

**CARACTERIZAÇÃO FÍSICO-
QUÍMICA E PERFIL LIPÍDICO
DE ARRAIA DE ÁGUA DOCE
POTAMOTRYGON MOTORO
CAPTURADAS EM
AMBIENTES LÊNICO E
LÓTICO DA AMAZÔNIA
OCIDENTAL**

**PHYSICOCHEMICAL CHARACTERIZATION AND LIPID PROFILE OF THE
FRESHWATER STINGRAY POTAMOTRYGON MOTORO CAPTURED IN
LENTIC AND LOTIC ENVIRONMENTS OF THE WESTERN AMAZON**

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ABSTRACT

This study aimed to characterize the physicochemical parameters and lipid profile of the freshwater stingray *Potamotrygon motoro* captured in lentic and lotic environments of the Western Amazon. Ten specimens collected from Moreno Maia Lake and the Purus River were analyzed for meat yield, proximate composition, caloric value, and fatty acid profile. The results showed satisfactory meat yield, with mean values close to 32%, consistent with values reported for other Amazonian fish species and previous studies on freshwater stingrays. Proximate composition indicated high protein content and low caloric value, characterizing the meat as lean and low in energy density. Total lipids were the only proximate component that differed significantly between capture environments. The fatty acid profile showed a predominance of polyunsaturated fatty acids, especially arachidonic acid, docosapentaenoic acid (DPA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), as well as nutritionally favorable ω -6: ω -3 ratios. These findings highlight the nutritional and technological potential of *P. motoro* meat and suggest that this species may represent a promising alternative for adding value to Amazonian fishery resources, provided that its use is associated with appropriate management and conservation strategies.

Keywords: Amazonian fish; Fatty acids; Meat yield; Nutritional quality; Proximate composition.

RESUMO

O presente estudo teve como objetivo caracterizar os parâmetros físico-químicos e o perfil lipídico da arraia de água doce *Potamotrygon motoro* capturada em ambientes lêntico e lótico da Amazônia Ocidental. Foram analisados dez exemplares coletados no Lago do Moreno Maia e no Rio Purus, avaliando-se rendimento

cárneo, composição centesimal, valor calórico e perfil de ácidos graxos. Os resultados demonstraram rendimento cárneo satisfatório, com médias próximas a 32%, compatíveis com valores descritos para outras espécies amazônicas e com estudos prévios envolvendo arraias de água doce. A composição centesimal evidenciou elevado teor proteico e baixo valor calórico, caracterizando a carne como magra e de baixa densidade energética. Os lipídios totais foram o único componente da composição centesimal que apresentou diferença significativa entre os ambientes de captura. O perfil de ácidos graxos revelou predominância de ácidos graxos poli-insaturados, com destaque para os ácidos araquidônico, docosapentaenoico (DPA), eicosapentaenoico (EPA) e docosahexaenoico (DHA), além de relações ω -6: ω -3 consideradas nutricionalmente favoráveis. Esses resultados evidenciam o potencial nutricional e tecnológico da carne de *P. motoro* e indicam que a espécie pode representar uma alternativa promissora para a agregação de valor aos recursos pesqueiros amazônicos, desde que seu aproveitamento esteja associado a estratégias adequadas de manejo e conservação.

Palavras-chave: Ácidos graxos; Composição centesimal; Pescado amazônico; Qualidade nutricional; Rendimento cárneo.

1. INTRODUCTION

The Amazon basin harbors one of the greatest ichthyological diversities on the planet, as a result of its high hydrographic complexity, habitat diversity, and the influence of the seasonal flood pulse. Among the aquatic organisms found in these ecosystems, freshwater stingrays of the family Potamotrygonidae stand out as the only group of elasmobranchs fully adapted to freshwater environments. These cartilaginous fishes play an important

ecological role as benthic predators and are distributed mainly across the Amazon, Orinoco, and Paraná–Paraguay basins (Dagosta; de Pinna, 2019; Fontenelle *et al.*, 2021).

