

## Consumption of armed catfish (*Hypostomus plecostomus*) in the municipality of centro, Tabasco

## Consumo del pez bagre armado (*Hypostomus plecostomus*) en el municipio del centro, Tabasco

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### Abstract

El bagre armado, conocido también como pez diablo (*Hypostomus plecostomus*), ha sido objeto de controversia en Tabasco debido a su impacto en la pesca local. Sin embargo, es importante aclarar que esta especie no es considerada invasora en el sentido estricto, ya que su presencia en la región se debe a su introducción deliberada y no a una invasión natural. Especie introducida a Tabasco en los años 2000 se ha convertido en una verdadera preocupación por su rápida expansión en las aguas de ríos y lagunas <https://www.cyd.conahcyt.gob.mx/archivo/247/Articulos/BagresArmados/Bagres-I.html>. La investigación tiene como objetivo el análisis del consumo y formas de degustación de manera integral del pez Bagre Armado (*Hypostomus plecostomus*) en el municipio del Centro, Tabasco. Esta investigación se enfoca en los resultados obtenidos sobre su consumo y beneficios. Esto permitirá incentivar su valorización en las comunidades e habitantes del municipio del centro, y promover su consumo responsable como recurso alimenticio. La metodología empleada incluye un enfoque descriptivo. Se realizaron encuestas a 2,458 habitantes del municipio del centro por medio de la aplicación FORMS OFFICE®, para evaluar las percepciones de la comunidad sobre consumo, conocimiento, formas de degustación del pez bagre armado. En los resultados obtenidos se comprobó que existe conocimiento del pez bagre armado por parte de los habitantes del municipio del centro repercutiendo en su consumo. La investigación contribuye a promover su consumo de un recurso subutilizado que tiene un potencial significativo para mejorar la alimentación y diversificar la dieta de las comunidades e habitantes y generar nuevas oportunidades para los pescadores y las comunidades rurales. Así como al fomentar una cultura de consumo responsable y sostenible, al integrar a la comunidad en el pez bagre armado y minimizar su impacto ambiental en la región.

### Resumen

Armed catfish, also known as devilfish (*Hypostomus plecostomus*), has been the subject of controversy in Tabasco due to its impact on local fisheries. However, it is important to clarify that this species is not considered invasive in the strict sense, since its presence in the region is due to its deliberate introduction and not to a natural invasion. A species introduced to Tabasco in the 2000s, it has become a real concern due to its rapid expansion in the waters of rivers and lagoons <https://www.cyd.conahcyt.gob.mx/archivo/247/Articulos/BagresArmados/Bagres-I.html>. The objective of the research is to analyze the consumption and ways of tasting in a comprehensive way of the Armored Catfish (*Hypostomus plecostomus*) in the municipality of Centro, Tabasco. This research focuses on the results obtained on its consumption and benefits. This will encourage its valorization in the communities and inhabitants of the downtown municipality, and promote its responsible consumption as a food resource. The methodology used includes a descriptive approach. Surveys were carried out with 2,458 inhabitants of the downtown municipality through the FORMS OFFICE® application, to evaluate the community's perceptions of consumption, knowledge, and ways of tasting armed catfish. In the results obtained, it was found that there is knowledge of armed catfish by the inhabitants of the municipality of the center, which has an impact on its consumption. The research contributes to promoting their consumption of an underutilized resource that has significant potential to improve the diet and diversify the diets of communities and inhabitants and generate new opportunities for fishers and rural communities. As well as by promoting a culture of responsible and sustainable consumption, by integrating the community into the armed catfish and minimizing its environmental impact in the region.

Objetivo	Methodology	Contribution
		

Objetivo	Metodología	Contribución
		

### Consumo, Conocimiento, Pez bagre armado

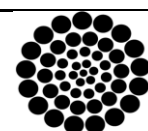
### Consumption, knowledge, armed catfish

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## Introduction

According to the authors [Mendoza, 2007] R. Mendoza, S. Contreras, C. Ramírez, P. Koleff, P. Álvarez, V. Aguilar. Devilfish: high impact invasive species. *Biodiversitas*, 70 (2007), pp. 1-5 was introduced into Mexico, in 1995 for the first time making its appearance in Pez diablo in the Mezcala river, in the Balsas river basin. Subsequently recorded in Tecpatán, Chiapas.

