

**SOCIOECONOMIC ASPECTS AND HEAVY METAL LEVELS
IN FISHES OF THE ORINOCO RIVER
CONSUMED BY CAICARA RIVERINE COMMUNITY,
BOLÍVAR STATE, VENEZUELA.**

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Abstract

The socioeconomic aspects and the metallic levels of Fe, Ca, Na, K and Mg were evaluated in six fish species of the river Orinoco: Caribe (*Pigocentrus cariba*), Morocoto (*Colossoma brachypomun*), Bagre rayao (*Pseudoplatysloma fasciatum*), Curvina (*Plagioscion squamosissimus*), Coporo (*Prochilodus mariae*) and Guaraguara (*Hypostomus* sp.) that are consumed by the residing population in the city of Caicara of the Orinoco, in order to quantify the concentrations of these elements in the fishes' muscular fabrics and to relate them with the preference levels and frequency of consumption of the different social strata in the above mentioned city. The fish samples were captured between the months of November 1998 and March 1999 in the main bed of the river and two of its flood lagoons. The Graffar method was used in a sample universe of 200 families to determine the socioeconomic stratum and the consumption preference for these fish in the population. The socioeconomic study, according to Graffar, indicated that 86 % of population is located in the lower middle class (level IV, 56%) and 28 % in the low class (level V), and these strata have a consumption preference toward the species of more economic value. The concentrations of trace metals for all the species oscillated in a range of: iron 19.88 – 47.41; magnesium 958.52 – 4951.32; potassium 11629.41 –

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19648.53; sodium 1386.73 – 3566.86; and calcium 387.05 – 2516.32 $\mu\text{g g}^{-1}$ dry weight. The results also indicate that the biggest concentrations of almost all the studied metals are in the species of lesser commercial value. These results allow us to make a recommendation to consume the species of lower economic value, namely Guaraguara (*Hypostomus* sp.), Caribem (*Pigocentrus cariba*) and Coporo (*Prochilodus mariae*), thereby contributing to the achievement of a balanced diet at low cost.

Key words: Orinoco river fish, metallic levels, socioeconomic aspects, fish consumption

Introduction

Caicara city, of the Orinoco riverine community, is the autonomous capital of Cedeño in Bolívar State, representing the largest municipal territory in all of Venezuela (Fig. 1). This city shows the highest potential in the “Eje Orinaco – Apure” Project (a project which will further socioeconomic development in the south-central region of Venezuela). It is located on the east border of the Orinoco River at 66° 10’ 36’’ and 7° 38’ 36’’ north latitude, on a fringe 50 to 100 Km parallel to the river, in the center of Venezuela. The city takes up 66,390 Km² of the 238,000 Km² in Bolívar State, which lies within the 457,095 Km² of the Guayana region. The population of Caicara city has shown accelerated growth at approximately 6.3% annually, leading to present day census of approximately 55,000 persons.

Caicara city’s economy is quite meager, relying mostly on mining production and, to a lesser extent, fishing. The immediate zone of influence is cattle raising, with some agricultural crops emerging. The fishing industry shows great potential but has not yet been properly developed. In light of the growing fishing industry on a national level in recent years, and the fact that increasing prices of red meat have encouraged consumption of other meats, Venezuela will become increasingly dependent on exporting fish and other marine products in the near future (Weibezahn *et al.*, 1990).

The amount of essential metals such as sodium, potassium, calcium, iron, and magnesium found in foods such as meats, vegetables, and especially milk, along with the population’s consumption patterns, may serve as a reference for

establishing nutritional requirements (Itriago *et al.*, 1997). However, products derived from fresh water fish may also fulfill an important role in this exercise.

It is well known that primary minerals such as sodium, potassium, magnesium, and calcium are necessary substances for living. However, it is lesser known that other metals, such as iron, are also essential to the development, and thus reproduction of living beings. No organic life can develop and survive without the participation of essential metallic ions, including Ca, Fe, Mg, Na and K.

According to Forster and Wittmann (1983) an element is essential when: (1) it can be consistently determined that the element is present in every healthy tissue of living beings, (2) the deficiency symptoms are noted with removal of such elements, which disappear when returned to the tissue, and (3) the deficiency symptoms can be attributed to distinct biochemical defects (above molecular levels).

