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Body morphometric measurements, yield and centesimal composition of king weakfish fillet

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ABSTRACT

The king weakfish *Macrodon ancylodon* is a marine species, Sciaenidae family, with economic importance due to the wide distribution and market acceptation. Thus, the aim of study was to evaluate body morphometric relationships, yield and centesimal composition of king weakfish fillet. Therefore, 60 fish were organized in four weight class (T1=100-200g, T2=201-300g, T3=301-400g e T4=401-500g). Body weights and measures were measured for subsequent analyzes of the morphometric relationships, the yields and the centesimal composition of the fillets. Results were submitted to Analysis of Variance (ANOVA) post hoc Tukey test ($p<0.05$). There is statistical difference on morphometric relationships with the better results for T3 and T4 fish class. Still, for T3 class was observed the largest fillet yield without skin (42.90%) and smallest skin yield (8.36%). The protein levels for all weight classes had an inversional value when compared to the lipid values, showing numbers above 19%. For these reasons, the king weakfish show excellent nutritional quality being fish above 300g has better yield and morphometric relationships.

Keywords: *Macrodon ancylodon*; fillet cuts; fishing technology; nutritional value.

Morfometria corporal, rendimento de cortes e composição centesimal do filé da pescada gó

RESUMO

A pescada gó (*Macrodon ancylodon*), é uma espécie marinha, da família Sciaenidae, economicamente importante, devido a sua ampla distribuição e grande aceitação no mercado. O objetivo do estudo foi avaliar as relações morfométricas corporais, os rendimentos de cortes e a composição centesimal do filé da pescada gó. 60 exemplares foram distribuídos em quatro classes de peso, (T1=100-200g, T2=201-300g, T3=301-400g e T4=401-500g). Pesos e medidas corporais foram aferidos para subsequentes análises das relações morfométricas, os rendimentos e composição centesimal dos filés. Os resultados foram submetidos à análise de variância (ANOVA) e teste Tukey ($P<0,05$). Houve diferenças significativas nas relações morfométricas, sendo os peixes das classes T3 e T4, apresentaram os melhores resultados. Em relação aos rendimentos dos cortes, os peixes da classe T3 foram os que demonstraram o maior rendimento de filé sem pele (42,90%) e o menor rendimento de pele (8,36%). O teor de proteína avaliado nos filés dos peixes das quatro classes de peso foi inversamente proporcional aos valores de lipídios, com valor superior a 19% de proteína bruta. Os resultados indicam que a pescada gó apresenta excelente qualidade nutricional e que peixes acima de 300g apresentam melhores relações morfométricas e rendimentos.

Palavras-chave: *Macrodon ancylodon,* cortes de filé, tecnologia do pescado, valor nutricional.

Introduction

Actually, there is an increase on demand for products on high nutritional quality, easy preparation and sanitation adequate (OETTERER, 2002). For this reason, fish consumption has been growing due to the high nutritional value and several benefits for human health (MACIEL et al., 2013).

The king weakfish *Macrodon ancylodon* Bloch & Schneider, 1801, Sciaenidae family, is a demersal marine species living on the coast region of Brazil. That species is called “king weakfish” or “soft mouth corvine” in the brazilian north region and “rocket fish” or “real fish” in brazilian south region (HAIMOVICI et al., 1994). That fish can be found in 60m deep with sand and mud at the bottom, but normally living in 30m deep and its juvenile phase inhabit estuarine regions (MENEZES; FIGUEIREDO, 1980). Is a fish with economic importance due to the wide distribution, large demand and market acceptance (ISAAC, 2006).

The standardization of products becomes necessary for better market acceptation. The body morphometric relationship and weight class indicates adequate cut increasing the process yield and providing subsidies for choice of used equipment on industry (CONTRERAS-GUZMÁN, 1994). Thus, evaluates morphometric relationship and fillet yields of fish in different size classes, is important to determine the ideal slaughter size and standards the process techniques (ADAMES et al., 2014).

