The calcium content in red muscles of *E.tetradeptylum* show up and down level throughout year and in case of *L.tade* calcium level higher during the pre-spawning and decrease during spawning period.

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Introduction

In fishes muscles can be broadly divided in white muscles and red muscles and differences are due to presence of myohaemoglobin. Decided that the important metabolites and minerals also play an important role in physical and physiological aspects of the muscles. The difference between the two muscles is also due to that the glycogen, lipid, protein and minerals content. The detail review of minerals status of both the muscles have been presented by Cause ret (1962), Love (1970) has presented valuable information in his book "The chemical Biology of Fishes" regarding muscles of the Fishes. It is known that the white muscles lie flat on the lateral sides of the body of fishes.

Some muscles of fishes are coloured, browner reddish at certain places. These red muscles are present as separate bundles in fishes quite unlike those of higher vertebrates; Red muscles are usually located in most active part of the body of fishes, fish as the base of fins etc. (Alexander, 1955). In comparison with white muscles the red muscles very few.

In body of fish, sodium is main extra cellular ion. It increases in the muscles in the fish body from head to tail regions. In starved fishes and increase in muscles, sodium is recorded. Among the muscles, dark or red muscles possesses higher amount of sodium (Love, 1970 a review), Variations in sodium and Potassium in fish muscles are suggested to be under control of steroid hormone (Macleod, et al. 1968; Idler and Bitners (1959). An influence of

adrenal cortical steroids over sodium & potassium concentration in the blood of a fish and their excretion through the gills have been recorded by Chester Jones (1956). Their probable control of fish mineral metabolism by cortizone and cortisol is also reported Idler, et al; 1959).

Teleosts live in wide range of aquatic media and maintain their internal osmotic pressure and electrolyte concentration. Hirano (1973), Varghese (1976) has presented variations in sodium content of white and red muscles of *Parastromateus niger* and *Pampus argentus*. The increase in muscle sodium of *Gadus morrhaua* with increase in body length in an undepleted fish has been reported by Love, et al (1968). Larger fish showed higher value of sodium (McBride and McCleod, 1956-a). According Tomlinson, et al. (1967). Feeding has negligible effects on mineral concentration. However the changes are associated with the development of gonads.

Potassium is the chief intracellular ion the body of a fish. It decreases in catadromous migratory fish. With an increased in the size at fish increase in potassium is reported (Thurston and Mac Master, (1959). Thurston (1961) reported that in *Auoploma fimbria* conspicuous, in *Sabastodus aletus*, *Gadus microcephalus* and *Ophiodon elongatus*, Uniform mineral composition irrespective of species size, season of fishing ground is reported. However, Love et al. (1968). Have shown that potassium concentration of *Gadus morrhura* potassium varies with the change in size if there is no depletion in the fish. Potassium in the fish decreases when there is depletion and the red muscles contain less potassium than the white muscles (Thurston and Mac Master, 1960).

Control of sex hormones over potassium content is suggested (Macleod, et al. 1958.), On the other hand, Chester Jones (1959) has shown adrenal activities influencing sodium and potassium concentration in the blood. Electrolyte regulatory hormone aldosterone has been found to regulate electrolytes in Salmon Plasma (Idler, et al. 1959 Philips, et al. 1959.). Some evidences have been presented suggesting influence of thyroid hormone over control of salts and water in teleosts (Hoar, 1957). The variation in potassium content of migratory anadromous, *Hilsa ilisha* and non migratory *Hilsa toli* has been studied by Joseph (1967). The variations in potassium content of white and red muscles of *Pampus argentus* and *Parastromateus niger* has been studied by Varghese (1976). Present study with an aim to study with monthly fluctuations occurring in potassium content of both white and red muscles of the fish, *E. Tetradactylum* and *L. tade* was undertaken.

