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Lipid Reserves of Pomfrets Fishes from Within and Outside PFZ Zone (Pisces: Stromateidea) off Ratnagiri Coast, Maharshtra State, India

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Abstract: The present investigation was carried out to quantify the lipid reserves for total lipid content in different body tissues of pomfret fishes. Energy allotment of lipid reserves into muscle, gonad and liver were analyzed for the first attempt for different gonad maturation stages of pomfrets. Results showed that lipid content in the female gonad varied between from Sakhri-Natye 5.64±0.74, Mirkarwada 5.64±0.10 followed by Harnai 5.56±0.24 from within PFZ as compared to male gonad in *Pampus argenteus* fish during November-December. Whereas in March-April from within PFZ in female gonad from Sakhri-Natye 6.86±0.61, for Mirkarwada 6.37± 0.14 and Harnai 6.21±0.37 as compared to outside PFZ as well as male gonad variations and revealed gonad is the major energy storage site in pomfret fishes. During late post-spawning and early pre-spawning season from within and outside PFZ showed slight variations throughout the study. A trend for male and female pomfrets emphasize that the lipid stored in the liver during the maturing stage as mobilized towards the gonad during late post-spawning and early pre-spawning for gonad development, gamete production and other reproductive purposes. The results gained from the present study provide information on nutritional status of different stages, reproductive potential of pomfrets fishes.

Key words: Lipid content · Muscle · Gonads and liver

INTRODUCTION

Energy storage in animals its typically in the form of lipids. Lipid and dynamics are particularly important aspect of fish health and population success [1] because they have a large influence on growth, reproduction and survival [2]. Now a day's fish lipid has been highlighted as being beneficial for human health [3]. Quantity of energy reserves in a fish influence the metabolic activities of it. Lipid content of fish is highly variable and provides indications on the fish quality [4, 5], affected by habitat characteristics and the food supply [6, Shulman *et al.* 2005). In a fish once the lipid content exceeds the needed quantity of metabolizable energy the balance will be deposited in its tissues. As a result the fish will show high lipid content and categorized as high lipid content fish. Generally, when lipids are stored only in the liver of fish they are termed as lean fish. If the lipids are stored in other body tissues they are termed as fatty fish [7]. In most cases energy is stored in the liver of the fish and therefore, liver indices becoming as an important indication of the overall fish condition [8]. As a fish mature, gonad development takes place and the fish must produce gametes. The related processes are very energy intensive and require lipids. During these phases, lipid levels decrease in the liver and muscle tissue and increase in the gonads [9, 10].

The changes that take place in the tissues of fish, at the onset of maturation, are often different in males and females. Generally in several fishes, male gonad is smaller than female. This is caused by differences in size of the fish, fish behaviour and the size of the gonads [11]. Lipids stored in the ovary of fish is the principal source of energy as it provide the energy for larval stages before first feeding and persuade the survival of fish larva [12]. For estimating the energy reserves of fishes determination of lipid content has been extensively used among the biochemical parameters [13]. The pomfrets *Pampus*

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argentus, P. chinensis and *Parastromateus niger* is an economically important food fishes in coastal as well as offshore fisheries under family stromateidae and Formionidae. These fishes have high consumer demand and market potential. The pomfrets are great topical and popular in fresh condition with export demands and especially consumed by mothers using during pregnancy and immediately after delivery. Information on the energy reserves of *P. argenteus* is still lacking and the present investigation was originated as a consequence of it in order to find out the nutritional status and also to understand the energy allocation for reproductive strategies. In the present investigation different biochemical aspects were studied in detail, total lipid content in muscle, gonad and liver was quantified and compared between maturing and pre-spawning stages.

