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Characterization Of Undervalued Fish Species In Indigenous Fishing Camps In The Northern Region Of Sinaloa, In Mexico.

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Abstract:
The northern region of Sinaloa is characterized by its intense fishing activity, which represents a primary source of income for coastal communities. However, these communities face economic and social challenges stemming from marginalization and dependence on overexploited commercial species, such as shrimp. In this context, the bycatch obtained during shrimp fishing includes undervalued species, which represent a resource with high potential for utilization but currently lack adequate valuation. This article presents the results of characterizing the physicochemical and nutritional properties, according to AOAC (1) methods, of two undervalued native species, identifying their viability for developing value-added products with the aim of reducing dependence on overexploited commercial species, diversifying fishers' income sources, and promoting sustainable use. The comprehensive approach is to transform undervalued species into an engine of regional development, contributing to the well-being of communities and the responsible management of fishery resources.
Background*: This article describes important characteristics of some of the undervalued native species, identifying their viability for the development of innovative and sustainable products, responding to the need to diversify the sources of income of the inhabitants in the indigenous communities of the local fishing camps, as well as the urgency of mitigating the overexploitation of commercial species.*
Materials and Methods*: Personal interviews were conducted with 25 fishermen from two fishing communities in Ahome, northern Sinaloa, primarily to obtain demographic information and data on the undervalued fish species they catch in their daily activities. Based on the responses and seasonal availability, two species were selected for physicochemical and nutritional analysis to determine their potential use in the production of food products for humans and animals, as well as other value-added byproducts.*
Results*: Based on the analyses performed, the results obtained demonstrate that the species analyzed compete with species in high demand for human consumption in terms of their nutritional value. In fact, one of them was reported to have fat levels higher than those of commercially valued species.*
Conclusion: *The undervalued species used in the research that underpins this article have high potential for use in the production of highly nutritious products, such as sausages, pâtés, and pasta. Furthermore, the analysis reported on dry weight demonstrates that the amount of protein found in both species enhances their use in the production of flours and animal feed.*
Key Word: *Commercial fishing, Added value, Economic development*

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I. Introduction

Fish is a nutritionally important food source. The edible muscle tissue has a high-water content and is rich in high-quality, easily absorbed protein. Furthermore, while its lipid content does not vary widely between species, it is particularly important due to its contribution of unsaturated fatty acids, which have significant health benefits[1]. From a quantitative perspective, the lipid content in fish varies from 10 to 15% in lean to oily species. Qualitatively, the interest lies in the presence of long-chain omega-3 fatty acids, which have been associated with beneficial effects in the prevention of cardiovascular diseases, neurological development in infants, and the control of inflammatory processes[2]. It is noteworthy that the consumption of seafood products is significant from the perspectives of health, food availability, and the efficient use of available and accessible resources. This is because seafood is an important source of essential micronutrients such as iodine, selenium, calcium, phosphorus, and iron, deficiencies of which are associated with at-risk populations[3].

Marine ecosystems contain a considerable number of undervalued, underutilized, or underexploited fish species. These species, even though they are a natural part of catches, often receive little commercial attention due to factors such as low consumer recognition, their appearance, size, processing difficulty, or simply the market's preference for a few high-value species. However, it has been shown that many of these fish have nutritional profiles comparable to, and even superior to, those of traditionally exploited species, making their underutilization a significant loss from a food, economic, and ecological perspective[4]. These species are rich in micronutrients, which, combined with the above, makes them an important food source for local populations. Therefore, their marginalization in the market is not due to a lack of quality, but rather to sociocultural and economic factors[5,6].

On the other hand, utilizing undervalued fish stocks has ecological relevance, as it reduces overexploitation, which can disrupt reproductive periods, population collapse, and food chains. Diversifying the use of marine species allows for a more balanced distribution of fishing effort and more sustainable use of available biodiversity. This approach is especially useful in areas like the Gulf of California and the Mexican Pacific coast, where discards can represent up to 30% of artisanal catches, including species perfectly suitable for consumption[7].

The northern coast of Sinaloa, in Mexico, is home to a great variety of fish. The lagoon system of Ohuira, Topolobampo, and Santa María bays has been reported to contain 106 species and 76 genera belonging to 45 families[8]. The objective of this work is to characterize the physicochemical and nutritional properties of two undervalued species and establish their potential use for the economic development of the inhabitants of the fishing camps of northern Sinaloa, Mexico.