In the Brazil, several studies determining morphometric characteristics and fillet yields were normally performed with freshwater fish such as aruanã *Osteoglossum bicirrhosum* Cuvier, 1829 (COSTA et al., 2009), pirarucu *Arapaima gigas* Schinz, 1822 (FOGAÇA et al., 2011), matrinxã *Brycon cephalus* Günther, 1869*,* curimatã *Prochilodus nigricans* Spix & Agassiz 1829*,* tambaqui *Colossoma macropomum* Cuvier, 1816, piramutaba *Brachyplatystoma vaillantii* Valenciennes, 1840 and tucunaré *Cicla monoculus* Agassiz, 1831 (SOUZA; INHAMUNS, 2011), traíra *Hoplias malabaricus* Bloch, 1794 (ARAÚJO et al., 2018). Among the rare studies with marine Fish, Corrêa et al. (2013) was determined the morphometric characteristics and fillet yields for robalo-peva *Centropomus parallelus* Poey, 1860.

Materials and Methods

A total of 60 fish *Macrodon ancylodon* were collected in the municipally market of Bragança-PA. The selection was performed with regard to the weight level organized into four classes (T1 = 100-200g, T2 = 201-300g, T3 = 301-400g and T4 = 401-500g). The experiment was conducted in completely randomized design with 15 replaces being each fish an experimental unit. Body morphometric analysis, yield and centesimal composition of fillet

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was carried out in Laboratory of Fishing Technology from Federal University of Pará *campus* Bragança.

The body morphometric was evaluated by: total length, standard length, head length, body length, body height, head height and body width. The measures were determined with the aid of digital caliper and ichtyometer (graduation 0.05mm and 0.1cm respectively). Afterwards, were evaluated morphometric relationships: head length/standard length, head length/head height, standard length/total length, body width/ body length, body width/body height and body height/body length (BOMBARDELLI et al., 2007). Two phenotypic selection indexes also were analyzed: profile index and head index, determined by the reason between total length and body height as well as standard length and head length (GONÇALVES et al., 2003).

The yield evaluation of eviscerated fish, clean body, fillet with or without skin, skin and carcass residue were determined eviscerated fish weight (without gill and viscera), clean body weight (without head and flippers), fillet weight with skin, fillet weight without skin, skin weight, residue weight (head, carcass, flippers and skin) and carcass weight (dorsal spine). Results of yield were performed by division of evaluated category weight and fish total weight (whole fish), multiplied by 100 to reach the yield percentage (SOUZA; INHAMUNS, 2011). Weight measurements were performed with the aid of a digital scale (EQU0031) at precision 0.01g, being all process conducted by only a trained man (weigh, evisceration, cuts of the fillet and skin).

Centesimal composition was determined only for fillet without skin, using five fillet per weight class. Nutrient levels: moisture, mineral material, lipid and crude protein were determined according to AOAC (2000) based to the natural matter. All analyses were carried out in triplicate. Moisture was determined by gravimetric method in laboratory stove 105º per 24 hours and mineral material in muffle furnace 550ºC per 6 hours. For crude protein and lipid analyses were used the Kjeldhal and soxhlet methods respectively. According to Jabeen and Chaudhry (2011) fish could be classified in four categories related to lipid concentration: Skinny (<5% of lipid), moderately fat (5 to 10% of lipid) and fat (>10% of lipid).

Statistical analysis was performed for morphometric relationships, yields and centesimal composition using BioEstat 5.0 software (AYRES et al., 2007). The normality and homoscedas-ticity of data was determined by Shapiro wilk and Bartlet test. Then, obtained results were submitted to Analyze of Variance (ANOVA) followed post hoc Tukey test (p<0.05).

Results

The body measure values used for determine morphome-tric relationships of *M. ancylodon*, in treatments and weight class, are showed in the table 1.

Table 1. Body measures of King weakfish *Macrodon ancylodon* in different weight classes.