MATERIALS AND METHODS

Fishes were collected from within and outside PFZ upon validation of potential fishing zone advisory sent from INCOIS throughout the regular intervals from November -November 2008 to March-April 2011 with the help of Federation of Fishermen Cooperative Society's of the Ratnagiri district. Following suitable PFZ advisory in fishing operation after landing fishes were taken to the laboratory for further analysis. Selected pomfret fishes representing the full size range (25-32cm) of each sex male and female separately. All the fishes were dissected, sex was determined and sexual maturity of gonads was examined macroscopically. Maturing stages were first classified according to sex by visual inspection of the gonads, through an incision made in the ventral mid line. Maturing stages ovaries were signified with the following characters: white in colour, L-shaped texture, oocytes present and oil droplets are distinct and zona radiata well formed. Early pre-spawning stages were distinguished by observing the following characters: Ovaries were large with blood capillaries, white, slightly red coloured. The maturing males were classified microscopically to be in the maturing stage: Milky whitish a paired, connective and muscle tissue prominent, spermatocytes were the dominant tissue. Percentage of lipid content in muscle, gonad and liver were analyzed as a measure of energy reserves.

RESULT

One hundred and fifty specimens of pomfret fishes were collected from within and outside PFZ upon validation of potential fishing zone advisory sent from INCOIS were utilized by following fishing boats going in the sea throughout the regular intervals from November -November 2008 to March-April 2011. Among the sample collected 60 maturing male, 90 maturing female were distinguished and recorded. Mean values (Mean ±Standard deviation (SD)) and percentage of lipid content of muscle, gonad and liver for male and female pomfret separately are presented in Table 1. One way ANOVA revealed significant interaction between lipid content in muscle, gonad and liver for male and female were examined in detail. Slight variations was observed for lipid content of pomfret fishes from within and outside PFZ among the maturing male and female. The following table and graph showed lipid content of *P. argenteus* during November-December and in March-April.

The highest lipid level from female gonad was observed 5.64% mostly and lowest value recorded 4.02 from male gonad outside PFZ region in *P. argenteus* fish during November-December whereas for within and outside PFZ from female gonad the highest value 6.86 and 5.16 while for male gonad the highest 6.29 for within PFZ and lowest 4.83 for outside PFZ. The lipid content was from within PFZ male gonad 4.91% to 5.64% for outside PFZ 3.61% to 4.26 during November-December on the other hand for within and outside PFZ represents value 5.72 to 6.26 and 4.83 to 5.08 respectively in March-April. The lipid level from female for within and outside PFZ showed 5.56 to 5.64 and 4.26 to 4.43 during November-December whereas for within and outside the highest and lowest value 6.21 to 6.86 and 5.16 to 6.21 in March-April. The highest lipid level from female gonad was observed for within PFZ 7.75 and lowest value 6.05 for outside PFZ recorded region in *P. chinensis* fish during November-December on the other hand the highest value 8.73 for within and lowest 5.81 for outside PFZ in Mar-April. The lipid content male gonads was from within and outside PFZ 6.62 to 7.02 and 6.29 to 6.86 during November-December on the other hand for within and outside PFZ represent value 7.51 to 8.24 and 6.29 to 7.19 respectively 1in March-April. The lipid level from female gonad for within and outside PFZ 6.78 to 7.75 and 6.05 to 6.29 showed during November- December whereas for within and outside the highest and lowest value 7.75 to 8.73 and 5.81 to 7.35 in March-April.

The following table of lipid content in *Pampus chinensis* from within and outside PFZ as compared to male and female separately from the Ratnagiri region showed variations during late post-spawning and early pre-spawning season. In the present study it seems that pomfrets fishes were utilizing fat as a main source of energy sparing protein for body building. This was

Table 1: Lipid content of *P. argenteus* during November - December

		Mirkarwada		Harnai		Sakhari-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	2.9700.140*	1.9150.486	3.2130.371ns	2.5640.281	2.0770.281ns	1.9150.486
	Female	3.7000.281**	2.3210.371	4.2680.371*	3.1320.243	3.3760.486**	2.1590.243
Gonad	Male	4.9180.371ns	3.6190.243	5.6480.743*	4.2680.140	5.3230.243ns	4.0250.743
	Female	5.6480.140*	4.4310.371	5.5670.243*	4.4310.371	5.6480.743*	4.2680.140
Liver	Male	0.8600.371ns	0.6980.243	1.5910.281*	0.6980.243	0.8600.371ns	0.6980.243
	Female	1.8340.371*	0.6170.140	1.8340.371ns	1.3470.506	1.9150.486ns	0.8600.371

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001, ns=P> 0.05 non -significant