Venezuela has little information on levels of Ca, Fe, Mg, Na, and K in many foods (Itriago *et al.*, 1997) and in particular freshwater fish. As such, this project includes a study of the presence of these elements in six fish species of the Orinoco River, with the purpose of relating them with socioeconomic factors in the Caicara population, since these elements are of great importance because they exist in many of the physiological processes of living beings.

Materials and Methods

Population of study. A total of 200 families were chosen randomly in the city of Caicara of the Orinoco riverine community, in Bolívar State (Fig. 1). Social strata were assigned via the Graffar method, a standardized method generally accepted worldwide to establish different socioeconomic strata within a population. Through this method, it was determined that 86% of the families occupying this zone are classified in the lower-middle stratum (level IV, 58%) and low stratum (level V, 28%).

Collection and storage of samples. Fifteen (15) examples of each species: Caribe (*Pigocentrus cariba*), Morocoto (*Colossoma brachypomun*), Bagre rayao (*Pseudoplatysloma fasciatum*), Curvina (*Plagioscion squamosissimus*), Coporo (*Prochilodus mariae*) and Guaraguara (*Hypostomus* sp.) were collected in the principal canal of the river and two of its lakes (Caicarita, Piedrita) between the months of November 1998 and March 1999 (Fig. 1). The fish were captured

using trawling nets. The samples corresponding to each location were put separately in plastic bags, ticketed and kept in wine vaults with ice until their arrival at the laboratories (Scott *et al.*, 1999). The muscle tissue samples were taken from above the lateral line, at the beginning of the dorsal fin in each fish, and were subsequently frozen at -15°C until the analyses. All species were identified through taxonomical clues and related bibliographies (Mago – Leccia, 1970; Taphorn and Lilyestrom, 1984; Machado – Allison, 1987a; Mago – Leccia, 1994; Machado *et al.*, 1995).

Analytical methods. The tissue samples were dried in an oven at 80°C at constant, weighed and homogenized. Two grams of dry sample per triplicate were submitted to concentrated nitric acid and analyzed by Atomic absorption of Spectrophotometry with acetylene air flames (Hansen *et al.*, 19990; Malcom *et al.*, 1994; Wood and Van Vleet, 1996) and corrected, using Perkin Elmer 3100 equipment with auto-muscletrader Perkin Elmer AS-51. The calibration patterns and targets were submitted to the same conditions as the samples.

Results and Discussion

The consumption of fishes by the population of Caicara riverine community of the Orinoco and the levels of metals (iron, magnesium, calcium, sodium, and potassium) found in tissue samples in six species of freshwater fish of the Orinoco River: Caribe (*Pigocentrus cariba*), Morocoto (*Colossoma brachypomun*), Bagre rayao (*Pseudoplatysloma fasciatum*), Curvina (*Plagioscion squamosissimus*), Coporo (*Prochilodus mariae*) and Guaraguara (*Hypostomus* sp.) are represented in Table 1 and in Figures 2-7. Similarly, the elements which the human body requires and their respective levels are shown in Table 2, which reveals differences in the concentrations of the 10 elements currently accepted as essential to human life.

Figure 2 presents the consumption preferences of 200 families in Caicara city of the Orinoco, Bolívar State, for nine species of freshwater fish that inhabit the Orinoco river: Caribe (*Pigocentrus cariba*), Morocoto (*Colossoma brachypomun*), Bagre rayao (*Pseudoplatysloma fasciatum*), Curvina (*Plagioscion squamosissimus*), Coporo (*Prochilodus mariae*), Guaraguara (*Hypostomus* sp.), Pavon (*Chicla ocellaris*), Cachama (*Colossoma macropomun*), and Palometa (*Mylossoma duriventris*). It is noted that consumption is skewed toward species of higher economic value in the regional and national markets, as is the case of the Morocoto, Cachama and Bagre rayao,

which show preferences of 27, 15.5 and 19 %, respectively: the lesser percentages for species of lesser economic value, such as the Caribe and the Guaraguara, which received only 4.5 and 0.5 % acceptance. This observation is of utmost significance, because despite the fact that 86% of the population is in the lower social class (level V) and lower-medium (IV), their preference is toward species of high economic value.

