

## ANALYSIS OF ENVIRONMENTAL AND SANITARY KNOWLEDGE OF SHELLFISH GATHERERS IN VERGEL DO LAGO, MACEIÓ/AL-BRAZIL, BEFORE AND AFTER EDUCATIVE ACTION

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### ABSTRACT

Fishing and processing of sururu in Mundaú lagoon (Maceió-AL) are carried out in a precarious sanitary situation. In addition, their shells are improperly discarded, aggravating environmental problems. This study was carried out with the aim of analyzing the knowledge of shellfish gatherers about environmental issues before and after an educational action. Therefore, a social characterization of them was carried out, as well as an analysis of their previous knowledge about environmental issues and good practices in food processing, by interviews based on semi-structured questionnaires, made before and after the educational action. Almost all shellfish gatherers (96.43%) were women, with 60.71% having only incomplete primary education and a maximum monthly income of R\$400.00 for 82.15%. All respondents understand that pollution affects their community, 71.43% of them considering the Mundaú lagoon polluted, 67.86% pointing out that pollution affects sururu fishing, and 71.43% recognizing that it affects negatively the quality of the sururu meat. Regarding good food handling practices, it was found that although there is an understanding of them, not everyone adopts them. Data from the post-educational action show that the promotion of educational practices contributes to improving the sururu production model and environmental knowledge, mitigating the impacts of shell disposal.

Keywords: Good food handling practices. *Mytella falcata*. Shell flour. Training.

### ANÁLISE DO CONHECIMENTO AMBIENTAL E SANITÁRIO DE MARISQUEIRAS DO VERGEL DO LAGO, MACEIÓ/AL-BRASIL, ANTES E APÓS AÇÃO EDUCATIVA

### RESUMO

A pesca e o beneficiamento do sururu na laguna Mundaú (Maceió-AL) são realizados em situação sanitária precária. Ademais, suas conchas são descartadas de maneira inadequada, agravando os problemas ambientais. O objetivo deste trabalho consiste em analisar o conhecimento de marisqueiras sobre questões ambientais antes e depois de uma ação educativa. Foi realizada uma caracterização social, bem como uma análise de seus conhecimentos prévios sobre questões ambientais e boas práticas no processamento de alimentos, por meio de entrevistas com base em questionários semiestruturados, realizados antes e após a ação educativa. Quase todos os marisqueiros (96,43%) eram mulheres, 60,71% possuíam apenas o ensino fundamental incompleto e renda mensal máxima de R\$ 400,00 (82,15%). Todos os entrevistados entendem que a poluição afeta sua comunidade, 71,43% deles considerando a laguna Mundaú poluída, 67,86% apontando que a poluição afeta a pesca do sururu e 71,43% reconhecendo que afeta negativamente a qualidade da carne do sururu. Sobre as boas práticas de manuseio de alimentos, constatou-se que embora haja um entendimento, nem todos as adotam. Os dados da ação pós-educativa mostram que a promoção de práticas educativas contribui para aprimorar o modelo de produção do sururu e o conhecimento ambiental, mitigando os impactos do descarte de conchas.

**Palavras-chave:** Boas práticas de manipulação de alimentos. Farinha de conchas. *Mytella falcata*. Treinamento.

### INTRODUCTION

The fishing community that lives around Mundaú-Manguaba Estuarine-Lagoon Complex (CELMM - acronym in Portuguese), according to Coutinho et al. (2014), faces a series of social and economic

difficulties, performing informal and subsistence activities in a precarious environment. One of the main sources of income for people living around the CELMM is the fishing activity, especially the extraction of a mollusk popularly known as sururu (*Mytella falcata*) (D'ORBIGNY, 1846). This has not only great economic importance, but also enormous cultural importance for the population of Alagoas, so much so that in 2014, through Resolution No. 08/2014 (Alagoas, 2014) of the State Council of Culture (Secult - acronym in Portuguese), this bivalve mollusk was declared intangible heritage of the State of Alagoas. However, it is known that the processing to obtain the edible part is carried out in a precarious way, which can put consumers at risk, not to mention the inadequate disposal of shells, causing different sorts of problems due to the volume produced.

In a study conducted by Reis et al. (2016), the average meat yield of sururu was 50.30%; thus, to obtain one kilogram of meat (fresh) it would be necessary to collect approximately 2 kg of closed shells. In the shucking process, to obtain sururu meat, the shells are usually discarded in garbage containers placed by Maceió City Hall workers and also irregularly discarded around the CELMM, resulting in sanitary and environmental impacts. However, it is known that these shells are rich in calcium carbonates ( $\text{CaCO}_3$ ), which enables this raw material to be used in civil construction – making new materials (Santos-Filho et al., 2017), agriculture – for correction of acidic soils (Lo-Monaco et al., 2015) and livestock farming – production of mineral supplementation in animal feed, supplied to meat quail (Lana et al., 2020), among others.