*Species introduced to Tabasco in the 2000s in the waters of rivers and lagoons*

Mainly in the Grijalva and Usumacinta river basin, as well as in several localities near Villahermosa Tabasco. During the last three years, the armoured catfish has expanded rapidly. It is now common to find them in several of the country's largest watersheds. This phenomenon has been characterised by a high rate of dispersal and a significant proliferation of their populations, causing a sudden abundance of juvenile organisms, demonstrating the establishment of their populations in the new sites.

The armoured catfish (*Hypostomus plecostomus*) is a species of freshwater catfish belonging to the family Loricariidae, known for its resilience and adaptability to diverse aquatic environments native to the Amazon basin, this fish has been introduced into numerous water bodies outside its natural range, where it has had significant ecological impacts (Weber, 1992; Armbruster, 2004; Nico et al., 2009; Winemiller & Jepsen, 1998).

Because of its 'armoured' appearance. Also known as armoured catfish. It is characterised by its ability to attach to surfaces thanks to its sucker-like mouth, which it also uses to feed on algae and detritus at the bottom of water bodies (Weber, 1991). *Hypostomus plecostomus* has a robust, elongated body, covered with bony plates that form armour, a distinctive feature of loricariids. Armbruster (2004) and Weber (2003) agree that robustness and body length are evolutionary adaptations for life in fast currents and for protection against predators.

The armoured catfish is a species that feeds on green algae generated in bodies of water, which rules out the possibility that it consumes excrement and fish roe, according to scientist Carlos Martínez Palacios (Ramírez J. H., 2017).

At first it was believed that it fed on mojarras, however, nothing could be further from the truth. The devil fish, or armoured catfish, is herbivorous, feeding on algae and debris. In fact, one of its many nicknames is 'Fishbowl cleaner'. (León S. M., 2017).

Most of the myths, in addition to its physical appearance, unattractive to some, generated a generalised rejection of the species. In 2006, at the request of the fishermen to the municipal presidents of Churumuco, La Huacana, Arteaga and Mújica, in Michoacán, CONACyT, through the Mixed Fund and supported by resources from the three levels of government, issued a national call for proposals to solve the problem. Within this call, the Aquaculture and Aquaculture Biotechnology group of the IIAF of the UMSNH proposed a project, which was approved with 2.4 million pesos, called 'Technological Development for the Use and Industrialisation of the Devilfish in the Bajo Balsas, in Michoacán'.

The project brought together researchers from nine institutions and two dependencies of the UMSNH: UNAM Campus Juriquilla, UAQ, UABC, University of Maringá, Brazil, University of Stirling, from the United Kingdom and the Research Centres CIAD Hermosillo, CINVESTAV-Mérida and CICIMAR-IPN, forming an academic and interdisciplinary group that brought together six researchers Level III of the National System of Researchers, as group leaders. The main result of the research, which lasted two years, was that the best way to control and take advantage of this resource was through the human consumption of armoured catfish (Martínez Palacios et al., 2010a; 2010b; Ramírez-Suárez et al., 2012). To this end, several public tastings were held at gastronomic fairs, as well as a book of 50 recipes collected in Colombia, Venezuela and Brazil, where this fish is a premium product.

The book, entitled 'Nutrition with flavour. Delicias del pez diablo' (Martínez-Palacios et al., 2009) was published by the UMSNH and presented at a tasting for Mexican chefs at the Los Mirasoles restaurant in the city of Morelia. Subsequently, in 2012, with the support of the National Fisheries Institute, a series of courses was initiated for Michoacán, Tabasco, Chiapas and Quintana Roo, to transfer processing technologies and demonstrate the use and consumption of this species. As a result, fishermen accepted the technology and were able to register this new species in the National Fishing Charter to promote its exploitation for human and animal consumption. Consumption refers to the exploitation of this species as a food resource, either by local fishing or commercialisation. In some places it has begun to be valued for its nutritional properties. Its consumption may be driven by initiatives to exploit it as a source of protein or to control its environmental impact. In Villahermosa, the capital of Tabasco has a long fishing tradition due to its strategic location near several important rivers, such as the Grijalva and the Usumacinta. Fishing has been a vital economic and cultural activity for the region. It was found that research conducted by the Universidad Autónoma de Tabasco UJAT by biologists such as Dr. Rafael Ruiz, his research indicates that, although the catfish, or pez diablo or pleco, is seen as a threat to biodiversity, it has also been integrated into the local culture as a common species in fishing and occasionally in local cuisine. Traditionally, the armoured catfish was not a species of great culinary value in the region. However, due to its abundance and the need to manage its population, local inhabitants began to incorporate it into their culinary practices, giving greater importance to local gastronomy.