However, when we observe and compare the levels of iron, sodium, potassium, magnesium, and calcium in the species of higher and lower economic value (Table 1 and Figures 2-7), it is apparent that concentrations of these elements in fish such as Guaraguara, Coporo and Caribe, which are quoted at more affordable prices, are very similar and in some cases higher than levels found in species of higher economic value. Thus, these species are suitable dietary alternatives of high nutritional value and low cost for strata IV and V within the population.

Figure 3 shows that iron is the metal, of the 5 metals studied, that is found in lower concentrations among the six species studied. These levels are increased in the Morocoto, Guaraguara and Coporo (45.71, 46.74, and 47.71 $\mu\text{g/g}$), which are higher than those in the Bagre rayao and the Caribe by almost a factor of two. The lowest concentrations are found in the Curvina, a fish that is sold at high prices.

Magnesium (Figure 4) is found in highest concentration in the Bagre rayao and the Morocoto (4951.32 and 1557.89 $\mu\text{g/g}$, respectively). However, concentrations in the remaining four species are very similar, all ranging above 900 $\mu\text{g/g}$. These concentrations are above those reported by Barrios *et al.* (1996) for some fruits such as the Lechosa, papaya and the Limonzón, lime (1262 and 665 $\mu\text{g/g}$, respectively).

The comparative results of concentrations of calcium and sodium for this study are presented in Figures 5-6. Calcium and sodium concentrations range between 1000-3500 $\mu\text{g/g}$, with the highest levels in the Morocoto (sodium 35,566.86; calcium 3,200.72 $\mu\text{g/g}$) and the Guaraguara (sodium 2,944.86; calcium 2,406.41 $\mu\text{g/g}$). This draws attention to the low calcium levels compared to the remaining species, which may be a function of physiological aspects of the fish, which may not be able to retain large quantities of calcium in its tissue compared to the other species in the study.

Figure 7 reports potassium levels. This element was the one that was most abundant in the six species studied. Concentrations of this element ranged between 10,000-20,000 $\mu\text{g/g}$, with the highest levels in the Morocoto (16,868.1 $\mu\text{g/g}$) and Guaraguara (1,961.53 $\mu\text{g/g}$), and the lowest levels in the bagre (11,629.41 $\mu\text{g/g}$). The diversity of metal concentrations for any species in particular, compared to the other species, may be influenced initially by factors such as the following: place of capture, dietary habits, and physiological activity.

It is important to note that nutritional metal levels of the species of low economic value, such as the Guaraguara, Coporo and Caribe, are comparable with those of high economic value. As such, there are no true correlations between purchasing power in the population of Caicara of the Orinoco riverine community and the nutritional levels of species of high or low economic value. This lack of correlations is due to a lack of research on this topic. This study can serve as the cornerstone for further developmental work to educate the population on the nutritional and economic factors related to the different freshwater fish species, particularly in light of the precarious economic situation facing this region.

Conclusions

The 86 % of families in Caicara city of the Orinoco River, Bolívar State, belong to strata IV and V, and are inclined to consume species of higher economic value such as the Morocoto, Bagre rayo and Cachama. However, such species can be substituted by other species of lesser economic value, such as the Guaraguara, which have comparable levels of metals Fe, Mg, Na, K and Ca.

There is no true correlation between nutritional value, purchasing power in the Caicara population of the Orinoco riverine community, and levels of essential metals Fe, Mg, Na, K and Ca in the freshwater fish species, including the Caribe (*Pigocentrus cariba*), Morocoto (*Colossoma brachypomun*), Bagre rayao (*Pseudoplatysloma fasciatum*), Curvina (*Plagioscion squamosissimus*), Coporo (*Prochilodus mariae*) and Guaraguara (*Hypostomus* sp.).

Therefore, we can recommend consumption of species of lesser economic value, such as the Guaraguara, Caribe and Coporo, thereby contributing to the achievement of a balanced diet at low cost.

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Table 1. Average (\pm SD) concentrations ($\mu\text{g/g}$) of iron (Fe), magnesium (Mg), potassium (K), sodium (Na) and calcium in muscular tissues in six fish species of the Orinoco River (n=15).