Table 2: Lipid content of *P. argenteus* during March-April

		Mirkarwada		Harnai		Sakhari-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	4.6740.140***	3.1320.243	4.5120.140*	3.9440.140	3.1320.243**	2.4830.140
	Female	4.9990.612ns	4.2680.506	4.9180.612ns	4.0250.140	4.7550.371ns	4.0250.743
Gonad	Male	5.8100.486ns	5.0800.243	6.2970.486*	4.8360.486	5.7290.702ns	4.9990.281
	Female	6.3780.140ns	5.4860.506	6.2160.371ns	5.1610.281	6.8650.612ns	6.2160.371
Liver	Male	1.5910.281ns	0.8600.371	1.4280.486ns	0.6980.243	2.3210.371ns	1.5090.140
	Female	2.3210.371ns	2.1590.243	2.4830.140**	1.5910.281	2.6450.243**	1.5090.140

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001, ns= P> 0.05 non- significant

Table 3: Lipid content of *P. chinensis* during November-December

		Mirkarwada		Harnai		Sakhri-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	3.7810.371*	2.8080.371	4.5120.371*	3.6190.243	4.2680.371ns	3.4570.140
	Female	5.2420.371ns	4.4310.140	4.8360.486*	3.7810.371	4.6740.140*	3.7810.140
Gonad	Male	6.7030.371**	6.2970.486	7.0270.243*	6.8650.371	6.6220.612*	6.4590.612
	Female	6.8650.140*	6.0540.243	7.7580.243***	6.0540.243	6.7840.421ns	6.2970.243
Liver	Male	1.1850.243ns	0.5360.140	1.7530.281ns	1.3470.371	1.5090.140ns	1.0230.371
	Female	2.0770.140ns	1.5090.140	2.3210.371**	1.0230.612	2.6450.243ns	1.9960.140

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001, ns= P> 0.05 non- significant

Table 4: Lipid content of *P. chinensis* during March-April

		Mirkarwada		Harnai		Sakhari-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	5.0800.644ns	3.9440.612	4.0250.612*	2.5640.140	3.9440.140ns	3.8630.486
	Female	6.3780.612ns	5.0800.486	4.9990.612ns	3.6190.243	4.7550.506ns	3.3760.486
Gonad	Male	7.5140.243ns	6.2970.486	8.2450.644ns	7.1900.371	7.8390.612ns	6.4590.612
	Female	7.8390.140***	5.8100.486	8.7310.486**	7.3520.371	7.7580.486**	5.9720.140
Liver	Male	2.8890.243ns	2.4830.140	3.0510.281ns	2.6450.243	2.5640.140**	1.4280.486
	Female	3.3760.486ns	2.7270.371	3.1320.243ns	2.2400.281	2.8890.486ns	2.4830.612

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001,ns= P> 0.05 non- significant

Table 5: Lipid content of *P. niger* during November-December

		Mirkarwada		Harnai		Sakhari-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	5.9720.281***	4.1060.243	6.0540.243**	4.6740.506	3.7810.371ns	3.1320.243
	Female	6.5400.243ns	5.6480.281	6.0540.243*	4.7550.281	6.3780.612ns	5.3230.486
Gonad	Male	7.7580.486ns	7.1900.506	6.2970.243ns	5.4040.140	5.8910.506*	4.6740.506
	Female	8.4880.243*	7.0270.243	8.8130.612**	7.1080.371	8.7310.486*	7.2710.486
Liver	Male	3.1320.243**	2.0770.281	3.7000.371ns	3.1320.243	2.2400.281ns	1.5910.140
	Female	3.6190.243Ns	3.3760.486	3.7810.854Ns	3.3760.486	2.4830.506ns	1.3470.371

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001, ns= P> 0.05 non- significant

Table 6: Lipid content of *P. niger* during March-April

		Mirkarwada		Harnai		Sakhari-Natye	
Tissue	Sex	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ	Within PFZ	Outside-PFZ
Muscle	Male	6.7030.371ns	5.3230.486	6.5400.243ns	5.4860.371	6.3780.612ns	5.2420.854
	Female	6.8650.140Ns	6.0540.243	6.9460.371*	5.7290.371	6.5400.421**	5.0800.644
Gonad	Male	9.0560.371*	7.7580.486	7.190.371*	6.0540.243	6.9460.371**	5.2420.506
	Female	9.7860.371*	8.0820.281	10.030.782Ns	8.8940.612	9.7860.612*	8.2450.486
Liver	Male	3.9440.743ns	3.2130.371	4.1060.421ns	3.1320.243	3.3760.486ns	2.9700.140
	Female	4.5930.243ns	3.8630.486	4.5930.644ns	4.1870.281	4.7550.506ns	3.8630.486

