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PRODUCTIVE CHAIN OF ARTISANAL MOLLUSK FISHING AND THE ROLE OF FISHERWOMEN

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ABSTRACT

Artisanal mollusk fishing is an activity developed in several countries around the world. In Brazil, bivalves appear as one of the most attractive mollusk fisheries. Fisherwomen play important roles in fishing, being sometimes made invisible, making it necessary for them to be valued and included in the management process. The aim of this study was to describe the productive chain of artisanal mollusk fishing, highlighting the role of fisherwomen activity. The research was carried out in the beneficiary people communities of the protected area from Acaú-Goiana Extractive Reserve, located in the Northeast of Brazil, in the period of 2017 and 2018. For this purpose, methods of observation of activities and unstructured interviews were used with 47 fisherwomen of *Anomalocardia flexuosa*, *Mytella guyanensis*, and *Crassostrea rhizophorae*; these being the main mollusk-bivalves caught by them. In general, there fishermen residing in communities located on the beach catch only one type of species, while those near the mangroves have more flexibility in capturing more types of species. The frequency of fisheries is related to fishing economic dependence and accumulation of other domestic and home activities. Strategies of fishing, processing, and sale are directly influenced by the financial return for fisherwomen. The middlemen's activities also play roles in the acutance of commerce. Shells reuse may be an important resource for increased commerce and fishery management. Ecological fishery knowledge and practices carried out by the fisherwomen must be valued, and used mainly in the construction of local regulations for fishing and protected areas management.

KEYWORDS: bivalve, fishery socioeconomy, gender, management.

CADENA PRODUCTIVA DE PESCA DE MOLUSCOS Y EL PAPEL DE LAS MUJERES PESCADORAS

RESUMEN

La pesca artesanal de moluscos es una actividad desarrollada en varios países del mundo. En Brasil, los mejillones aparecen como uno de los principales grupos explotados. Las pescadoras desempeñan una función sobresaliente en la pesca, ya que a veces se las invisibiliza, por lo que es necesario valorarlas e incluirlas en el proceso de manejo. El objetivo de este estudio fue describir la cadena productiva de la pesca artesanal de moluscos, destacando el papel de las pescadoras en esta actividad. La investigación se llevó a cabo en las comunidades de la población beneficiaria del área protegida de la Reserva Extractiva Acaú-Goiana, situada en el nordeste de Brasil, durante los años 2017 y 2018. Para este propósito, se utilizaron métodos de observación y entrevistas no estructuradas a 47 mujeres pescadoras. *Anomalocardia flexuosa*, *Mytella guyanensis* y *Crassostrea rhizophorae*, fueron los moluscos

que mayormente capturaron las pescadoras. Se observó que las pescadoras que residen en las comunidades ubicadas en la playa utilizaron un solo tipo de especies, mientras que las que se encuentran cerca de los manglares tienen más flexibilidad para capturar otras especies. La frecuencia de la pesca está relacionada con la dependencia económica de la pesca y la acumulación de otras actividades domésticas. La pesca, elaboración y estrategias de venta de los pescados están directamente influenciadas por el rendimiento financiero. Las actividades de los intermediarios también desempeñan un papel en la agudización del comercio. La reutilización de las conchas puede ser un recurso importante para el aumento del comercio y la ordenación de la pesca. Se deben valorar los conocimientos y prácticas ecológicas y pesqueras realizados por las pescadoras, y utilizarlos principalmente en la elaboración de normas locales que regulen la pesca y el manejo de las áreas protegidas.

PALABRAS CLAVE: bivalvos, género, manejo, socioeconomía pesquera.

INTRODUCTION

Artisanal fishing can be characterized as a traditional, small scale economic activity (with worldwide importance), carried out in social groups with specifications about the division of labor (Diegues, 1983). For mollusk extraction, this is a fishery developed in several countries, such as Spain (Urrea *et al.*, 2018a), Fiji (Bao and Drew, 2017), Mexico (Urrea *et al.*, 2018b), and Brazil (Mourão *et al.*, 2020) as a main economic activity. In Brazil, bivalves are one of the main fishing resources used on the coast of the northeast region (Souto and Martins, 2009; Cidreira-Neto *et al.*, 2019) due to the history and livelihoods for local people.

The fisher's local ecological knowledge (LEK) part of empirical ecological knowledge that can be socially shared (Narchi *et al.*, 2014) from the histories processes of environmental management. Artisanal mollusk fishing presents several singularities, where each fisherwoman presents fishing know-how that makes it unique, based on the knowledge and practices took during her trajectory, where the women act daily in contact with the environment of the ecosystems of beaches and mangroves. In this way, the natural elements are appropriated, mainly from the daily practice, being endowed with knowledge such as tidal variation, salinity, rainfall, biology, and ecology of the organism (Silva-Cavalcanti and Costa, 2011; Mourão *et al.*, 2020).