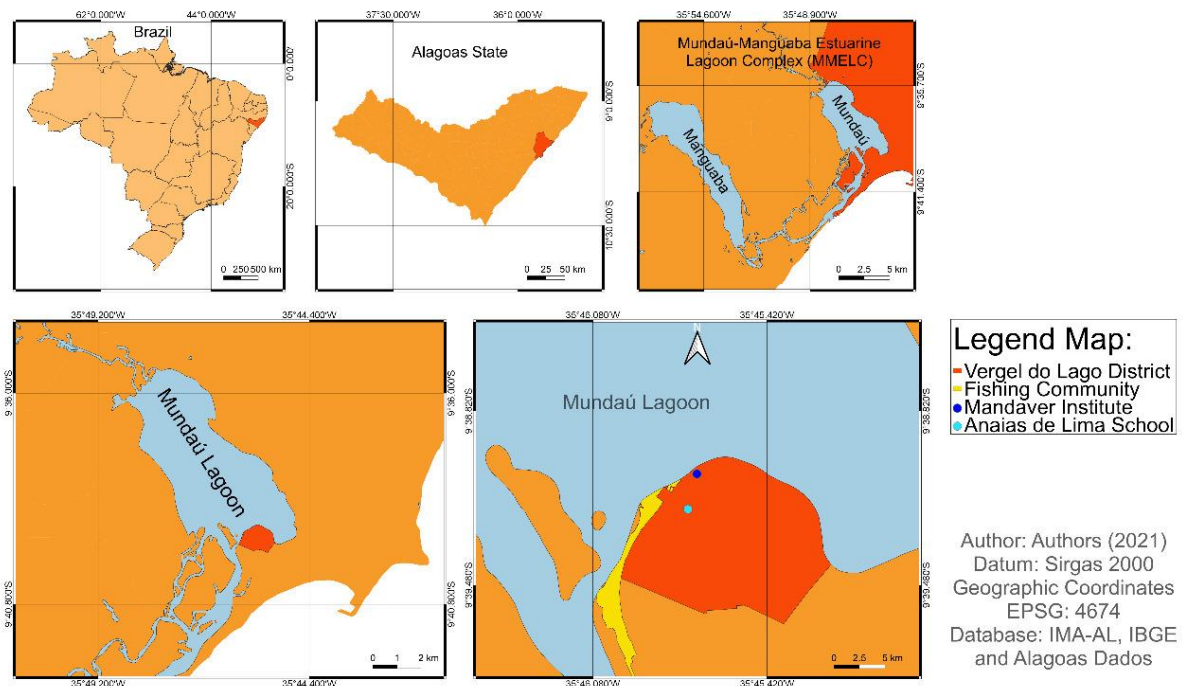
In addition to practical actions that prove the possibility of using sururu shells in other production chains, such as construction and agriculture, other actions can be carried out as alternative to contribute to the minimization of social and environmental impacts: promotion of environmental education and training of the population. In this context, Lima and Lopes (2016) highlight the importance of a certain degree of organization of those who work in fishing to reuse mollusk fishing waste, with the possibility of an alternative source of extra income for shellfish gatherers through the direct sales of this waste, hence generating a circular production chain from the shells. Thus, considering all these factors, in addition to studies that promote reuse of shells, the need for training shellfish gatherers and fishers in different aspects of their work is evident. Therefore, knowing the good practices of handling of sururu as food, understanding that sururu shells can be reused for income generation (stimulating circular economy), as well as understanding how environmental pollution interferes with fishing and the quality of the sururu produced, are issues that can help the community maintain its way of life.

Thus, this study was carried out with the objective of analyzing the degree of knowledge of shellfish gatherers in the region of Vergel do Lago, Maceió - Alagoas, about general environmental issues, related to the adequate processing of sururu and the possible uses of its shells, as coproducts of fishing, for income generation. In addition, an educative action was carried out to analyze the understanding of shellfish gatherers about the aforementioned issues after training, as well as the importance of the correct destination of sururu fishing coproducts and their possible uses.

## METHODS

All field activities were carried out in the neighborhood of Vergel do Lago, Maceió – AL (Figure 1), the interviews were conducted in the residences of shellfish gatherers near Mundaú lagoon and at 'Professora Anaias de Lima Andrade' State School, the short course was held at the headquarters of the MandaVer Non-Governmental Organization (NGO). All stages of this research met the recommendations of the Research Ethics Committee of the Federal University of Alagoas, with approval opinion nº 3.986.255.

Figure 1 - Places where activities with shellfish gatherers were carried out: Shellfish gatherers residences, Professora Anaia de Lima Andrade State School and MandaVer Non-Governmental Organization (NGO), Maceió - Alagoas, Brazil.



Source - Authors, 2021.

For the literature review, articles were selected in Google Scholar using the expressions “environmental perception”, “shellfish gatherers”, “fishers”, “good food handling practices”, “training of shellfish gatherers”, “use of sururu shells”, “*Mytella falcata*”, “socioeconomic characterization”, “shellfish gatherers”, and “Laguna Mundaú”, which were also used to create the questionnaire. The questionnaires before (N = 28) and after (N = 6) educative action were made through questions related to social characterization, environmental perception related to fishing, good food handling practices and possibilities of use of sururu shells.

The field research began with incursions to obtain initial knowledge of the fishing community, through guided visits carried out with the help of collaborators and volunteers of MandaVer NGO. This mediation was important to meet the shellfish gatherers and create the first links of trust. It was through this NGO that the target audience was accessed and mobilized so that the initial questionnaire was applied – pre-educative action (Figure 2 - A and B). The questionnaire was semi-structured and divided into four main segments, namely: 1. Initial characterization of the interviewees; 2. General perceptions related to fishing; 3. Good practices of sururu processing; and 4. Reuse of sururu processing waste. It is worth informing that all field activities were carried out before the Covid-19 pandemic.

The average duration of the interview with each shellfish gatherer ranged from five to fifteen minutes. During the application of this first questionnaire, the community involved with the sururu production chain was invited to participate in the short course “Good Food Handling Practices (GFHP) and Production of Sururu Shell Flour”, and those who were interested were enrolled, which totaled twenty-eight people. During the interviews, participants were asked what the best day for the short course was, and all mentioned Saturday morning as the most appropriate day for the activity.

After the interviews, the short course was planned and the presentation was prepared aiming at adapting the content to be addressed, as well as the language and method to the target audience. The central themes addressed in the short course were: food microbiology, biological, physical and chemical contamination of food, foodborne diseases, adequacy of good practices of sururu processing, in addition to shell flour production and its uses, mainly for soil pH correction and as ingredient for animal feed (fish).

Figure 2 - Application of pre-educational action questionnaires in sururu processing sites (A) and at the Professora Anaias de Lima Andrade State School (B), Vergel do Lago, Maceió – AL.



Source - Authors, 2020.

The short course offered lasted 4 hours. This educational activity was carried out in an expository way, with the aid of a multimedia projector. During this activity, an attempt was made to perform yarning circles, including the participants in the addressed themes with initial questions before presenting the topics, in order to reduce the distance between the speaker and the audience during the activity. Some of the questions asked by the lecturer were: “Do you know what good food handling practices are?”, “Why is it important to use good food handling practices?”, “What is food contamination?”, “What kind of contamination do you think may occur in the sururu production chain?”, “Where do you throw sururu shells after removing the meat?”, “What are the correct places where sururu shells should be discarded?”, “Can sururu shells be used for something?”, “Have you ever reused the shells instead of throwing them in the trash?”. Alternated with the expository part and the yarning circles, there were also some dynamic activities on GFHP (Figures 3A and 3B), such as hand hygiene, as well as the use of shell flour for soil correction.

