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Evaluation of the hygienic and sanitary conditions in mixed vessels of the Amazon region

Avaliação das condições higiênico-sanitárias em embarcações mistas da região Amazônica

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ABSTRACT

Introduction: The hygienic and sanitary conditions of vessels carrying passengers and cargo requires constant diagnosis and monitoring for disease prevention. **Objective:** The objective of this study was to identify health hazards in food preparation conditions and water potability in mixed vessels in the State of Amazonas-Brazil. **Method:** 33 vessels were analyzed with qualitative detection analysis of *Escherichia coli* by chromogenic substrate for water potability and environmental evaluation with questionnaire application. **Results:** There was microbiological contamination in 13 (39.39%) drinking water samples and 31 (93.93%) sink samples for *E. coli*. The structural and operational conditions of kitchen handlers mostly did not meet the minimum percentages of safety in food production. **Conclusions:** This is the first report on the structural and operational conditions of food preparation in mixed vessels in Manaus-AM and we conclude that intervention is necessary with public policies regarding hygienic and sanitary issues involving the supply of water served in vessels for the protection of passenger health and training of food handlers and inspection of environments.

KEYWORDS: Coliform; Potability; Food Safety

RESUMO

Introdução: A condição higiênico-sanitária de embarcações que transportam passageiros e cargas requer diagnóstico e monitoramento constantes para prevenção de doenças. **Objetivo:** Identificar perigos sanitários nas condições de preparação de alimentos e potabilidade de água em embarcações mistas em Manaus, Amazonas. **Método:** Foram analisadas 33 embarcações com análise de detecção qualitativa de *Escherichia coli* por substrato cromogênico para potabilidade da água e avaliação ambiental com aplicação de questionário. **Resultados:** Havia contaminação microbiológica em 13 (39,39%) amostras de água de bebedouro e 31 (93,93%) amostras de pia para *E. coli*. As condições estruturais e operacionais das embarcações em maioria não atendiam aos percentuais mínimos de segurança na produção de alimentos. **Conclusões:** Esse é o primeiro relato sobre as condições estruturais e operacionais da preparação de alimentos em embarcações mistas em Manaus e conclui-se que é necessária intervenção com políticas públicas quanto às questões higiênico-sanitárias que envolvam o fornecimento das águas servidas nas embarcações para proteção da saúde de passageiros, capacitação dos manipuladores de alimentos e inspeção de ambientes.

PALAVRAS-CHAVE: Coliforme; Potabilidade; Segurança de Alimentos

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INTRODUCTION

Food risk management is a fundamental tool that is already used in many countries. To be implemented, it requires the identification of existing hazards, whether of an environmental or operational origin.[1,2] In the Amazon region, river transportation is of the utmost importance to the population, as rivers are used as roads in the absence of land transportation. Therefore, the hygienic and sanitary conditions of the kitchens and the potability of water on mixed vessels, which transport passengers and cargo, are aspects that must be monitored to prevent diseases.

According to the World Health Organization, food risk assessment can be defined as the scientific assessment of known or potential adverse health effects resulting from human exposure to foodborne hazards. This process consists of hazard identification, hazard characterization, risk exposure and risk characterization.[3] Biological hazards include pathogenic bacteria that can contaminate food and water and cause foodborne diseases (FBDs). There are more than 250 types of FBDs in the world, most of which are infections caused by bacteria and their toxins, viruses, and other parasites.[4] Different microorganisms can contaminate food, so there are different forms of contamination.[5] In this context, the hygienic and sanitary conditions of food handling and storage areas, as well as the potability of drinking water, can be forms of transmission if they do not meet the health requirements aimed at protecting health.

Food outbreaks result from the association between the consumption of food contaminated by inappropriate handling and improper storage or distribution.[6] In relation to vessels, the Brazilian legislation has a guide for cruise ships, which are larger and more complex than the regional vessels commonly found in the Amazon. Rooney et al.[7] reported that in ship outbreaks there was a high frequency of food-related *Salmonella* sp. bacteria, a pathogen that puts the health of passengers and crew at risk. However, in the Amazon, data about the sanitary conditions of food handling on vessels that carry passengers and cargo are scarce. In this region, reports of FBDs are related to locally marketed food, like curd cheese contaminated by staphylococcal toxin[8] and the oral transmission of Chagas disease through the consumption of *açaí*.[9] In this context, vessels can be suitable places for FBD outbreaks arising from the lack of good handling practices (GHP), which are hygiene rules that must also be applied to river boats, or from passengers carrying diseases that can be transmitted by inadequate environmental and sanitary conditions, especially because boats are confined spaces.[10] Another aspect that can be a hazard and put passengers' health at risk is the potability of the water used by the vessels. Finger et al.[11] reported that, among the outbreaks officially registered in Brazil from 2000 to 2018, 12% were related to water contamination. In a study on vessels in the Amazon, de Paula et al.[12] evaluated that the water consumed by passengers and crew was of poor quality, with 89% of samples contaminated by total coliforms and 84% by *Escherichia coli*. In Brazil, to be considered potable, water must comply with the standard recommended by Consolidation Ordinance n. 5, of September 28, 2017,[13] of the Ministry of Health, which defines the physical, chemical and microbiological parameters that guarantee the potability of the water. However, in the Amazon, many mixed vessels acquire underground water (from wells) supplied by companies in drums or carboys loaded onto the boats. Given the lack of data on the hygienic and sanitary conditions of mixed vessels and to contribute to the analysis of hazards in the definition and implementation of public health protection policies, the objective of this study was to verify the potability of water, as well as aspects of hygiene and environmental conditions of food preparation, on mixed vessels in the ports of Manaus, state of Amazonas, Brazil.