	Weight Class			
	T1	**T2**	**T3**	**T4**
Category (cm)	**100-200**	**201-300**	**301-400**	**401-500**
Total length (TL)	21.35 ± 1.06	30.60 ± 1.21	31.83 ± 0.70	34.60 ± 1.45
Standard length (SL)	17.38 ± 0.98	25.77 ± 1.33	27.17 ± 0.84	29.54 ± 1.36
Head length (HL)	4.85 ± 0.31	7.16 ± 0.49	6.93 ± 0.77	8.07 ± 0.92
Body length (BL)	12.52 ± 0.79	18.61 ± 1.09	20.24 ± 0.87	21.47 ± 0.94
Body height (BH)	3.38 ± 0.28	5.21 ± 0.83	6.43 ± 0.74	6.76 ± 1.23
Head height (HH)	2.88 ± 0.20	4.33 ± 0.27	4.66 ± 0.27	5.53 ± 1.45
Body width (BW)	1.91 ± 0.21	2.91 ± 0.37	3.48 ± 0.64	4.02 ± 1.58

Data presented as mean values ± standard deviation

There is statistical difference (p<0.05) for morphometric relationship of head length/standard length (HL/SL), head length/head height (HL/HH), standard length/total length (SL/TL) and body height/body length (BH/BL) inside of weight classes studies. Only relationship as body width/body height (BW/BH) and body width/body length (BW/BL) does not differ statistically. Phenotypic selection index: profile index (PI), head index (HI), also showed statistical difference (p<0.05) inside of the different studies weight classes (Table 2).

Table 2. Morphometric relationships of *Macrodon ancylodon* in different weight classes.

Category	Weight class				**F test**	**P value**	**C.V. (%)**
	T1	**T2**	**T3**	**T4**			
	100-200	**201-300**	**301-400**	**401-500**			
HL/SL	0.28 ± 0.01 a	0.28 ± 0.01a	0.25 ± 0.03b	0.27 ± 0.02 ab	4.3127	0.0085	7.53
HL/HH	1.69 ± 0.08 a	1.66 ± 0.12 ab	1.49 ± 1.14 b	1.51 ± 0.26 b	5.8073	0.0019	10.16
SL/TL	0.81 ± 0.02 b	0.84 ± 0.02 a	0.85 ± 0.02 a	0.85 ± 0.02 a	18.7103	0.0001	1.99
BW/BL	0.23 ± 0.01 a	0.23 ± 0.01 a	0.23 ± 0.02 a	0.25 ± 0.02 a	1.8112	0.1543	17.20
BW/BH	0.57 ± 0.07 a	0.56 ± 0.04 a	0.54 ± 0.08 a	0.59 ± 0.13 a	0.7633	0.5223	15.18
BH/BL	0.27 ± 0.03 b	0.28 ± 0.04 ab	0.32 ± 0.03 a	0.32 ± 0.07 a	4.4427	0.0074	14.10
PI	5.17 ± 0.43 a	5.03 ± 0.63 a	4.28 ± 0.50 b	4.50 ± 0.81 b	7.2962	0.0005	13.49
HI	3.58 ± 0.17 b	3.61 ± 0.19 b	3.96 ± 0.39 a	3.70 ± 0.37ab	5.0427	0.004	8.07

Data presented as mean ± standard deviation; Different smallest letters in the line indicates statistical difference (p<0.05) by Tukey test; C.V. = Coefficient of variation.

Results of eviscerated fish yield, clean body, fillet yield with skin and carcass yield does not differ statistically (p>0.05). However, fillet yield without skin, skin yield and residue yield had statistical difference among the studies weight classes (Table 3).

Table 3. Mean values for fillet yield of King weakfish in different weight classes.