Figure 3 - (A) Dynamic activity about hand hygiene on the left and representation of the use of shell flour to correct soil pH on the right (B).



Source - Authors, 2020.

After the expository class of the educative action, the interview was conducted using the specific semi-structured questionnaire for the moment after the educative action. The questionnaire also addressed questions about environmental perception related to fishing, good handling practices in sururu processing, as well as reuse of shells, viability of use and their applications. With this post-course questionnaire, the aim was to analyze whether the discussions held during the course helped to improve the understanding of shellfish gatherers on the proposed themes.

The data obtained with the questionnaires used to conduct the interviews before and after the educative action were tabulated in an electronic spreadsheet in Excel® to obtain the total answers for each question and to transform them into percentages, which made it possible to interpret the results using descriptive statistics.

## RESULTS AND DISCUSSION

### *Social characterization*

Table 1 shows the social aspects of the interviewees, such as gender, time in shellfish gathering activity, age group, housing, level of education, and family members who depend on sururu fishing and work in this production chain.

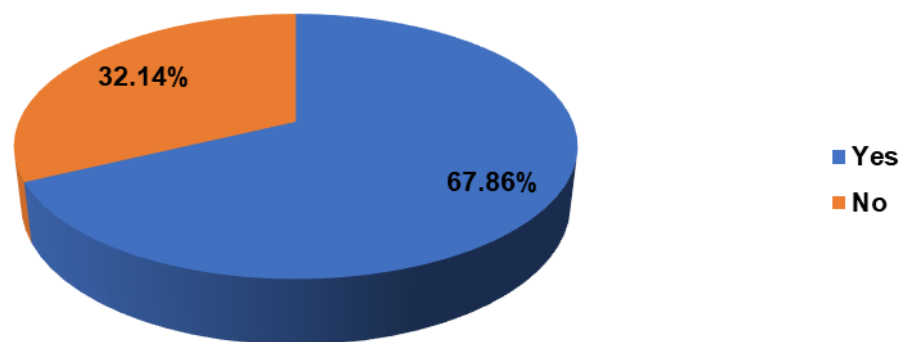
Table 1 - Social aspects of shellfish gathering workers of Vergel do Lago, Maceió-AL, Brazil.

Questions	Population	
	N	%
	28	100.00
<b>Gender</b>		
Female	27	96.43
Male	01	03.57
<b>Age group distribution</b>		
Younger than 18	01	03.57
18 – 20	01	03.57
21-30	05	17.86
31-40	09	32.14
41-50	06	21.43
51 years or older	06	21.43
<b>Education level</b>		
Never studied	02	07.14
Incomplete elementary school	15	53.57
Complete elementary school	02	07.14
Incomplete high school	04	14.29
Complete high school	04	14.29
Did not answer	01	03.57
<b>Have you always lived close to the lagoon?</b>		
Yes	21	75.00
No	07	25.00
<b>People who live in the same residence</b>		
Lives alone	03	10.71
01	04	14.29
02	05	17.86
03	05	17.86
04	05	17.86
05	02	07.14
More than 05	04	14.29
<b>Children</b>		
None	03	10.71
01	06	21.43
02	10	35.71
03	05	17.86
More than 03	04	14.29
<b>Time in shellfish gathering activity</b>		
Less than 1 year	01	03.57
2- 3	05	17.86
4-6	05	17.86
7-10	03	10.71
11-20	07	25.00
21-30	04	14.29
31-40	02	07.14
Did not answer	01	03.75

Source - Authors, 2020.

Of the twenty-eight interviewees represented in Table 1, 96.43% were female, having the most representative age group, between 31 and 40 years, and low level of schooling. According to the interviewees' reports, 53.57% have incomplete elementary school, and low educational level is a very common situation among fishing communities, which was also reported in several studies (NISHIDA, NORDI and ALVES, 2008; SANTOS; SAMPAIO, 2013; TAMANO et al., 2015) on professionals who practice artisanal fishing as source of income and survival. Even with the low level of education, 82.14% stated that they could read and write, 10.71% can be classified as functionally illiterate and 7.14% are illiterate. The low level of education is associated with their beginning in the shellfish gathering activity, still in childhood. A study conducted by Nishida; Nordi; Alves (2008) indicates that the need to assist in family income, the lack of stimulation to study, and the incompatibility between fishing and school schedules contribute to school dropout. In view of these circumstances, one can understand the low level of education among this group of professionals. Artisanal fishing is characterized as an activity that is passed down from generation to generation. In this context, we can affirm that this transmission of family knowledge also occurs with the population studied (Figure 4), as 67.86% of the interviewees reported that they had relatives working in the sururu production chain.

Figure 4 - Does anyone in the family relatives working in sururu production chain? (Data from shellfish gatherers interviews; N=28).

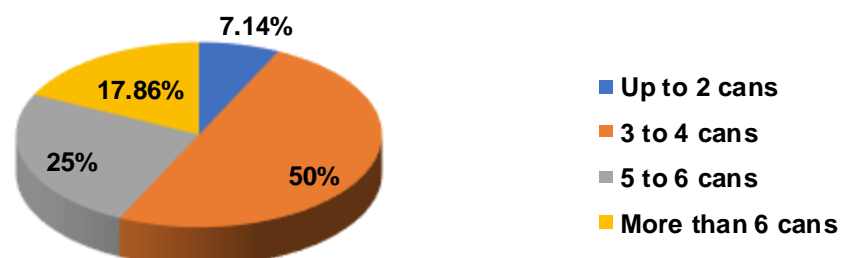


Source - Authors, 2020.

For being an activity with subdivisions of an arduous workday from the moment of extraction, cleaning and commercialization, the participation of family members results in a significant contribution to income generation. With the scarcity of offers of formal jobs and/or jobs with better remuneration, the income obtained by one or two people from the same family unit working in sururu fishing is not compensatory; it is a *sine qua non* condition for subsistence. Thus, the participation of other family members, whether adults or children, is fundamental, especially considering that this activity requires long working periods that commonly exceed eight hours a day, that is, they could hardly increase the amount of hours worked to earn higher pay.