Mean value of 3 sample size with ± SD, *= P<0.05, **= P<0.01,***= P<0.001, ns= P> 0.05 non- significant

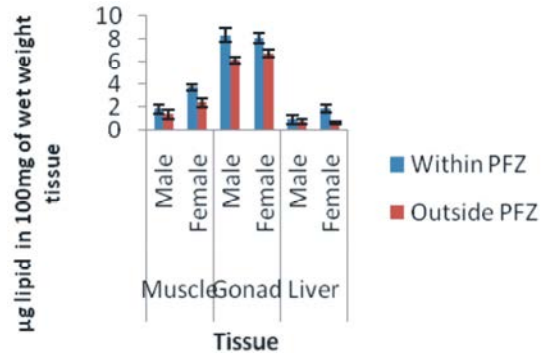

Fig. 1: Lipid content in P. Argenteus during November - December at Mirkarwda

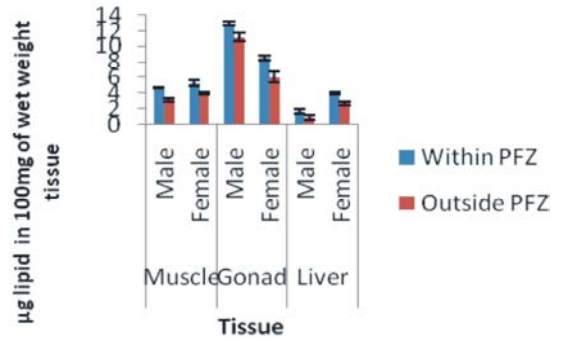

Fig. 2: Lipid content in P. Argenteus during March - April at Mirkarwda

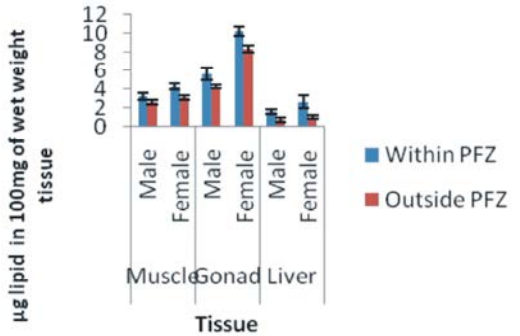

Fig. 3: Lipid content in P. Argenteus during November - December at Harnal

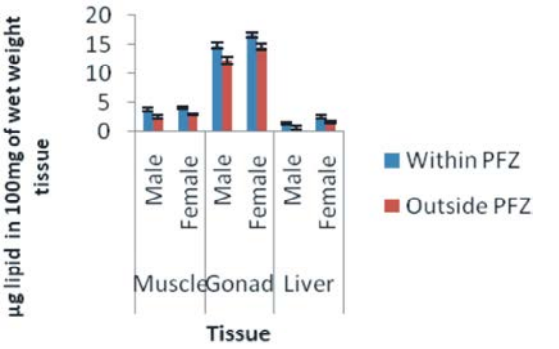

Fig. 4: Lipid content in P. Argenteus during March - April at Harnal

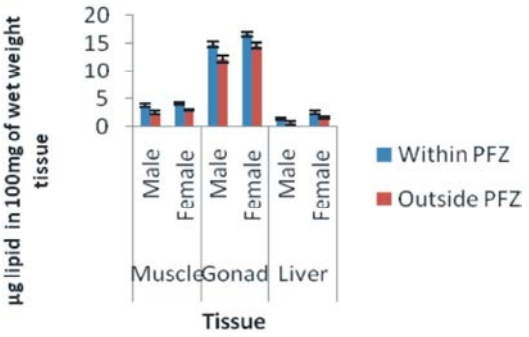

Fig. 5: Lipid content in P. Argenteus during November - December at Sskhr-Natye

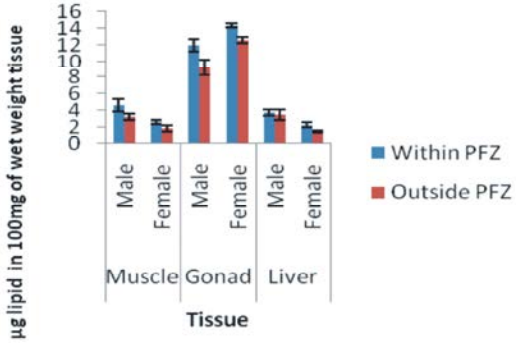

Fig. 6: Lipid content in P. Argenteus during March - April at Sskhr-Natye

corroborated by findings recorded by Phillips *et al.* (1966). They found that carbohydrates were utilized for energy by trout and thus spared protein for protein purposes in the body. Protein is not an efficient energy source for fish. It will be used for energy if the available energy from other sources (lipid and carbohydrates) is insufficient (Phillips, 1969). Rattan (1994) suggested that protein and visceral lipid resources may be utilize in the prespawning period and the muscle reserve in the post - spawning period in *Etroplus suratensis*. Therefore, the sequence of mobilization of endogenous source of energy could be the possible reason of high level of lipid content in the mature spawners. Protein cycle and lipid cycle of muscle in three pomfret were more or less inversely related. It seems that there is an alternative uses of the energy sources (lipids and protein) in the pomfret fishes. The higher fat content in some species of fish is of nutritional value as that support protective effect against coronary heart disease for fish consumption and intake of marine omega-3 fatty acids [14].

The highest lipid level from female gonad was observed for within PFZ 8.81 and lowest value for outside PFZ 4.67 from male gonad recorded in *P. niger* fish during November-December on the other hand the highest value from female gonad for within PFZ 10.03 and lowest for outside PFZ 5.24 from male gonad in March-April. The lipid content male gonads was from within and outside PFZ 5.89 to 7.75 and 4.67 to 7.19 during November-December on the other hand for within and outside PFZ 6.94 to 9.05 and 5.24 to 7.75 represent value respectively in March-April. The lipid level from female gonad for within and outside PFZ 8.48 to 8.81 and 7.02 to 7.27 showed during November-December whereas for within and outside the highest and lowest value 9.78 to 10.03 and 8.08 to 8.89 in March-April. A highly significant parallel relationship exists between lipid and protein contents for both male and female sexes.

