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Proximate composition of white muscles of young grey mullet, *Liza saliens*, from the Kaštela Bay

Biokemijski sastav bijelih mišića mladog cipla *Liza saliens* iz Kaštelanskog zaljeva

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INTRODUCTION

The chemical composition of fish is most significantly affected by environmental conditions as well as by feeding regime and intensity (Love, 1970; Stirling, 1976; Perera and De Silva, 1978). Changes in body composition can also be in connexion with the fish length and growth respectively, what is particularly pronounced in younger fish stages (Love, 1970; Šuljman, 1972; Marais and Erasmus, 1977). It is also well known that there are biochemical and physiological differences between red and white muscles (Love, 1970). However, some authors suggested that the results on body composition obtained by the analyses of a whole fish were much more reliable than those obtained by the analyses of muscles only (Marais and Erasmus, 1977).

The present paper is an attempt to show the extent to which the basic proximate composition of young *Liza saliens* change with length. It was also attempted to show whether fish from two different locations in the Kaštela Bay show any differences in chemical composition. One of these locations is strongly affected by municipal and industrial pollution and some biochemical changes caused by organic pollution have already been recorded in grey mullet (Tudor and Bannister, 1978; Thomas *et al.*, 1980).

MATERIAL AND METHODS

Samples of young grey mullet *Liza saliens* were obtained by small trawl from two locations in the Kaštela Bay (Fig. 1).

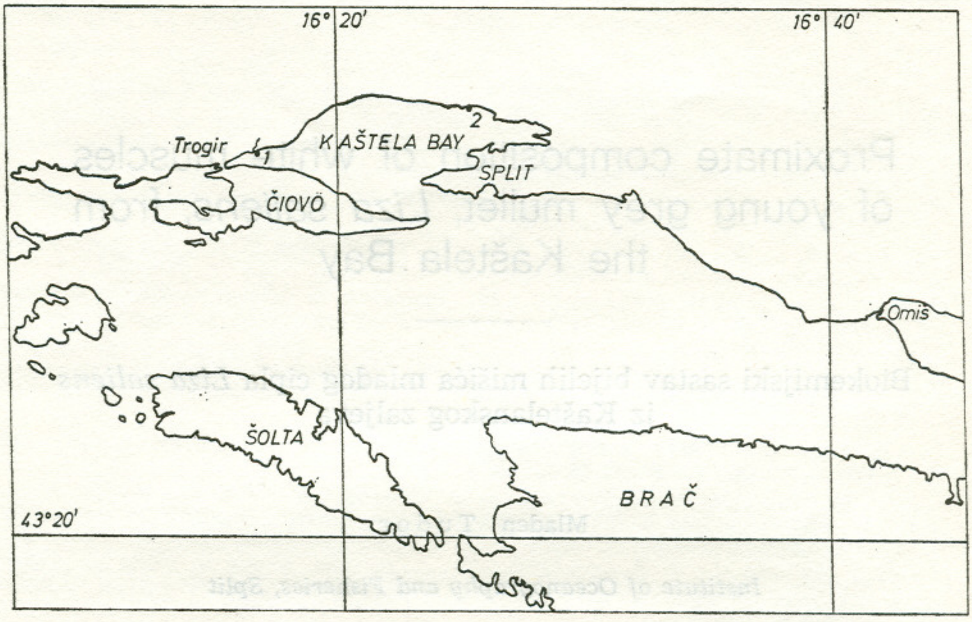

Fig. 1. Chart of the sampling locations

Location 1 is at the mouth of small Pantan River. Depth does not exceed 1 m. Salinity ranges from 3—15‰ and temperature from 13—20°C (Katavić, 1980).

Location 2 is in the eastern part of the Kaštela Bay. Depth is 30—80 cm. Salinity ranges from 27—35‰ and temperature from 12—25°C (Katavić, 1980). This location is strongly affected by municipal and industrial pollution.

Sampling was carried out in August/September 1982 and June 1983. Specimens up to 50 mm were selected from 1982 samples and those of 60—90 mm from the 1983 samples. After Katavić (1980) it was assumed that they belonged to the same generation.

Length of analysed specimens from the location 1 varied between 28 and 90 mm and weight from 0.19 to 6.50 g; length of specimens from location 2 varied between 35 and 91 mm and weight from 0.44 to 7.47 g.

For analyses of chemical composition about 150—300 mg of white muscle tissue was taken from each specimen of known length and weight and weighed. Tissue was immersed in 1 ml water and homogenized at Ultra-Turrax homogenizer at 200000 rmp for 1 minute. Dry weight, protein, total lipid and carbohydrate were determined from homogenate aliquots. Ash was not determined due to the small quantity of tissue.

Dry weight was determined from 2 ml homogenate dried at 105°C for 24 h.

Protein was determined from 1 ml homogenate by the method of Kjeldahl with selenium as catalyst (Petrović and Petrović, 1971). Total nitrogen was multiplied by factor 6.25 to get protein content.