II. Material And Methods

Raw materials: Two species of fish with no commercial value were collected in July from the port of Topolobampo (a fishing community with an indigenous population designation) in the northern part of Sinaloa. This location was selected because it is the second most important port in the state of Sinaloa and the largest fishing community in the northern region. The species collected were Nematistius pectoralis, commonly known as roosterfish, and Caranx caninus, known as bullfish. These were processed fresh for morphological measurements. The resulting fillets (edible portion) were dried at 70 °C for 12 hours, vacuum-packed, and protected from light for subsequent analysis.

Determination of physical parameters: The collected fish were measured for size (length, width, and height in centimeters) and weight (total weight in grams, percentage of viscera and fillet) using an ichthyometer and a Fowler brand caliper (±0.05 mm precision). Weight was recorded using an AND GX-2000 electronic scale (±0.01 g precision). The fish were then gutted, washed, and filleted to obtain the edible portion.

Proximate analysis: The moisture content was determined according to the Mexican standard NOM-116-SSA1-1994[9]. The procedure consisted of the total removal of water content by means of oven drying (Ecoshel model 9025H) at 100º ± 2 ºC. The determination of fat content in the samples was carried out using the Soxhlet method, in accordance with the Mexican standard NMX-F-615-2018[10]. Three grams of sample were weighed and carefully transferred to an extraction cartridge, where it was covered with a thin layer of grease-free cotton to prevent sample loss. The cartridge was placed in the extraction vessel of the Soxhlet apparatus using petroleum ether (approximately 250 mL, or enough for two siphoning cycles). The apparatus was placed over a heat source, and the temperature was adjusted to achieve a drip rate of approximately two drops per second. Extraction was carried out for 4 to 6 hours, sufficient time to ensure repeated solubilization and transport of the lipids from the sample to the collecting flask. After extraction, the solvent in the flask was evaporated at a low temperature, avoiding overheating that could degrade the extracted lipids. Once the solvent had evaporated, the flask was returned to the oven to complete drying and remained there until a constant weight was reached. Subsequently, it was placed in a desiccator for cooling prior to final weighing. The total fat content was reported as grams of total fat per 100 grams of dry sample. The determination of protein content was carried out using the Kjeldahl method, established for the quantification of total nitrogen in food products according to the Mexican standard NOM-131-SSA1-1995[11]. One gram of sample was weighed and transferred to a Kjeldahl flask, where the digestion mixture was added. This mixture consisted of 2 g of copper sulfate (Frama), 10 g of anhydrous sodium sulfate (Faga Lab), and 25 mL of concentrated sulfuric acid (Frama). Boiling chips were also added to ensure uniform heating. The flask was initially placed at a low temperature, allowing the mixture to begin charring in a controlled manner. Subsequently, the temperature was gradually increased until the contents became completely clear and transparent, indicating the complete digestion of the organic nitrogen and its conversion to ammonium sulfate. This process constituted the digestion stage. Once digestion was complete, the flask was allowed to cool slightly and connected to the distillation system. The distillate was collected in a 500 mL Erlenmeyer flask containing 50 mL of boric acid solution (Faga Lab) and a few drops of Wesslow indicator. Simultaneously, approximately 400 mL of distilled water were added to the Kjeldahl flask containing the digested residue to completely dissolve any remaining salts, ensuring proper entrainment during the distillation stage. The mixture was allowed to cool again, and 6 to 7 zinc granules were added without stirring. Then, 50 mL of sodium hydroxide solution (Faga Lab) was carefully added. Finally, distillation was started, allowing the ammonia to be carried over into the receiving solution until approximately 300 mL of distillate was obtained. Once distillation was complete, the receiving flask was removed, and the contents were titrated with 0.1 N hydrochloric acid solution until the indicator changed color. The volume of titrant consumed allowed for the calculation of the total nitrogen present in the sample and, subsequently, the amount of protein, using the corresponding conversion factor. The total protein content was reported as grams of protein per 100 grams of dry sample. Ash determination was performed in accordance with Mexican standards NMX-F-066-1978[12]. This method is based on the complete elimination of the organic fraction present in the sample through high-temperature combustion, yielding only the minerals naturally present in the fish tissue as residue. One gram of sample was weighed directly into a crucible. The crucible was initially placed over a burner for controlled pre-drying and charring of the sample, preventing sudden material loss due to rapid volatilization. Subsequently, the crucibles were transferred to a muffle furnace (Fisher Scientific model 650-58) preheated to 600 °C, allowing for complete incineration of the organic tissue. This process was continued until white or light gray ash was obtained, indicating complete oxidation of the organic fraction; approximately 6 hours. Ash results were reported as grams of ash per 100 grams of dry sample.