The armoured catfish is an accessible source of protein. According to studies by the Universidad Juárez Autónoma de Tabasco (UJAT), its meat is rich in protein and essential minerals, making it a viable alternative to other more expensive and less abundant fish species. The gastronomy of Villahermosa has incorporated the armoured catfish in several traditional dishes Among the most outstanding are: Caldo de Pez bagre: A nutritious broth that is prepared with local vegetables and spices, Grilled catfish: Prepared grilled, marinated with herbs and spices from the region, Breaded catfish, prepared marinated and breaded fried.

Some local chefs have experimented with new ways of preparing catfish, combining traditional techniques with contemporary approaches. These efforts have resulted in the creation of dishes that are not only delicious but also sustainable, helping to control the population of this invasive species. The last festival held in Villahermosa, Tabasco on 7 February 2022, organised by the authorities of the municipality of El Centro, was held with the aim of raising awareness of what can be consumed and the ways in which it can be consumed, as well as making it known that it is not really a threat, we can take advantage of it and see it as a business opportunity for the inhabitants of the municipality of El Centro and promote the culture of consumption of the species.

The inclusion of the armoured catfish in the local diet also has a positive impact on sustainability. By consuming this invasive species, it helps to maintain the balance in Tabasco's aquatic ecosystems. Studies by Garcia-Berthou et al. (2007) highlight that the meat of this fish contains a significant amount of high quality protein, comparable to other more commonly consumed fish species.

The meat of armoured catfish is low in saturated fat, making it a healthy option for people looking to reduce their intake of unhealthy fats. According to a study by Ruiz and López (2018) from the Universidad Juárez Autónoma de Tabasco (UJAT), the fatty acid profile of armoured catfish is favourable, with a higher proportion of beneficial unsaturated fats. Omega-3 fatty acids are essential for cardiovascular health and brain development. Research from UNAM (2020) indicates that armoured catfish contains significant amounts of omega-3 fatty acids, which may contribute to reduced risk of heart disease and improved cognitive function.

Research from various academic and scientific institutions supports its inclusion in a balanced diet, highlighting its potential benefits for cardiovascular health, cognitive development and strengthening the bone and immune systems.

**Box 1****Table 1**

Sampling of respondents

Age Group	Man	Woman	Total
20 – 24	572	514	1,086
25 – 34	430	278	708
45 – 54	160	202	362
55 – 60	84	92	176
61 – More	41	76	117
Total	1,287	1,162	2,449

Source: *Own elaboration*

The research on armoured catfish presents an innovative approach compared to previous studies, as it focuses on the valorisation of the inhabitants of the municipality of Centro and its communities. Unlike other research that has focused primarily on the control of this species as an invasive, this study highlights its potential as a food and economic resource.

A distinctive aspect of this research is its emphasis on integrating the participation of local communities, thus promoting management based on principles of social and solidarity economy. This approach not only seeks to recognise the value of armoured catfish within an economic context, but also considers the negative knowledge and perspective that communities have about the species. This contrasts with previous research that has prioritised ecological and control aspects, leaving aside the socio-economic importance that the fish may have in the lives of local inhabitants.

The problem is to know the consumption of the armoured catfish in the municipality of the centre of the research is the lack of knowledge, lack of information and community valorisation strategies, which has generated a negative perception of its limited potential for exploitation. The article consists of the following sections. Development of the methodology explains the type of study, the non-probabilistic sampling by convenience was elaborated and a research instrument was applied through Forms Office, as well as the collection of data, presentation of the results by means of graphs and tables with their respective interpretation, conclusions and recommendations.

**Methodology**

In the methodology to be followed in the research was carried out under a descriptive approach as it is key to accurately document the data, describes in detail the consumption habits, preferences of the inhabitants and methods of preparation, knowledge, forms of tasting and its potential to consume the armoured catfish in the municipality of Centro, the study population are the inhabitants of the municipality of Centro, Tabasco which consists of 683 607 inhabitants (*INEGI. Census of Population and Housing 2020*).

The sample includes 2458 participants from the municipality of Centro selected through non-probabilistic convenience sampling: The sample is chosen according to the convenience of the researcher, it allows him to arbitrarily choose how many participants can be in the study (*Hernández González, Osvaldo, 2021*).

