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Checklist application to evaluate good management practices in aquaculture

Aplicação da lista de verificação para avaliar boas práticas de manejo na aquicultura

Aplicación de la lista de verificación para evaluar buenas prácticas de gestión en acuicultura

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Abstract

The objective of the study was to evaluate good management practices through a Checklist for aquaculture enterprises in the Marajó archipelago (Pará, Brazil). The research was carried out in the municipality of Curralinho, as part of the actions of the project "Transfer of technology through training and technical assistance for creators of tambaqui, *Colossoma macropomum*, in the archipelago of Marajó/PA" of the Federal Institute of the Pará (IFPA), *Campus* Breves, between September 2019 and January 2020. A total of 13 fish farms participated in the survey. The instrument for data collection was a checklist, which includes items related to the management of fish farming. After applying the checklist, it was possible to identify that the implementation of fish farming, identification of infrastructure, soil management and application of limestone, occurrence of diseases and storage of fry, presented levels of non-conformities between 75% to 79%. The items filters and anti-leak prevention, handling during the process of draining the tanks, stocking density and handling of fishing, presented levels of non-conformities between 80 - 89%. For the item soil disinfection the level of non-conformities was 94% and for the items: fertilization, protection of tanks with anti-bird nets, water quality, biometrics management, transfer management, cleaning procedures and equipment asepsis and the condition and safety of fish farming workers, presented levels of non-conformities varying between 95

- 100%. It was concluded that all sites are not suitable for good practices and therefore put the species' fish farming in the region at risk.
Keywords: Aquaculture assessment; Checklist; Diagnostic method; Eastern Amazon; Validation studies.

Resumo

O objetivo do estudo foi avaliar as boas práticas de manejo por meio de uma Lista de Verificação para empreendimentos de aqüicultura no arquipélago do Marajó (Pará, Brasil). A pesquisa foi realizada no município de Curralinho, como parte das ações do projeto "Transferência de tecnologia por meio da capacitação e assistência técnica para criadores de tambaqui, *Colossoma macropomum*, no arquipélago de Marajó/PA" do Instituto Federal do Pará (IFPA), *Campus* Breves, entre setembro de 2019 e janeiro de 2020. Ao todo, 13 pisciculturas participaram da pesquisa. O instrumento de coleta de dados foi um *checklist*, que inclui itens relacionados ao manejo da piscicultura. Após a aplicação do *checklist*, foi possível identificar que os itens implantação da piscicultura, identificação de infraestrutura, manejo do solo e aplicação de calcário, ocorrência de doenças e armazenamento de alevinos, apresentaram níveis de não conformidades entre 75% a 79%. Os itens filtros e prevenção anti-vazamento, manuseio durante o processo de drenagem dos tanques, densidade de estocagem e manejo da pesca, apresentaram níveis de não conformidades entre 80 - 89%. Para o item desinfecção de solos o nível de não conformidades foi de 94% e para os itens: fertilização, proteção de tanques com redes anti-pássaros, qualidade da água, gerenciamento biométrico, gerenciamento de transferência, procedimentos de limpeza e assepsia dos equipamentos e o estado e segurança dos trabalhadores da piscicultura, apresentaram níveis de não conformidades variando entre 95 - 100%. Concluiu-se que todos os locais não são adequados para boas práticas e, portanto, colocam em risco a piscicultura da espécie na região.
Palavras-chave: Avaliação da aquicultura; *Checklist;* Método diagnóstico; Amazônia oriental; Estudos de validação.