In the northeast of Brazil, fishing is not carried out uniquely in all locations, each fishing community develops

fishing based on the social, environmental, and economic conditions as in the mangrove, estuary, or the “croas” (sandbanks). The production chain comprises exactly the processes that compete in the development of fisheries, such as the type of resource caught, management methods, and sales or trade-in strategies (Nascimento *et al.*, 2017; Cavalcanti *et al.*, 2019). Thus, the production chain is based on historical-cultural experiences, which are constantly adapting, being reformulated based on local needs, seasonality, social and economic drives.

Walter *et al.* (2012), show that knowledge of the production chain makes it possible to understand how the patterns are established between production and fishing, resulting in important information for fisheries management. It is also worth mentioning that it is necessary to understand how gender issues present themselves in the productive chain of artisanal fisheries, valuing the work of fisherwomen and enabling this knowledge to serve as a subsidy for management. Artisanal fishing is an activity that is commonly related to male work, even though women occupy about 50% of fishing workers (Ogden, 2017). Kleiber *et al.* (2015), identified that there is a gap in researches involving gender and artisanal fishing, promoting a lack of data regarding LEK and the role of women in fishing. Fisherwomen work is invisible, but they are the main ones responsible for some modes of fisheries and/or act remarkably in the production chain in artisanal fishing. It is also emphasized that in Brazil until 2003 the wife's fisher or fisherwomen were not considered as a fisheries workgroup.

However, seeking to understand how the socioeconomic processes that comprise fisheries management in Northeast Brazil have been formulated, the aim of this study was to describe the productive chain of the artisanal mollusk fishing, making the role of the fisherwomen evident in a protected area.

MATERIAL AND METHODS

Study area. The study was carried out in the Acaú-Goiana Marine Extractive Reserve (Reserva Extrativista Marinha Acaú-Goiana - RESEX), located in the Northeast of Brazil (07° 33'59" S; 34° 50' 14" O); but precisely on the northern coast of the state of Pernambuco (PE) and the southern coast of Paraíba (PB), covering the total area of 6,676.60 hectares with a presence of two rivers (Goiana and Megaó), extensive mangrove ecosystem and the largest area of the estuary with reef barriers (Figure 1).

RESEX has a Deliberative Management Council (DMC) that it was formalized in 2012 and consisting of four governmental and non-governmental spheres: (i) Environmental Public Institution; (ii) User of the Territory; (iii) Non-Governmental Civil Society Organization and (iv) Teaching and Research Institutions. In this way, local management is carried out in a participatory manner at DMC meetings, seeking to promote dialogue between representatives of different spheres (Lima *et al.*, 2016). Prado *et al.* (2019), analyzed some Extractive Reserves in Brazil, and they pointed to the difficulties in promoting participatory management, especially on the difficult action of the environmental management staff showed the gap between the local people and legislative institutions.

The main actors for the creation of this Protected Area were the fisherwomen, who demanded the protection of the estuary, lasting about eight years of discussion and legal procedures for its implementation (Fadigas and Garcia, 2010). The RESEX was created to protect the traditional populations living on the sites as well as the rivers and estuary's fishery resources.

Six communities are beneficiaries of RESEX: (i) Carne de Vaca, (ii) Povoação São Lourenço, (iii) Tejucupapo, and (iv) Balde do Rio in the municipality of Goiana (PE), and (v) Acaú in the municipality of Pitimbu (PB) and (vi) Porto de Congaçari in Caaporã (PB). Several fishery resources are exploited in the estuary, including crustaceans, fish, and mollusks. The management of the RESEX is carried out by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), linked to the Ministério do Meio Ambiente (MMA), being subjected to normative instances of this ministry (it's up to reading the law nº 9.985 of 2000). As a local normal measure, this RESEX has a Management Agreement (MA), through Order No. 851, dated December 22, 2017, to regulate the fishing activity developed in the area. However, this MA it took ten years to complete, with shortcomings such as a lack of disclosure in fishing communities, and a lack of more robust data about the fishing resources used by fishermen and fisherwoman. For mollusks, the MA only includes regulations related to shellfish fishing of *Anomalocardia flexuosa* (LINNAEUS, 1767), with a maximum amount per family nucleus of 300 kg, minimum size for catch of 15mm of shell, and 12mm for fishing gear.

Another measure that has to commonly used in the desire to promote sustainable use in the protected areas in Brazil, is the Management Plan, which seeks, through participatory processes, between the management body and the communities, the construction of norms that regulate the use of resources locations (Di Franco *et al.*, 2016). This study seeks to contribute to its construction, mainly in issues related to artisanal fishing of the mollusk *A. flexuosa* in the region.

The research has the agreement of ICMBio, through the Biodiversity Information and Authorization System (nº 58139-1), due to the study being performed in a federally protected area. Also, it was agreed by the Ethics Committee of the Federal University of Pernambuco (Nº. 2337271).