Yields (%)	Weight classes				**F test**	**P valor**	**C.V.(%)**
	T1	**T2**	**T3**	**T4**			
	100-200	**201-300**	**301-400**	**401-500**			
Eviscerated fish	87.71 ± 3.84 a	89.12 ± 3.26 a	88.43 ± 5.75 a	87.02 ± 5.85 a	0.5334	0.6654	5.52
Clean body	63.38 ± 4.34 a	66.58 ± 2.67 a	62.77 ± 3.63 a	65.09 ± 4.67 a	29.201	0.0510	5.10
Fillet with skin	51.37 ± 3.32 a	55.44 ± 4.32 a	51.61 ± 4.23 a	54.89 ± 4.91 a	38.202	0.0545	7.93
Fillet without skin	36.42 ± 3.90 b	40.34 ± 3.16 b	42.90 ± 3.70 a	40.51 ± 6.32 b	54.086	0.0028	10.96
Skin	14.61 ± 4.17 a	14.87 ± 3.14 a	8.36 ± 4.37 b	14.58 ± 0.90 a	47.486	0.0054	35.75
Residue	56.56 ± 5.89 a	53.02 ± 4.51 a	47.10 ± 3.52 b	46.59 ± 7.21 b	11.8241	0.0001	11.72
Carcass	11.20 ± 4.15 a	10.34 ± 2.64 a	10.99 ± 1.63 a	9.63 ± 1.79 a	0.9714	0.5860	28.93

Data presented as mean ± standard deviation; Different smallest letters in the line indicates statistical difference (p<0.05) by Tukey test; C.V. = Coefficient of variation.

About the centesimal composition King weakfish fillet, only moisture does not differ statistically (p>0.05) among the different studies weight classes. Nonetheless, for mineral material, lipid and crude protein there is statistical difference (Table 4).

Table 4. Centesimal composition of King weakfish fillet in different weight classes.

Composition (%)	Weight classes						
	T1	T2	T3	T4			
	100-200	201-300	301-400	401-500	F Test	P valor	C.V. (%)
Moisture	70.50 ± 1.13 a	72.95 ± 0.87 a	68.78 ± 1.33 a	71.90 ± 1.81 a	5.5416	0.0530	1.87
Mineral Material	3.60 ± 0.07 b	3.67 ± 0.47 b	5.90 ±0.60 a	5.79 ± 0.95 a	13.0642	0.0024	12.93
Lipid	9.48 ± 1.90 a	6.29 ± 0.18 b	7.69 ± 1.14 b	3.01 ± 0.05 c	18.0858	0.0010	16.83
Crude Protein	16.38 ± 0.24 b	17.08 ± 0.21 a	17.62 ± 0.71 a	19.27 ± 0.03 a	29.4492	0.0003	2.23

Data presented as mean ± standard deviation; Different smallest letters in the line indicates statistical difference ($p<0.05$) by Tukey test; C.V. = Coefficient of variation.

Discussion

Morphometric relationships between HL/SL and HL/HH are related to the head size being sometimes inedible (FARIA et al., 2003). Nonetheless, how much larger the head size smaller the body size making loss of yield and smaller available meat (BOMBARDELLI et al., 2007). In the present study largest relationships for HL/SL and HL/HH were observed to the largest weight classes. According to Adames et al. (2014) and Bombardelli and Sanches (2008) with barbado *Pinirampus pirinampu* Spix & Agassiz 1829 and armado *Pterodoras granulosus* Valenciennes, 1821, showed the largest values HL/SL and HL/HH for fish with smallest weight class.

The largest relationships with SL/TL were observed for fish to the class T2, T3 and T4. Samples of *P. granulosus* also showed larger relation SL/TL when evaluated in the largest weight classes (BOMBARDELLI; SANCHES 2008). These results indicate a relative reduction in proportion of caudal fin for the largest animals, showing an influence between weight class and edible parts of the fish.

The fish of class T2, T3 and T4 also showed large relation BH/HL how much larger the morphometric relation larger the fish development in height and smaller in length (ADAMES et al., 2014). Thus, fish with high BH/HL relation had a larger fillet yield due to the larger body height and consequent larger fillet width (LUNDSTEDT et al., 1997).

For king weakfish, the smallest profile index and largest head index were determined in the largest weight classes T3 and T4. According to Gonçalves (2003) the profile index is determined by reason of standard length and height, based in this fact, meat increase is related to body height and not to body length, how much smaller profile index better the meat yield. For other side, head index is determined by standard length/head length, being the head an inedible part, how much smaller head index.

