

The Importance of Consuming Charales (*Chirostoma jordani*) for Human Nutrition

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Abstract: The diversity of existing food may decrease malnutrition through the consumption of underutilized species. In Mexico, the “charal” fish *Chirostoma* spp. is grouped in five species: *Chirostoma grandocule*, *Chirostoma patzcuaro*, *Chirostoma humboltianum*, *Chirostoma attenuatum* and *Chirostoma jordani* which live in lakes in the country, and they are not consumed or their demand is low. The objective of this research was to analyze the macronutrients of *Chirostoma jordani* charal and inform population their nutritional value to increase human nutrition. Sampling was provided at Xochimilco channels in Xochimilco, D.F., summer and winter seasons at 2009. Fish (200 g) were maintained in channels water for proximal analysis according AOAC methods (1995). The results in dry bases were: protein 74.36%, lipids 1.24%, fiber 0.27%, minerals 4.9%, and soluble carbohydrates 19.23%. This fish grants protein, plastic material essential for human development: its lipid and carbohydrate contents, sources of energy, are low; however, the excess of disseminated proteins increase the energy sources. Fiber is found in a minimum amount. Dehydrated charales may be stored without refrigeration up to 3 months, maintaining their nutritional value. Consumption of the charal should be considered in the basic diet for its nutritional properties, to diminish malnutrition in the Mexico and other countries.

Key words: Nutrition, Charales fish, *Chirostoma jordani*, macronutrients.

1. Introduction

According to the FAO [1], almost 30% of the population worldwide suffers some type of malnutrition, either those who do not have access to a sufficient amount of energy or basic nutrients, or those who suffer diseases due to excessive and/or unbalanced eating. The deficiency in the intake of food with nutritional value unchains a series of chronic diseases which are increasing around the world [2]. It has been calculated that in 2001 these diseases caused approximately 60% of the deaths notified in the world and 46% caused a global load of morbidity, being malnutrition considered within the main causes of mortality [3]. Nevertheless, malnutrition can modify some intermediate

mechanisms, such as cardiac function, metabolizing lipids or glucose, causing several diseases and even death [4]. For this reason, it is highly important to find natural origin foods that provide macro-nutrients of high nutritional value that, when consumed, complement a balanced diet. In Mexico there are a large number of these foods, such as the “charal”, fish *Chirostoma* spp. by its scientific name. It is grouped in five species: *Chirostoma grandocule*, *Chirostoma patzcuaro*, *Chirostoma humboltianum*, *Chirostoma attenuatum* and *Chirostoma jordani*, these fishes inhabit in lakes, mainly in the central part of the country. These little fish live in fresh, clear water, are silvery white, they are 5 cm to 12 cm long and an average weight of 12 g.

Since prehispanic times, charales have played an important role in the feeding of Mexicans; however, the consumption of this species has decreased in time, for official surveys reveal that the consumption

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per capita of this fish between 1992 and 2002 was 12.72 kg/hab [5]; however, these numbers are lower than the minimum requirements that are 20 kg per capita per year [6]. In Mexico, *Charales* spp. is found within the six species that support fisheries, according to Olmos [7]. Nevertheless, this resource lacks acceptance among the population, for its consumption is not homogeneous, despite being reported as a highly functional food, with biologic and nutritional quality, and its consumption brings multiple benefits to health, beyond conventional nutrients [8].

The objective of the present study was to determine the macro-nutrient and mineral content present in *Chirostoma jordani*, to propose to the general population the consumption of this fish as a daily food, with a good content of nutrients and as a source of natural energy.

2. Method

The sampling area was the canals of the lakes in the municipality of Xochimilco, Mexico City; the weather is tropical, with an average temperature of 16 °C, and two climatic seasons were identified: dry season from January to May, and rainy season from June to September [9]. The samples were captured during January and July 2009, using 30 m long water nets with an 8.0 mm mesh, 2 m deep. Six samples at four different canals each of 200 g were gathered and analyzed in duplicate. The obtained samples were transported in glass container with water from their environment, at a stable temperature of 4 °C until they were processed, to the Food Science Laboratory at the Universidad Autónoma Metropolitana, Campus Xochimilco. With this material, taxonomic identification of the species was performed and the proximal analysis according to the AOAC methods [10]. The samples were dried at 60 °C for 24 h and ground to a fine powder for further determination of protein, ash lipid and crude fiber. Proteins were calculated from nitrogen content by Kjeldhal method

using the conversion factor 6.25. Ash was determined by incinerating at 650 °C in a furnace muffle for 3 h. Lipids were determined by an extraction process with petroleum ether (b.p. 60-80 °C) at 120 °C for 6 h using a Goldfish apparatus. Crude fiber by acid hydrolysis followed by alkaline hydrolysis; the total carbohydrates content were calculated by difference [100 – (protein + lipids + ash + crude fiber)].