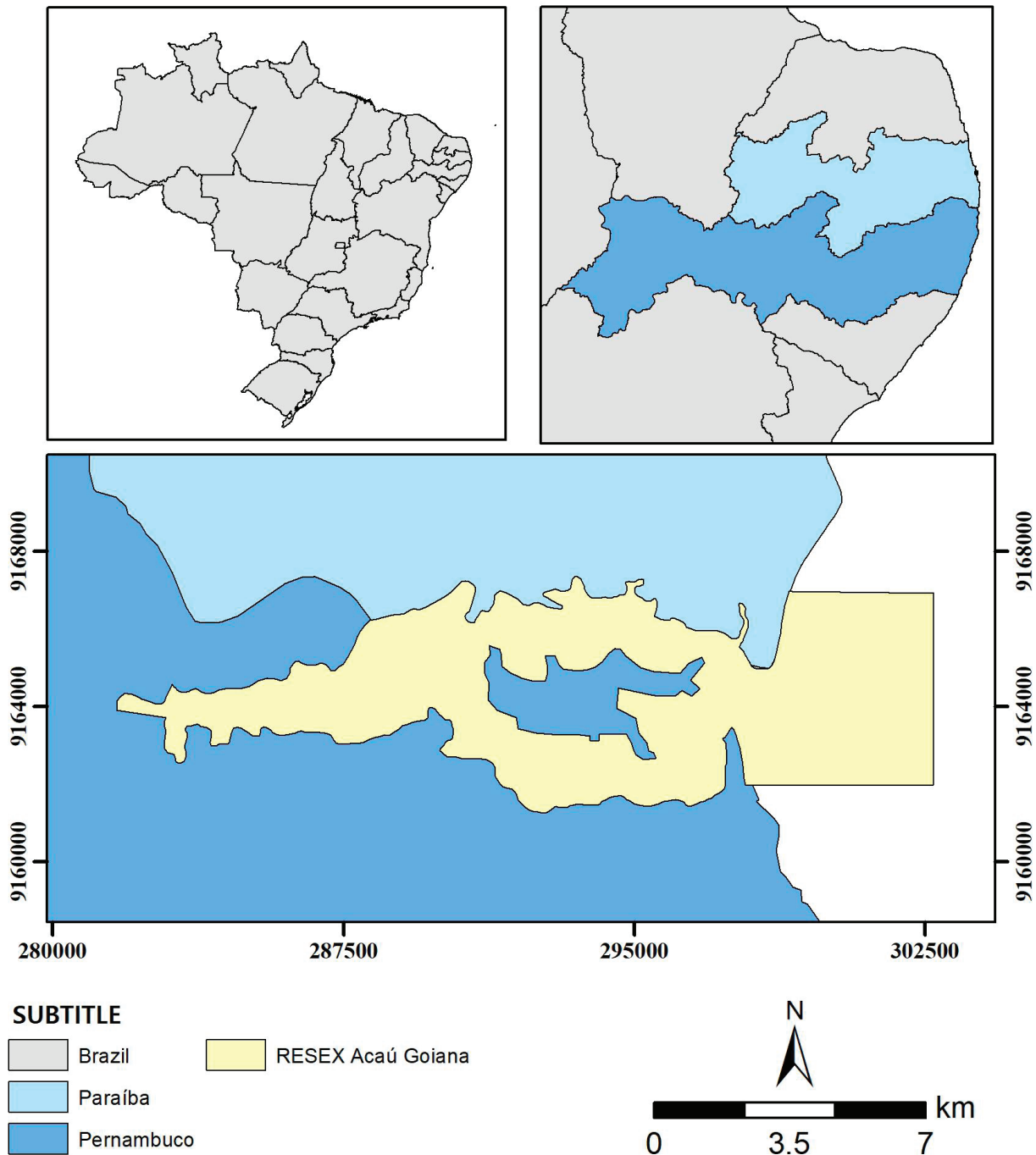


Figure 1. Location of the Acaú-Goiana Extractive Reserve located between the states of Pernambuco and Paraíba, Northeast Brazil.
Made by: Hévila Mendes, 2018.

MATERIAL AND METHODS

Fieldwork was conducted in the years 2017 and 2018), with participation in DMC meetings and immersions in RESEX beneficiary communities. The field data collection was performed for 28 days, alternating between 3 and 5 days followed by visits in every six communities in

September/17, October/17, November/17 and January/18, May/18, June/18 October/18, and November/18. The study presented a qualitative method, based on ethnographic research, using the methods of observation and interview with fisherwomen, that use economically the mollusks *A. flexuosa* (popularly known as *Marisco*), *Crassostrea rhizophorae* (GUILDING, 1828) (popularly known as *Ostra*),

and *Mytella guyanensis* (LAMARCK, 1819) (popularly known as *Sururu*).

Initially, rapport was carried established with women in the communities of study to understand the local fisheries dynamics in advance and also allowing the identification of the key research informant, and in a preliminary way, strengthening ties and relationship with the popular community. This moment was fundamental in the development of this research, allowing for the final design of the project. After this initial contact, observational methodologies and interviews were applied, following the proposed by Gil (2008) and Bernard (2017).

The non-participant observation (NO) was used to understand the fishing activity without the intervention of the researcher, being carried out by distance, monitoring the fishing processes. It was also used participant observation (PO), which consisted of active participation in the process of mollusk catch management, accompanying the fisherwomen throughout the fishing process. Observation methods enable understanding about human behaviors and everyday experiences in communities, providing the researcher's experience in local social dynamics (Etkin, 1993). The use of observation methods made it possible to see and experience the stages involved in artisanal mollusk fishing, allowing immersion in the fishery's culture.