Among the edible parts of fish, fillet is considered a noble part with the better acceptance for consumer (FERNANDES et al., 2010; ARAÚJO et al., 2018). The fillet yield with skin of marine and fresh water species reach between 32.80% and 59.80%, with mean value 50.50%, but when removed that skin is observed reduction for 43% (CONTRERAS-GUZMÁN, 1994). These values corroborate with those found in the present study having fillet yield with skin between 55.44% and 51.37%, while the better fillet yield without skin was 42.90% ± 3.70 in the fish of T3 class.

The fillet yield obtained in the present study was higher those found for traíra *H. malabaricus*, with variation of 34.62 and 34.76% (ARAÚJO et al., 2018), tucunaré *Cichla* sp. with variation of 32.92 and 36.99% (HONORATO et al., 2014), however, it was similar to the results for the tambaqui *C. macropomum* with mean value of 50.36% in three evaluated weight classes (LIMA et al., 2018).

Samples of T3 class showed smaller values of skin yield 10.14% ± 5.28, corroborating with the better result found of fillet yield without skin for this class. Expected fish with larger fillet yield without skin had a smaller proportion of skin. According to Contreras-Guzmán (1994) about the 7.5% of a total weight if represented by skin, however, for the present study was observed higher values for all studies weight classes.

The results of residue yield had reduced values when compared to Costa et al. (2014) determining 67.62 and 69.15% of residue yield for jaraqui *Semaprochilodus* spp. For King weakfish was observed a reduction of skin yield on fish with large weight class, bone percentage reduction, skin, head and skin, associated with the increase of fish weight indicates, with de fish development is observed a muscle development (ADAMES et al., 2014). This could be related to the larger fillet yield without skin of fish in T3 class.

The obtained results for centesimal composition of King weakfish fillet are according to Ogawa and Maia (1999) determining some values between 60 to 80% for moisture, 15 to 20% for crude protein, and they quote lipid levels on muscle fish reaching 36% with regard to the characteristics of species. Only material mineral values differ of authors above, suggesting values between 1 and 2% for fish.

Found values of mineral material in the present study were higher when compared to Lima et al. (2018) having values between 0.7 and 1.3 for tambaqui *C. macropomum* in three weight classes. For other side, according to Menezes et al. (2008), found values of mineral material between 4.94 ± 0.55 and 5.40 ± 0.75 in tainha fillet *Mugil cephalus* and robalo-flecha *Centropomus undecimalis* Bloch, 1792, respectively, close values those found in the present study. According to Contreras-Guzmán (1994), variation in values for centesimal composition of mineral material could be influenced by several factors such as seasonal period or size among the marine and fresh water species.

The lipid concentration found in king weakfish fillet presented similarity with the results of Souza et al. (2015) showing lipid concentration for rainbow trout *Oncorhynchus mykiss* Walbaum, 1792, fillet between 7,96% to 9,04% in two weight classes. According to Bombardelli and Sanches (2008) were observed smallest lipid values for armado *P. granulosus*, variating between 2.97% ± 0.18 and 3.57% ± 0.18. For other side, Adames et al. (2014) were observed high concentration between 8.67% ± 2.95 and 21.87% ± 8.61 for barbado *P. pirinampu.*

Lipids in the fish has a functional importance to the human and animal feeding. Beyond the energy source, build the cell wall, act as metabolic modulator, are important source of polyunsaturated fat acids, acting on reduction of cholesterol preventing heart diseases (OGAWA; MAIA 1999). However, high levels of lipid could influence maintenance of product harm the fish market and reducing the acceptance of consumer (BOMBARDELLI et al., 2007). The lipid levels observed for this study, had inversional values to the weight classes reducing with the increase of fish, the opposite was observed crude protein levels that increased with larger fish. Same results were observed for curimbatá *Prochilodus lineatus* Valenciennes, 1837 (MACHADO; FORESTI 2009). This way according to the classification to Jabeen and Chaudhry (2011), king weakfish is moderately fat having 6.61% of lipid, being indicated for human feeding and industrial production.