Stingrays of the genus *Potamotrygon* exhibit high ecological plasticity and can inhabit rivers, marginal lakes, and seasonally flooded areas. Among them, *Potamotrygon motoro* is notable for its wide geographic distribution and growing scientific interest due to the nutritional potential of its meat. The species feeds mainly on crustaceans, mollusks, aquatic insects, and small fish, factors that may directly influence its chemical composition and lipid profile (Almeida *et al.*, 2008; Barbosa *et al.*, 2025).

In recent decades, fish has become an important source of animal protein because of the high biological value of its proteins, good digestibility, and presence of polyunsaturated fatty acids, especially EPA and DHA, which are associated with the prevention of cardiovascular and inflammatory diseases (Mohanty *et al.*, 2019). According to FAO (2024), global production of aquatic organisms exceeded 223 million tons in 2022, highlighting the economic and nutritional relevance of fishery and aquaculture products worldwide. In the Brazilian Amazon, fish also has major social importance, representing one of the main protein sources for riverine populations (Isaac *et al.*, 2015).

The proximate composition and fatty acid profile of fish may vary according to environmental conditions, food availability, and species-specific energy metabolism. In Amazonian environments, differences between lentic and lotic habitats may influence muscle lipid accumulation and fatty acid composition, potentially modifying the nutritional quality of fish meat (Inhamuns *et al.*, 2009; Junk *et al.*,

2011). In addition, balanced ratios between omega-6 and omega-3 fatty acids are considered important indicators of nutritional quality and have been associated with the reduction of inflammatory processes and chronic diseases (Simopoulos, 2008).

Despite the ecological relevance and technological potential of Amazonian freshwater stingrays, information remains limited regarding the physicochemical composition and lipid profile of *P. motoro* captured in different environments of the Western Amazon. Therefore, this study aimed to characterize the physicochemical parameters and fatty acid profile of *P. motoro* captured in lentic and lotic environments, contributing to the understanding of its nutritional potential and to the value-added use of Amazonian fishery resources.

2. LITERATURE REVIEW

2.1. Freshwater Stingrays

Stingrays, also known as rays or batoids, belong to the class Chondrichthyes and the subclass Elasmobranchii, a group of cartilaginous fishes characterized by a cartilaginous skeleton, dermal denticles, absence of a swim bladder, and highly specialized sensory systems, including electroreception through the ampullae of Lorenzini. Batoids have a dorsoventrally flattened body, pectoral fins fused to the body disc, and predominantly benthic habits. More than 650 species are currently recognized, distributed across marine, estuarine, and freshwater environments, where they play an important ecological role in the control of benthic organisms and aquatic trophic dynamics (Last *et al.*, 2016; Weigmann, 2016; Jerikho *et al.*, 2023).

Fishes constitute the most diverse group of vertebrates on the planet, with more than 36,000 described species, approximately half of which occur in freshwater environments. Brazil stands out as one of the countries with the greatest ichthyofaunal diversity worldwide, much of it concentrated in the Amazon basin, where more than 2,500 species have been recorded. This high biodiversity is associated with hydrographic complexity, habitat diversity, the seasonality of the flood pulse, and the long evolutionary history of South American river systems (Reis *et al.*, 2016; Dagosta; De Pinna, 2019; Albert *et al.*, 2020).

Freshwater stingrays of the family Potamotrygonidae constitute the only group of elasmobranchs fully adapted to freshwater environments and are endemic to South America. Phylogenetic studies indicate that these species originated from marine ancestors that colonized South American rivers during Miocene marine incursions, giving rise to an adaptive radiation in tropical continental waters. The genera *Potamotrygon*, *Paratrygon*, *Plesiotrygon*, and *Heliotrygon* are currently distributed mainly across the Amazon, Paraná–Paraguay, and Orinoco basins (Rosa, 1985; Fontenelle *et al.*, 2021; Barbosa *et al.*, 2025).

Brazil harbors a wide diversity of freshwater stingrays, including *Potamotrygon motoro*, *Paratrygon aiereba*, *Potamotrygon orbignyi*, *Potamotrygon falkneri*, *Potamotrygon leopoldi*, and *Plesiotrygon iwamae*, many of which show high levels of endemism. In addition to their ecological importance as benthic predators, these species have increasing economic relevance due to the ornamental fish trade, fishery potential, and scientific interest in their biology, toxicology, and nutritional quality (Loboda, 2026; Jerikho *et al.*, 2023).