Socioeconomic and Fisheries Characterization: To determine the socioeconomic situation and characteristics of the population in the fishing communities of northern Sinaloa, a survey was conducted with 25 fishermen in the port of Topolobampo, located in Ahome, Sinaloa, Mexico. Among the most relevant questions, information was obtained regarding age, years of experience as fishermen, whether they have access to fishing support funds, the most caught fish species in the port, and species with potential for exploitation but not commercially viable, among other questions.

III. Result

The species collected in Topolobampo, Ahome, Sinaloa, were *Nematistius pectoralis*, commonly known as roosterfish, and *Caranx caninus*, known as bullfish, according to Figure 1. These species, although they have no commercial value for human consumption, are collected for use as bait for catching other species.

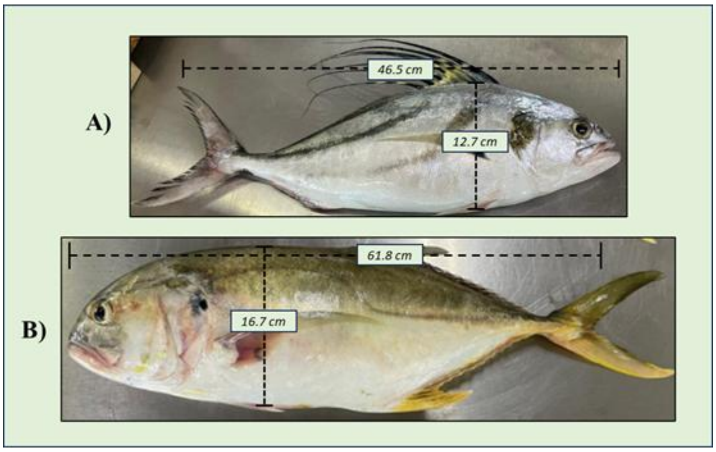

Figure 1. A) Roosterfish, B) Bullfish

Physical parameters, such as size measurements (length, width, and height in centimeters) and weight measurements (total weight in grams, percentage of viscera and fillet), are presented in Table 1. Bullfish exceeds roosterfish by 78% in weight; however, the percentage of edible fillet obtained is 26% higher in roosterfish. The percentage of viscera is 32% higher in bullfish, which should be considered as waste that cannot be used for human consumption.

Table 1. Physical parameters from rooster fish (Nematistius pectoralis) and bullfish (Caranx caninus).

Physical parameters	*Roosterfish*	*Bullfish*
Weight, g	1153 ± 27.01	3207 ± 787.72
Long, cm	46.5 ± 1.29	61.75 ± 5.30
Broad, cm	12.7 ± 0.48	16.69 ± 2.00
Height, cm	4.53 ± 0.21	8.62 ± 0.62
Viscera, %	9.51 ± 1.07	12.59 ± 2.37
Edible portion, %	43.85 ± 2.24	34.86 ± 0.12

Table 2. Proximate analysis of roosterfish (Nematistius pectoralis) and bullfish (Caranx caninus).

Proximate analysis	Roosterfish	Bullfish
Moist, %	69.77 ± 0.76	70.68 ± 0.19
Protein, g/100 *	60.33 ± 3.34	64.65 ± 2.06
Total fat, g/100 *	20.27 ± 3.43	17.29 ± 2.37
Ash, g/100 *	5.70 ± 0.38	6.06 ± 1.77

* Dry base

The socioeconomic and fishing characterization survey showed that in a sample of 25 male fishermen from the port of Topolobampo, 44% were between 50 and 59 years old and 32% between 40 and 49 years old, representing 76% of the total sample (Figure 2).