The crude protein concentration of King weakfish fillet collaborates with the findings of Souza et al. (2015) having mean values of crude protein 19,05% for rainbow trout *O. mykiss*. According to Menezes et al. (2008) were observed same results with tainha *M. cephalus* and robalo-flecha *C. undecimalis*, 20.85% and 18.29% of crude protein respectively. For Corrêa et al. (2013) analyzing crude protein concentration on robalo-peva *C. parallelus* fillet were found values between 19.45% ± 0.33 and 20.94% ± 0.14. The protein levels observed by Viana et al. (2013) present variation of 17% to 23% on the fillets for ariacó *Lutjanus synagris* Linnaeus, 1758, guaiúba *Ocyurus chrysurus* Bloch, 1791, sardinha-laje *Opisthonema oglinum* Lesueur, 1818 and tainha *Mugil* sp., close values those found in this study.

According to Corrêa et al. (2016) with study about the centesimal composition of fillet for several fish species traded in free fair from Belém PA, they have found crude protein values 18.63% ± 0.40 for fillet of King Weakfish *M. ancylodon*, same species of the present study being larger the found value among the analyzed species. The fish chemical composition is related with the species, feeding behavior, habitat, maturation stage, age, body size, sex and environmental seasonality (CONTRERAS-GUZMÁN, 1994). The fish is considered an excellent essential amino acid source, important source of poly-unsaturated fat acids such as eicosapentaenóico (EPA) and docosaexaenóico (DHA) as well as vitamin and minerals (OGAWA; MAIA 1999). Specially to the protein with high biologic value and easy digestibility (OETTERER, 2002).

The knowledge about fish centesimal composition provide some information for nutritionists building diets with low lipid levels and high protein levels (SOUZA et al., 2015). Furthermore, this information is important for industry providing essential subsidy of technology character, acting in the processing of fisheries products, reducing loss, increase the shelf time, making these products safer to the consumer (JABEEN; CHAUDHRY 2011).

The king weakfish fillet have high yield index and adequate composition, with larger protein levels when compared to the other's meat, milk or eggs (GONÇALVES et al., 2003). For these reasons, studies about centesimal composition of marine fish such as King Weakfish *M. ancylodon* is important due to the economic and social value represented by this species for several country regions.

Conclusion

The better morphometric relationships were observed to the fish with the largest weight classes (T3 and T4). Fish of T3 class (300 – 400g) showed the best yields, mainly for fillet yield without skin (42.90%) as a noble part of the fish. Centesimal composition of King Weakfish fillet showed excellent nutritional quality for species having high crude protein levels (19%) and moderate lipid levels.

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References

ADAMES, M. S.; KRAUSE, R. A.; DAMASCENO, D. Z.; PIANA, P. A.; OLIVEIRA, J. D. S.; BOMBARDELLI, R. A. Características morfométricas, rendimentos no processamento e composição centesimal da carne do barbado. **Boletim do Instituto de Pesca**, v. 40, n. 2, p. 251-260, 2014.

AOAC. ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. **Official Methods of Analysis of AOAC International**. 17. ed. Washington, DC: AOAC, 2000. 1115 p.

ARAÚJO, K. C.; CIRNE, L. G. A.; SOUZA, W. S.; SILVA, J. R.; FELTRAN, R. B.; MELO, D. R.; ROCHA, P. R. R.; MACIEL, E. S. Características morfométricas, rendimento de filé e composição química da traíra. **Agroecossistemas**, v. 10, n. 2, p. 25-36, 2018.

AYRES, M.; AYRES JUNIOR, M.; AYRES D. L.; SANTOS A. A. S **BioEstat: aplicações estatísticas nas áreas das ciências biomédicas**. Versão 5.0. Belém, Pará: Sociedade Civil Mamirauá, MCT-CNPq, 2007. 324 p.

BOMBARDELLI, R. A.; BENCKE, B. C.; SANCHES, E. A. Processamento da carne de pacu (*Piaractus mesopotamicus*) cultivado em tanques-rede no reservatório de Itaipu. **Acta Scienciarum. Animal Science**, v. 29, n. 4, p.457-463, 2007.