For the interviews, the snowball sampling method (Chain-referral-sampling) was used. It consists of a referral sampling search, allowing access to a particular social group, being a not-probabilistic method (Goodman, 1961; Etikan *et al.*, 2015). The research initially used the people indications made by the key informants in each locality, since they were known as "ethno-specialists" (fisherwoman with fisheries knowledge and fishing practices), also has extensive LEK about who develops the fishing activity in the region.

The unstructured interviews were carried out in places that the interviewee felt comfortable, such as boat ports, during fishing, and at the fisherwomen's home residence. The interviews were conducted in the form of

a conversation with the fisherwomen, focusing on topics such as fishing know-how, mollusk management process, and fishing profitability. It took a long time in each so that, so that in addition to the answers obtained, the researcher would have closer ties with the fisherwoman, thus allowing the development of participatory research (Gil, 2008). The interview allows us to know, through orality, the individual memory, bringing the social context and the emotions lived during the fact studied, being this information important in ethnoecological research (Stanisk *et al.*, 2015).

A total of 47 fishermen were interviewed in the RESEX, distributed in five communities that caught the mollusks as main activities. The community of Balde do Rio does not have this type of mollusks fishing, mainly due to the distance of the main point's sandbank of collection. In addition to these fishermen, a hand craftswoman who works with the shells of mollusks, two fishermen who accompanied the fisherwomen during the fishing, the president of the Colony of Fishermen Z-12, and a middleman were interviewed in a complementary way.

The analysis of the data was performed through a qualitative technique, from the ethnography of oral history considering the oral discourse of the interviewees, analyzing the different narratives, thus seeking the collected understanding of the production chain (Bernard, 2017). The perspective of immature knowledge (Posey, 1992) was used as a base for the understanding of the fishing productive chain of the main mollusks extracted in the region.

RESULTS AND DISCUSSION

Initially, a pattern was identified in the structure of artisanal mollusk fishing, wherein communities that are located closer to the coast (beach area), fisherwomen specialize only in one fisher resource. In the communities that are located closer to the river and mangrove areas, where the greater abundance of other fishery resources is found besides mollusks (crustaceans), there is a certain flexibility in fishing, resulting in fisherwomen using different fishing resources, thus dominating more than a fishing art. This relation of how the fisher is adapting according

to the availability and profit of the fish product is clear with the following speech: “*Everybody takes everything, the activity is not one, if there is more shellfish, go for the shellfish (A. flexuosa), if you have mollusk-sururu (M. guyanensis) buyer, go for the mollusk-sururu, if you have crab-aratu (Goniopsis cruentata, Latreille 1803), go for the crab-aratu*” (Fisherwoman, 40 years old). The seasonality of the fishery resources used determines what will be the type of fishery carried out.

The journey to the tide and local ecological knowledge.

Among the processes that comprise artisanal fishing, some environmental factors have a direct influence on the activity. The tide is one of them which varies according to the lunar phase where it should present its minimum value (low tide). The fishing period lasts about five hours corresponding to the dry tide period.

The periodicity about the frequency of fishing during the week can present three main groups (Table 1): (i) Up to three days a week, which mainly includes fishing for consumption and/or income food supplementation, as they have some type of benefit (such as retirement); (ii) Five days a week, in which fishing is the main source of income, and Saturday and Sunday are used for processing and selling fish (local fairs take place on these days), in addition to the care of children and parents, who do not have face-to-face activities in schools at the weekend, under the care of mothers; and (iii) Seven days a week, mainly in communities with greater economic vulnerability and dependence on artisanal fishing, this category is related to fishing with paraphernalia, and there are high physical wear and overload with other activities (processing, sale, domestic care and of the children).

The fisheries periodicity is related to some factors, such as the type of fishing resource used, how made (manual or with equipment), processing, yield, and abundance of the mollusk, in addition to the sales strategies (commerce). The combination of these factors will result in the economic profitability of fishing. These factors that compete for the management of mollusks will be addressed later in the text. The periodicity of fishing reflects gender inequalities, as women need to reconcile fishing activity with the home care and children and parents care, in addition to the processing and sale of the product caught by the husband (Uc-Espadas *et al.*, 2018). In this way, gender influences profitability, assigning fisherwomen to work long hours due to the accumulation of functions.

The fishing process begins with a way to the estuary (tide), which may be in social groups, usually composed of neighbors, colleagues, and parents, as well as alone. The LEK acquired from orality and practice, and experience the fisherwomen know exactly what, when, and why the tide ebbs and floods, then one understands the fishing trip for each tide. Artisanal fisherwomen relate environmental parameters, such as type of tide and precipitation, with the disposition of mollusks.

The “way to the tide” is a symbology that characterizes the fishing practice and activity, where the women leave their house dress down the wearing apparel used in the shellfishing. In this way to the tide, they walk to the sandbanks, which can be located in the borders of the rivers, or the beach environment. For those who go in groups, this moment also refers to the strengthening of social relationships. Due to the high distance to the

Table 1. Fishing frequency observed for artisanal mollusk fishing from RESEX Acaú-Goiana, northeast Brazil.

