Effect of Biological Variables and Capture Period on the Proximate Composition and Fatty Acid Composition of the Dorsal Muscle Tissue of *Hypophthalmus edentatus* (Spix, 1829)

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ABSTRACT

This study analyzed the chemical composition of the dorsal muscle tissue of <u>Hypophthalmus edentatus</u>, *in particular, fatty acids of the lipidic fraction, and its relationship with the biological variables and the capture period. The average values for moisture, ash, protein and total lipids were 63.15, 1.11, 14.27 and 17.24%, respectively. In the lipidic fraction, 35 fatty acids were identified, the most abundant being: 16:0, 18:1ω9, 18:0, 16:1ω7, 18:3ω3, DHA and EPA. The totals of respectively saturated, monounsaturated and polyunsaturated fatty acids were 41.15, 35.30 and 23.88%. The PUFA/SFA ratio was equal to 0.68 and the ω3/ω6 ratio equal to 1.98. The PCA demonstrated that the long chain PUFAs contributed positively to the formation of the first axis. The CCA showed some effects of the biological factors (weight, reproductive cycle, sex) and the capture period on the variation of total lipids and some fatty acids.*

Key words: Freshwater fish, fatty acids, lipid contents, proximate composition, *Hypophthalmus edentatus*

INTRODUCTION

Since the 1950s, many researchers have studied the chemical composition of teleosts, the lipidic fraction in particular, and its relationship with the biological, physiological and ecological characteristics of fish, in addition to its nutritional properties. The study of total lipids, different lipid categories and their fatty acid components allows evaluation of the dynamic of the compositions in several tissues of the fish during its different development phases, as well as the effect of seasonality on the metabolism of the fish (MacFarlane et al., 1993).

Lipids constitute a group of several natural chemical compositions capable of carrying out a variety of functions in living organisms. In fishes, (ectothermic animals), polar lipids (mainly phospholipids) act, basically, as structural components responsible for the maintenance of the fluidity of the plasmatic membrane, while neutral lipids (triacylglycerols) act as suppliers and stores of energy that will be used as fuel for the accomplishment of basic physiological functions, such as metabolism, migratory activity, growth and gonadal development (Henderson and Sargent, 1985; Brown and Murphy, 1995).

Studies about the lipid composition in freshwater fish have generally been made, using species of both temperate and boreal areas, but reports are also available on tropical and equatorial species. Although Brazil has important hydrographic

basins, only some species were, until now, evaluated as regards total chemical composition (fatty acid composition in particular) (Gurgel and Freitas, 1977; Carvalho, 1980a; Maia et al., 1983; Saint-Paul, 1984; Junk, 1985; Gutierrez and Silva, 1993; Andrade et al., 1995; Inhamuns and Franco, 2001).

On the whole, freshwater fishes present a smaller quantity of polyunsaturated fatty acids (PUFA) of the ω3 family and a larger amount of ω6-PUFA in relation to marine fish (Kinsella, et al., 1977; Henderson and Sargent, 1985; Ahlgren et al., 1994). They also present higher proportions of saturated fatty acids (SFA) and PUFA with 18 carbons, lower levels of PUFA with 20 and 22 carbons and a lower ω3/ω6 ratio than the lipids of marine fish (Gruger et al., 1964; Viswanathan Nair and Gopakumar, 1978; Henderson and Tocher, 1987).

Hypophthalmus edentatus (Spix, 1829) (Osteichthyes, Siluriformes), known as mapará, sardela and perna-de-moça, is one of the five most caught species in the Itaipu reservoir (Agostinho et al., 1994a; Agostinho and Júlio Jr, 1999). It makes an important contribution to fishing and is the only zooplanktophagous-filterer species in the upper Paraná River basin (Benedito-Cecílio and Agostinho, 1999).

Considering the importance of mapará to fishing in the Itaipu Reservoir, in addition to the information available about the chemical composition of samples of this species from the Amazon basin (Carvalho, 1980a; Junk, 1985; Inhamuns and Franco, 2001), this work had as its objective to complement the study of the chemical composition of the dorsal musculature of mapará through the (i) evaluation of the moisture, ash, protein and total lipids, (ii) identification and relative quantification of the fatty acid components of its lipidic fraction, (iii) verification of the relationship between the different fatty acid components of the lipidic fraction and (iv) verification of the correlation between the total proximate composition and the fatty acids of the lipidic fraction with some biological variables (weight, length, sex, reproductive cycle and condition factor) and the capture period of the fish.