BOMBARDELLI, R. A.; SANCHES, E. A. Avaliação das características morfométricas corporais, do rendimento de cortes e composição centesimal da carne do armado (*Pterodoras granulosus*). **Boletim do Instituto de Pesca**, v.34, n. 2, p. 221-229, 2008.

CONTRERAS-GUZMÁN, E. S. **Bioquímica de pescados e derivados**. Jaboticabal: Funep, 1994. 409 p.

CORRÊA, C. F.; TACHIBANA, L.; LEONARDO, A. F.; BACCARIN, A. E. Rendimentos de carcaça, composição do filé e análise sensorial do robalopeva de rio e de mar. **Boletim do Instituto de Pesca**, v. 39, n. 4, p. 401-410, 2013.

CORRÊA, F. C.; SANTOS, P. L.; SILVA, F. E. R.; BARBOSA, I. C. C.; SANTA-ROSA, R. M. S. Avaliação físico-química e composição centesimal de filés de peixe comercializados em Belém do Pará, Brasil. **Scientia Plena**, v. 12, n. 12, p. 1-10, 2016.

COSTA, T. V.; MACHADO, N. J. B.; BRASIL, R. J. M.; FRAGATA, N. P. Caracterização físico-química e rendimento do filé e resíduos de diferentes espécies de jaraqui (*semaprochilodus* spp.). **Boletim do Instituto de Pesca**, v. 40, n. 1, p. 35-47, 2014.

COSTA, T. V.; SILVA, E. C. S.; OSHIRO, L. M. Y. O potencial do aruanã *Osteoglossum bicirrhosum* (Vandelli, 1829) (Osteoglossiformes, Osteoglossidae) para a criação em cativeiro. **Acta Amazônica**, v. 39, n. 2, p. 439-446, 2009.

FARIA, R. H. S.; SOUZA, M. L. R.; WAGNER, P. M.; POVH, J. A.; RIBEIRO, R. P. Rendimento do processamento da tilápia do Nilo (*Oreochromis niloticus* Linnaeus, 1757) e do Pacu (*Piaractus mesopotamicus,* Holmberg, 1887). **Acta Scientiarum. Animal Science**, v. 25, n. 1, p. 21-24, 2003.

FERNANDES, T. R. C.; DORIA, C. R. C.; MENEZES, J. T. B. Características de carcaça e parâmetros de desempenho do tambaqui (*Colossoma macropomum*, Cuvier, 1818) em diferentes tempos de cultivo e alimentado com rações comerciais. **Boletim do Instituto de Pesca**, v. 36, n. 1, p. 45-52, 2010.

FOGAÇA, F. H. S.; OLIVEIRA, E. G.; CARVALHO, S. E. Q.; SANTOS, F. J. S. Yield and composition of pirarucu fillet in different weight classes. **Acta Scientiarum**, v. 33, n. 1, p. 95-99, 2011.

GONÇALVES, T. M.; ALMEIDA, A. J.; BORGES, E. E. S. Características de carcaça de tilápias do Nilo (*Oreochromis niloticus*) em quatro classes de peso ao abate. **Acta Scientarium. Animal Science**, v. 25, n. 1, p. 25-29, 2003.

GRIGORAKIS, K. Compositional and organoleptic quality of farmed and wild gilthead sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) and factors affecting it: a review. **Aquaculture**, v. 272, n. 1, p. 55-75, 2007.

HAIMOVICI, M.; MARTINS, A. S.; FIGUEIREDO, J. L. D.; VIERA, P. C. Demersal bony fish of the outer shelf and upper slope of the southern Brazil subtropical convergence ecosystem. **Marine Ecology Progressive Series**, v. 108, n. 12, p. 59-77, 1994.

HONORATO, C. A.; SMERMAN. W.; ANGÉLICI, A. F.; DAL BEM, C. R. Efeito das classes de peso sobre o rendimento de processamento de tucunaré (*Cichla* sp.). **Scientia Agraria Paranaensis**, v. 13, n. 1, p. 65-70, 2014.