Regarding the amounts of sururu processed by the shellfish gatherers, 7.14% of them process up to two cans, 50.00% of them daily process between three and four cans of sururu, 25.00% between five and six cans and 17.86% more than six cans (Figure 5).

Figure 5 - How many kilograms of sururu do you sell/extract?" (Data from shellfish gatherers interviews; N=28).

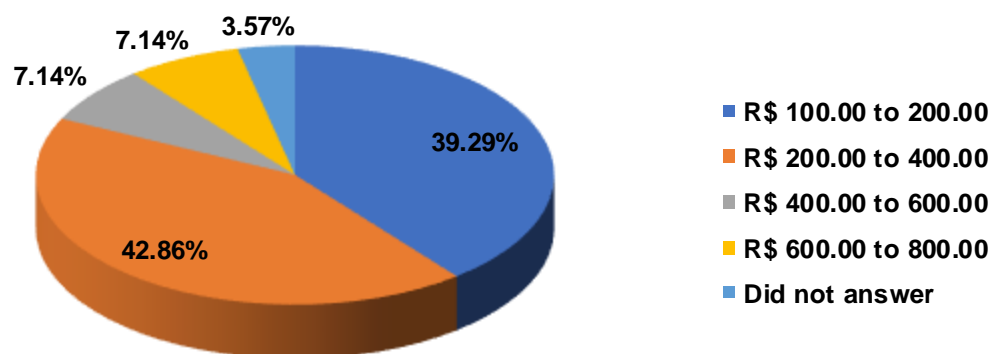


Source - Authors, 2020.

According to the shellfish gatherers, on average, each 18-L can full of whole sururus (in the shell), after processing, results in 2 kg of meat. Usually, shellfish gatherers work in pairs or groups and divide the amount of cans (equally), which corresponds to two cans per person per day. Considering that they work, on average, between 5 and 6 times a week, their weekly production would be 8 to 10 cans per person. Seasonally, production decreases because of climatic conditions that interfere with the reproductive cycle of sururu, which usually occurs during winter or prolonged rainy season. In the summer, sururu production and commercialization increases, especially in the Holy Week, a period in which sururu, as well as other fish, is highly sought after by the population. It is during this festive period that the families of shellfish gatherers and fishers try to increase the income as much as possible with the commercialization of sururu to compensate for periods of lower demand for the product, of lower production or disappearance of this mollusk from the lagoon, which often occurs. In these situations of reduced fishing production, social misery imposes an intense pace of work to generate more products for sale (PENA; FREITAS; CARDIM, 2011).

Among the interviewees, 42.86% profit monthly, with the marketing of sururu, between R\$ 200.00 and 400.00, 39.29% from R\$ 100.00 to 200.00, 7.14% between R\$ 400.00 and 600.00, while 7.14% earn between R\$ 600.00 and 800.00. Thus, as the minimum wage in September 2020 was R\$ 1,045.00, they do not earn a minimum wage with the activity (Figure 6).

Figure 6 - Monthly profit (R\$) from seafood harvesting? (Data from shellfish gatherers interviews; N = 28).



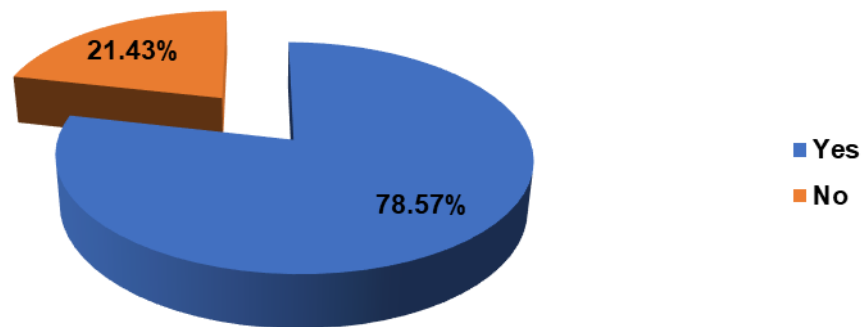
Source - Authors, 2020.

Costa et al. (2017) describe the remuneration of shellfish gatherers as the lowest in the entire production process of artisanal fishing, combined with poverty and social exclusion of producers, leading them to a situation of vulnerability. In many situations, all family members work in the sururu production chain to achieve, at least, the minimum income necessary for the family's subsistence.

The urban occupation of Mundaú lagoon consists of needy populations and, according to Araújo and Marisco (2018), since the 1970s, there has been a socio-spatial segregation in the region of low-income people migrating from the countryside of the State of Alagoas and other regions of the Northeast and Brazil in search of better living conditions. Also, according to the authors mentioned above, the natural residents of the capital of Alagoas are the ones who most occupied the surroundings of Mundaú lagoon. In the present study, 75.00% of the interviewees stated that they always lived near the lagoon, while 25.00% of them migrated from places far from the lagoon areas, as well as from municipalities in the countryside of Alagoas to the vicinity. The shellfish gatherers reported that they were born in municipalities such as São José da Tapera, Palmeira dos Índios and Rio Largo. The 25.00% of the population that did not live near the Mundaú lagoon are related to those 21.43% who have little experience in shellfish gathering, between two months and three years of experience in the activity (already represented in Table 1). It seems that they were driven by the lack of opportunity in the labor market and began fishing for these organisms, as this activity is considered of low initial investment cost and requires little training in fishing.

The shellfish gathering activity is the only source of income for 78.57% of the interviewees (Figure 7), and 21.43% stated that they were cleaning houses to supplement the income. Many seek sustenance in shellfish gathering when they are unemployed and, according to Nishida; Nordi; Alves (2008), this is due to the fact that there is little demand for capital investment and work commitment, which acts as an important point of flexibility until some activity outside the mangrove appears.

Figure 7 - Do you work only with shellfish gathering? (Data from shellfish gatherers interviews; N = 28).



Source - Authors, 2020.

When asked if they had already participated in some type of training involving the improvement of the sururu production chain, 67.86% of the research participants reported having never participated in any lecture, course or training related to the sururu production chain, and 32.14% of the interviewees commented that they had already participated in courses, some about handicrafts and decoration with pieces manufactured from sururu shells, while others participated in activities about good food handling practices.