Among Amazonian species, *P. motoro* stands out for its wide geographic distribution, ecological importance, and economic potential. The species has a rounded body disc, dorsal coloration ornamented with orange or reddish spots, and benthic habits. Its diet is mainly based on crustaceans, aquatic insects, mollusks, and small fishes, which reinforces its role as a predator of benthic organisms. The external morphology and typical dorsal coloration pattern of the species are shown in Figure 1. In addition, the species exhibits high ecological plasticity and may occupy sandy beaches, main river channels, marginal lakes, and seasonally flooded environments (Almeida *et al.*, 2008; IUCN, 2024; Barbosa *et al.*, 2025).

In the Brazilian Amazon, the reproductive cycle of freshwater stingrays is closely associated with the hydrological pulse, since the rising-water and flood periods increase food availability and shelter areas for juveniles. These environmental variations may influence reproduction, energy metabolism, and body composition, potentially modifying nutritional parameters of the meat, such as proximate composition and fatty acid profile (Barbosa *et al.*, 2025; Batista *et al.*, 2026).



Figure 1: Freshwater stingray *Potamotrygon motoro*, showing the typical rounded body disc and spotted dorsal coloration. *Source:* Authors (2026)

In lentic environments, such as marginal lakes and floodplain areas, greater hydrodynamic stability and the accumulation of organic matter may favor higher food availability and muscle lipid deposition in fish. In contrast, species inhabiting lotic environments, which are exposed to greater swimming activity and energy expenditure, tend to show lower intramuscular fat accumulation. Studies on Amazonian fish have shown that specimens from lentic environments generally present higher total lipid and monounsaturated fatty acid contents, whereas individuals from lotic environments may exhibit leaner muscle, higher protein levels, and changes in the proportion of polyunsaturated fatty acids, especially EPA and DHA (Inhamuns *et al.*, 2009; Junk *et al.*, 2011; Souza *et al.*, 2023).

2.2. Fish as Food

In recent decades, global fish production has increased substantially, consolidating fish as an important source of animal protein. According to FAO (2024), global production of aquatic organisms exceeded 223 million tons in 2022. Fish is notable for its high nutritional value, providing proteins of high biological value, vitamins, minerals, and bioactive lipids (Mohanty *et al.*, 2019; FAO, 2024).

In Brazil, especially in the Amazon region, fish has major nutritional and socioeconomic importance. In some riverine populations, consumption exceeds 30 kg per inhabitant per year, driven by the broad availability of native species and the importance of artisanal fishing for food security and income generation (Isaac *et al.*, 2015; FAO, 2024; FAPESPA, 2024).

Although species such as tambaqui, pirarucu, and large catfishes predominate in commercial landings, Amazonian freshwater stingrays have attracted increasing scientific and economic interest. Historically underused, these species have shown considerable nutritional potential, with meat characterized by good protein content, high digestibility, and a lipid profile favorable for human consumption (Barbosa *et al.*, 2025; Batista *et al.*, 2026).

The technological quality of fish is related to characteristics such as meat yield, proximate composition, and fatty acid profile. Compared with beef and pork, fish generally contains less connective tissue and has greater protein digestibility, favoring its use in human nutrition. In addition, fish proteins contain essential amino acids and bioactive peptides associated with antioxidant, antimicrobial, and immunomodulatory activities (FAO, 2011; Dogan *et al.*, 2017; Mohanty *et al.*, 2019).

Among the main nutritional attributes of fish, the quality of the lipid fraction is especially important. Fish generally contain higher proportions of unsaturated fatty acids, particularly omega-3 and omega-6 fatty acids, which are associated with cardiovascular protection, cognitive function, and inflammatory modulation. Compounds such as EPA, DHA, and arachidonic acid (ARA) play important roles in the nervous system, immune response, and cellular metabolism (Gutierrez *et al.*, 2025; Makay *et al.*, 2025).

In freshwater fish, the lipid profile varies according to species, diet, and seasonality. In Amazonian environments, hydrological fluctuations directly influence muscle chemical composition and fish energy metabolism (Batista *et al.*, 2026; Loayza *et al.*, 2026).