ISAAC, V. J.; FRÉDOU, F. L.; HIGUCHI, H.; SILVA, B.B.; ESPIRITO- SANTO, R. V.; OLIVEIRA, F. P.; MOURÃO, K. R. M.; OLIVEIRA, C. M. E.; ALMEIDA, M. C. A. Exploração e manejo dos recursos pesqueiros do litoral Amazônico: um desafio para o futuro. **Ciência e Cultura**, v. 58, n. 3, 33-36, 2006.

JABEEN, F.; CHAUDHRY, A. S. Chemical compositions and fatty acid profiles of three freshwater fish species. **Food Chemistry**, v. 125, n. 3, 991-996, 2011.

LIMA, L. K. F.; NOLETO, S. S.; SANTOS, V. R. V.; LUIZ, D. B.; KIRSCHNIK, P. G. Rendimento e composição centesimal do tambaqui (*Colossoma macropomum*) por diferentes cortes e categorias de peso. **Revista Brasileira de Higiene e Sanidade Animal**, v. 12, n. 2, p. 223-222, 2018.

LUNDSTEDT, L. M.; LEONHARDT, J. H.; DIAS, A. L. Alterações morfométricas induzidas pela reversão sexual em tilápias do Nilo *Oreochromis niloticus* (Linnaeus, 1757). **Revista Unimar**, v. 19, n. 2, p. 461-472, 1997.

MACHADO, M. R. F.; FORESTI, F. Rendimento e composição química do filé de *Prochilodus lineatus* do rio Mogi Guaçu, Brasil. **Archivos de Zootecnia**, v. 58, n. 224, p. 663-670, 2009.

MACIEL, E. D. S.; SAVAY-DA-SILVA, L. K.; VASCONCELOS, J. S.; SONATI, J. G.; GALVÃO, J. A.; LIMA, L. K. F.; OETTERER, M. Relationship between the price of fish and its quality attributes: a study within a community at the University of São Paulo, Brazil. **Food Science and Technology**, v. 33, n. 3, p. 451-456, 2013.

MENEZES, N. A.; FIGUEIREDO, J. L. **Manual de Peixes Marinhos do Brasil IV** - Teleostei (3). Museu de Zoologia, Universidade de São Paulo: São Paulo-SP, 1980. 96 p.

MENEZES, M. E. S.; LIRA, G. M.; OMENA, C. M. B.; FREITAS, J. D.; SANT'ANA, A. E. G. Composição centesimal, colesterol e perfil de ácidos graxos dos peixes tainha (*Mugil cephalus*) e camurim (*Centropomus undecimalis*) da Lagoa Mundaú, AL/Brasil. **Revista do Instituto Adolfo Lutz**, v. 67, n. 2, p. 89-95, 2008.

OETTERER, M. **Industrialização do pescado cultivado**. Guaíba: Agropecuária, 2002. 200 p.

OGAWA, M. e MAIA, E. L. **Manual de pesca: ciência e tecnologia do pescado**. São Paulo: Livraria Varela, 1999. 430 p.

SOUZA, A. F. L.; INHAMUNS, A. J. Análise de rendimento cárneo das principais espécies de peixes comercializados no estado do Amazonas, Brasil. **Acta Amazônica**, v. 41, n. 2, p. 289–296, 2011.

SOUZA, M. L. R.; MACEDO-VIEGA, E. M.; ZUANON, J. A S.; CARVALHO, M. R. B.; GOES, E. S. R. Processing yield and chemical composition of rainbow trout (*Oncorhynchus mykiss*) with regard to body weight. **Acta Scientiarum. Animal Sciences**, v. 37, n. 2, p. 103-108, 2015.

VIANA, Z. C. V.; SILVA, E.; FFERNANDES, G. B.; SANTOS, V. L. C. S. Composição centesimal em músculo de peixes no litoral do estado da Bahia/Brasil. **Revista de Ciências Médicas e Biológica**, v. 12, n. 2, p. 157-162, 2013.