FREQUENCY	ADHERENCE	TYPE	OBSERVATION
Up to 3 days	Low	Fishing for consumption and income supplementation	Fishing carried out from the previous need
5 days	High	Fishing as the main economic activity	Allocates the weekend for childcare, processing, and sale of fish (including husband)
7 days	Mean	Fishing as the main economic activity	Physical overload, and accumulation of domestic and fishing tasks

sandbanks, some needs of vessel ports, in which they can be used to start the process of processing the shellfish product, thus reducing the physical effort necessary to transport to home.

The production chain. The productive chain of mollusks in the RESEX Acaú-Goiana presents different configurations for each fishing resource used, in this case, for each mollusk caught by the local fisherwoman.

(i) *Anomalocardia flexuosa* - Marisco

The fishing of *A. flexuosa* is taken in two procedures, manual, which includes fishing and processing in the same period, and with help of tools made by the fisherwomen and/or by someone of the community, assisting during fishing and processing the fish product. Productivity, quality, and profit from the sale of the final product are influenced by the TEK of each fisherwoman.

Manual fishing involves hand-picking (Figure 2A) or small hand-made utensils. An example of these tools is a type of spoon (Figure 2B) that helps in sediment turnover but does not necessarily increase productivity significantly. The processing of mollusks consists of cooking to facilitate the opening of the shells, cooked in cauldrons, without the need to add water, performed mainly in the fisherwomen's homes, with a wood fire, removing the meat individually (Figure 2C). The average production by a fisherwoman during tide is about 2 kg already processed. According to the fisherwoman, it varies according to the type of tide and rainfall. These daily factors influence the distribution and abundance of this resource.

In the fishing caught with the help of instruments (Figure 3), these utensils are used to help in the fishing process, increasing productivity. However, it is noteworthy that some of these devices require high physical strength for their use, therefore, they are usually linked to the male presence. After fishing, the mollusks undergo the process of *galear*, in which they are placed in plastic boxes, and are still stirred in the tide so that the smaller sizes are fall, leaving only the largest.

The processing takes place initially in the same technic as the cooking process, however, for the removal of the meat, the mollusks are conditioned in boxes (known as a sieve) and beaten, allowing the meat to come out of the shells and fall through the holes in a cloth previously placed on the bottom.

After the cooking process, the meat is washed and separated by the bags/kg, and either frozen or destined for commerce. The commercialization is made at home, using plaques on the exterior façade of the houses to attract buyers, mainly tourists who come during the summer period or selling to fixed buyers, such as markets, fairs, and small restaurants in the region. Regarding fisheries management, the fishing is done manually, both in the fishing process and in the beneficiation process, results in a product with higher added value, mainly because of its quality. Manual fishing results in lower productivity by the tide, but with greater added value.

The introduction of new fishing strategies (social technologies) has enabled an increase in the productivity of fish, reaching double that of manual fishing (Gomes *et al.*, 2019), however, there has been a reduction in quality and added value. This constant modification of fishing techniques, sometimes including new devices that enable better performance in capturing fishing resources, is already something that has been reported in studies (Furtado, 1981; Magalhães *et al.*, 2016). Issues such as climate change and vulnerability may be related to the use of fishing gear (Senapati and Gupta, 2017).

The value obtained from the commercialization of the product is U\$ 2.5 per kg, in periods of low demand, up to U\$ 6.25 per kg, in the high season, this leading to the process of manual processing. The product that was sieved, shows a decrease in the price, due to its lower quality because it contains traces of shells and residues from the moment of the beat, costing about U\$ 3.0 for kg. Unfortunately, for the fisherwoman the main trade has the presence of the middleman, which is less profitable for the fisherwoman, reaching

the value of the final product from U\$ 1.2 to U\$ 4.2 dollars per kg.

(i) *Mytella guayanensis* - Sururu

The fishing of *M. guayanensis* is done mainly by hand, requiring only equipment to help the caught. This mollusk is found in the bottom of manarove (sediment or mud)

or associated with the roots of mangrove three, where it comes mainly in a tangle of other organisms (macroalgae, sponges) and other matter, popularly known as “*bucha*” (loofah).

The processing initially consists of cleaning/removing the loofah that comes with the mollusk. The need to carry out this initial cleaning. makes this fishing the most

