

Biochemical composition and caloric content in sand whiting *Sillago sihama* (Forsskal), from Zuari Estuary, Goa

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Running title: Biochemical components of sand whiting, Goa

Abstract

Fish condition and the seasonal variation in biochemical composition (moisture content, lipid, protein and carbohydrate) of an economically important fish *Sillago sihama* (Forsskal), from Zuari Estuary, Goa were monitored over fifteen months period on dry weight basis (DWB). Moisture content ranged from 76.2 to 79.6 %. Lipid content varied between 4.2 and 2.2 %. Protein content forms the highest percentage among the other components and varied from 19.1 to 24.96 %, while carbohydrate was the lowest, fluctuated between 0.46 and 0.63 %. The results revealed that moisture content was high when lipid was low during the peak spawning indicating a significant inverse relationship between the two components ($r = - 0.6$, $P < 0.05$). Highest protein values were recorded in November when the lipid content was lowest. The carbohydrate does not contribute much to the reserve in the body.

Key words: *Sillago sihama*, Protein, Lipid, Carbohydrate, Goa.

Introduction

The biochemical composition of the fish muscle generally indicates the fish quality. Therefore, proximate biochemical composition of a species helps to assess its nutritional and edible value. An increasing amount of evidences suggest that due to the high content of polyunsaturated fatty acid, fish flesh and fish oil are beneficial in reducing the serum cholesterol (Stansby, 1985). In addition to that, the special type of fatty acid, the omega- 3 polyunsaturated fatty acid, recognized as an important nutritive supplement to prevent a number of coronary heart diseases (Edirisinghe, 1998), is also present in fishes.

Although several studies deal with the proximate composition of biochemical components of many commercially important fishes but no work on similar lines has been carried out in *Sillago sihama* particularly from Goa waters. Therefore, the present study was undertaken to elucidate the dynamics of biochemical composition of muscle of *Sillago sihama* with reference to season and size.

Material and methods

Samples of *Sillago sihama* were collected from Zuari estuary (Dona Paula) during the period of January 2004 to April 2005. The specimens were properly cleaned in the laboratory and the total length, total weight, and sex were determined. Based on their total length, fishes were arranged into size groups with 10 mm intervals. Body muscle samples (free from skin and scales) of different size groups in each month were collected and homogenized in a hand homogenizer, dried and kept in a desiccator before the analysis of biochemical components. Estimation of the moisture content was carried out by drying the pre-weighed wet samples at 60 °C in a thermostat until a constant weight was obtained. The difference in weight was calculated and expressed as percentage moisture content of the sample. All sampling was carried out at room temperature ($28 \pm 1^\circ\text{C}$).

The dried samples were finely powdered using mortar and pestle. Biochemical analyses for lipid, protein and carbohydrate were carried out using standard methods. Lipid was estimated by the method of Folch et al. (1957). Protein was estimated following the method of Lowry et al. (1951). Total Carbohydrate was estimated by the phenol sulphuric acid method (Dubois et al, 1956). All the values of biochemical components were expressed as percentage dry weight basis (%DWB). Caloric content was calculated by multiplying the concentration of various components with conversion factors 4.15, 9.4,

and 5.65 for carbohydrate, lipid and protein, respectively, (Phillips, 1969). The caloric values were expressed as calories per gram (cal gm^{-1} DWB).

Results:

Both, seasonal and size wise variation in biochemical components are tabulated in Table 1 and 2, respectively. Moisture forms the major component and its seasonal variation was in the range of 76.2 - 79.6 % with an annual average value of $77.8 \% \pm 1.03$. The moisture content was observed to be high from January to March (79.3% - 79.1 %) followed by gradual decline until June (76.9 %). It was steady during July - September after which moisture content increased until November followed by sharp decline. It reached its minimum in December 2004 (76.2 %). The moisture content was independent of size class as no coincident pattern was discernable. Seasonal variation of Lipid content ranged between 4.2 % in May and 2.2 % in November with an average value of $3.2 \% \pm 0.61$. The percentage of lipid content showed a low values during January-April, followed by sharp increase in May-June just prior to spawning season. Thereafter, gradual decline was observed to reach its lowest value in November, after which the value increased.