### ***Environmental perception related to fishing***

Table 2 presents the results regarding the interviewees' knowledge on issues related to environment and fishing.

Table 2 - Perception of sururu gatherers of Vergel do Lago, Maceió-AL, Brazil, on environmental aspects related to fishing.

Questions	Population	
	N	%
	28	100.00
<b>Is environmental pollution harmful to your community?</b>		
Yes	28	100.00
No	00	0.00
<b>Is the lagoon polluted?</b>		
Yes	20	71.43
No	06	21.43
Did not know how to answer	02	07.14
<b>Does pollution affect or hinder sururu fishing?</b>		
Yes	19	67.86
No	07	25.00
Did not know how to answer	02	07.14
<b>Can fishing harm the environment?</b>		
Yes	06	21.43
No	22	78.57

Source - Authors, 2020.



All survey participants think that pollution is harmful to the fishing community, but many of them did not know clearly how pollution harmed their community. However, in their answers, problems related to pollution were commonly mentioned, such as: “accumulation of garbage on the streets”, “garbage thrown in the lagoon, which affects fishing and contributes to the death of fish/shellfish”, “garbage adhered to the sururu shells”, “bad smell due to garbage, which attracts diseases”, among others. It was possible to perceive, through the statements of the shellfish gatherers, that they identified the precariousness of basic sanitation in the region as one of the most impactful factors when reporting their conception of polluted environment and some of them recognized the shared responsibility between public power and community for cleaning and maintaining the locality.

Tamano et al. (2015) pointed out that the region where the fishers of Vergel do Lago live is considered to have one of the worst conditions of urbanization and sanitary sewage in the city of Maceió. As can be noticed when walking across Vergel do Lago, there are urban domestic effluents that cross the region, very close to the houses, and flow into Mundaú lagoon. Along with this problem, the inadequate disposal of waste from artisanal fishing, especially of sururu, amplifies the pollution of soil and water. The lack of sanitary education of residents and passers-by also contributes to the production of environmental and landscape impacts on the community.

About how they considered the lagoon, 71.43% of the interviewees stated that it was polluted, but the percentage of people who considered that pollution could hinder sururu fishing was lower, corresponding to 67.86% of the interviewees (Table 2). In their work, Tamano et al. (2015) reported that there is disposal of waste from slaughterhouses, pesticides from sugarcane plantations (predominant monoculture in the State of Alagoas), chemicals from adjacent industries, dead domestic animals and even the dumping of human bodies of people murdered or drowned in the Mundaú lagoon. What was described by these authors is also confirmed by the reports obtained during this field research. According to the shellfish gatherers, pollution is aggravated during rainy periods, which causes greater concentration of garbage in the lagoon, on its banks and surroundings.

In addition to pollution, another anthropic activity that contributes to the reduction of stocks of sururu and other aquatic animals is predatory fishing. Most of the interviewees (78.57%) do not attribute to fishing the capacity to cause harm to the environment, so only 21.43% understand that, depending on how fishing is carried out, disorderly or in a predatory way, this can affect their own livelihood. This environmental perception of shellfish gatherers linked to subsistence was reported by Monteles et al. (2009), who demonstrated that the environmental preservation awareness of shellfish gatherers is not based on an environmental foundation but on the survival of families who depend on sururu for commercialization and subsistence.

### ***Good practices of sururu processing***

The stages of the sururu production chain are divided into: fishing (extraction), with a pre-wash that begins in the lagoon, with the sururus still in the boat, to remove excess mud, steps that are usually carried out by men. Subsequently, the sururus are distributed to the women, who perform a detailed cleaning and separate the animals one by one, removing their byssus (a process locally called ‘despinicagem’). Then, the phase of full cleaning of the sururu is carried out, subdivided into: pre-cooking and sifting (shucking with separation of the remaining residues) and then bagged for commercialization. In this context, the interviewees were asked about good practices of sururu processing and the interference of pollution in its commercial aspects. Data of their knowledge are presented in Table 3.

Table 3 - General knowledge on good practices of sururu processing by shellfish gatherers of Vergel do Lago, Maceió-AL, Brazil.

Questions	Population	
	N	%
	28	100.00
<b>Does pollution affect (hamper) sururu meat quality?</b>		
Yes	20	71.43
No	07	25.00
Did not answer	01	03.57
<b>Is it important to wash hands prior to sururu processing?</b>		
Yes	20	71.43
No	07	25.00
Did not know how to answer	01	03.57
<b>Do you wash your hands before sururu processing (byssus removal)?</b>		
Yes	19	67.86
No	08	28.57
Did not answer	01	03.57
<b>Do you cook sururu using tap water or lagoon water?</b>		
Tap water	22	78.57
Lagoon water	03	10.71
Did not answer	03	10.71
<b>Do you process sururu (remove the byssus) with long or painted nails?</b>		
Yes	08	28.57
No	18	64.29
Did not answer	02	07.14
<b>Is it important to have short nails with no polish to process sururu (remove the byssus)?</b>		
Yes	25	89.29
No	02	07.14
Did not answer	03	10.71
<b>Can handling money during sururu processing (byssus removal) affect meat quality?</b>		
Yes	21	75.00
No	06	21.43
Did not answer	01	03.57
<b>Can eating or smoking during sururu processing (byssus removal) affect meat quality?</b>		
Yes	17	60.71
No	10	35.71
Did not answer	01	03.57
<b>Can sururu meat transmit any disease?</b>		
Yes	10	35.71
No	16	57.14
Did not answer	02	07.14

Source - Authors, 2020.

When asked if they believed that pollution affected the quality of sururu meat, 71.43% of the interviewees said yes and, according to reports of the shellfish gatherers, this has become increasingly frequent. They reported episodes in which the mollusks collected, after going through the

byssus removal process, were not suitable for commercialization. The shellfish gatherers correlated the pollution with the delayed or the reduced growth of sururu, as well as to problems in the formation of the shells, making them little resistant and brittle. Some of them expressed the perception that “without the protection of the shell, the sururu dies”. The stiffness of the shells stems from their composition of calcium carbonate crystals and, according to Silva; Silva; Sousa (2008), their formation depends largely on environmental conditions (temperature, availability of food, dissolved salts, etc.), as well as the internal conditions of the animal (health status, stress etc.). In addition to the problems with the shells, the increase in mortality and changes in color (loss of yellow tint and subsequent darkening), consistency (crumbling) and smell (rotten smell) of the meat during processing are also pointed out as resulting from pollution.