MATERIALS AND METHODS

Sampling and initial procedures. The 49 *H. edentatus* analyzed were captured in the Itaipu Reservoir - Paraná State/Brazil with the aid of gill nets in December 1998 and February and March 1999. After capture, the fishes were refrigerated, weighed and had their total and standard lengths measured. After being eviscerated, both sex and reproductive cycle were identified by direct visual examination of the gonads. The reproductive cycle was characterized as at rest (res), in maturation (mat), ripe (rip) and spent (spt) (Benedito-Cecílio, 1989). An adequate portion of dorsal muscle tissue (with white fibers and, in smaller amount, red fibers) from each fish was stored in a cylinder containing liquid nitrogen until analysis. The tissue was homogenized and divided into two portions, frozen (-20°C) and analyzed in at most one week.

Analysis of the proximate composition. The first portion of homogenized tissue was used to determine water (AOAC, 1990), ash (AOAC, 1990) and protein content (Method of Kjeldhal, Pearson, 1973). The other was used to extract the total lipids (Bligh and Dyer, 1959), taking into account the proportions recommended between the methanol and chloroform solvents and the tissue moisture. An aliquot of the extracted lipid fraction was used to determine the total lipids in the samples (Maia, 1992). The remaining extract was concentrated in a rotary-evaporator at 35°C and frozen.

The results of the proximate composition are presented in median and the mean values are compared with the results of other authors in the discussion.

Metylation and chromatographic separation of the fatty acids. The stored extract was metylated (Maia, 1992) and the fatty acid methyl ester composition (FAME) was then determined by gas chromatography accomplished in a Shimadzu 14A chromatograph equipped with a flame ionization detector and a 50 m fused silica capillary column with a 0.22 mm internal diameter and polyethilenoglycol as liquid phase (Carbowax 20M). The following operational parameters were used: flame ionization detector temperature 245°C; injection port temperature 220°C; column temperature 150°C for 3 min, programmed at a rate of 10°C min^{-1} to a final temperature of 240°C.

Hydrogen was used as a carrier gas (1.2 ml min^{-1}) and nitrogen (30 ml min^{-1}) was used as an auxiliary gas. Flame gases were hydrogen (30 ml min^{-1}) and synthetic air (300 ml min^{-1}) and the injection was operated in a split mode (1:100) with hexane as a solvent. A CG-300 integrator processor processed retention times and peaks areas. The results were given in percentage of each FAME in relationship to the total area of each peak in the chromatogram.

Identification of the fatty acids. Several procedures were used to identify the fatty acid methyl esters on chromatograms: technique of co-elution (spiking) of standards and sample, comparison of the elution order (retention time) of FAMEs of the sample with standards (Sigma no. 189-19 and Standard Sigma of cod liver oil - USA) and mass spectrometry analysis using a gas chromatograph-mass spectrometer Shimadzu QP 2000 equipped with a 25 m capillary column with a 0.25 mm internal diameter (Carbowax 20M). In this case, the FAMEs were broken into fragments by an electronic impact of 70 eV.

Calculation of the condition factor. Standard length and weight data were used to calculate the condition factor of the fish, using the equation W $= aL^b$, where: L is the standard length; W, the weight; a, an estimated coefficient and b, a value close to three in isometric growth, also estimated mathematically (Le Cren, 1951).

Statistical analysis. The non-parametric Kruskal-Wallis Test (Siegel, 1975) was used to show the significant differences between the results of the determination of the water, ash, protein and total lipid content of the muscle in relation to the capture period and the reproductive cycle. Principal Components Analysis (PCA) was applied to summarize the variation of the fatty acid components of the lipidic fraction. Only the axes with eigenvalues larger than 1.0 (Kaiser-Guttman approach in Jackson, 1993) were retained for interpretation. Correlation Canonical Analysis (CCA) was applied to synthesize the relationships between the biological data (sex, weight, standard length, reproductive cycle and condition factor) and the capture period with the results of both the total chemical analysis and the composition of fatty acids (Harris, 1975; Johnson and Wichern, 1992). In order to carry out CCA, the reproductive cycles were summarized as: in reproduction (rip

and spt) and non-reproduction (res and mat). The collection months were put into two groups: December, in the first and February and March, in the second. All statistical analysis was accomplished using the program STATISTICA 5.0 (STATSOFT - USA).