Protein content of *S. sihama* varied from 19.1 to 24.96 %. The average value was calculated to be $22.49 \% \pm 1.77$. There was stability in protein content from January to May followed by increase in June. Slight decrease was observed in July. From August to November protein values were obviously increased to reach the maximum value (24.96 %) in November followed by decline in December.

Carbohydrate varies between 0.35 % and 0.63 % with an average value of $0.53 \% \pm 0.07$. Monthly variation showed that carbohydrate was high from January to April 2004 (0.46 - 0.57 %) followed by a sudden fall in May (0.35 %). Abrupt increase was observed in June (0.54 %) to September (0.63 %). Thereafter, there was a decline in carbohydrate values until December 2004 (0.44 %).

The biochemical components fluctuated widely irrespective of size and growth of the fish. It did not show a distinct pattern. Inverse relationship between lipid and moisture content was observed from the negative correlation between the two constituents ($r = - 0.6, P < 0.05$). Total caloric value observed during the study period ranged between $1316.23 \text{ cal g}^{-1}$ and $1798.61 \text{ cal g}^{-1}$ (Table 1). There was a significant correlation between total caloric value and lipid content ($r = 0.456, P < 0.05$) and highly

significant correlation with protein content ($r = 0.856$, $P < 0.001$). The values were higher in smaller fishes and lesser in larger fishes.

Discussion: -

Depending upon the level of lipids in the fish muscles, fishes are classified into three categories e.g. fat fish with more than 8% average fat content, average fat fish with fat content vary between 1% and 8% and lean fish with fat content less than 1% (Srivastava, 1999). Accordingly, *Sillago sihama* having an average 3.16% fat content, fall into the second category (average fat fish). Seasonal variation in the moisture content of the body muscles of *S. sihama* showed the increase in moisture content from January-May which coincided with the increase in water salinity. Moisture increased from July until October, with the advancement in maturation and spawning activity. That can be ascribed to similar rapid fall in lipid content during spawning season. The moisture was inversely related to lipid content in the present study. The inverse relationship has also been reported by Jafri (1968), Jafri (1969) and Ramaiyan and Pandian (1978). Chandra Shekhar et al (2004) reported that moisture content was low when other constituents (Lipid, protein and carbohydrate) were high in *Labeo rohita*. In the present study, high values of moisture were observed during the second half of monsoon and post-monsoon when feeding activity was low. The results of the present study revealed that changes in moisture content in the muscle of *S. sihama* could be attributed to changes in lipid level directly and to spawning and feeding intensity indirectly. This corroborates findings by Das (1978) in which low values of moisture content were noticed during the spawning season and high could be due to the decline in food intake.

Intensive feeding in *S. sihama* in January and April - May (pre-spawning) (Shamsan, unpublished data) coincides with relatively high values of lipids. With the commencement of spawning season in June, feeding activity also decreased until October. There was a parallel decrease in the muscle lipid during spawning season (June - November). These could be attributed to less food intake. Bumb (1992) reported coincidence of intensive feeding with occurrence of high fat content in the muscle of fish. In contrast to lipid, values of protein were observed to be increased from July to November when maximum numbers of mature fishes were found. Parulekar (1964) reported that the maximum protein content in the ripe fishes and the minimum were associated with the spent and early maturation phases. Protein content can be correlated with the phases of maturity and spawning when the gonads were ripe

and decline during post-spawning period (Parulekar and Bal, 1969; Das, 1978). Bhuyan et al (2003) reported higher fat and protein content were observed in ripe and gravid fish where a low level of fat and protein was recorded in spent and young fish. The feeding intensity does not appear to have any effect on the protein content. Bumb (1992) reported that low rate of feeding intensity during summer and heavy feeding during monsoon did not show direct relationship between feeding intensity and maturation and spawning and protein content. The low values of carbohydrates recorded in the present study also suggest that glycogen in many marine animals does not contribute significantly to the total reserves in the body (Jayasree *et al.*, 1994). It is further supported by Vijay Kumaran (1979) who stated that carbohydrate plays a minor role in energy reserves of *Ambassis gymnoccephalus* and its depletion during the spawning season is insignificant.