Resumen

El objetivo del estudio fue evaluar las buenas prácticas de gestión a través de una lista de verificación para empresas acuícolas en el archipiélago de Marajó (Pará, Brasil). La investigación se realizó en el municipio de Curralinho, como parte de las acciones del proyecto "Transferencia de tecnología mediante capacitación y asistencia técnica para creadores de tambaqui, *Colossoma macropomum*, en el archipiélago de Marajó/PA" del Instituto Federal de Pará (IFPA), *Campus* Breves, entre septiembre de 2019 y enero de 2020. En total, 13 piscifactorías participaron en la encuesta. El instrumento de recolección de datos fue una lista de verificación, que incluye ítems relacionados con el manejo de la piscicultura. Luego de la aplicación del checklist, se pudo identificar que los ítems implantación de piscicultura, identificación de infraestructura, manejo de suelos y aplicación de calizas, ocurrencia de enfermedades y almacenamiento de alevines, presentaron niveles de no conformidades entre 75% a 79%. Los ítems filtros y prevención de fugas, manejo durante el proceso de drenaje de los tanques, densidad de población y manejo de pesca, presentaron niveles de no conformidades entre 80 - 89%. Para el ítem desinfección de suelos el nivel de no conformidades fue del 94% y para los ítems: fertilización, protección de tanques con redes anti-aves, calidad del agua, manejo biométrico, manejo de transferencia, procedimientos de limpieza y asepsia de equipos y el estado y seguridad de los trabajadores de la piscicultura, presentaron niveles de no conformidades que variaban entre el 95 - 100%. Se concluyó que todos los sitios no son aptos para buenas prácticas y, por lo tanto, ponen en riesgo la piscicultura de la especie en la región.
Palabras clave: Evaluación de acuicultura; Lista de verificación; Método de diagnóstico; Amazonia oriental; Estudios de validación.

1. Introduction

Aquaculture is already responsible for a large part of the supply of fish to the world population (FAO, 2018; Rahman et al., 2019; Akter et al., 2020). The Amazon has enormous potential for the development of aquaculture (Silva et al., 2018; Medeiros et al., 2017). The water potential of the region, the favorable climate and the geographical condition, are the essential factors for the growth of the activity (Dantas et al., 2019; Ferreira et al., 2020).

In the State of Pará, fish farming is in full development, being an activity practiced by small, medium and large aquaculture farmers. It is worth noting that this activity has also been carried out by family farmers, extractivists and riverside residents (Aizawa et al., 2014; Zacardi et al., 2017). Fish farming is practiced in several municipalities, from subsistence to large producers, with production focused on the interstate market (De-Carvalho et al., 2013), including in the Marajó archipelago. Fish farming contributes to rural development, enabling economic returns to producers, collaborating in job creation, optimizing the natural resources existing on farms and with a strategy for fixing rural people (Cantisani et al., 2015).

The native fish most produced in Marajó aquaculture is the tambaqui (Colossoma macropomum Cuvier, 1818), due to

the wide availability of fry throughout the year, to the complete mastery of their artificial reproduction, growth potential, high productivity, rusticity, acceptance of food in captivity and good acceptance by the population (Araújo & Goulding, 1998). Among the main municipalities in western Marajó, there is Curralinho, which has this culture in several rural communities, where there is a shortage of literature on the history of Good Management Practices (BPM) in fish farming.

In this context, it is important to develop a tool capable of thoroughly evaluating the correct conditions for handling fish and that can serve as a basis for future studies. Among the ways to diagnose the real conditions of their production systems, the food industries and companies from different branches, use a checklist (checklist) to monitor the compliance levels of their production process (Silva et al., 2017; Cardoso et al., 2019; Jacudi & Ferreira, 2019). Given this, adapting this assessment instrument for aquaculture becomes relevant, as it will make it possible to trace the initial profile of these aquaculture enterprises and monitor the improvement that has occurred as a result of interventions such as training, technical assistance and rural extension.

Thus, understanding the BPM in fish farming allows us to have an overview of the system, which will help in the development of strategies and promote the integration of the activity (Mercante et al., 2011; Queiroz & Rotta, 2016). Given the above, the objective of the present study was to use a Checklist to assess the BPM conditions in aquaculture projects in the archipelago of Marajó, Pará, Brazil.