Therefore, studies involving *P. motoro* are of high scientific and economic relevance, since the characterization of chemical composition, meat yield, and fatty acid profile may contribute to the value-added use of this fishery resource and to the development of food products with functional potential (FAO, 2024; Barbosa *et al.*, 2025; Batista *et al.*, 2026).

3. METHODOLOGY

Ten specimens of *P. motoro* were obtained from different locations in the Western Amazon, including five individuals collected from Moreno Maia Lake, near Rio Branco, Acre, Brazil, and five individuals collected from the Purus River, near Boca do Acre, Amazonas, Brazil. The capture sites are shown in Figure 2A–B.

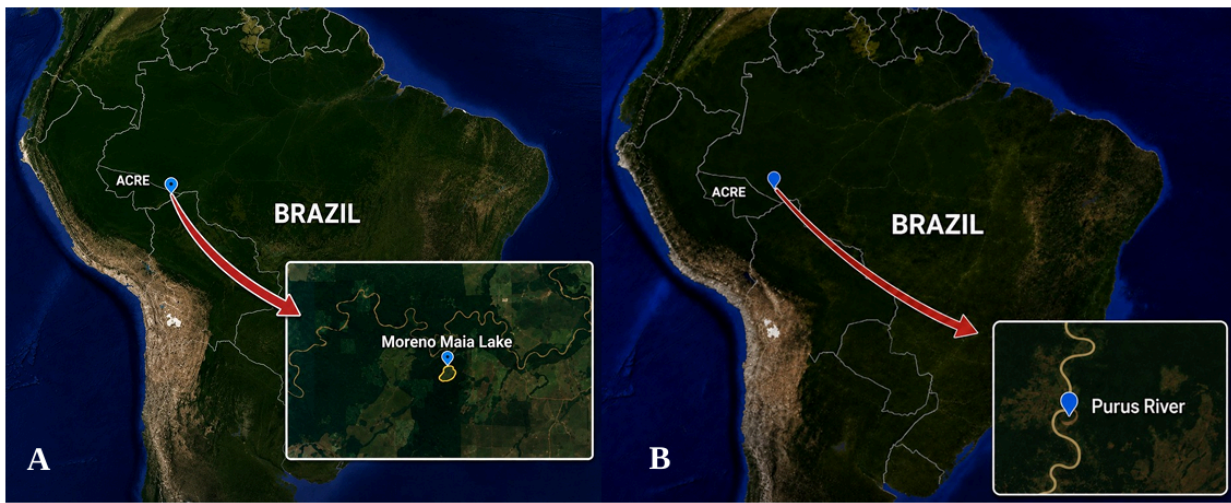


Figure 2: Capture sites of *Potamotrygon motoro* in the Western Amazon: Moreno Maia Lake, Rio Branco, Acre, Brazil (A), and the Purus River, Boca do Acre, Amazonas, Brazil (B).

Source: Authors (2026).

The specimens were collected by artisanal longline fishing using traditional boats commonly employed in the Amazon region. After capture, the caudal spine was removed, and the animals were stunned by perforation of the anteromedian cephalothoracic cavity. The specimens were then stored on ice until laboratory analyses were performed. Morphological identification was conducted according to the taxonomic criteria proposed by Rosa (1985), considering the external diagnostic characteristics typical of the family Potamotrygonidae.

Meat yield was determined from skinless fillets containing cartilaginous rays, a procedure commonly used in fish-processing plants for small-sized animals. The entire edible portion of the pectoral fins was used, considering that the low weight of the cartilaginous rays does not interfere with the sensory acceptability of the product. Meat yield was calculated according to the procedures described by Contreras-Guzmán (1994) and Morais *et al.* (1992).

Samples of approximately 400 g were subjected to freeze-drying in an LS 3000 freeze dryer (Terroni, Brazil) for 30 h. Moisture content was determined by oven drying at 105 °C until constant weight,

according to the analytical procedures of the Instituto Adolfo Lutz (1985). Crude protein was quantified by digestion and distillation using a Micro-Kjeldahl apparatus, with a conversion factor of 6.25, according to the methodology of the AOAC — Association of Official Analytical Chemists (1990). Fixed mineral residue, or ash content, was determined by incineration in a muffle furnace at 550 °C until constant weight, following the recommendations of the Instituto Adolfo Lutz (1985).