The sample guaranteed the representation of different socio-economic groups, age, sex, socio-economic level, for the collection of data structured surveys consisting of 13 closed multiple-choice questions were applied by means of the application of Forms Office Microsoft to the inhabitants of the municipality of Centro, Tabasco,

The central hypothesis of this research is that ‘the level of knowledge about armoured catfish (*Hypostomus plecostomus*), food consumption and ways of preparation is related to the negative perception of the species. However, by promoting education about its consumption characteristics, forms of preparation and marketing possibilities, it is possible to change this perception and encourage responsible consumption. This change would not only generate economic gains for fishing communities, but would also diversify the food supply and contribute to controlling the environmental impact of this species.

In this hypothesis, the dependent variable is the *knowledge* of existence derived from the lack of information on the biological characteristics and benefits of the fish. The independent variable is *Negative Perception*, based on the belief that it is a poisonous, non-consumable and unattractive looking species.

## Results

In the analysis of the data the central hypothesis of this research states ‘the level of knowledge about armoured catfish (*Hypostomus plecostomus*) food consumption and ways of preparation is related to the negative perception about the species, in the municipality of the centre. The results obtained throughout this research allowed us to identify the level of knowledge that the inhabitants of the municipality of El Centro have about the armoured catfish, how much they consume it, as well as their general perception of this species. These are presented below. Data related to knowledge (dependent variable)

### Box 2

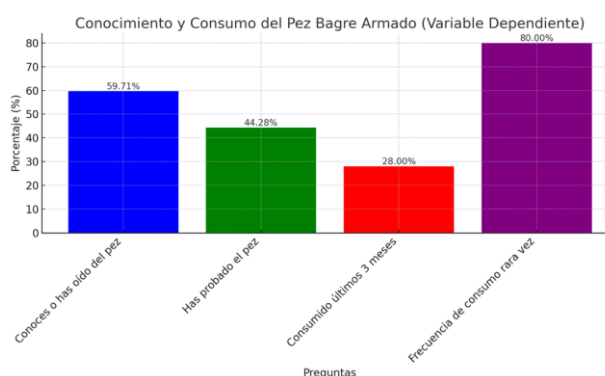


Figure 1

- Do you know or have you heard of armoured catfish? (59.71% yes):

Interpretation: 59.71% of the respondents know or have heard of armoured catfish, indicating a significant level of prior knowledge about the species. However, the 40.29% who do not know about it shows that there is still a significant proportion of the population that needs more information about this resource.

- Have you ever tried armoured catfish (44.28% yes)?

Interpretation: 44.28% of the respondents have tried armoured catfish, suggesting that although it is known, its consumption is not yet common among the population. This may be due to factors such as negative perception or lack of promotion of its nutritional benefits.

- Have you consumed armoured catfish in the last three months? (28% yes):

Interpretation: Only 28% have consumed catfish in the last three months, indicating that its inclusion in the recent diet is low. This reinforces the idea that, despite knowledge about the fish, its acceptance as a regular food is still limited.

- How often do you consume armoured catfish (80% rarely)?

Interpretation: (80%) of the respondents consume the fish rarely, showing a very low frequency of consumption, which could be directly related to their negative perception, lack of habit or lack of knowledge on how to prepare it. This analysis shows that, although there is basic knowledge about catfish, its consumption remains low and sporadic, which underlines the importance of further efforts to promote its benefits and improve its acceptance in the population's diet.

### Results on negative perception (independent variable)

The results obtained throughout this research allow us to identify the general perception of this species, which are presented below.

To demonstrate the variable ‘Negative perception’ of armoured catfish, the following questions were selected for analysis:

### Box 3

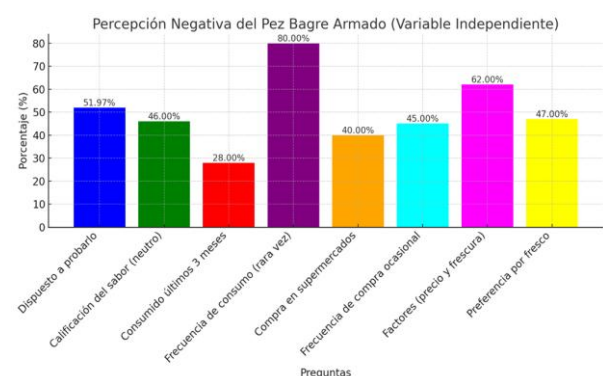


Figure 2

General interpretation of the independent variable: The results reflect that

- Willing to try the armoured catfish (51.97% yes):

Interpretation: 51.97% of the respondents would be willing to try the fish, reflecting some interest. However, the rest of the population is still hesitant, possibly due to hesitation or lack of information.