Species	Fe	Mg	K	Na	Ca
Caribe (<i>Pigocentrus cariba</i>)	26.24 \pm 3.60	982.25 \pm 236.70	14125.90 \pm 679.04	2368.39 \pm 132.35	1668.65 \pm 125.44
Coporo(<i>Prochilodus mariae</i>)	47.41 \pm 11.01	1039.20 \pm 73.86	13412.42 \pm 597.82	2255.24 \pm 305.44	2516.32 \pm 361.16
Curvina (<i>Plagioscion squamosissimus</i>)	19.88 \pm 9.28	958.52 \pm 166,80	13179.67 \pm 978.36	2095.78 \pm 367.13	2392.82 \pm 105.12
Morocoto (<i>Colossoma brachypomun</i>)	45.71 \pm 7.63	1557.89 \pm 303.64	16868.10 \pm 724.23	3566.86 \pm 784.63	3200.72 \pm 411.12
Bagre rayao (<i>Pseudoplatysloma fasciatum</i>)	26.03 \pm 5.08	951 \pm 236.04	11626.41 \pm 365.23	1386.73 \pm 47.39	387.05 \pm 33..38
Guaraguara (<i>Hypostomus</i> sp.)	46.74 \pm 8.03	1242 \pm 170.24	19648.53 \pm 427.48	2944.86 \pm 419.52	2406.41 \pm 177.81

Table 2. Essential metals and their respective concentrations in humans (expressed in mg/70 kg of body weight (Forstner & Wittmann, 1983).

Metal	Fe	Mg	K	Na	Ca	Mn	Cu	Zn	Co	Mo
mg/70 kg body weight	7.000	4.000	250.000	70.000	1.700.000	30	150	3.000	1	5

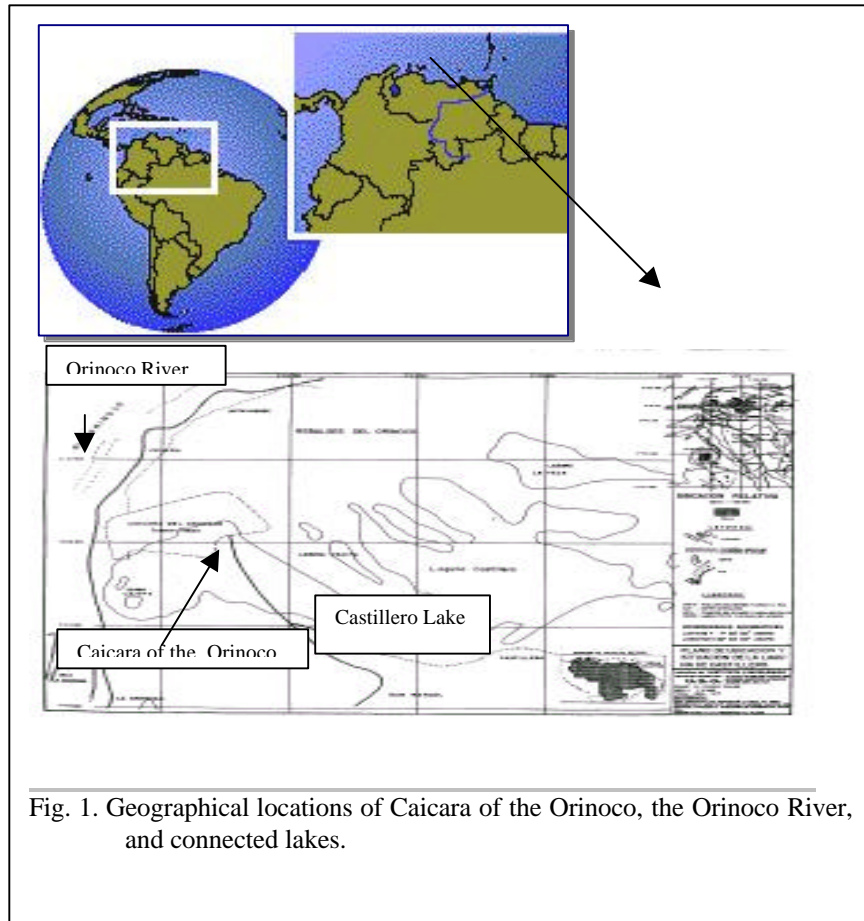


Fig. 1. Geographical locations of Caicara of the Orinoco, the Orinoco River, and connected lakes.