Total lipids were extracted using chloroform, methanol, and water, according to the method described by Bligh and Dyer (1959). The relative fatty acid composition was obtained from freeze-dried samples, whereas total caloric value (TCV) was calculated according to the methodology proposed by Silva (1981).

The nitrogen-free extract fraction (NFE) was calculated using the following equation:

$$NFE = 100 - (CP + EE + M + A),$$

where:

- NFE = nitrogen-free extract fraction;
- CP = crude protein;
- EE = ether extract, corresponding to total lipids;
- M = moisture;
- A = ash, corresponding to fixed mineral residue.

Total caloric value (TCV) was calculated using the following equation (Silva, 1981):

$$TCV = (CP \times 4) + (EE \times 9) + (NFE \times 4),$$

where:

- TCV = total caloric value, expressed as kcal 100 g⁻¹;
- CP = crude protein;
- EE = ether extract;
- NFE = nitrogen-free extract.

For transesterification, total lipids were subjected to transmethylation according to method 5509 of the International Organization for Standardization (1978). Fatty acid methyl esters obtained from total lipids were separated using a Shimadzu 14-A gas chromatograph (Japan), equipped with a CP-7420 fused-silica capillary column (Varian, USA; 100% bonded cyanopropyl; 100 m × 0.25 mm × 0.39 μm) and a flame ionization detector.

Gas flow rates were 1.2 mL min⁻¹ for the H₂ carrier gas, 30 mL min⁻¹ for the N₂ make-up gas, and 30 and 300 mL min⁻¹ for the H₂ and synthetic air flame gases, respectively. The sample split ratio was 1:100. The column temperature was maintained at 165 °C for 18 min and then increased to 240 °C at a rate of 15 °C min⁻¹, remaining at this temperature for 20 min. Injector and detector temperatures were set at 220 °C and 230 °C, respectively. Analyses were performed in triplicate, using an injection volume of 1 μL.

Chromatographic peak areas were obtained by the normalization method using a CG-300 integrator processor (Instrumentos Científicos CG, Brazil). Peaks were identified by comparing retention times with fatty acid methyl ester standards from Sigma-Aldrich (Merck, Germany).

Data related to technological characterization between lots were subjected to frequency analysis, mean calculation, and significance testing at the 5% level, using Statistica Release 6.0 software (Statistica®, 2001).

4. RESULTS AND DISCUSSION

The body weight of captured specimens ranged from 1770 to 2820 g in the lake and from 2220 to 3010 g in the river.

Table 1. Weight and meat yield of *Potamotrygon motoro* specimens captured in Moreno Maia Lake and the Purus River.

Location	Lot	Total weight (g)	Yield (%)
Lake	01	2264 ± 456.21	32.29 ± 0.80
River	02	2784 ± 385.27	32.42 ± 0.75

Means with their respective standard deviation estimates.

The processing of stingrays in fish-processing plants follows principles similar to those used for other cartilaginous fishes; however, specific adaptations are required because of the peculiar anatomy of these animals, particularly the presence of the caudal spine, the cartilaginous body disc, and the amount of connective tissue. In Brazil, the processing of freshwater stingrays of the family

Potamotrygonidae is still limited and, in many cases, occurs on an artisanal or semi-industrial scale.

The meat yield obtained in both lots was considered satisfactory, with no significant differences between them ($p > 0.05$), and remained within the range described in the literature for fillets with cartilaginous rays of *P. motoro*. Similar results were reported by Santos *et al.* (2019), who recorded yields between 31.4% and 39.8%, whereas Kirchheim *et al.* (2013) reported values ranging from 31.5% to 34.8%. These findings demonstrate consistency between the data obtained in the present study and those previously reported for the species, reinforcing the technological potential use of freshwater stingray meat in processing.

In addition, other Amazonian fish species show yields close to those observed in this study. Souza and Inhamuns (2011) reported, for skinless fillets of Characiformes, yields between 29.54% and 32.52% for curimatã (*Prochilodus* spp.), between 30.91% and 32.38% for jaraqui (*Semaprochilodus* spp.), and between 30.50% and 31.66% for matrinxã (*Brycon amazonicus*), indicating that the meat yield observed for *P. motoro* is within the range commonly recorded for important commercial species of the Amazonian ichthyofauna.