Lipid was extracted from 1 ml homogenate by the method of Folch *et al.* (1957). Upon the separation of the chloroform layer from the water layer by a centrifuge at 1000 g for 10 minutes, extracted chloroform was dried at 60°C.

Total lipid in dried extract was determined using the technique described by Marsh and Weinstein (1966) with stearic acid as standard.

Carbohydrate was determined from 1 ml homogenate upon 5% TCA precipitation and supernatant hydrolysis by the phenol-sulphuric acid method (Dubois *et al.*, 1956) with glucose as standard.

RESULTS AND DISCUSSION

The proximate chemical composition was determined only from white muscles which were dominant muscle mass. White and red muscles of fish show considerable differences in biochemical and physiological properties and consequently in the quantity of macroconstituents (Love, 1970). Mean percentage of water, protein, total lipid and carbohydrate (on the wet weight basis) in the white muscles of young *Liza saliens* from two locations in the Kaštela Bay are given in Table 1.

Table 1. Percentage composition of principal chemical constituents (in % wt. weight) of the white muscles of young mullet *Liza saliens* from the Kaštela Bay (location 2) and Pantan (location 1). SD: standard deviation

	Location 1		Location 2	
	n	$\bar{x} \pm SD$	n	$\bar{x} \pm SD$
Total length (mm)	17	57.6 ± 16.7	30	68.7 ± 15.4
Weight (g)	17	2.14 ± 1.65	30	3.54 ± 1.98
Condition factor*	17	0.90 ± 0.07	30	0.95 ± 0.10
Water (%)	17	84.7 ± 3.76	29	82.5 ± 2.40
Protein (%)	17	11.8 ± 3.23	28	11.7 ± 2.97
Total lipid	17	1.11 ± 0.32	29	1.15 ± 0.27
Carbohydrate (%)	17	0.69 ± 0.29	29	0.50 ± 0.10
Energy kJ/g	17	3.31 ± 0.84	28	3.14 ± 0.60

$$* CF = \frac{\text{weight in g} \times 100}{\text{total length in cm}^3}$$

Since it is very useful to correlate developmental and some other changes in young fish to the length (Love, 1974) the obtained macroconstituent percentages in white muscles were correlated to total fish length. Results are presented in Table 2. Even though not all relationships of white muscle macroconstituents to total fish length were significant at P = 0.05, they showed a trend of changes with length.

Table 2. Correlation coefficients (r), number of determinations (n), intercepts (a), regression coefficients (b), standard errors of b (SE), significance level (P) of different constituents of white muscles ($y = bx + a$) of young *Liza saliens* from two different locations (Pantan — 1, Kaštela Bay — 2)

Location	n	r	a	b	SE	P
Total lenght in mm (X) and percent water (Y)						
1	17	—0.619	92.781	—0.139	0.045	0.01
2	29	—0.325	85.940	—0.050	0.028	(*)
Total lenght in mm (X) and percent protein (Y)						
1	17	0.734	3.679	0.142	0.034	0.001
2	28	0.411	6.268	0.079	0.034	0.05
Total lenght in mm (X) and percent total lipid (Y)						
1	17	0.379	0.691	0.007	0.004	*
2	29	0.279	0.798	0.005	0.003	*
Total lenght in mm (X) and percent carbohydrate (Y)						
1	17	—0.363	0.329	—0.006	0.004	*
2	29	—0.028	0.512	—0.002	0.013	*
Percent water (X) and percent protein (Y)						
1	17	—0.957	81.530	—0.822	0.064	0.001
2	28	—0.670	79.143	—0.817	0.177	0.001
Percent water (X) and percent total lipid (Y)						
1	17	—0.839	7.080	—0.070	0.011	0.001
2	29	—0.622	6.822	—0.069	0.017	0.001
Percent water (X) and energy kJ/g (Y)						
1	17	—0.998	22.118	—0.222	0.004	0.001
2	28	—0.653	16.371	—0.160	0.036	0.001

(*) — significant at 10% level only
* — not significant at 5% level

Water

The percentage of water in white muscles decreased with the increasing total length of *Liza saliens.* Although the regression coefficient of water to total fish length at location 1 (Table 2) exceeded that at location 2 there was no statistically significant difference ($P > 0.05$) between them. Perera and De Silva (1978) also found negative signs for the relationship of water content to total length in *Mugil cephalus.* These authors found that fish kept and fed at different salinities showed no significant differences in the relationship of water content to fish length.

Protein

Protein content significantly increased with increasing fish length. According to the regression coefficients (Table 2) one would expect the protein content in fish from location 1 to exceed that in fish of the same length from location 2. However, no statistically significant difference ($P > 0.05$) in the coefficients of regression of protein to total fish length was found for these two locations.