RESULTS

Proximate composition. Proximate composition was evaluated for 49 *H. edentatus* samples (20 females and 29 males). The median values for the total sample were (in %): moisture, 63.15; ash, 1.11; protein, 14.27; and total lipids, 17.22. The moisture values were higher for females than for males (65.36 and 62.52%, respectively), while the males presented larger values for total lipids than the females (18.73 and 14.27%, respectively). Protein and ash values were almost similar between the two sexes, 14.13 and 1.11% for the females and 14.4 and 1.1% for the males, respectively (Fig. 1).

Although the capture of the fish had been concentrated in a short period (December, February and March), the chemical composition values of the dorsal muscle showed significant variations (Fig. 1). The differences happened mainly between December and March. In December, the highest values were for moisture (69.01%) and protein (16.51%) and the lowest for total lipids (8.97%), while in March the lowest value was for moisture (59.18%) and the highest for total lipids (18.99%). In agreement with the Kruskal-Wallis Test, the variations were significant ($P < 0.05$) for the moisture, protein and total lipid contents.

When the different reproductive cycles were considered, the medians for the moisture, ash, protein and total lipids did not present significant variations in the Kruskal-Wallis Test.

Composition and relative percentage of the fatty acids. In all thirty-five fatty acids were identified. The predominant ones, in decreasing order, were (in %): palmitic acid (16:0), 25.24; oleic acid (18:1ω9), 23.50; stearic acid (18:0), 8.61; palmitoleic acid (16:1ω7), 4.88; α-linolenic acid (18:3ω3), 4.09; docosahexaenoic acid (DHA - 22:6ω3), 3.42 and eicosapentaenoic acid (EPA - 20:5ω3), 3.29. Linoleic acid (18:2ω6) and arachidonic acid (20:4ω6) were presented in

smaller amounts: 1.92 and 1.91%, respectively (Table 1).

The totals of SFA, MUFA and PUFA were 41.15, 35.30 and 23.88%, respectively. The mean PUFA/SFA ratio was equal to 0.68. The values of ω3-PUFA and ω6-PUFA, 5.15% and 7.81%, respectively, resulted in a ω3/ω6-ratio equal to 1.98 (Table 1).

Principal Components Analysis. The first two axes of the PCA presented eigenvalues higher than 1. Therefore, they were retained for analysis. These two axes explained 48.03% of the data variability (25.97 and 22.06% for axes 1 and 2, respectively). The fatty acids that most contributed to the formation of the first axis were 22:5ω6, EPA, 18:4ω3, 22:5ω3, DHA and 20:4ω3, with positive values for the linear Pearson's correlation.

Negative values for the correlation were registered for 18:0, 17:0, i17:0, 14:1ω5 and 15:0. For this axis, the largest positive correlations were shown by the polyunsaturated fatty acids with a carbon number higher than 20 and the negatives ones by both the saturated and monounsaturated fatty acids with a carbon number equal or lower than 18 (Fig. 2A).