Table 2. Proximate composition of *Potamotrygon. motoro* captured in Moreno Maia Lake and the Purus River.

Location	Moisture	Ash	Total lipids	Crude protein	Carbohydrates
Lake	78.14 ± 0.13	0.84 ± 0.03	0.55 ± 0.02	19.62 ± 0.11	0.85 ± 0.03
River	78.20 ± 0.25	0.68 ± 0.01	0.47 ± 0.02	20.34 ± 0.35	0.31 ± 0.01

⚠ Esta tabela possui muitas colunas e foi cortada para impressão. Para visualizá-la completa, acesse o artigo original em:

<https://revistatopicos.com.br/artigos/caracterizacao-fisico-quimica-e-perfil-lipidico-de-arraia-de-agua-doce-potamotrygon-motoro-capturadas-em-ambientes-lentico-e-lotico-da-amazonia-ocidental?noblockage>

Means with their respective standard deviation estimates.

The crude protein contents observed in the present study were higher than those described by Kirchheim *et al.* (2013) for *P. motoro*, whose values ranged from 14.01% to 15.31%. Likewise, the results also exceeded those reported by Batista *et al.* (2026) for *Paratrygon aiereba*. Barai *et al.* (2021), when evaluating the proximate composition of different Amazonian species, reported crude protein contents ranging from 18.82% to 22.38% for *Astronotus ocellatus*, from 15.53% to 19.80% for *Pseudoplatystoma tigrinum*, and from 16.56% to 18.16% for *Leporinus friderici*, demonstrating that the values obtained in this study are similar to those described for other Amazonian fish species and highlighting the high protein potential of *P. motoro*.

Total lipids were the only proximate component that showed a significant difference between lots ($p < 0.05$). Among the nutritional variables of Amazonian fish, the lipid fraction is one of the most sensitive to environmental variation and may be influenced by the hydrological cycle, food availability, reproductive stage, and species-specific energy metabolism. In Amazonian environments, differences among locations and hydrological periods can modify the availability of food resources, which may be reflected in the accumulation or mobilization of muscle lipid reserves (Inhamuns *et al.*, 2009; Barbosa *et al.*, 2025).

Kirchheim *et al.* (2013), evaluating the proximate composition of *P. motoro*, observed lipid contents ranging from 0.41% to 0.48%, values similar to those found in the present study. These results reinforce the lean character of the musculature of this species, a characteristic also observed in other Amazonian freshwater stingrays. Batista *et al.* (2026), studying *Paratrygon aiereba*, reported low levels of total lipids, indicating that Amazonian potamotrygonids tend to show reduced intramuscular fat accumulation when compared with fish species with sedentary habits or high energy storage.

Similar results have been described for several Amazonian species considered lean. Souza *et al.* (2023), analyzing commercial fish from the Amazon, found low lipid contents in *Cichla monoculus* (0.78–1.54%), *Pseudoplatystoma fasciatum* (0.89–1.82%), and *Brycon amazonicus* (0.70–2.41%), demonstrating that species with predominantly white musculature show lower fat deposition. In contrast, species such as *Colossoma macropomum* and *Mylossoma duriventre* frequently present higher lipid concentrations, especially during periods of greater food availability, and may exceed 8% total lipids in the muscle (Barbosa *et al.*, 2021).

The low fat contents observed in freshwater stingrays directly influence the sensory characteristics of the meat, resulting in firmer texture, lighter coloration, and mild flavor, in addition to greater oxidative stability during refrigerated and frozen storage. Fish with reduced lipid content generally show lower susceptibility to oxidative rancidity, a technologically desirable characteristic for conservation and industrial processing (Ogawa; Maia, 1999; Batista *et al.*, 2026).

The carbohydrate contents in stingray meat were low, probably due to the low presence of connective tissue and the reduced expression of skeletal tissue, represented by cartilaginous structures in the pectoral fin cut. This also contributed to the low fixed mineral residue found, similar to values reported for *Colossoma macropomum*, ranging from 0.35% to 1.59% (Dantas Filho, 2021), and from 0% to 1.2% for *Brachyplatystoma vaillantii* (Campos *et al.*, 2026).