The knowledge of the shellfish gatherers about the importance of good hand hygiene for a hygienic processing of sururu was also investigated. About this, the question asked was whether they thought it was important to wash their hands before processing the sururu. Among the respondents, 71.43% reported that it is important to maintain hand hygiene. However, they pointed out that, in their conception, it would be important to wash hands only during the “pre-cooking” phase (to then put the edible part in the bag). For them, it was not important to sanitize their hands during the stage of byssus removal, because at this stage their hands are covered with mud; they describe their shellfish gathering work by saying that they remove “mud from the ‘little gut’ of the sururu”. This “little gut” to which they refer is the byssus, protein filament organ that serves for the mollusk to attach itself to the substrate. However, despite not finding it important, 67.86% of them said they washed their hands during the byssus removal stage. Camilo et al. (2016), when working with educational actions with shellfish gatherers from the Extractive Reserve (RESEX - acronym in Portuguese) Baía do Iguape – Bahia, identified that the presence of pathogenic bacteria such as *Escherichia coli* and *Staphylococcus aureus* in processed foods, such as sururu indicates post-processing food contamination. Also, according to the authors, a precarious hygiene of the hands during the handling of bivalves may be responsible for this type of contamination with pathogenic organisms.

Although most interviewees demonstrated to know the importance of performing the adequate hygiene of the environment where sururu is processed, it is possible to notice that many practice inappropriate actions for food handlers. According to Brasil (2004), based on resolution nº 216 of September 15, 2004, of the National Health Surveillance Agency (ANVISA - acronym in Portuguese), one should not smoke and use cell phone during food processing, and shellfish gatherers do so. The handling of objects, such as money, which serve as accumulation and transfer of pathogenic microorganisms during the processing of sururu and other foods, occurs during the sales, and is considered an inappropriate practice, according to the ANVISA resolution mentioned above.

Considering what is established in the legislation on GFHP and analyzing the sanitary perception of money handling during sururu processing, 75.00% of the interviewees considered that the combination of these actions, simultaneously, can affect sururu quality, and 60.71% considered that eating or smoking during the byssus removal activity are also harmful practices. The informal work carried out at the door of the residences and on the shores of the lagoon by the shellfish gatherers, associated with low level of education and schooling, are factors that contribute to the non-observance of the adoption of good food handling practices according to the ANVISA standards.

Another parameter of good food handling practices refers to the overall appearance of nails, such as length and use of polish. Among the female shellfish gatherers interviewed, 64.29% reported that they do not use long or painted nails to remove the byssus from the mollusks, 89.29% consider it important to have short and unpolished nails. However, according to reports, this reasoning is more linked to the fact that the nails break during shellfish gathering and cause pain than necessarily to the possibility of food contamination.

When asked about the origin of the water used during the pre-cooking of sururu, whether from the tap or the lagoon, 78.57% indicated using piped water, only when necessary, as they generally do not use water for this treatment. According to them, the moisture present in the mollusk is enough to cook them until the shell opens to remove the meat. 10.71% of the interviewees stated that they use water from the lagoon for this procedure. As many houses do not have piped water and basic sanitation is extremely precarious in Vergel do Lago region, shellfish gatherers reported using clean, piped water from a community house in the region. However, although most shellfish gatherers state that water

from the lagoon is not used for cooking prior to shucking, Tamano et al. (2015) reported having observed this practice, including on the shores near the point of release of domestic sewage.

Coutinho et al. (2014) revealed that 69.70% of the fishing community members stated that there was no contamination of the sururu fished in Mundaú lagoon and were afraid that the image of the lagoon contamination could be associated with sururu because, after all, they economically depend on its commercialization. Therefore, 57.14% of the interviewees believe that sururu meat does not transmit any disease, while 35.71% cited bacterial intestinal infections after consuming sururu, which is considered evidence of contamination. According to the interviewees, when the meat “is too crumbling”, it is an indication of its decomposition, when there may also be a bad smell.

Despite all the contamination, due to pollution, and the poor sanitary conditions during sururu processing, studies conducted by Nascimento et al. (2011) and Schmalz et al. (2018) found that, after the pre-cooking phase, described by the authors as heat treatment of sururu fished in the Mundaú lagoon under adequate hygiene conditions, microbiological contaminations decrease and fall within the range allowed for human consumption.

### ***Post-educative action questionnaire***

After scheduling the course previously with those who were interested, the twenty-eight shellfish gatherers were contacted on the day before by telephone to confirm the offer and ratify which of them would be present. Almost without exception, all of those who were on the initial list stated that they would participate in the intervention. However, on the day and time of the short course, given the reduced audience present, telephone calls were made to invite the shellfish gatherers again, and yet there were many absences. Among the justifications, the most common were the appearance of cleaning work, fatigue due to the shellfish gathering activity, which extended until in the early hours of the morning, and visits of relatives to their residences. Of the twenty-eight interviewees in the first stage of the study, only six participated in the short course (Figures 8A and 8B).

Figure 8 - On the left (A), the short course about Good Food Handling Practices and Shell Flour Production and, on the right (B), application of post-course questionnaire.



Source - Authors, 2020.

The information transmitted during the short course was adapted with language appropriate to the level of education of the shellfish gatherers. During the short course, there was disparity in the participation of shellfish gatherers; while some were very shy, others liked to participate and talk about their work with sururu. They seemed to be proud and aware of the cultural importance of showing their livelihood and work. Some were members of the Cooperative of Female Shellfish Gatherers Mulheres Guerreiras (COOPMARIS - acronym in Portuguese), which was still in its formation in Vergel do Lago region. They expressed their understanding on the adoption of GFHP, such as hygiene and product quality control, as they do in the cooperative, demonstrating awareness that the implementation of appropriate processing practices results in valorization of the final product.

The shellfish gatherers reported that, without having been processed according to the appropriate sanitary conditions, sururu is sold in stalls near their homes and in the public market of Maceió for R\$ 10.00. On the other hand, the sururu processed by them, following higher hygiene standards, as they

do in the cooperative, is sold for R\$ 16.00, being directed to a selected clientele, which is more concerned with the hygienic and sanitary quality of the food it consumes.