3. Results

Charales are classified as vertebrate, class Actinopterygii, order Atheriniformes, family Atherinopsidae, genus *Chirostoma*, specie *Chirostoma jordani* (Table 1), the moisture content is under 50% (Table 2).

Protein levels are high, the mineral content represent a high concentration of metal ions, thus these must to be assessed to determine the presence of some specific essential ions, carbohydrates content is high as well (Table 3). Edible portion used only, no bones analyzed.

4. Discussion

According to the results obtained from the proximal analysis of *Chirostoma jordani*, it was found that the amount of protein, an essential nutrient in human nutrition, was present in a high proportion, followed by soluble carbohydrates. Lipid and fiber contents were lesser and the percentage of minerals present in the sample was significant. In this way, charales are characterized mainly for being an important source of proteins of high biological value, for when consuming around 200 g of charales, they grant the following amino acids: valine, threonine, leucine, isoleucine, lysine and tryptophan [11] and the importance of their consumption is that they constitute the plastic material indispensable for human development, in addition of forming part of a low-fat diet, rich in protein [12]. This is paramount, for it has been demonstrated that the implementation of these types of diets constitute one of the main forms to fight malnutrition, currently

Table 1 Taxonomic determination of the charal (*Chirostoma jordani* Woolman, 1894).

Order	Atheriniformes
Family	Atherinopsidae
Genus	<i>Chirostoma</i>
Species	<i>Jordani</i>
Common name	Charal

Table 2 Moisture content in Charales, *Chirostoma jordani*.

Water: 41.12 %	Dry sample: 58.88%
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Table 3 Proximal analysis of macronutrients in Charales, *Chirostoma jordani*, g/100 g dry basis.

Proteins*	Lipids	Minerals	Crude fiber	Soluble carbohydrates
74.369	1.24	4.90	0.27	19.23

*Protein = Kjeldhal N \times 6.25. $n = 3$, mean reported $P < 0.05$.

considered a leading worldwide problem, which causes mortality and morbidity in different countries and in all sectors of the populations [13]. Data reported by Blouet et al. [12] and Belobrajdic et al. [14] establish that the diets given to patients with malnutrition problems act directly in the body by increasing the energy expenditure and the feeling of satiety, which contributes in a short term to improve human nutrition.

Even more, several studies indicate that the metabolism of proteins and consequently the energy consumption depends on the source from which they originate, for some of the factors that determine the metabolism of these macromolecules is their absorption rate and their amino acid composition, which is determined by the wide variety of carbon chains and cofactors which are derived from the catabolism of these [15]. Another mechanism due to the increase of protein intake in the diet is the suppression of hyperinsulinemia or insulin secretion, thus blocking the storage of carbohydrates in the body, leading to a balanced diet. Hence, implementing charales to diets designed to combat malnutrition problems is a viable alternative due to the high protein content versus low proportions of fat present in this *Chirostoma jordani*.

It is important to point out that recommencing the intake of *Chirostoma jordani* in the daily diet, represents enormous benefits to health, for according

to Stamler [3] and Latham [16], the increase in chronic diseases worldwide are largely due to unbalanced food consumption. The lipid content in *Chirostoma jordani* is found in low proportions and these fish are rich in omega-3 fatty acid important in health, as the intake of this oil from aquatic species contributes to lower blood triglycerides, and cholesterol, in addition to lowering vascular pressure and having antithrombotic and anti-inflammatory [17].

The low fiber content in *Chirostoma jordani* is another factor that contributes to consider this species as an excellent food choice for people with malnutrition, in addition to its composition of lean meat which makes it easy to digest. The mineral content in *Chirostoma jordani* was 4.9%, the consumption of these very important since their intake is essential for the nervous system development. The contribution of soluble carbohydrates, source of energy, is slightly higher than the recommended daily requirements; however this excess is not significant.

In some communities, it is customary to process charales, removing the viscera from the fish and covering it with small amounts of salt to be placed to direct sunlight for 3 days, obtaining a dry product that can be kept without refrigeration for up to 3 months retaining their nutritional value.

The excellent nutritional properties of this species are the main reasons for implementing its daily intake

of the general population, for its frequent intake may contribute to reduce malnutrition in the Mexican population and in other nations. In addition, it represents a consumer alternative that would reduce over exploitation directed only to certain types of seafood such as shrimp, tilapia, being these species the most in demand [5].

5. Conclusions

To implement the consumption of charales among the population represents an important source mainly of proteins, and in the diet of persons with malnutrition they constitute an essential food for a balanced diet. In addition, the acquisition of this highly functional food is feasible among different population sectors for it is available throughout the year and thanks to its preservation flexibility.

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