The fatty acids that were more positively related to the second principal component were 18:2ω6, 15:0, 16:1ω7, DHA, 18:1ω7, 17:0 and 18:3ω3, while those more negatively related were 18:1ω9 and 20:1ω9 (Fig. 2A). The PCA scores, derived from the samples analyzed, are shown in Fig. 2B.
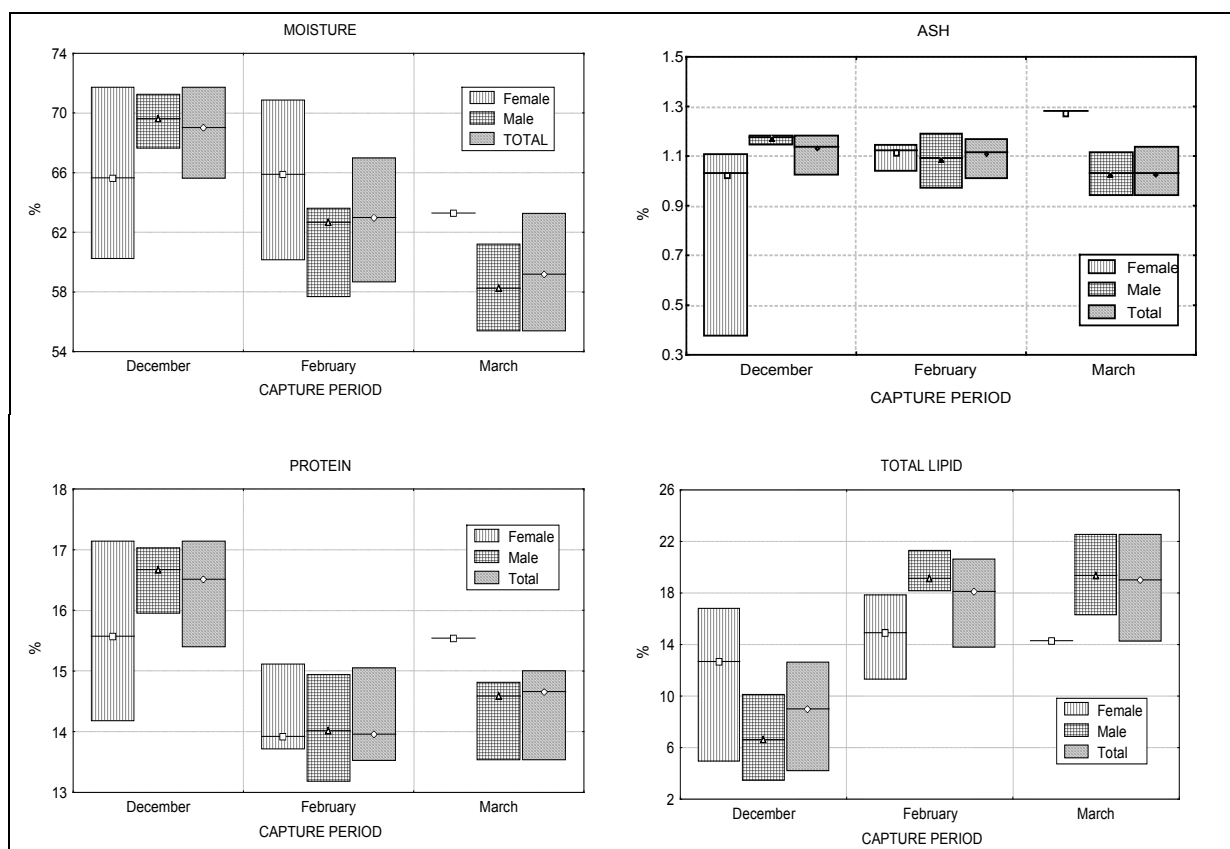

Figure 1 - Variation in moisture, ash, protein and total lipid content (% humid base) of the dorsal muscle of females, males and the *H. edentatus* total during the capture months. The horizontal line indicates the median value and the inferior and superior portions correspond to quartis of 25% and 75%, respectively.

Table 1. The fatty acids identified in the total lipidic fraction of the dorsal muscular tissue of *H. edentatus**.