Table 4 shows a comparative diagnosis chart of the learning about environmental and sanitary perception before and after the educative action of the shellfish gatherers who participated in all phases of this study, identified with alphabetical letters (A, B, C, D, E and F).

Table 4 - Comparison of answers before (N = 28) and after (N = 6) educative action of the sururu fishing workers of Vergel do Lago, Maceió-AL, Brazil.

Participant	Is environmental pollution harmful to your community?	
	Before	After
A	Yes. Could not explain.	Yes. Even the sururu shell pollutes, attracts insects, drives away buyers, favors the appearance of diseases, and harms the people.
B	Yes. Bad smell, dirt.	Yes. It brings disease, rats, scorpions and cockroaches.
C	Yes. Air, health and lung problem caused by dirt in the city.	Yes. In the air, health and survival.
D	Yes. Could not explain.	Yes. It hinders sururu marketing.
E	Yes. Could not answer.	Yes. Due to the dirt.
F	Yes. Sururu fishing with washing using water that is dirty and polluted by the sewage in the lagoon.	Yes. Lack of cleaning disturbs the environment and the lagoon.
How do you identify if an environment is polluted?		
	Before	After
A	Garbage in beds, sururu shells being discarded in improper places.	Animal feces, organic waste, toxic products, chemicals, human waste, everything that is disposed of in the lagoon.
B	Garbage, bad smell.	When there is waste and garbage.
C	In a dirty environment, lack of hygiene, pollution in city, water, forests.	Bad smell, dirt and diseases.
D	Could not explain.	Garbage, vultures around.
E	Because of garbage and dirt.	Dirt.
F	Channels dumping sewage in the lagoon.	Because of sewers and garbage, garbage bags in the lagoon.
Does pollution affect (hinder) sururu fishing?		
	Before	After
A	It affects little. I do not know how it is possible to fish for sururu in such a polluted lagoon.	Yes. Rains and muddy water harm and kill sururu.
B	Yes. Color and taste of clam	Yes. Bringing disease to food and people
C	Yes. Garbage, waste, corpses and polluted water.	Yes. Survival and income of the population, well-being of the community.
D	Could not explain.	Yes. Dirt in the lagoon that adheres to the mollusk (syringe, plastic etc.).
E	Yes. Could not explain.	Yes. The marketing of sururu.
F	No.	Yes. Because of sewage and garbage.
Can sururu meat transmit any disease?		

	Before	After
<b>A</b>	No.	Yes. Diarrhea, intestinal infection.
<b>B</b>	Yes. Intestinal infection	Yes. When not well prepared, intestinal infection.
<b>C</b>	Yes. Diarrhea when not well prepared.	Yes. If not well prepared.
<b>D</b>	No.	Yes. Intestinal infection.
<b>E</b>	No.	No.
<b>F</b>	Yes. Bacterial diseases	Yes, but hygiene solves, kills bacteria. Only if you are not careful during cooking with flies and bacteria.

<b>Can sururu shells be used to improve income?</b>		
	Before	After
<b>A</b>	Yes. Handicrafts (making pieces with sururu shells, such as cup holders).	Yes. Handicrafts, feed, gravel, 'cobogó' (decorative block), compost.
<b>B</b>	Did not know how to answer.	Yes, making sururu shell flour and using for gardening, handicrafts.
<b>C</b>	Did not know how to answer.	Yes. Adornments, curtains, shell flour for fertilizer and feed.
<b>D</b>	Did not know how to answer.	Yes. Resale of shell flour to industries through the cooperative.
<b>E</b>	Did not know how to answer.	Yes. Shell flour for fertilizer.
<b>F</b>	Yes, but could not explain.	Yes, selling clean shells for fertilizer and feed.

Source - Authors, 2020.

When invited to answer the questions contained in the questionnaire prepared for the post-educative action investigation, they were afraid, as if they were going to take an exam and might not get correct answers, not meeting expectations. It was explained to all of them that there would be no right or wrong answer, that it was important for the research to understand whether this type of training would be the most appropriate for them, and that was the educative action that was being evaluated. With this, it was noticed that the shellfish gatherers felt more comfortable and none of them refused to continue participating in the study.

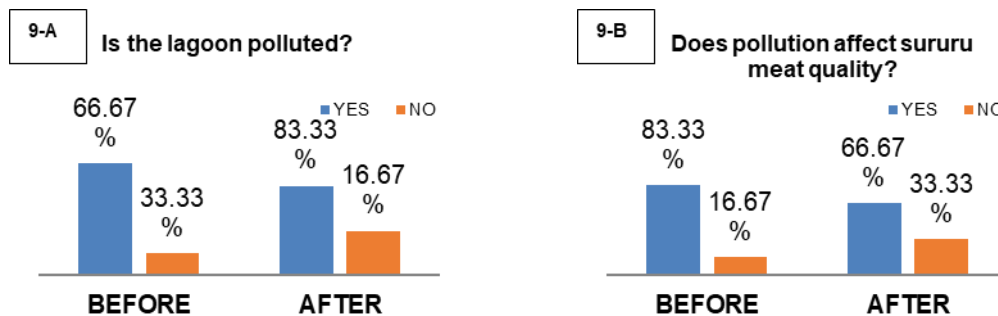
When analyzing the results obtained through the interviews after the educative action, it was possible to notice in the responses given by the course participants sentences such as: "pollution affects the environment and drives away buyers". In the pre-intervention interviews (performed with a larger number of shellfish gatherers: N = 28), this perception was rarely diagnosed, because they did not associate possible problems arising from pollution with something that could impair sururu commercialization.

In view of the results shown in Table 4, after the educative action, the objectives with the course were considered to have been achieved, as the shellfish gatherers were able to understand, among other topics addressed, how pollution can impact sururu fishing and commercialization and compromise their source of income. In this context, the effects of pollution on the marketing of mollusks is known and has already been reported by Pontinha (2012), who demonstrated that diseases transmitted by mollusks due to pollution are one of the factors of reduction in the value of the product, as well as in its acceptance by the consumer.