The caloric value observed for *P. motoro* was identical between the two collection sites, with a mean of 86.83 kcal/100 g of muscle, a result that highlights the lean character of this species. This low energy value is directly related to the reduced lipid contents found, since lipids represent the proximate fraction that contributes most to increased caloric value in animal-derived products.

When compared with other animal protein sources, *P. motoro* meat has a considerably lower energy value. Lean beef cuts usually range from 140 to 250 kcal/100 g, depending on the intramuscular fat content, whereas chicken meat presents average values between 120 and 190 kcal/100 g (USDA, 2024). Among Amazonian fish, species considered semi-fat or fatty frequently present caloric values higher than those found in this study. Souza *et al.* (2023), evaluating native Amazonian species, observed higher energy densities in *Colossoma macropomum*, *Mylossoma duriventre*, and *Hypophthalmus edentatus*, species characterized by greater muscle and visceral lipid deposition.

On the other hand, the energy values found for *P. motoro* are close to those described for Amazonian fish with white musculature and low lipid content, such as *Cichla monoculus*, *Pseudoplatystoma fasciatum*, and *Brycon amazonicus*, which generally present values

below 110 kcal/100 g (Inhamuns *et al.*, 2009; Souza *et al.*, 2023). This characteristic gives freshwater stingray meat potential nutritional and dietary interest, especially for consumers seeking foods with reduced fat content and lower energy density while maintaining high biological-value protein.

The stability of energy value between the evaluated sites also suggests that, despite the environmental and dietary variations characteristic of Amazonian ecosystems, the energetic composition of *P. motoro* muscle remains relatively constant, probably because of the reduced intramuscular fat accumulation observed in this species. Studies with Amazonian fish have shown that lean species tend to present lower seasonal caloric variation when compared with fish that have greater body lipid reserves (Rocha *et al.*, 1982; Inhamuns *et al.*, 2009; Batista *et al.*, 2026).

Table 3. Fatty acid profile of *Potamotrygon. motoro* captured in Moreno Maia Lake and the Purus River.

Fatty acid	Capture Location	
	Lake	River
16:0 Palmitic	21.11 ± 1.40	21.23 ± 1.83
18:0 Stearic	11.12 ± 0.66	11.41 ± 1.60
18:1n-9 Oleic	8.85 ± 0.51*	9.80 ± 0.88*
18:2n-6 Linoleic	4.75 ± 0.26*	5.61 ± 0.71*
18:3n-3 Linolenic	0.45 ± 0.06*	0.11 ± 0.01*
20:4n-6 AA	29.16 ± 2.19*	21.52 ± 2.22*
20:5n-3 EPA	1.58 ± 0.13*	4.57 ± 1.12*

22:4n-6 Adrenic	4.03 ± 0.30	5.64 ± 1.31
22:5n-3 DPA	13.14 ± 1.08*	7.57 ± 2.18*
22:6n-3 DHA	1.61 ± 0.14*	6.35 ± 1.08*
ΣPUFA	54.73	51.36
ΣFAω6	39.06	32.76
ΣFAω3	16.74	18.60
Σω6/Σω3	2.33	1.76
EPA+DHA	3.19	10.92

Means with their respective standard deviation estimates.

* Significant difference between capture locations at the 5% significance level.

When observing the fatty acid profile of *P. motoro* samples, a relatively homogeneous distribution was found between the evaluated lots. Palmitic acid (C16:0), with values of 21.11% and 21.23%, and arachidonic acid (C20:4n-6), belonging to the omega-6 family, with values of 29.16% and 21.52%, were the most prominent fatty acids. Among the omega-3 fatty acids, the main component was docosapentaenoic acid (DPA; C22:5n-3), with contents of 13.14% and 7.57%. Stearic acid (C18:0), with 11.12% and 11.41%, and oleic acid (C18:1n-9), with 8.85% and 9.80%, were also present at relevant levels.