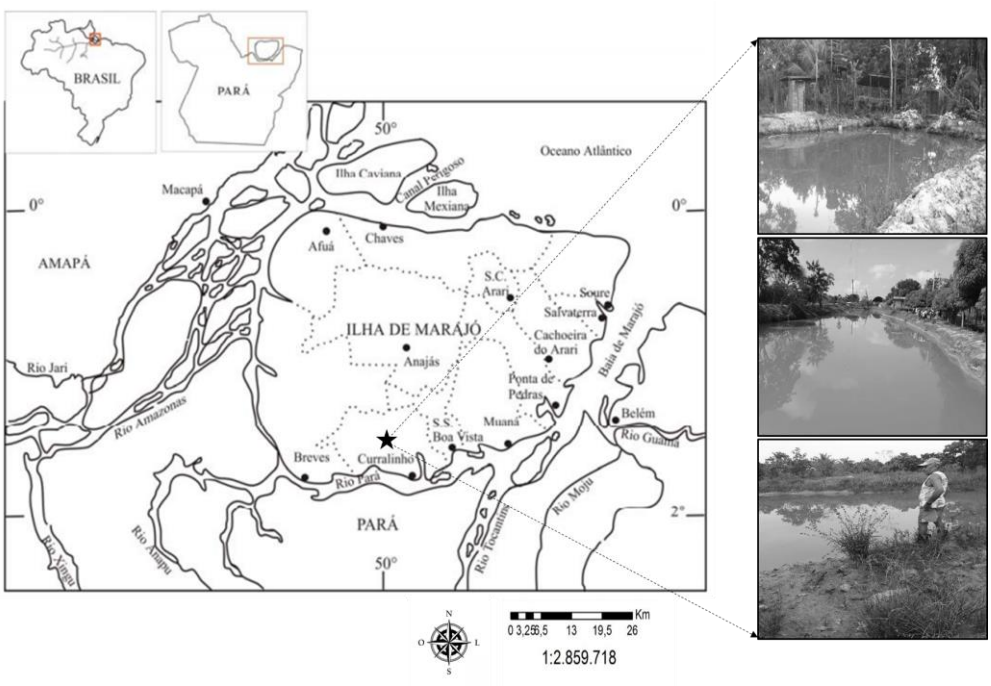
2. Material and Methods

2.1 Study area

The study was carried out on 13 aquaculture properties in the Marajó archipelago, in Curralinho, Pará, Brazil (Figure 1). Marajó is located on the Amazon coast (Amaral et al., 2012), which comprises 16 municipalities, which make up the micro-regions of Arari (Cachoeira do Arari, Chaves, Muaná, Ponta de Pedras, Salvaterra, Santa Cruz do Arari and Soure), Furo de Breves (Afuá, Anajás, Breves, Curralinho and São Sebastião da Boa Vista) and Portel (Bagre, Gurupá, Melgaço and Portel).

The hydrography of Marajó is composed of drainage networks of recent channels, such as: basins, channels, meanders, lakes and streams, among which the Amazon, Pará, Anapu, Jacundá and Anajás rivers stand out, with their numerous affluents. Curralinho has a territorial extension of 3,620,279 km2, its population is estimated at 33,893 people for 2018 (IBGE, 2010). Most of this population is riverside, due to the city being surrounded by rivers and islands, especially fishermen, extractivists, aquaculture and family farmers.

Figure 1 - Location of the study area, indicating the municipality of Curralinho, Archipelago of Marajó, Pará, Brazil.



Source: Adapted from Furtado et al. (2007).

2.2 The extension project

The project "Transfer of technology through training and technical assistance for creators of tambaqui, Colossoma macropomum in the archipelago of Marajó/PA" was funded by the Pro-Rector of Extension and External Relations (PROEX) of the Federal Institute of Education, Science and Technology of the Pará (IFPA), under notice number 03/2019. The project called "Piscicultura Marajoara" was conducted by teachers and students from the Federal Institute of Education, Science and Technology of Pará (IFPA), *Campus* Breves. The duration of the project was from August 2019 to January 2020.

2.3 Development of the checklist

For the creation of the Checklist, the manual of good production practices in fish farming, developed by Ushizima et al. (2016), addressing 22 important points, presented in Table 1.

Table 1 - Points verified in the checklist in a fish farming enterprise in the archipelago of Marajó, Pará, Brazil.