As seen in Figure 9A, there was an increase in the percentage of people who considered the lagoon polluted after the short course, but 16.67% still did not have this conception of the polluted lagoon, arguing that there are still fish, because "if it were polluted there would be no life there". The existence of aquatic life in the lagoon is related to the resistance of some species to survive in diverse environments, including polluted ones. Thus, the existence of life in the lagoon, as already mentioned, is related to the adaptability of different species to survive in anthropized environments, and the existence of fish does not mean that the lagoon is not suffering from human actions. It is known that

Mundaú lagoon undergoes the eutrophication process (Souza et al., 2004), which causes low oxygenation in the aquatic environment; however, at the current level, this is not enough to cause the “disappearance of life”, which would justify the above-mentioned report made by one of the shellfish gatherers. In addition, according to Silva-Castiglioni et al. (2012), intertidal mollusks (as well as crustaceans and other aquatic animals) can survive at low oxygen concentrations, since oxygen in the aquatic environment is 25 times lower than in atmospheric air. Therefore, these animals undergo physiological and biochemical adaptations that enable survival in aquatic environments with hypoxia.

Figure 9 - Questions (A) on the left and (B) on the right demonstrating percentages of the comparison of responses of shellfish gatherers before (N = 28) and after (N = 6) educative action.



Source - Authors, 2020.

In Figure 9-B, after the course, it was noticed that 66.67% of the shellfish gatherers understood that microbiological contamination of sururu may occur through contact with polluted water, either water from the lagoon or during processing. However, 33.33% of them reported that they believed there was no relationship between the pollution of the lagoon water and sururu quality. In the comparison of the results before and after the course, there was 16.66% increase in the number of people who stated that pollution does not affect sururu quality. Such increase is related to the report of one of the shellfish gatherers, who stated that even if the lagoon was polluted, the sururu would not be contaminated because, according to her, the “shell protects the meat”. According to Silva et al. (2010), mollusk shells are rigid exoskeletons and have the function of providing mechanical protection against predators and supporting the water pressure of the aquatic environment in which they live. However, the shell does not “protect sururus from pollution”, as described by one of the shellfish gatherers, since they are filtering bivalve mollusks and, during their feeding process, ingest particles suspended in the water at the bottom of the lagoon. Furthermore, for being sessile animals as adults, as they occupy position at the muddy bottom of the lagoon, which is where sediments, such as chemical and organic contaminants, accumulate, they are most subject to pollution.

All participants understand the appropriate place to discard the shells; however, one of the shellfish gatherers, which represents 16.67% of the interviewees, admitted discarding them in flower beds on the shores of the lagoon, although she knew it is wrong. Silva et al. (2010) stated that the shells of some mollusks can constitute about 70.00% of their weight and, as they are not used for human consumption, the disposal of large quantities causes environmental impacts, although their shells are not considered potentially hazardous waste. In the case of sururu shells, Tamano et al. (2020) performed a biometric analysis and determined that the weight of the shells may represent 43.90% of the mollusk weight and that, based on statistics from official fishing production agencies, 889,532.00 kg of shells were generated in Alagoas alone between 2001 and 2009. Although the official data are very inaccurate, quite underestimated, this demonstrates the potential for the generation of shell volumes. These shells, when disposed of improperly, they mix with household waste, increasing their volume, accumulate water, the residues of soft parts rot and thus attract vectors and become the focus of contamination and transmission of diseases to people. According to Prefeitura de Maceió (2019), 6 Ton of sururu shell is collected daily in the Vergel do Lago region, which represents 5% of the total volume of waste collected in Maceió, considering all that is sent to the municipal landfill, which demonstrates the importance of studies that mobilize people for actions to reuse the shells.

After the course, it was possible to notice that the shellfish gatherers understood the importance of correctly disposing of this waste from the sururu production chain, which goes beyond the preservation

of the environment through the disposal in the landfill. They could understand that other uses for shells are possible, some of them are more common and some people in the community already do, such as production of handicrafts and pots for plants, and others that were new to them, such as the use in the pharmaceutical industry, in the correction of soil pH, in animal feed, among others, being a possible source of income generation.

With regard to the offers of educational activities, Costa et al. (2012) highlight the importance of conducting workshops of good food handling practices, called by the authors Good Manufacturing Practices (GMP), because they are low cost and of simple application, as the method that is designated by handlers with the sanitary conditions of the food production chain affects the commercial value of the final product. In the case of the educative action described in the present study, it is possible to consider it a valid action, because it brought the academy closer to the production sector, promoting mutual learning. If, on the one hand, it was possible to instruct the shellfish gatherers to better understand the importance of hygiene care in sururu handling and the effects of pollution on the production chain, besides demonstrating the viability of using shells for the composition of their family income, on the other hand they were able to demonstrate the local knowledge about the fishing, processing and marketing of sururu.

## FINAL CONSIDERATIONS

We conclude that shellfish gathering is the most fragile stage of the sururu production chain, being predominantly composed of women with low level of schooling and low income who seek their source of subsistence in the marketing of sururu.

In view of the data presented, we identified that the socio-environmental aspects related to sururu fishing act in the reduction of its availability, a phenomenon caused by two factors: overexploitation and pollution, with the first factor resulting from negligence in terms of environmental education for communities, which leads to little knowledge on the reproductive biology of aquatic animals by fishers and shellfish gatherers, so that there is no time to replenish the stocks. Another factor is pollution, which originates from the local population, passers-by and which is mainly intensified by the lack of action of the public authorities in the region.

The pollution of Mundaú lagoon results in the loss of sururu quality and work overload of shellfish gatherers. Therefore, we understand that it is necessary to strengthen the cooperative of shellfish gatherers in the region, aiming to improve the quality of work of these women and the mollusk sold, through the dissemination of educative actions in the community aimed at environmental education focused on the biology of aquatic animals of commercial importance, as a way to induce environmental conservation, good food handling practices and alternatives for the use of shells as a way to propagate sustainability in the region, an important factor to reduce the high rates of waste of raw material from shells, and generate an extra source of income for sururu handlers. In addition, it is necessary to implement management plans for sururu and for infrastructure and sanitation in the region, considering that this mollusk is an intangible heritage of Alagoas and has wide distribution and consumption in the State.

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