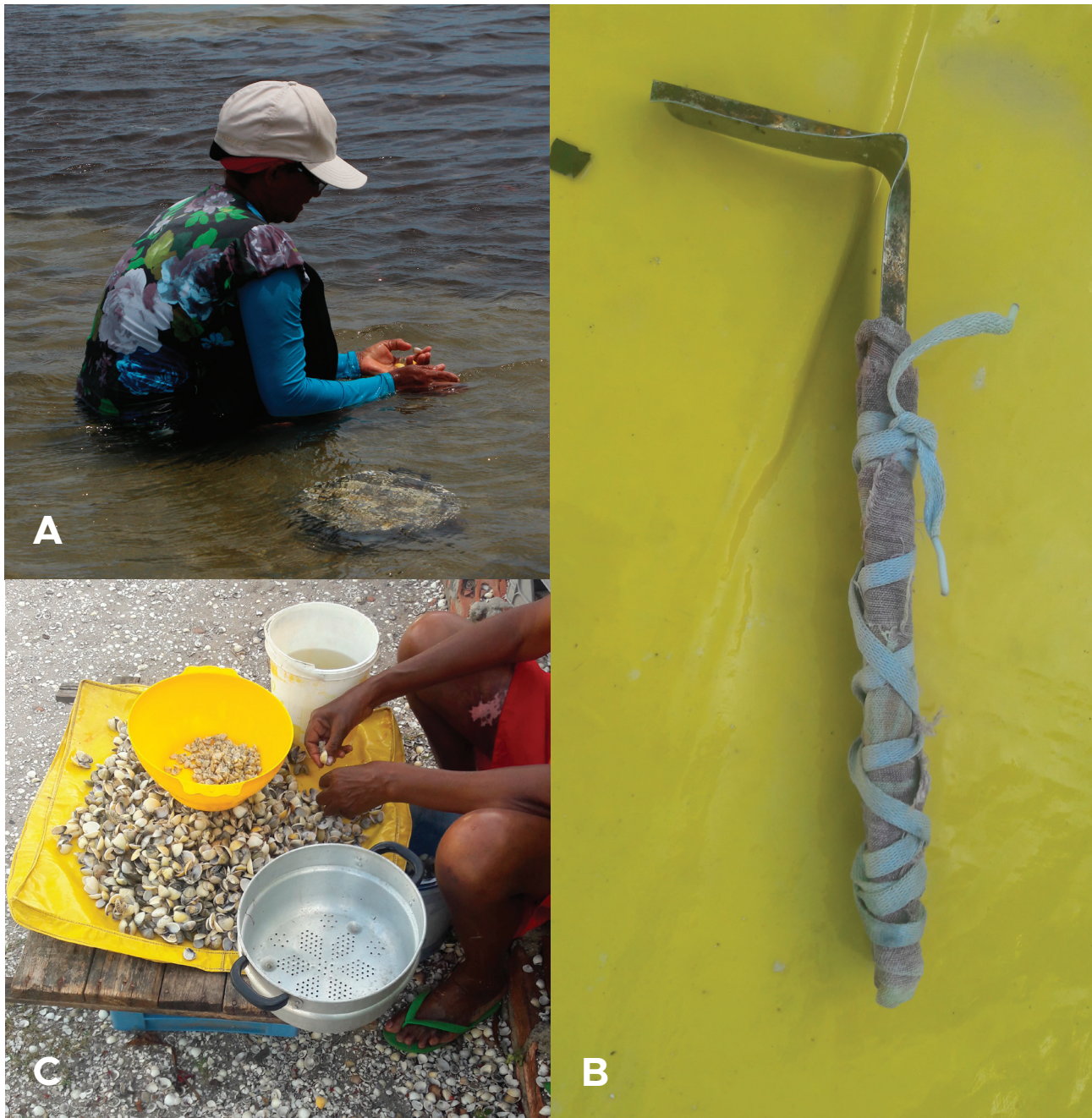


Figure 2. Fishing and manual processing of the mollusk *Anomalocardia flexuosa* (LINNAEUS, 1767). A) Fishing. B) Fishing tackle. C) Processing. Source: Ivo Raposo, 2017.



Figure 3. Fishing equipment used to enhance the catching capacity of the *Anomalocardia flexuosa* (LINNAEUS, 1767).
A) Gadanho. B), C), and D) Puça variations. Source: Ivo Raposo, 2017/2018.

laborious of the mollusks, according to the fishermen's report. The removal of loofah consists of a social group work, where family members or community members assist in this process, realized manually.

After the cleaning, the cooking process begins to open the shells, similar to *A. flexuosa*, using cauldrons and wood fire, without the addition of water. After cooking, the mollusks are placed in boxes and beaten so that the meat loosens from the shells and falls into a cloth or container previously placed at the bottom. Finally, the meat is washed and separated by the kilo in bags. It can be sold fresh or frozen. However, selling it fresh is more advantageous.

Regarding the value of the product, the price can vary from U\$ 3 to U\$ 4.2 for kg. It varies according to the demand of buyers and availability of the fishing stock "*The more you have, the lower the price*" (Fisherwoman, 40 yrs.). This value occurs when the sale is "at the house doors", as well as in the one destined to the local commerce (bars or restaurants). To commercialization for the middleman, the value goes from U\$ 1.9 to U\$ 3 for kg.

(iii) *Crassostrea rhizophorae* : *Ostra*

C. rhizophorae fishery is dangerous for the fisherwoman because of the cuts from the mangrove roots or sharp objects hidden in the mud. In this way, it is necessary to use specific protective equipment, such as gloves, boots, and "socks" (product made individually with jeans fabric, serving to avoid cuts in the feet and legs).