1) Implementation of fish farming;	**12)** Storage density;
2) Water supply for fish farming;	**13)** Feed storage and analysis;
3) Isolation of the fish production area;	**14)** Food management;
4) Infrastructure identification;	**15)** Water quality;
5) Maintenance of fish farming and property;	**16)** Occurrence of diseases;
6) Filters and anti-leakage prevention;	**17)** Storage of fry;
7) Soil management and limestone application;	**18)** Biometrics management;
8) Soil disinfection;	**19)** Transfer management;
9) Handling during the draining process of the t	**20)** Management of fishing;
10) Fertilization;	**21)** Equipment cleaning and asepsis procedures;
11) Protection of tanks with anti-bird nets;	**22)** Condition and safety of fish farming workers;

Source: Field research (2020).

The result of the application of the Checklist provided an overview of the conditions of good management practices for fish farming, by groups, similar to the classification attributed by RDC nº 275, of October 21, 2002/ANVISA, when using the Checklist for the food industry (Brazil, 2002), in this case adapted for aquaculture enterprises:

- Group 1: Management conditions with low risk for fish farming - 76 and 100% of attendance of other items;
- Group 2: Management conditions with medium risk for fish farming - 51 to 75% of attendance of other items;
- Group 3: Management conditions with high risk for fish farming - 0 to 50% of attendance of other items.

At the end of the Checklist, the respondent was asked to sign the Free and Informed Authorization Form stating his knowledge of his participation in the research. To continue the study, after the completion of each Checklist, the interviewee was asked to indicate other fish farmers in the community/municipality to contribute to the study, according to the "snowball" interview method (Bailey, 1982). The identities of the participants were kept confidential, guaranteeing their anonymity and confidentiality of the information. This study was approved by the Research Ethics Committee of the Institute of Health Sciences (CEP) of the Federal University of Pará (UFPA), registration number 2.576.907.

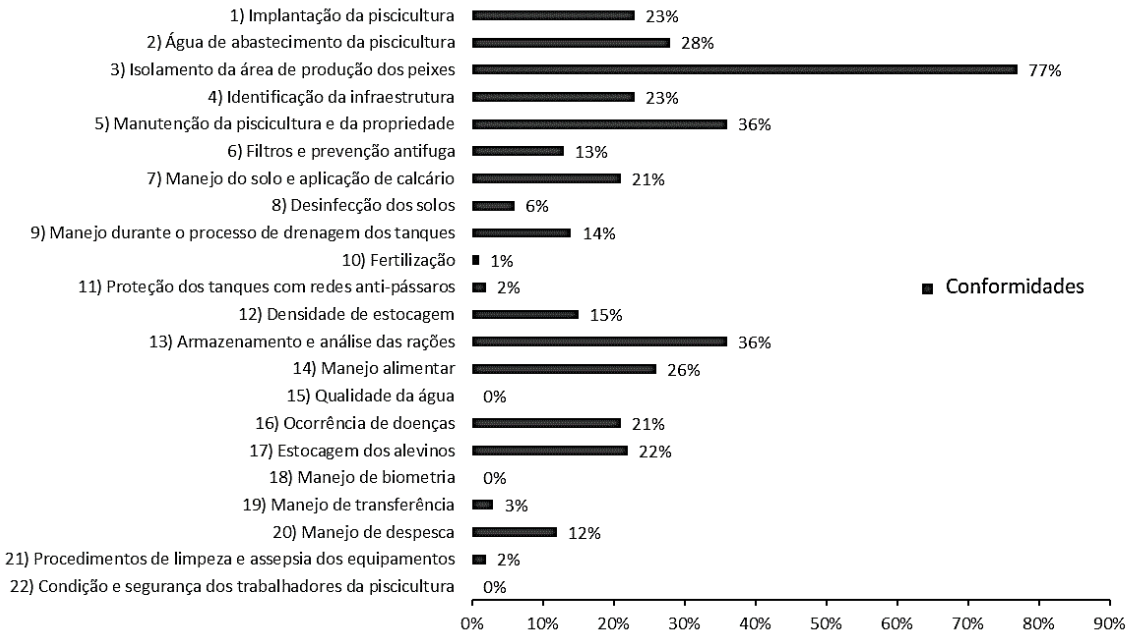
2.4 Data analysis

The data collected were grouped, tabulated and analyzed using descriptive statistics (Oladejo, 2010).