Palmitic acid is frequently described as one of the main saturated fatty acids in captured Amazonian fish, such as tambaqui (*Colossoma macropomum*), tucunaré (*Cichla monoculus*), jaraqui (*Semaprochilodus* spp.), and curimatã (*Prochilodus nigricans*), demonstrating a common pattern among Neotropical freshwater teleosts. However, the high levels of arachidonic acid observed in this

study distinguish the species from many traditionally consumed Amazonian fish, in which oleic, palmitic, and linoleic acids usually predominate (Rodrigues *et al.*, 2017; Souza *et al.*, 2020).

The fatty acids C16:0, C18:0, and C22:4n-6 did not show significant differences ($p > 0.05$) between lots, indicating partial stability in the lipid profile of the species. In contrast, the other fractions varied significantly ($p < 0.05$), reflecting environmental factors, food availability, hydrological seasonality, and individual metabolic variation. In captured Amazonian fish, especially carnivorous and migratory species, the hydrological cycle modulates muscle lipid composition due to seasonal changes in diet. Studies conducted with fish from the Amazon basin have shown that species with different feeding habits present distinct lipid profiles, reflecting ecological and metabolic adaptations related to the natural environment (Souza *et al.*, 2020).

The ω -6: ω -3 ratios observed in the lake and river lots were 2.33:1 and 1.76:1, respectively, values considered excellent from a nutritional perspective and highly suitable for human consumption. Ratios below 4:1 are frequently associated with reduced inflammatory processes and decreased risk of cardiovascular and metabolic diseases (Harris, 2007; Simopoulos, 2010). Simopoulos (2008) highlights that the modern Western diet often presents ratios above 15:1, which are considered unfavorable to human health, whereas foods with lower omega-6 to omega-3 ratios present better nutritional quality. Similarly, Cholewski *et al.* (2018) emphasize the physiological importance of long-chain polyunsaturated fatty acids, especially those belonging to the omega-3 family, in the prevention of chronic diseases and maintenance of cellular functions.

P. motoro showed a favorable ω -6: ω -3 ratio when compared with other Amazonian fish. While regional piscivorous fish accumulate more omega-3 fatty acids, especially EPA and DHA, and detritivorous or omnivorous species retain more omega-6, the profile of *P. motoro* stood out for its lipid balance in both lots. This stability is related to the expressive presence of DPA and the low ω -6: ω -3 ratio, variables commonly influenced by feeding habit and seasonality (Rodrigues *et al.*, 2017; Souza *et al.*, 2020).

Compared with beef and chicken meat, *P. motoro* meat has a nutritionally favorable lipid profile due to the quality of its polyunsaturated fatty acids. Conventional beef concentrates saturated fatty acids, such as palmitic and stearic acids, monounsaturated fatty acids, such as oleic acid, and an unfavorable ω -6: ω -3 ratio. Chicken meat, in turn, accumulates linoleic acid (ω -6), often exceeding a 20:1 ratio because of the use of plant-based feeds in poultry production (Elkin; Harvatine, 2023; Krusinski *et al.*, 2023; Gutierrez *et al.*, 2025). This excess of omega-6, when associated with low omega-3 intake, is directly related to the development of inflammation and chronic diseases in humans (Mariamenatu; Abdu, 2021). In contrast, the presence of long-chain omega-3 polyunsaturated fatty acids in *P. motoro* reinforces its potential as an alternative protein source of functional value.

5. CONCLUSIONS

The meat of *Potamotrygon motoro* captured in lentic and lotic environments of the Western Amazon presents satisfactory meat yield and proximate composition compatible with lean fish species of high nutritional value. Its high protein content and low caloric

value characterize the species as a low-energy-density protein source.

Although total lipid content varies between lots, caloric value remains stable across capture sites. This pattern indicates that *P. motoro* maintains an overall lean meat profile, even when captured under distinct environmental conditions.

The fatty acid profile is characterized by a predominance of polyunsaturated fatty acids, especially arachidonic acid, DPA, EPA, and DHA, as well as nutritionally favorable ω -6: ω -3 ratios. These findings reinforce the technological, nutritional, and functional potential of *P. motoro* meat and indicate that the species represents a promising alternative for adding value to Amazonian fishery resources, provided that its use is associated with appropriate management and conservation strategies.

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