- Taste rating (46% neutral):

Interpretation: 46% of respondents rate the taste of the fish as 'neutral', indicating that they do not have a strong opinion for or against. This could be a point of neutrality to improve perception if the taste is properly promoted.

Consumed in the last three months (28% yes): Interpretation: 28% of respondents have consumed the fish recently, suggesting that it is not a frequent food choice, reinforcing the negative perception or lack of availability.

- Frequency of consumption (80% rarely):

Interpretation: 80% of respondents rarely consume the armoured catfish, reinforcing the negative perception and its limited inclusion in the local diet.

- Purchase (40%):

Interpretation: 40% indicate the most common channel of purchase in local markets or fishmongers.

- Occasional purchase frequency (45%):

Interpretation: 45% of the respondents buy catfish occasionally, which reflects that it is not a regular food in households and its consumption remains sporadic.

- Factors for purchase (62% mention price and freshness):

Interpretation: 62% of respondents indicate that price and freshness are the key factors for the purchase of armoured catfish, indicating that consumers mainly value these aspects when purchasing it.

- Preference for fresh (47%):

Interpretation: 47% of the respondents prefer to buy fresh catfish, suggesting that presentation and quality are important aspects in their purchasing decision.

The results show that, the negative perception of armoured catfish is very present, with a large proportion of the population not having tried it or having rated it negatively in terms of taste.

Although there is some interest in trying it, especially if it is offered in good freshness conditions, the low frequency of consumption and hesitancy of the respondents show that negative perception remains an obstacle to its adoption as a regular food resource. Taste and freshness are key factors in the purchasing decision, and improving these aspects, together with increased dissemination of its benefits, could help to change this negative perception in the long term.

### Data visualization

As shown in Figure 1, 59.71% of respondents have heard of armoured catfish, indicating that more than half of the population is aware of this fish, although 40.29% are still unfamiliar with it. It is observed that only 44.28% of the respondents have consumed it, which shows that more of the population is familiar with it and a smaller percentage has consumed it.

#### Box 4

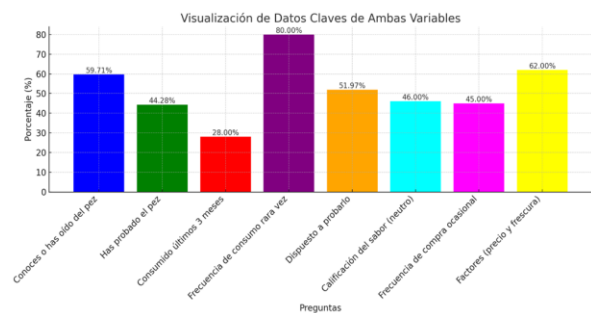


Figure 3

Source: Own elaboration

This graph shows that, although armoured catfish is well known, its consumption and acceptance still faces challenges, mainly due to taste perception and lack of frequency of consumption.

### Conclusions

The development of this project has allowed us to clearly identify the challenges and opportunities related to the consumption of armoured catfish (*Hypostomus plecostomus*) in the fishing communities of the municipality of Centro, Tabasco. Throughout the research, it is confirmed that **knowledge** about the consumption of this species is one of the main factors that has contributed to its negative perception, which has limited its acceptance as a viable food resource. Results obtained: 1.

Familiarity and limited consumption: Although 59.71% of respondents are aware of the existence of armoured catfish, only 44.28% have ever consumed it.

This gap between knowledge and consumption reflects a clear lack of information on the preparation methods and benefits of the fish, which inhibits its inclusion in the diet of local communities.

**Potential for improvement:** To improve the project on the consumption of armoured catfish, work is being done on projects that address issues such as: promotion strategies, marketing and creation of web pages on the consumption of this species.

**Economic Benefits for Fishing Communities:** The armoured catfish fishery not only offers a sustainable food alternative, but also opens up economic opportunities for fishing communities. Its commercialisation, still in its early stages in many areas, can generate additional income and diversify sources of local employment.

Promoting its consumption and sale can contribute to the economic development of these communities, while helping to mitigate the negative impacts of its presence as an invasive species.

#### Improved Marketing:

To maximise the economic potential of armoured catfish, improved marketing strategies are critical. This includes the development of efficient value chains, from capture and processing to distribution in local and regional markets.