Fatty Acid	Females	Males	Total
	Mean ± sd	Mean ± sd	Mean ± sd
14:0	2.86 ± 0.6	2.75 ± 0.7	2.80 ± 0.6
14:1ω5	0.86 ± 0.5	0.92 ± 0.3	0.89 ± 0.4
15:0	0.57 ± 0.1	0.55 ± 0.1	0.56 ± 0.1
16:0	25.76 ± 1.7	24.88 ± 2.0	25.24 ± 2.0
16:1ω9	0.66 ± 0.2	0.55 ± 0.2	0.60 ± 0.2
16:1ω7	4.89 ± 1.0	4.88 ± 1.0	4.88 ± 1.0
i17:0	0.50 ± 0.2	0.58 ± 0.2	0.55 ± 0.2
ai17:0	0.28 ± 0.1	0.25 ± 0.1	0.26 ± 0.1
17:0	1.32 ± 0.3	1.39 ± 0.2	1.36 ± 0.2
17:1ω7	0.39 ± 0.1	0.48 ± 0.1	0.44 ± 0.1
18:0	8.27 ± 0.9	8.84 ± 0.7	8.61 ± 0.8
18:1ω9	22.93 ± 3.6	23.89 ± 3.6	23.50 ± 3.6
18:1ω7	2.26 ± 0.7	2.39 ± 0.7	2.34 ± 0.7
18:2ω6	1.94 ± 0.4	1.89 ± 0.5	1.91 ± 0.5
18:3ω6	0.25 ± 0.1	0.19 ± 0.1	0.21 ± 0.1
18:3ω3	4.40 ± 1.0	3.87 ± 0.6	4.09 ± 0.8
18:4ω3	0.88 ± 0.2	0.71 ± 0.3	0.78 ± 0.3
20:0	0.44 ± 0.2	0.46 ± 0.1	0.45 ± 0.1
20:1ω9	2.01 ± 0.5	2.40 ± 0.5	2.24 ± 0.5
20:2ω6	0.39 ± 0.2	0.49 ± 0.2	0.45 ± 0.2
20:3ω9	0.44 ± 0.2	0.58 ± 0.2	0.52 ± 0.2
20:3ω6	0.37 ± 0.2	0.40 ± 0.2	0.39 ± 0.2
20:4ω6	1.96 ± 0.4	1.89 ± 0.7	1.92 ± 0.6
20:3ω3	0.74 ± 0.3	0.82 ± 0.3	0.79 ± 0.3
20:4ω3	1.29 ± 0.5	1.29 ± 0.5	1.29 ± 0.5
20:5ω3	3.52 ± 0.6	3.13 ± 0.9	3.29 ± 0.8
22:0	0.69 ± 0.2	0.73 ± 0.2	0.72 ± 0.2
22:1ω9	0.31 ± 0.2	0.37 ± 0.1	0.34 ± 0.1
22:2ω6	0.34 ± 0.3	0.28 ± 0.2	0.30 ± 0.2
23:0	0.41 ± 0.2	0.44 ± 0.2	0.43 ± 0.2
22:5ω6	2.15 ± 0.6	1.91 ± 0.7	2.01 ± 0.6
22:5ω3	1.16 ± 0.3	1.19 ± 0.3	1.18 ± 0.3
24:0	0.39 ± 0.1	0.38 ± 0.1	0.38 ± 0.1
22:6ω3	3.66 ± 0.6	3.25 ± 1.1	3.42 ± 1.0
24:1ω9	0.34 ± 0.1	0.30 ± 0.2	0.31 ± 0.1
SFA	41.26 ± 2.4	41.08 ± 2.5	41.15 ± 2.5
MUFA	34.35 ± 3.1	35.95 ± 3.4	35.29 ± 3.3
PUFA	24.34 ± 4.2	22.88 ± 4.2	23.47 ± 4.2
PUFA/MUFA	0.72 ± 0.2	0.65 ± 0.2	0.68 ± 0.2
∑ ω3	15.94 ± 2.6	14.60 ± 2.9	15.15 ± 2.8
∑ ω6	7.99 ± 1.9	7.69 ± 1.8	7.81 ± 1.8
∑ω3/∑ω6	2.05 ± 0.4	1.94 ± 0.3	1.98 ± 0.3

* Results are expressed as a relative percentage of the total fatty acids present in the 19 females and 20 males analyzed.

Relationship between the chemical and biological variables and the capture period. The CCA showed significant relationships (first two axes; $P < 0.05$) between the biological data (sex, weight, reproductive cycle and condition factor) and the capture period with the general chemical composition (moisture, ash, protein, total lipids) and the more important fatty acids. The significant relationship between the data groups suggested an effect of the biological factors and the period on the total chemical and fatty acid composition in *H.edentatus* (Table 2).

In agreement with the values of Pearson's correlation between the original variables and the

linear combinations inside of each data group, the chemical variables that contributed positively to the formation of the first axis were total lipids and 18:1ω9, while the ones that were related negatively to this axis were protein, 16:1ω7 and 14:0. Period was the most important variable on the axis, being positively related, while the biological variables, weight and reproductive cycle, were positively and negatively, respectively, related to the axis.