In conclusion the present study revealed seasonal changes in biochemical composition of the muscle associated with feeding, reproductive cycle, storage and utilization of reserves. Moisture showed a negative relationship with lipid content of the fish muscle. Phillips et al. (1967) found that carbohydrates were utilized for energy by trout and spared protein for body building. Similarly, in the present study lipid has been used for energy, however, protein was used for body building during different phases of maturation.

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Table (1): Seasonal variation in various biochemical compositions (dry weight basis) in *S. sihama*.

Month	Moisture	Lipids		Carbohydrate		Protein		Total
	%	%	cal g ⁻¹	%	cal g ⁻¹	%	cal g ⁻¹	Caloric
			DWB		DWB.		DWB	
								value cal g ⁻¹
Jan.04	79.32	3.20	300.80	0.46	19.09	19.21	1085.33	1405.22
Feb.04	79.27	2.25	211.50	0.58	24.07	19.13	1080.66	1316.23
Mar.04	79.08	2.65	241.27	0.52	21.58	22.80	1288.28	1551.13
Apr.04	78.47	3.05	286.70	0.57	23.66	23.19	1310.44	1620.80
May.04	77.91	4.19	393.86	0.35	14.48	22.38	1264.37	1672.71
Jun.04	76.99	4.07	378.74	0.54	22.53	24.73	1397.34	1798.61
Jul.04	77.04	3.79	356.73	0.44	18.47	21.65	1222.96	1598.16
Aug.04	78.09	3.12	292.97	0.56	21.08	22.63	1278.36	1592.41
Sep.04	78.20	2.94	276.26	0.63	26.23	23.89	1349.51	1652.00
Oct.04	78.70	2.69	249.53	0.54	22.41	24.27	1371.09	1643.03
Nov.04	79.40	2.16	202.10	0.48	20.09	24.96	1410.17	1632.35
Dec.04	76.20	3.04	286.23	0.44	18.43	21.23	1199.63	1504.29
Jan.05	77.43	3.00	246.75	0.53	19.30	22.67	1280.70	1546.74
Fe.05	77.06	3.76	353.84	0.58	24.07	22.97	1297.61	1675.52
Mar.05	76.62	3.87	363.47	0.62	25.65	20.46	1155.89	1545.01
Apr.05	76.70	2.83	280.12	0.59	24.61	23.73	1340.77	1645.50

Table (2): Variation in various biochemical composition in different size groups in *S. sihama*.

Size group	Moisture %	Lipids		Carbohydrate		Protein		Total Caloric value cal g ⁻¹
		%	cal g ⁻¹ DWB	%	cal g ⁻¹ DWB	%	Cal g ⁻¹ DWB	
85-94	75.95	3.75	352.50	0.71	29.40	17.78	1004.85	1386.75
95-104	77.07	2.99	262.26	0.54	22.59	13.84	782.07	1066.91
105-114	77.54	3.24	310.72	0.50	20.94	16.98	959.36	1291.01
115-124	77.32	3.25	305.97	0.53	21.81	16.96	958.19	1285.97
125-134	77.57	3.01	283.96	0.51	21.12	14.45	816.47	1121.55
135-144	77.46	3.89	347.92	0.53	20.25	17.58	993.18	1361.35
145-154	77.21	3.46	323.22	0.49	20.50	21.02	1187.39	1531.10
155-164	77.88	3.11	298.06	0.49	20.52	13.09	739.49	1058.07
165-174	77.07	3.70	333.23	0.52	21.56	17.96	1014.76	1369.55
175-184	77.80	2.99	279.31	0.53	21.85	14.96	845.05	1146.21
185-194	77.63	2.93	275.42	0.48	20.00	16.11	910.37	1205.79
195-204	77.80	2.55	239.70	0.40	16.76	16.02	905.12	1161.58
205-214	78.38	2.25	211.50	0.46	19.21	18.50	1045.09	1275.79
215-224	77.71	2.65	249.10	0.38	15.85	15.31	864.88	1129.83
225-234	77.24	1.60	150.40	0.43	17.97	18.15	1025.26	1193.63