Protein content in fish depends on feeding regime. If sufficient food is available the excess energetic requirements will be used up for building body proteins. Thus the highest level of proteins was found in muscles of *Mugil* *cephalus* at salinity at which fish growth was maximum (Perera and De Silva, 1978). Energy expenditure for osmoregulation processes is lowest and excess energy is utilised for building up the body constituents (Canagaratnam, 1959). De Silva and Perera (1976) found optimum *Mugil cephalus* growth at 20‰ salinity.

Total lipid

White muscles of *Liza saliens* contain low lipid levels (Table 1). The relationship of lipid percent to fish length was found to be insignificant at studied locations.

Relationship of the percent of total lipid to *Liza saliens* length show that relative total lipid content of white muscles is slightly changed with increasing length. The same was recorded for other mullet species (Marais and Erasmus, 1977; Perera and De Silva, 1978). Significant positive correlation of body lipid to fish length was mainly recorded in pond fish kept under controlled feeding regime (Love, 1970; Perera and De Silva, 1978).

Carbohydrate

Low levels of carbohydrate in the muscles of young *Liza saliens* suggest it does not store carbohydrate. It is possible that carbohydrate is being utillised for energy. This is supported by the fact that the regression coefficients of the corbohydrate to total length relationship are negative nevertheless insignificant. This means that in bigger fish carbohydrate is utilised for energy since owing to their being more motile they require it more.

Relationship between principal chemical components

Highly significant correlations were recorded between some principal chemical entities of white muscles of young *Liza saliens*. Percent water of white muscles is in good correlation with percent lipid and percent protein respectively. This correlation is highly statistically significant ($P < 0.001$). Protein and lipid levels decrease with increasing muscle water content. Regression coefficent of the relationship protein to water was found to be almost equal in fish from both locations as well as the regression coefficent of the lipid to water relationship. Inverse relationships of lipid to water and protein to water were also recorded in some other fish species (Iles and Wood, 1965; Love, 1970; Stirling, 1976) as well as for mullet species (Marais and Erasmus, 1977; Perera and De Silva, 1978).

Iles and Wood (1965) showed that the slope of the fat to water line of north sea herring was independent of the growth conditions and feeding cycle, that is, it maintained the same form irrespective of different physiological conditions.

Energy content (as the chemical equivalent to energy) of white muscles is also negatively correlated to percent water. The difference in the relationship of energy to water of fish from these two locations was also found to be insignificant ($P > 0.05$). Inverse relationship of water to energy muscle content was recorded for mullet species (Marais and Erasmus, 1977) as well as for some other fish (Kitchell *et al.*, 1977).

Salinity at location 2 in the eastern part of the Kaštela Bay slightly exceeds salinity at location 1 (Katavić, 1980). Location 2 is strongly affected by industrial and municipal pollution thus that some body deformities were observed in fish from that area (Jardas, 1978). Katavić (1980) found no morphometric differences between fish from these two locations.

In the present study it has also been shown that there is no significant difference in the relationship of proximate composition of white muscles to the length of fish from these two locations.

Relationships of chemical macroconstituents to water in white muscles of *Liza saliens* (Table 2) seem to maintain the same form irrespective of the ecological factors and feeding conditions.

Stirling (1976) showed that the proximate chemical composition of fish during feeding differs from that during starvation. These changes are illustrated by the inverse relationships of water to protein and water to lipid, that is during feeding percentages of protein and lipid increase and percent water decreases, and opposite.

Our future investigations shall be focused on the seasonal variations of the proximate composition of white muscles of young *Liza saliens* from the Kaštela Bay.

CONCLUSION

Water and protein contents of white muscles of young *Liza saliens* show statistically significant increase with increasing length. The relationship of the total lipid content to total fish length was found to be insignificant but showed a trend of lipid increase with length. On the contrary carbohydrate level decreases with increasing length.

Although fish were obtained from two different locations of the Kaštela Bay, equations of the relationship of chemical macroconstituents of white muscles to total fish length showed no statistically significant differences.

Protein to water and lipid to water equations have the same form irrespective of the location the fish were taken from. This property may be very useful since protein and lipid contents can be routinely estimated by determination of the water content of the muscles of young *Liza saliens* which is much more simple and cheaper.

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BIOKEMIJSKI SASTAV BIJELIH MIŠIĆA MLADOG CIPLA *LIZA SALIENS* IZ KAŠTELANSKOG ZALJEVA

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KRATKI SADRŽAJ

Sadržaj vode i proteina u bijelim mišićima mladih *Liza saliens* statistički signifikantno raste s povećanjem dužine riba.

Jednadžbe odnosa kemijskih makrokonstituenata bijelih mišića i totalnih dužina riba sa dva različita lokaliteta Kaštelanskog zaljeva nisu pokazale statistički značajne razlike. Također jednadžbe proteini/voda te lipidi/voda imaju istu formu bez obzira na lokalitet sa kojeg su ribe uzete.