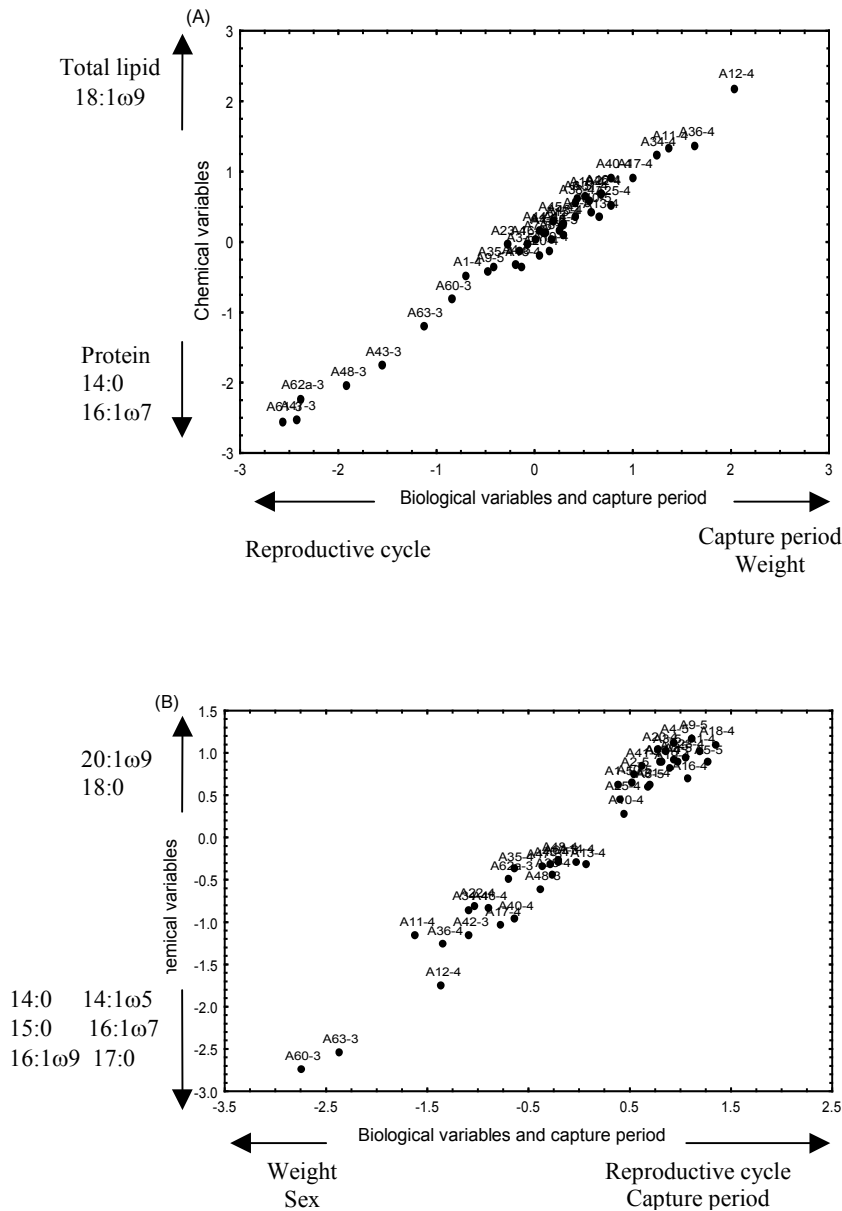The chemical variables that contributed positively to the formation of the second axis were 20:1ω9 and 18:0.

Figure 3 - Graphic score representation of axes 1 (A) and 2 (B) derived from the chemical composition data (y) and the biological variable/capture period data (x) for *H. edentatus*. Ay-x corresponds to: Ay = sample number, x = sampling month (3 = December, 4 = February and 5 = March).

Table 2. CCA results accomplished between the total chemical composition data and the fatty acid data of the dorsal muscle of *H. edentatus* and the biological data and period of capture of the fish. R is the canonical correlation and χ^2 refers to the sphericity test applied to the first two canonical axes.

Axes	R	R^2	χ^2	LD	*P*
0	0.9904	0.9810	277.5	145	**< 0.001**
1	0.9786	0.9577	180.4	112	**< 0.001**
2	0.9131	0.8338	102.9	81	0.0507
3	0.8666	0.7509	59.0	52	0.2358
4	0.7990	0.6384	24.9	25	0.4669

Those that contributed negatively were 14:0, 15:0, 16:1ω7, 16:1ω9, 17:0 and 14:1ω5. Period contributed positively on this axis. Among the biological variables, the reproductive cycle had positive contribution, while weight and sex contributed negatively.

Figures 3A and 3B are graphic score representations of the chemical composition combined with the biological variables and the period for axes 1 and 2, respectively.

DISCUSSION

The mean value of 16.24% (median = 17.22%) presented by the *H. edentatus* for the total lipids allowed it to be considered a high fat content species, in agreement with the classification proposed by Ackman (1989). Similar amounts were reported for this species in the Amazon area (Junk, 1985; Inhamuns, 2000). Other neotropical species that presented high amounts of total lipids in the muscle were *Pinirampus pinirampu* (19.75%) and *Colossoma mitrei* (18.31%) (Andrade et al., 1995).