Rise in calcium in body of female fish is correlated with sexual maturity (Bailey, 1957; Wood head and Wood head, 1965). However, no definite trend of depletion in calcium of muscles during reproductive cycle of fishes has been recorded (Love, 1970). As a Fish increases in size Calcium in skin increases (Phillips et al., 1960; Mashiko and Tozuka, 1962, 1964; Norris et al., 1963; White et al., 1964; Podoliak Holder, 1965 and Copp, 1964). The influence of estrogen and pituitary hormones, mainly ACTH and prolactin, have been found to play vital role in Calcium metabolism in fish oestrodial sex hormones were injected in the fish in a non spawning season caused a rise in calcium level (Karrangi and Jakuda, 1966, 1967). It is now known that calcium is bound to vitelline membrane (Bailey, 1957) and is utilized in developing eggs along with protein.

Materials and Methods

white and Red muscles of *E. tetradactylum* and *L. tade* of 10 to 20cm length range were dissected out from the live fishes every month, taking care to avoid stress, The muscles were stored separately in polythene bags and brought to the laboratory. After absorbing water using blotting papers, muscles were dried in an oven at 48°C for three to five days. The dried homogenized powder was prepared and the samples were kept separately. The known amount of powder was digested with conc. H₂SO₄ and perchloric acid & was made up to a certain volume. Sodium and Potassium was determined by flame photometer (Eel make) using sodium filter and Potassium filter and Calcium present in the above solution was determined by E.D.T.A. METHOD, using Erichrome Black-T as an indication, the all minerals reading were then converted to mg/gm of dry weight of white and red muscles respectively.

Results and Discussion

The sodium content in white muscles of *E. tetradactylum* shows higher level during March, June, and August. While it shows lower level during April, July and September to November. Thus it shows up and down level during post spawning and pre-spawning period. The sodium content in white muscles gradually increases during just before spawning period. The level continues to increase till the spawning time and starts to decrease after the spawning period. In case of *L.tade*, sodium content increases gradually during post spawning and pre-spawning period. It shows low level during spawning period. The rise in sodium recorded in white muscles of both the species, during

pre-spawning period, have relation with the gonadal activities during breeding period and the active period of gametogenesis. The increased level in sodium content is observed in fishes is considered to be the relative increases in extra cellular space. McBride and McCleod (1956), Love, et al. (1968) have observed maximum value of sodium content during depletion in fishes. Varghese (1976) has reported in *Parastromateus niger* and *Pampus argenteus* that Sodium content in the white muscles increases during sexual maturity.

The sodium content in the red muscles of *E. tetradactylum* shows higher level during July and August i.e. during pre-spawning period. It shows decrease level during spawning period i.e. during November to February. The sodium content shows more amounts in red muscles at the end of the spawning period and it immediately decreases during post spawning period.

In case of *L. tade* same trend is observed about sodium Content in the red muscles. The sodium level gradually increases during pre-spawning period and significantly decreases during spawning period, and again Sodium content shows the increase level during period of just after spawning is over during this period it is clear from the above statement that sodium content, decreases when the mature fish are found more in number. So for breeding purpose active metabolic process are taking place and during this period decrease level in sodium Content i.e. breeding period is observed. Sodium and potassium variations are under the control of steroid hormones (Macleod, et al. 1968). Variation in sodium Content in white muscles and red muscles in both the species with the increase in body length are observed has been reported by (Idler and Bitners, 1959; Macleod, et al. 1968), Love, et al. (1968), have observed maximum value of sodium during depletion in fishes. Varghese (1976) has report in *Parastromateus niger* and *Pampus argenteus* sodium in white muscles increases during sexual maturity.

It is evident from the table that potassium content in the white muscles of *E. tetradactylum* shows decrease level from July to September i.e. during pre-spawning period. It gradually increases from October to December i.e. during beginning of pre-spawning and just before spawning period. An increase in amount of potassium is correlated with increase in size of fish (Thurston and McMaster, 1959). The depletion causes reduction in potassium content in fishes (Macleod, 1958; Idler and Bitners 1959; Varghese, 1976). In case of *L. tade* potassium content of white muscles show an increase trend during pre-spawning period and moderate level is found during spawning periods. There is gradual increase in potassium content in white muscles is observed during post spawning i.e. during April to September.