C. rhizophorae is mainly extracted from the mangrove roots, but requiring an ideal salinity for its development, "*When the oyster is full it does not have much, it does not support freshwater*" (Fisherwoman, unknown age).

Their oyster fishing is done manually, presenting only the scythes and knives, which help to the remove the roots but do not interfere in the increase of productivity, serving only as facilitators of the work (Figure 4A). The oyster collected is conditioned in nylon bags and buckets, washed in the estuary to reduce the weight of

the mud, to be taken to fisherwomen's homes (Figure 4B and 4C). The processing begins with the cooking of the mollusk, in cauldrons, wood fire, and without the addition of water. At the moment when the shells are already open, there is two modes of processing, which the first is when the mollusk is still whole and taken to the main beaches in the region and sold, still with the shells, mainly during the summer period, for present a greater number of tourists on the beaches. The second way is when the processing follows the same model as the other mollusks, in which the meat is removed (manually), washed, and separated by the kilo in bags, for disposal to the buyer (fresh), or freezing. The amount collected will depend on each season of the year, averaging 2 to 3 kg per tide.

The *C. rhizophorae* is the most profitable resource, among the mollusks, the value can reach up to U\$ 6.1 per kg in the sale at home's doors or for local trade, and an average of U\$ 3.1 per kg by the middleman.

- (i) Record of Artisanal Fishing of *Iphigenia brasiliensis* (Lamarck, 1818) and *Tagelus plebeius* (Lightfoot, 1786)

I. brasiliensis and *T. plebeius* are an important resource in artisanal fishing, but there is a constant decrease in their availability. According to reports, few fishermen still carry out this mode of fishing.

The period of fishing the *I. brasiliensis* is from August to September. The price arrives at about U\$ 6,00 because nowadays it is difficult to be found. *T. plebeius* is fishing mainly for the own food consumption, since the low availability and the high knowledge necessary for its fishing, which is realized through the identification of the place in the sediment (small holes in the sandbanks), using handcrafted hooks for catching.

The middleman of fishery. Is characterized by being a resident of the village who is responsible for the trade of the resource destination of the product to other locations. The presence of the middleman in the artisanal fishery is mainly interconnected with the



Figure 4. Fishing and manual processing of the *Crassostrea rhizophorae* (GUILDING, 1828). A) Fishing. B) Mollusk fishing. C) Fisherwoman carrying the product caught by the mangrove. Source: Ivo Raposo, 2018.
C) Processing. Source: Ivo Raposo, 2017.

non-guarantee of a quick sale, distance, and the difficult access of many communities. Santos and collaborators (2017), brings that the economic difficulties of shellfish farmers are because the sale of fish is not guaranteed due to the seasonality of production throughout the year, influenced by environmental factors, rainy season, and the flow of tourists in the region, often dependent on the middlemen, actors in the productive chain who profit most from the trade-in fish.

The middleman comes as capitalist pressure in the artisanal fishing, removing the autonomy of the fisherman responsible for all processes, submitting to urban-capitalist labor issues (Ramalho, 2010). In places where most fishermen depend on the fisher, other economic models, and the flow of the product is more difficult to perform (Capellesso and Cazella, 2013).

The trade by middleman occurs in all communities. The difference is how this relationship is established in each one. In the communities located closer to the beaches, the flow of the product is easier, especially in the summer period, which increases, and the tourists. However, in the communities that are closest to the mangroves and rivers, in which many have difficult access, this relationship with the middlemen may be marked by the imposition, setting up almost labor standards, resulting in an economic system marked by dependence between fishermen and middlemen. It is emphasized in the following speech: *"Almost anyone who fishes here sells to the middleman"* (Fisherwoman, 40 yrs.). This dependence relationship depends on the economic situation of the fisherwoman that needs the middleman. They don't have vessels or boat and the rent of this one cause this dependence. The fisherwomen need to make trade-offs to the middleman to sell the fish resource because there is a consequent impossibility of marketing production.

Middlemen end up being responsible for supplying boats, fuel, fishing equipment, and even ice, causing dependency for fisherwomen (Senapati and Gupta, 2017). In this way, middlemen contribute to the development of artisanal fishing, but they are also responsible for controlling activity in some locations

(Bailey *et al.*, 2016). Socioeconomic dependence of the artisanal fishermen with the middleman influences the sustainability of the artisanal fishery, influencing the socio-ecology of the fishery, needing a greater fortification of associations and cooperatives that allow the production flow ethically and sustainably (Nascimento *et al.*, 2017). These intermediation actions are of relevant importance in solving local problems, thus avoiding the mischaracterization of artisanal fishing. However, there are not normative by the RESEX to regulate the presence of middleman or the minimum price to sell the mollusks product.

Waste from artisanal mollusk fisheries. Most of the biomass weight of the mollusks refers to the shells, which are discarded on the sandbanks of the rivers and in the vicinity of the fisherwoman's homes (Figure 5). Unfortunately, there is no management or control plan for the discard of shell residue.

According to the fisherwoman, the shell residue can be used to make handicrafts, landfill holes in the nearby streets serving to civil construction (mixing crushed shells with cement). Another use is through the trade, which can be negotiated with the buyer the relationship between value and quantity.