The high percentage of muscle fat is very important for *H. edentatus* because of its important role in floatability. This species has an extremely reduced natatory bladder and pelagic habit, concentrating on the water surface (Agostinho et al., 1994 b). In addition to floatability, the high fat content should supply the metabolic needs of this species, which possesses intense mobility because of its zooplanktophagous-filterer habit (Lansac Tôha et al., 1991) and requires great amounts of oxygen, more abundant in the pelagic area (Carvalho, 1980b).

The evaluation of the dorsal muscle proximate composition of *H. edentatus* captured in Castanho Lake, Amazonas State demonstrated that the females presented mean fat values superior to the males (14.25 and 11.43%, respectively) and mean protein values similar to the males (16.09 and 16.42%, respectively) (Carvalho, 1980a). *H.*

edentatus of the Itaipu Reservoir had mean protein values between males and females of 14.57% and 14.48%, respectively; however, the total lipids presented larger differences between the sexes. The males presented means higher than the females (17.57% and 14.32%, respectively). *H. edentatus*, a high fat content fish, presented proportionally smaller protein amounts in its dorsal muscle because the storage of excess energy like muscle fat occured with the reduction in protein (Junk, 1985). Thus, in December, when the percentage of muscle lipids was lower than in the other months, the protein percentage was higher.

Junk (1985) and Inhamus and Franco (2001) have reported an inverse relationship between moisture and fat for *H. edentatus* of the Amazon basin. Protein and ash content did not present important variations.

The dynamics of the reproductive process of the fish depends on both intrinsic and extrinsic factors (Benedito-Cecílio, 1989). The lowest total lipid values obtained for *H. edentatus* in this work corresponded to the spawning period of the species (from October to December, Agostinho et al., 1994b). In this period, there is an accentuated diversion of somatic energy reserves for the development of reproductive organs and for the process of spawning itself. The fall in the nutritional level of this species in this period should also be linked to the formation of the growth ring in otoliths in the subsequent months. This happens during the slow growth period of the year (Ambrósio, 2000).

The pulse of the floods in the Itaipu Reservoir, with more than 90% of the rain falling from October to April, restricts primary production by limiting the passage of light (large amounts of particulate inorganic matter in suspension). There is also a loss of nutrients due to the reduction in the residence time of the water (Gomes and Miranda, 2001). Decrease in primary production

leads to a reduction in the zooplanktonic community, the main item in the diet of the species in this study. Therefore, the full pulse of the floods, which is fundamental to complete the life cycle of fluvial fish, as demonstrated by Junk (1985), seems to have an adverse effect on the diet and nutritional condition of planktophagous organisms in reservoirs (Gomes and Miranda, 2001).

The reduction in food availability during the period of high precipitation and the increased spawning seemed to be the principal factors that contributed to the reduction in the total lipid values in the dorsal muscle of *H. edentatus* in the Itaipu Reservoir.

The composition pattern of the fatty acids observed in *H. edentatus* of the Itaipu reservoir, in general, did not differ from what was expected in freshwater species (Gruger et al., 1964; Ackman, 1967; Ågren et al., 1987; Wang et al., 1990; Gutierrez and Silva, 1993; Ahlgren et al., 1994), as it was very similar to what was observed by Inhamus and Franco (2001) in the same species in the Amazon and by Maia et al. (1983) in *Prochilodus scrofa* in the same area. It was, though, very different from that observed by Ågren et al. (1987) in freshwater fish in northern areas and by Wang et al. (1990) in freshwater species of Lake Superior (USA-Canada).

Andrade et al. (1995) have evaluated the fatty acids of 17 freshwater fish species marketed in the city of Maringá (Paraná State- Brazil). They found high interspecific variation in the amounts of SFA, total PUFA, ω3-PUFA and in the ω3/ω6 ratio. However, the most abundant fatty acids among all the species were the same as those registered in this work. On the other hand, different from what is expected in freshwater species (Gruger et al., 1964; Viswanathan Nair and Gopakumar, 1978; Wang et al., 1990), the percentages of 18:2ω6 and 20:4ω6, fatty acids of significance physiological importance were very low in *H. edentatus* when compared to those reported by some authors in marine fish, frequently deficient in ω6 fatty acids. Linoleic acid, an essential fatty acid in fish and man, is the precursor of arachidonic acid that, by means of both elongation and desaturation reactions, gives origin to the longer chain ω6-PUFAs (Gibson, 1983). These were also present in small amounts in *H. edentatus*. Very low fatty acid values were observed by Gutierrez and Silva (1993) in other Brazilian fresh water species, e.g.