3. Results

Figure 2 shows the percentages of conformities for each item evaluated. Item 3 was the only item with a high percentage of compliance (77%). However, inadequate organization of chemicals was a non-conformity, being evidenced in this item. Items 5 and 13 showed levels of compliance of 36%. Among the main problems found, we can mention the presence of decomposing materials in the nurseries, the absence of protective screens at the entrance and exit of the water, the presence of invasive fish and inadequate feed storage.

Figure 2 - Percentage of conformities in fish farming enterprises in the Marajó archipelago, Pará, Brazil.



Source: Authors.

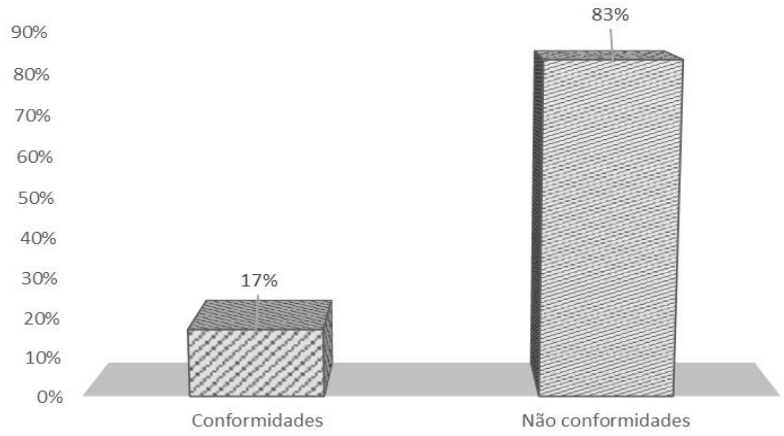
Items 1, 2, 4, 7, 14, 16, and 17 showed 21 to 28% of conformities. The main problems were identified: the lack of authorization for the activity with the environmental agencies, the failure to carry out prior analysis of the soil and water, the irregular construction of the nurseries due to the lack of technical monitoring, the absence of protection against runoff in the nurseries, the lack of protection of the rivers, the lack of information boards for the location of the sectors, the absence of the application of limestone in the soil, the inadequate use of the feed for the fish breeding phase in addition to irregular feeding, the excessive use of feed in the pond, the lack of adequate control of fish health and the lack of adequate procedures for acclimatizing fish.

Regarding items 6, 9, 12, and 20, compliance varied from 12 to 15%. In these items, the main inadequacies are related: the non-verification of the transparency of the water, the failure to perform the water renewal, the absence of drainage of the nurseries, the non-compliance with the water retention time, the inadequate performance of the water renewal, the lack of control of the fish density, the absence of anti-leak filters, the disordered distribution of the ponds, by stages of creation and the fasting of the fish is not carried out.

Finally, the items that presented the lowest levels of compliance (0 to 6%) were mainly: 8, 10, 11, 15, 18, 19, 21 and 22. The absence of disinfectant application to the soil, the non pH control, the absence of the application of manure, the absence of an anti-bird protection screen, the presence of terrestrial animals, the absence of physico-chemical analyzes of the water, the absence of fish biometrics, the disrespect of fish fasting for handling, the lack of application of salt for handling, inadequate hygiene of handling materials, absence of personal protective equipment (PPE) and training of aquaculture farmers, were the main problems detected.

Regarding the general assessment of the aquaculture enterprises studied, it was possible to observe that they presented only 17% of conformities (Figure 3), being classified in group 3 (high risk).

Figure 3 - General percentage of conformities and non-conformities in fish farming enterprises in the Marajó archipelago, Pará, Brazil.



Source: Field research (2020).