Training of fishermen in processing and preservation techniques is recommended to increase the quality of the product and make it more competitive.

#### Strengthening partnerships

Successful marketing for consumption of armoured catfish also depends on strengthening strategic alliances between the different actors involved.

Through the work carried out by NODESS: Karina González Izquierdo, Roger Notario Priego, Diana Rubí Oropeza Tosca, María Rivera Rodríguez, Sepúlveda Quiroz Cesar Antonio and Manuel Vergel Escamilla of the NODESS Alim-Del-Sur (N2723000009), Edén-Del-Sur (N2723000010), Acuisur (N2723000018), Bagre-Del-Sur (N2723000011), Hermanos Del Sur (N2723000019) and Mecsur (N2723000013) who provide the facilities and the link with the fishing cooperatives associated with Fedecooptab (Federación de Cooperativas Pesqueras, Acuícolas y Permisarios de Tabasco), providing the human capital to carry out the study, with the participation of the Cooperatives of: Pescadores De Boca Del Campo S.C. de R.L. de C.V., Barra Ciega S.C. de R.L. de C.V., Cooperativa Boca de Aztlán S.C. de R.L. de C.V., the Dirección de Emprendimiento y Desarrollo Empresarial de la Secretaría para el Desarrollo Económico y la Competitividad del Estado de Tabasco and the Universidad Juárez Autónoma de Tabasco (UJAT). They are key to knowledge and sustainable consumption.

These alliances can facilitate access to finance, training and technology, thus improving product competitiveness and benefiting communities as a whole.

#### Annexes

Category	Option	Percentage (%)
Age	20-24 years old	44.0
	25-34 years	29.0
	35-54 years	15.0
	55-60 years	7.0
	61 years and over	5.0
Sex	Men	53.0
	Women	47.0
Socio-economic status	Low medium a (\$8,499 \$16,787)	37.0
	Low (under \$8,499)	35.0
	Medium-high a (\$16,788 \$34,622)	20.0
	High (over \$34,623)	8.0
Knowledge of armoured catfish	Yes	59.71
	No	40.29
Willingness to try armoured catfish	Yes	51.97
	Indeciso	48.03

Armed catfish test	Yes	44.28
	No	55.72
Taste rating of armoured catfish	Neutral	46.0
	Very bad	24.0
	Good	13.0
	Malo	10.0
	Very good	6.0
Consumption of armoured catfish in the last three months	No	72.0
	Yes	28.0
Frequency of consumption	Rarely	80.0
	Monthly	6.0
	Annually	5.0
	Fortnightly	4.0
	Weekly	4.0
Place of purchase	Supermarket	40.0
	Market	20.0
	Fish market	15.0
	Other	25.0
Frequency of purchase	Occasionally	45.0
	Monthly	25.0
	Weekly	20.0
	Daily	10.0
Factors considered when purchasing	Price	62.0
	Freshness	62.0
	Taste	61.0
	Availability	51.0
	Nutritional value	34.0
	Sustainability	31.0
	Other	46.0
Purchase presentation preference	Fresh	47.0
	Frozen	22.0
	Vacuum packed	14.0
	Other forms	17.0

Table 2 of results

Source (Own elaboration)

### Authors' contribution

*María Rivera Rodríguez:* Contributing to the identification and classification of information sources - Problem statement, general objective: I contributed to the drafting of the general objective, for the knowledge and consumption of armoured catfish in the municipality of Centro, Tabasco, with a focus on sustainability and social economy, as well as the elaboration of the research instrument.

*María del Carmen Hernández Martínez,* my contribution in this article was the elaboration of the instrument, application of the instrument, analysis of the instrument data, and elaboration of the methodology.

*Karina González Izquierdo* selected a representative sample of 2,458 participants through non-probabilistic convenience sampling. In order to ensure that the sample adequately reflects the socio-economic diversity of the municipality's population, which is crucial for the results to reflect the different perceptions of Armed Bagre fish.

During data collection, she applied surveys using digital tools such as Microsoft Forms. He also participated in the subsequent analysis of the data obtained to identify patterns and trends in consumption of armour catfish. She proposes practical recommendations to promote a positive change in the perception towards this species, thus contributing to environmental control and food diversification in the region.

*María Patricia Torres Magaña,* I contributed to the collective construction of knowledge, when an original article is published in a scientific journal, it contributes to the generation of knowledge. It contributes to the advancement of other researchers in the specific field of research.

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