Physical effort that comes from fishing for shellfish is mainly due to the high shell weight, which at the end of the processing process will be discarded, possibly causing the silting of the mangrove areas, suppression of the vegetation due to the accumulation of this material, strong odors and attraction of mosquitoes (Lima and Lopes, 2016). The authors also point out that this problem is a result of the lack of fishery management, as well as precarious places to carry out the processing.

Use of this residue can guarantee an increase in the income of these fisherwomen, resulting in sustainable fishing, since it does not generate a neglected discard. Complete closure of the productive fall, from the collection of mollusks to the use of shells, allows a new paradigm in this activity, making it more complex, but with greater profitability.



Figure 5. The residue of the artisanal fishing of mollusks in the Acaú-Goiana Extractive Reserve. A) *Anomalocardia flexuosa* (LINNAEUS, 1767). B) *Mytella guyanensis* (LAMARCK, 1819). C) *Crassostrea rhizophorae* (GUILDING, 1828). Source: Ivo Raposo, 2018.

The relationship between the kilogram of meat benefited and the kilogram of shells is not yet completely clear since there are variations regarding the time of year, locality, among other factors. An average found for the Goiana River was that for every 10 kg of *A. flexuosa*, it results in 800 gr of meat benefited (Silveira *et al.*, 2013). About the *C. rhizophorae*, 75% of its weight is due to the shells (Tenório *et al.*, 2014). This residue is rich in calcium carbonate (CaCO_3) and can be used for other purposes, adding profit.

When one thinks about the reuse of mollusks shells, craftsmanship is the main form of use, that on an individual level it is possible to add plus income, but one must analyze from two perspectives. The first perspective is about the amount of waste that is greater than the use for the manufacture of handicrafts, and the second perspective is to link to the fact that the many fishing communities are small and have not a tourist attraction, resulting in low profits. However, this craftsmanship should not be ignored, since it also represents resistance to a sustainable and artisanal activity, but this should not be the only action focused on this problem.

There are few initiatives to use shell residues. It has been found that shellfish woman already points to solutions for this problem, such as the use of lime and complement of poultry feed, as well as the use of street maintenance and wall decoration, as was described in the present study. The use of environmental education as a diffuser of socio-environmental practices that provide solutions to the issue of the use of bivalve fishery residue could be considered as the transforming agent necessary to modify the current situation (Oliveira *et al.*, 2016).

M. guayanensis shell can be used to produce lime, pesticides, feed, glass, medicine, and in construction, such as cement, ceramic blocks, concrete, and bricks (Oliveira and Lima, 2016). *A. flexuosa* shells have also been tested in the manufacture of bricks for the construction industry, being adequate according to the norms in force by the Brazilian Association of Norms and Techniques, being a viable alternative, adding income for entrepreneurs and the community, with a profit margin of 131% (Santos *et al.*, 2017).

C. rhizophorae shells can also be used for civil construction, with a 100% success rate in replacing fine and medium sand, with a reduction of up to 40% in the total cost of production, resulting in material rich in silicon (SiO_2 ; Tenório *et al.*, 2014).

There are several alternatives for the use of residues from artisanal mollusk fishing, however, it is necessary to manage this material, so that it is used, thus avoiding its disordered disposal. Partnerships must be established between the public and private sectors so that together the shells of mollusks can be used in a sustainable destination.

Women are present at all stages of the fishing productive chain, making it necessary to value and make visible their competence and importance in the socio-economic processes of artisanal fishing (Gopal *et al.*, 2020). It is necessary that fisheries policy and management aggregate gender inequalities in the fisheries sector linked to information about the performance of women in the production chain (Harper *et al.*, 2017).

Management of artisanal fisheries also sometimes neglects the role of women in decision-making moments, being necessary for their broad participation to promote ethical and sustainable management (Torre-Castro *et al.*, 2017). In other words, management must be participatory and inclusive to guarantee fishing sustainability allowing the breaking of paradigms, supported by structural male sexism, such as the binding of women only in fisheries carried out in the mangrove (Alonso-Población and Niehof, 2019).

CONCLUSION

Artisanal fishing for mollusks *Anomalocardia flexuosa*, *Mytella guayanensis*, and *Crassostrea rhizophorae* is mainly developed by fisherwomen. It requires a set of unique traditional and local ecological knowledge necessary for their development. Management and profitability will depend on several factors, such as the location of the community, the type of mussel's resources caught, frequency, fishing strategy, and processing mode. The knowledge and practices carried out by mollusk fisherwomen must

integrate the artisanal fisheries management processes, bringing relevant problems to the construction of the Management Plan for the Protected area, such as the adoption of strategies regarding commercialization for middlemen, and measures for the use of fishing residue.

It is necessary to value the work developed by the fisherwomen, demonstrating their importance for fishing, and registering their unique knowledge, in addition to encouraging the inclusion of women in the areas responsible for fisheries management.

It is important to emphasize the need to carry out studies on the populations of the mollusks, as well as on the use of the collection sites, allowing the total understanding of the artisanal fisheries processes in the Acaú-Goiana RESEX.

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