4. Discussion

In the present study, it was observed that producers practice aquaculture without legal authorization. The properties do not have an environmental license or grant the right to use water and do not have the Rural Environmental Registry (CAR). These results are similar to those found by Dotti et al. (2012) when studying fish farming in the municipalities of Dourados, Fátima do Sul, Vicentina and Itaporã, in Mato Grosso do Sul (Brazil), where the survey revealed that the majority of aquaculture farmers (90%) work without regulation. Unlike what reported by Barros et al. (2011), who, when characterizing fish farming in the Baixada Cuiabana micro-region, in Mato Grosso (Brazil), observed that 100% of aquaculture enterprises had authorization and 87.5% received technical support in the implementation of the project. Possibly, this setback observed between studies may be related to the lack of technical assistance for aquaculture farmers before the start of activities in the implementation of the project. The absence of filters, protection of ponds with anti-bird nets and anti-leak prevention in fish farms compromises the smooth running of the activity, as observed in the present study. These findings were similar to the results of Brito et al. (2017) when analyzing fish farming in Capitão-Poço, in Pará (Brazil), where they observed that only 35.33% of the enterprises met this requirement.

In Marajó, the main source of supply for the excavated ponds is with water from the rivers. The use of a mechanical filter to capture water in nurseries is important to prevent the entry of larger particles or undesirable organisms (Crepaldi et al., 2006). The floods that can carry solids and contaminates and the distancing of the nurseries from the rivers are problems observed in this research related to the water supply of the fish farms. According to Martins (2004), the observation of the water source and the path it takes to reach the nurseries is extremely important. Care during these processes can prevent contamination by chemical and organic waste, such as animal and human excreta.

In the present study, the only item that showed expressive compliance values was the “isolation of the fish production area”, demonstrating that the production area is within the recommendations in relation to isolation. For Crepaldi et al. (2006) the proper location of production systems for fish farming is of fundamental importance for guaranteeing the quality of the fish produced and reducing the chances of contamination. On the other hand, the presence of decomposing organic matter in the nurseries, are among the main problems observed. Such results were also found by Ribeiro-Neto et al. (2016) when studying extensive family fish farming in the Baixo Rio São Francisco region, in Sergipe (Brazil).

The non-use of limestone in the nurseries for correct soil management was a problem in this research. Different results were found by Barbosa & Lima (2016), when they evaluated fish farms in Presidente Figueiredo, in Amazonas (Brazil),

observed that 100% of aquaculture enterprises use limestone in the preparation of the nurseries. We also identified that the absence or inadequate disinfection of the soil was an evident problem in this study. Ushizima (2016) state that the use of appropriate disinfection products eliminates possible pathogenic organisms present in the soil, corrects the pH and fertilizes the water. In addition, in a dry nursery, calcium oxide - CaO (quicklime) is applied to further disinfect it.

Failures were also observed during the draining process of the nurseries. This represents a major production and health problem, since it is not possible to drain the organic matter or disinfect the nurseries. This fact harms water quality and fish development (Rodrigues et al., 2013). Another negative effect is artificial eutrophication, with the discharge of effluents (Macedo & Sipaúba-Tavares, 2010), altering biodiversity (Henares et al., 2011). Such precautions are essential, due to the generation of organic matter from the addition of fertilizers, fish excretion and uneaten feed waste, which are deposited at the bottom of the ponds (Hussar et al., 2005). For Zaniboni Filho (1997), there are several alternatives for the treatment of fish farming effluent, such as: use of aerated ponds, treatment through beds with aquatic macrophytes, use of evaporation ponds and even the agricultural use of said wastewater.

The stocking density and diseases in fish are considered high in the enterprises of the present study. Fish raised at low densities can accumulate more fat, due to the greater supply of feed and less competition for food (Lazzari et al., 2011). However, low density leads to an underutilization of space for fish farming (Piaia & Baldisserotto, 2000). At high densities, there is a greater chance of stress and its effects on the immune system (Salaro et al., 2003) and a greater probability of degradation of water quality (Jobling, 1994). Possibly, the appearance of animal diseases is related to storage rates in Marajó. The best density varies according to the species, fish size and cultivation system (Lazzari et al., 2011).