The larger size group 12-15 cm 15-18 cm and 18-21 cm are more in number in catch in *E. tetradactylum* where potassium content shows higher level in white muscles of male and female of *E. tetradactylum*.

In case of *L. tade* potassium content shows more amount in white muscles during June to October when larger size group (12-15 cm; 15-18 cm) are captured in more number (18-21 cm; 21-24 cm) size group are observed in less number during this period. It indicates that potassium concentration has correlation with the size group of fish.

The potassium content in red muscles of *E. tetradactylum* shows up and down level from March to September. The level increases during pre-spawning and spawning period and the level immediately decline after the spawning is over. In case of *L. tade*, potassium level declines just before spawning. It decreases significantly during spawning and it shows higher level during post spawning period. Higher amount of potassium in red muscles is observed during July to October and November, December, it is important to note that potassium content in white muscles shows lower level, than that of red muscles in case of *E. tetradactylum* while in case of *L. tade* potassium concentration is less in red muscles than that of white muscles. Potassium concentration in white and red muscles of both the species is observed during period of spawning and it falls significantly when spawning period correlate with sexual development and release gametes during spawning period. During depletion fall in potassium of the muscles of the fishes, *Gadus morrhua* (Love et al 1968.) in *Pampus argenteus* and *Parastromateus Niger* (Varghese, 1976) and in *Hilsa toli* (Joseph, 1967) have been reported.

The calcium contents in white muscles of *E. tetradactylum* show higher level during August to October i.e. during period of pre-spawning. It is important to note that it reaches at the highest level in October when fish starts to breed the calcium level decreases remarkably at the end of spawning period and remain at low level during post-spawning period i.e. during April to July. In case of *L. tade* the calcium level gradually increases from August to December respectively. Same trend is observed in this fish also. The calcium level in white muscles increases if during pre-spawning period, it remains higher in beginning of spawning period and gradually decreases during the late period of spawning and still remains at low level during post spawning period. It is clear from the above result that calcium content in white muscle has relation with the process of gamete formation. Pituitary gland, adrenal gland and the endocrine cells of the gonads become active when the fish just starts to prepare for breeding purpose. A general

trend of increase in calcium value of muscles according to maturity has been suggested by Bailey (1957). This is more conspicuous in male than female. However, several workers have shown no definite trends of calcium in depletion (Love, 1970). The results presented here show rise in calcium during the period of gamete formation and a fall during and after spawning of the fishes.

The calcium content in red muscles of *E. tetradactylum* shows up and down level throughout the year it increases during pre-spawning period and the level comes down during November, December, spawning times and again it increases in January and February.

In case of *L. tade* the calcium level in red muscles remains at higher level during pre-spawning, it decreases during spawning period i.e. during October, November. It again increases during January and February and repair low level from April to July. It is clear from the above results that calcium content of red muscles of both the species decreases during spawning and post spawning period. It increases during the period of gamesomeness, the calcium level remain at low level in both the muscles of *L. tade* in comparison to those of *E. tetradactylum*

Table-1 Showing the Sodium content in White muscles and Red muscles in mg/gm.

Month	<i>E. tetradactylum</i>		<i>L. tade</i>	
	White muscles	Red muscles	White muscles	Red muscles
January	8.80 ± 0.30	10.05 ± 0.00	7.28 ± 0.00	5.95 ± 0.17
February	9.60 ± 0.17	10.15 ± 0.16	6.90 ± 0.16	6.50 ± 0.35
March	1.60 ± 0.17	12.75 ± 0.00	8.40 ± 0.16	9.40 ± 0.30
April	8.30 ± 0.17	13.85 ± 0.15	10.52 ± 0.17	15.70 ± 0.17
May	8.60 ± 0.15	10.40 ± 0.35	11.75 ± 0.35	12.25 ± 0.35
June	9.50 ± 0.35	6.25 ± 0.34	12.25 ± 0.34	11.10 ± 0.34
July	9.10 ± 0.00	29.25 ± 0.17	13.15 ± 0.17	16.50 ± 0.17
August	8.10 ± 0.46	24.35 ± 0.16	11.70 ± 0.17	18.70 ± 0.17
September	7.70 ± 0.17	15.30 ± 0.17	10.90 ± 0.35	21.45 ± 0.35
October	6.40 ± 0.00	13.25 ± 0.46	11.65 ± 0.17	20.85 ± 0.17
November	6.35 ± 0.30	6.25 ± 0.34	10.45 ± 0.34	17.40 ± 0.34
December	7.40 ± 0.15	9.25 ± 0.35	9.50 ± 0.33	14.25 ± 0.33