The significance of the two seasonal variations from within and outside PFZ biochemical constituents is intricate to distinguish between the effects of many factors which will influence the biochemistry of the fish. In fishes, the biochemical content with regards to maturation of gonads and the food supply [15]. The biochemical texture are also affected by metabolism mobility of the fish and geographical area (Stansby, 1962).The results of the present study revealed that changes in biochemical composition in the different tissues of pomfret from both within and outside PFZ could be attributed to changes in lipid level directly and to spawning and feeding intensity indirectly. The maturation and the enrichment of gonads in lipid coincided with a decline of the lipid content in muscles and liver. In the present study the more intense reduction in the lipid content in the liver and muscle of males compared to female's pomfrets indicate that the reproductive cost is higher in females than in males in all the three pomfret fishes collected from the within and outside PFZ validation experiment conducted.

Seasonal variations in lipid levels in fishes are fundamentally related to the reproductive cycle since most marine fishes generally accumulate large lipid deposits prior to gonadal development [16]. In pomfrets fishes a higher percentage of lipid reduction was observed in liver compared to muscles, indicating that the use of liver reserves in a better extent than the muscle reserves. The total lipid also increases for within than outside PFZ zone in the testis of three pomfret species during late post -spawning andearly pre-spawning time. In fish body the gonads store large quantity of lipid during maturation (Wada, 1955). The present intricate and important investigation was undertaken with a purpose to investigate variations in lipid level of three pomfrets ovaries and testis viz. *P. argenteus, P. chiensis and P.niger*. Increase in ovarian total lipids in relation to sexual maturity has been reported by some workers (Wada, 1955; 17, 18]. It is also suggested that the ovarian total lipids depleted during spawning.