In the present study, producers do not take the fish breeding phase into account when supplying feed. In most properties the amount of feed distributed in the nurseries is not controlled. Expenditures on feeding fish can correspond to 60 to 80% of the total production costs (Pereira Filho, 1995). Thus, it is necessary that the food is administered in a way that the cost is minimized. The feeding of the fish must be according to the stage of development (larvae, post-larvae, juveniles or adults). Similar results were reported by Castellani & Barrella (2005), in fish farms located in Vale do Ribeira, São Paulo (Brazil). Unlike the findings by Brabo et al. (2017), evaluating fish farming in Juruti, Pará (Brazil). Regarding food management, 70% of producers supplied commercial feed and agricultural by-products and 30% used only feed. We observed in the present study that there are flaws during the storage and analysis of the feed. They are stored without protection inside the homes of fish farmers. It is worth mentioning that for correct handling, the feed must be stored in an appropriate place, with ventilation and without the presence of water (dry place), protected from rodents and other animals. Stacked on pallets, without contact with the floor, thus preventing moisture absorption.

The lack of fertilization and water quality analysis was a frequent non-compliance in the studied enterprises. According to Kubitza (1998), the dissolved oxygen and temperature parameters must be checked daily in each production nursery. For tropical fish, the ideal is a concentration above 3.0 mg / L (Ostrensky & Boeger, 1988). Ideal temperatures that provide greater thermal comfort between 26 ° C to 30 ° C for tropical fish (Teixeira, 1997). The other parameters such as pH, ammonia, nitrite, nitrate and phosphorus in inadequate conditions, will cause problems in the creation, leading the fish to death (Sipaúba-Tavares, 2016). In a study of fish farms in the North Coast of Rio Grande do Sul (Brazil), only 25% of the sites had periodic physical and chemical analyzes (Bassani & Rocha 2020). The constant monitoring of the water allows to verify how the environmental conditions of the environment are for the survival and health of the fish, helping in the management (Ostrensky & Boeger, 1998).

In the present study, the management of fish transfer and biometrics was not performed by most aquaculture farmers. Similar to the study by Brabo et al. (2017) in Capitão Poço, Pará (Brazil) it was reported that only 13% of producers performed fish biometrics. Biometrics management must be carried out every fifteen days or monthly, always in the early hours of the

day, with 3 to 5% of the fish population, by breeding structure (Nogueira & Rodrigues, 2007). Biometrics is an important indicator of fish development and helps in the amount of feed to be offered. This technique avoids the squad's waste or malnutrition (Sandoval Junior, 2010).

It is worth considering that, after the last biometrics, the fish are depleted. In this management, the fish is removed from the pond after it reaches its ideal size for commercialization. In Marajó, we observed that producers remove fish without criteria, not applying the proper practice. It should be noted that the ideal process for harvesting begins with the application of a fast of 24 hours before slaughter. This process is recommended for emptying the intestine and maintaining the flavor, appearance and texture of the meat (Mendes & Carvalho, 2016).

Problems related to the cleaning of utensils and equipment used in fish farming were observed in the present study. The disinfection and cleaning of the materials used in the cultivation (buckets, ichthyometer, basins, trays, sieves, trawls, tanks, puçá, isopores, among others), must be used disinfectant agents based on chlorine, iodine or aldehydes (Rodrigues, 2013). The absence of training and Personal Protective Equipment (EPI) in the aquaculture enterprises studied were considered non-compliant. Similar results were observed by Frazão et al. (2019), studying occupational risks in fish farming in the municipality of Santa Rita, Maranhão (Brazil). The survey revealed that the incidence of occupational hazards was 21.05% for physical hazards, 21.05% for chemicals, 10.53% for biologicals, 10.53% for ergonomic risks and 36.84% for accidents. In view of this, it is possible to verify that fish farmers are vulnerable with regard to job security in aquaculture.

5. Conclusion

From the application of the Checklist, it was possible to verify that the aquaculture enterprises studied in Marajó, present a high risk for tambaqui fish farming, as they do not adequately adopt good practices. The lack of knowledge, technical guidance and restricted access to public policies for producers are considered the main factors for the high levels of non-conformities found. Therefore, for the full development of fish farming, it is necessary to transfer technologies through training in BPM and technical assistance, so that producers can perform the activity in a more appropriate way.

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