Table-2 Showing the Potassium content in White muscles and Red muscles in mg/gm.

Month	<i>E. tetradactylum</i>		<i>L. tade</i>	
	White muscles	Red muscles	White muscles	Red muscles
January	10.40 ± 0.74	17.80 ± 1.48	9.15 ± 0.43	7.65 ± 0.43
February	8.00 ± 0.74	16.30 ± 1.46	14.85 ± 0.00	12.85 ± 0.43
March	19.30 ± 1.49	29.70 ± 2.96	12.00 ± 0.53	13.60 ± 0.85
April	14.85 ± 0.00	10.40 ± 0.74	11.80 ± 0.75	10.60 ± 0.85

May	11.90 ± 0.77	12.40 ± 0.43	13.35 ± 0.00	12.85 ± 0.42
June	16.30 ± 1.14	14.85 ± 0.00	12.85 ± 0.42	14.10 ± 0.75
July	13.85 ± 0.85	20.30 ± 0.85	8.40 ± 0.43	17.30 ± 0.85
August	11.10 ± 0.72	13.35 ± 1.48	11.30 ± 0.32	7.70 ± 0.87
September	9.65 ± 0.74	14.85 ± 0.00	14.10 ± 0.76	9.90 ± 0.42
October	13.10 ± 0.74	10.40 ± 1.50	9.90 ± 0.86	11.40 ± 0.43
November	14.35 ± 0.43	4.45 ± 0.00	13.60 ± 0.85	8.16 ± 0.00
December	12.60 ± 0.72	11.85 ± 1.57	14.50 ± 0.00	4.45 ± 0.74

Table-3 Showing the Calcium content in Red muscles and White muscles in mg/gm.

Month	<i>E. tetradeptylum</i>		<i>L. tade</i>	
	White muscles	Red muscles	White muscles	Red muscles
January	1.15 ± 0.05	1.20 ± 0.05	0.80 ± 0.00	1.20 ± 0.02
February	1.75 ± 0.06	1.40 ± 0.00	0.60 ± 0.00	1.00 ± 0.04
March	2.05 ± 0.05	0.85 ± 0.05	0.75 ± 0.06	0.80 ± 0.00
April	1.70 ± 0.08	1.20 ± 0.08	0.80 ± 0.02	0.47 ± 0.06
May	1.45 ± 0.05	0.80 ± 0.04	1.00 ± 0.02	0.65 ± 0.02
June	0.85 ± 0.05	0.65 ± 0.07	0.60 ± 0.06	0.45 ± 0.04
July	1.25 ± 0.05	1.15 ± 0.04	0.40 ± 0.00	0.55 ± 0.02
August	2.35 ± 0.04	0.80 ± 0.00	0.70 ± 0.02	1.20 ± 0.00
September	2.75 ± 0.11	1.60 ± 0.05	0.85 ± 0.04	1.12 ± 0.04
October	2.90 ± 0.10	1.35 ± 0.07	1.00 ± 0.00	1.00 ± 0.04
November	2.10 ± 0.08	0.95 ± 0.05	1.20 ± 0.02	0.80 ± 0.02
December	0.95 ± 0.12	0.80 ± 0.00	1.30 ± 0.02	0.60 ± 0.00

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