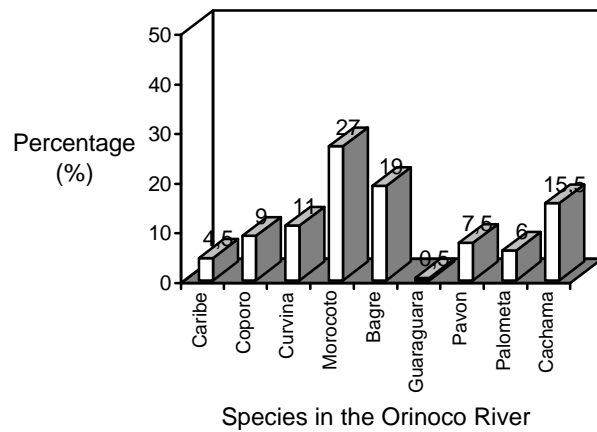


Fig. 2. Consumption (%) of freshwater fishes in the Caicara riverine population of the Orinoco River, Bolívar State, Venezuela.

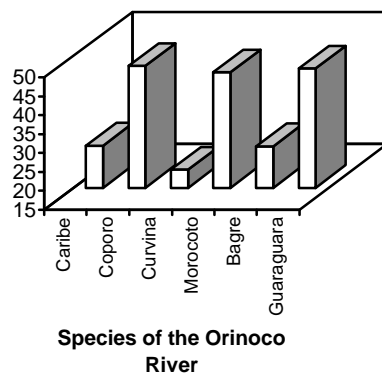


Fig. 3. Comparison of iron levels (mg/g) in muscle tissues of six fish species in the Orinoco River.

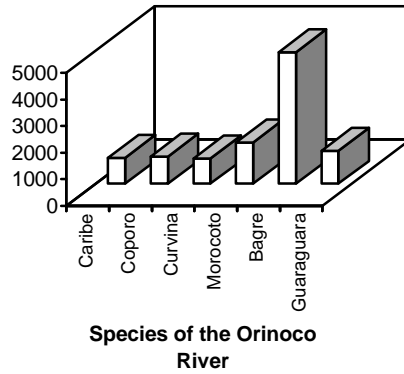


Fig. 4. Comparison of magnesium levels (mg/g) in muscle tissues of six fish species in the Orinoco River.

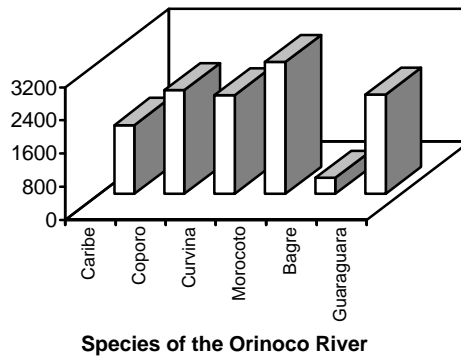


Fig. 5. Comparison of calcium levels (mg/g) in muscle tissues of six fish species in the Orinoco River.

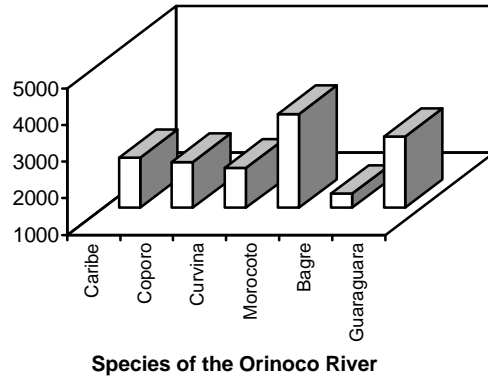


Fig. 6. Comparison of sodium levels (mg/g) in muscle tissues of six fish species in the Orinoco River.

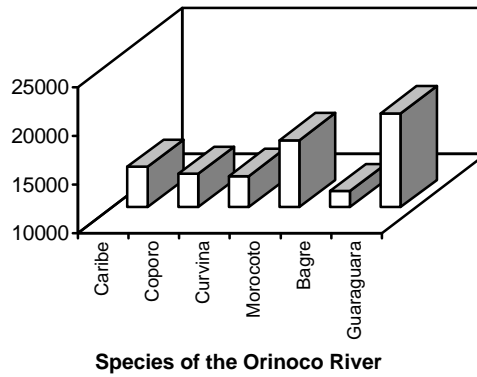


Fig. 7. Comparison of potassium levels (mg/g) in muscle tissues of six fish species in the Orinoco River.