DISCUSSION

Even though lipid concentrations varied greatly among individuals, results show that in the pomfret fishes lipids are less stored in the liver and mainly in the gonads then followed by muscles. Shao Ning *et al* (2010) [19] identified from their research that the liver in important energy storage organ in *Trachinotus ovatus* (Family : Carangidae). These results are in consistent with the values obtained in the present study for pomfret. For *Parastromateus niger*, Chedoloh et al. (2011) [20] reported muscle lipid of 2.58% whereas, Nurnadia et al. (2011) [21] reported 2.33%. Further Chedoloh et al. (2011) [20] reported a muscle lipid content of 2.13% for *Atule mate*, 3.31% for *Selar crumenophthalmus*, 2.12% for *Carangoides gymnostethus,* 2.74% for *Elagatis bipinnulata* and 3.22% for *Pampus argenteus*. However, Nurnadia et al. (2011) [21] reported 2.09% for *Pampus argenteus* and 2.12% for *Selaroides leptolepis.* All these values fall well within the range recorded in the present

study. In the present study during late post-spawning and early pre-spawning lipids represented high in the *P. niger* then *P. chinensis* followed by P. argenteus.

Less relatively lipid content in the liver of pomfret fishes with size indicates a progressive accumulation of energy in the liver as fish grows till sexual maturation. Female almost seem to expend much energy on reproductive activities since they presented lower liver lipid reserves than those of maturing individuals. Therefore, it could be emphasized that less lipids stored in the liver of pomfrets fishes during the maturing stage are mobilized towards the gonad during early pre-spawning for gonad development, gamete production and other reproductive purposes. Generally various authors [22, 13, 23] emphasized that lipid reserves stored in the body of fishes greatly reduced during breeding as it had been supplied to the ovary in the form of energy. The present study has detected differences in the lipid content of pomfrets tissues in different maturing stages. The quantity of lipid has been used as biochemical index of tropical condition for fresh water and marine fish [24].

Fish can be grouped into four categories according to their fat content: lean fish (<2%), low fat (2-%), medium fat (4-8%) and high fat (>8%) [25]. Accordingly pomfrets is having a cumulative average of 8.48% from Mirkarwada in *P. niger* gonad female from within PFZ as compared to outside male during Novembr-December. While in March-April from within female gonad 10.03% from Harnai as compared male gonad and other two landing centers. It can be classified under the medium fat fish. From the inferences of the present study being a medium fat fish can be recommended as a good nutritional source of food fish for the human health. Ramadan (2003) reported that the fat content was affected by maturation and the depletion of fat reserve in muscle accompanied by a rise of fat content in gonad for gilthead seabream *Sparus aurata* along the Tunisian coast. The changes in percentage of gonad lipid from maturing to early pre-spawning stage is higher in female than the male imply that the energy expended for gamete production in female was higher than male [26]. The gender related differences in lipid depletion reveal the different energy expenditure for gamete production between the sexes [27-29].

CONCLUSION

The maturation and the enrichment of gonads in lipid coincided with a decline of the lipid content in muscles and liver. In the present study the more intense reduction in the lipid content in the muscle and liver of males compared to female's pomfrets indicate that the reproductive cost is higher in females than in males in all the three pomfret fishes collected from the within and outside PFZ validation experiment conducted. Marked changes were observed in the biochemical composition of the muscle of pomfret fishes during different seasons of the year especially from November-December and March-April,

Pomfret is having a cumulative average of Accordingly pomfrets is having a cumulative average of 8.48% from Mirkarwada in *P. niger* gonad female from within PFZ as compared to outside male during Novembr-December. While in March-April from within female gonad 10.03% from Harnai as compared male gonad and other two landing centers. It can be classified under the medium fat fish. Being a medium pomfret fat fishes it can be recommended as a good nutritional source of food fish for the human health. High value of lipids in ovary of early pre-spawning females reflects high reproductive potential. Female early pre-spawning possessed lower liver lipid reserves than maturing individuals confirm that lipids stored in the liver of pomfrets during the maturing stage are mobilized towards the gonad during early pre-spawning for gonad development. The percentage of lipid of pomfrets individuals positively related to the size of the fish showed a significant relationship in lipid content in both within and outside PFZ zone from all the fish landing centers off Ratnagiri coast [27-29].

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