Pseudoplatystoma corruscans, *Pimelodus maculatus* and *Hoplias malabaricus*.

The main ω3 polyenoic fatty acids responsible for the ω3/ω6- ratio being equal to 1.98 are 18:3ω3, EPA and DHA. Ahlgren et al. (1994) considered this ratio as the main indicator of lipid quality in fish and that it best reflected the food quality of the fish. In freshwater fish, its value was, in general, lower than in marine fish, indicating for the former, a diet richer in 18:2ω6 and 18:3ω6 than in 18:3ω3 (Ackman, 1967).

Palmitic acid (16:0), with more than 60% of the total SFA, was pointed out by Ackman and Eaton (1966) as a key metabolite in fish, whose amount did not depend on diet. This independence was reflected in the smaller variation coefficient observed for this fatty acid (7.7%). Similar values for the fatty acid were observed in Australian freshwater and marine fish (Gibson, 1983), in Brazilian freshwater fish (Andrade et al., 1995), in tilapia (*Oreochromis niloticus*) from African lakes (Zenebe et al., 1998), in several North American freshwater species (Wang et al., 1990) and in Finnish freshwater species (Ågren et al., 1987).

The PCA results demonstrated the existence of an inverse relationship between long chain PUFA and short chain SFA and MUFA on the first axis. Inverse relationships between PUFA and SFA seemed to be a consistent pattern in several fish species (Ågren et al., 1987; Ahlgren et al., 1994). On the second axis, the inverse association was between 18:1ω9 and 20:1ω9, and 18:2ω6, DHA and 18:3ω3, indicating that an increase in the fatty acids of both the ω6 and ω3 family was accompanied by a reduction in those of the ω9 family.

Capture period was the variable that contributed most to the variations in the chemical composition of the fish, followed by the variables weight and reproductive cycle. In addition, the increase in weight was accompanied by an increase in fat deposits and a reduction in muscle protein. Increase in lipids was almost always due to triacylglycerol accumulation in the tissues, which could be confirmed by the simultaneous increase in oleic acid, generally associated to that lipid class (Kanazawa, 1985; Greene and Selivonchick, 1987). The CCA demonstrated that the metabolism of the *H. edentatus* dorsal muscle was influenced by the capture period and almost all biological variables.

The dynamics of proteins, total lipids and fatty acids, important chemical compounds involved in fish energy metabolism, were demonstrated to be related to sex, reproductive cycle and capture period of the fish. As these variables were influenced by other biotic and abiotic variables such as hydrologic level, pluviometric index, food availability and others, a conclusion about the dynamics required a deeper study involving a longer period of analysis and an additional control of the largest possible number of variables.

ACKNOWLEDGEMENTS

RESUMO

Este trabalho teve como objetivo estudar a composição química da musculatura dorsal de *Hypophthalmus edentatus*, em particular, a composição dos ácidos graxos da fração lipídica, e relacionar esta composição com variáveis biológicas e o período de coleta. Os valores de mediana para umidade, cinzas, proteína e lipídio total foram 63,15%, 1,11%, 14,27% e 17,24%, respectivamente. Na fração lipídica foram identificados 35 ácidos graxos sendo os mais abundantes: 16:0, 18:1ω9, 18:0, 16:1ω7, 18:3ω3, DHA e EPA. Os totais de ácidos graxos saturados, monoinsaturados e poliinsaturados foram, respectivamente, 41,15%, 35,30% e 23,88%. A razão AGPI/AGS foi igual a 0,68 e a razão ω3/ω6 igual a 1,98. Na ACP contribuíram positivamente para formação do primeiro eixo AGPIs de cadeia longa e, negativamente, alguns AGSs e AGMIs de 14 a 18 carbonos. A análise de variáveis canônica sugere a existência de algum efeito de fatores biológicos (peso, estádio, sexo) e do período de coleta sobre a variação de alguns dos componentes químicos do tecido muscular dorsal de *H. edentatus*, principalmente, lipídios totais e alguns ácidos graxos.

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