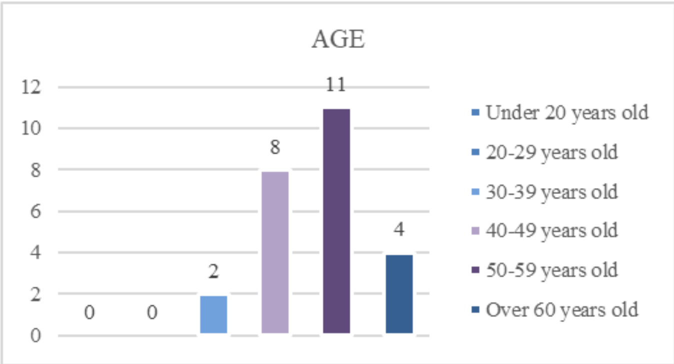

Figure 2. Age of the 25 fishermen interviewed.

Furthermore, 52% had been engaged in fishing for between 30 and 39 years, and 16% had been working in this activity for more than 40 years (Figure 3).

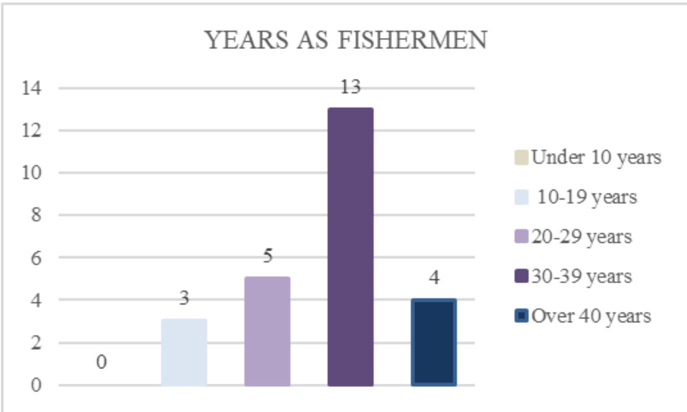

Figure 3. Years carrying out fishing activity.

On the other hand, the species with the highest commercial value caught by fishermen in the port of Topolobampo are: corvina (*Cynoscion othonopterus*), pargo (*Lutjanus guttatus*), sierra (*Scomberomorus sierra*), botete (*Sphoeroides annulatus*), and cochito (*Balistes polylepis*). Meanwhile, the species with little or no commercial value are gallo (*Nematistius pectoralis*) and toro (*Caranx caninus*).

IV. Discussion

The initial physical characterization of fish is a fundamental step in designing processes for the valorization and utilization of undervalued fish. Variables such as weight, body dimensions, and fillet yield directly influence heat and mass transfer, important aspects in drying and smoking processes[1,2]. The fish species analyzed in this study showed an important source of edible portion, which is not being used for human consumption and a source of income for the indigenous communities, which are dedicated to fishing activity in the northern region of Sinaloa.

On the other hand, according to the composition of the proximate analysis, the evaluated species present relatively lower protein values than those reported for other exploited species of high commercial value such as the snapper (*Lutjanus guttatus*) with a protein content of 85.02 g/100 g dry weight, 84.26 g/100 g dry weight for sierra (*Scomberomorus sierra*) and 71.78 g/100 g dry weight for the skipjack tuna (*Euthynnus pelamis*)[13]. Conversely, the total fat content is higher for snapper (11.07 g/100 g dry weight) and spanish mackerel (11.45 g/100 g dry weight); but lower for skipjack tuna (24.59 g/100 g dry weight)[13]. This indicates that the studied species can be a good, inexpensive source of unsaturated fatty acids. Ash content levels are similar in the species, reported to range from 4.44 to 5.17 g/100 g dry weight[13].

The socioeconomic and fisheries characterization survey showed that the situation in the sector is critical. This is because the fishing population is already past retirement age, and the average age of fishing activity is over 40 years. Furthermore, this is a consequence of the lack of government support or incentives to promote the development of this important activity in the region. This situation has been reported as a risk by international organizations such as the FAO (Food and Agriculture Organization of the United Nations)[7].

V. Conclusion

There are fish species in the northern region of the state of Sinaloa that are an important source of nutrients but are not being exploited. The species *Nematistius pectoralis*, commonly known as roosterfish, and *Caranx caninus*, known as bullfish, represent an opportunity for exploitation and an important source for developing high-value products, generating additional income for indigenous families in the fishing communities of northern Sinaloa.

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