METHOD

Sampling

Mixed vessels (n = 33) from the ports of Manaus in the period from 2018 to 2019 were studied. Visual inspection by inspectors of the state health surveillance body was performed on the vessels, considering that inspection is an effective tool for gathering information to support risk analysis.[14,15] To assess the hygiene of the environments, we applied a questionnaire with inspection script items based on the current legislation on food handling.[16,17] The following conditions were visually observed and evaluated: (a) refrigeration equipment (cold room, freezer or refrigerator), (b) environments, and (c) food handlers in kitchens and their compliance with GHP.

Potability: (a) qualitative detection of Escherichia coli: Colilert® (IDDEX) chromogenic substrate was used. The analysis was performed inside a laminar flow hood. For each sample in a 100 ml flask, asepsis was performed on the flask with a cotton pad soaked in alcohol, and the sample was then transferred to a sterile graduated flask. Then, a vial containing the exact amount of culture medium was added to each flask and incubated at 35 ± 0.5°C for 24 h. After incubation, the sample was observed under 365-nm UV light for the presence of fluorescence in positive samples; (b) pH: the samples were also evaluated for their potential of hydrogen using a potentiometer, according to APHA.[18] *Although the Brazilian legislation for potability of water mentions other laboratory tests, only the tests mentioned above were performed, (a) and (b), due to the limited provision of resources for the execution of the project (Call from the National Council for Scientific and Technological Development - CNPq/National Health Surveillance Agency - Anvisa/ Research in health surveillance - Process: 441816/2017-7).*

RESULTS AND DISCUSSION

Refrigeration equipment

The presence of a freezer was verified on 79.41% of the mixed vessels we evaluated, and only 55.88% of them had a cold room (Figure 1). These data are relevant because they alert to the

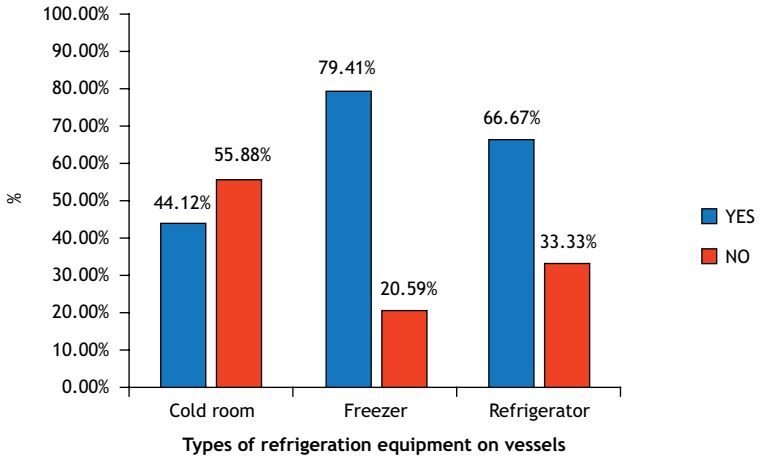
possible lack of adequate temperatures in the transportation of food both for consumption during travels and loads that require a cold room environment. As for the cleaning conditions of the environments (cold room, freezer and refrigerator), 90.91% were adequately clean and 87.88% could be sanitized, that is, they had a smooth surface, waterproof paint and no wood (Figure 2).

Although all vessels had restrooms for passengers and crew, only the unisex classification was found on 100.00% of the vessels. Distinction between restrooms for females and males was not found on any of them. We could identify that 100.00% of the vessels had waste storage devices (for example: trash cans, drums and refrigerated garbage area). Solid waste would only be disposed of on land, upon arrival at the port of destination; according to reports, wastewater is disposed of directly into the rivers.

Figure 3 shows that 81.82% of the kitchens were not clean and organized and had the presence of animals. The inspection reported both the presence of pets and animals commonly found in port settings. There were hand washing sinks (93.94%), however, the ceiling, floor and wall materials did not meet sanitary standards (81.82%). Wood was the most frequent material and was often worn out, with built-up dirt and rusty metals that prevent proper cleaning. All vessels met the passenger limit.

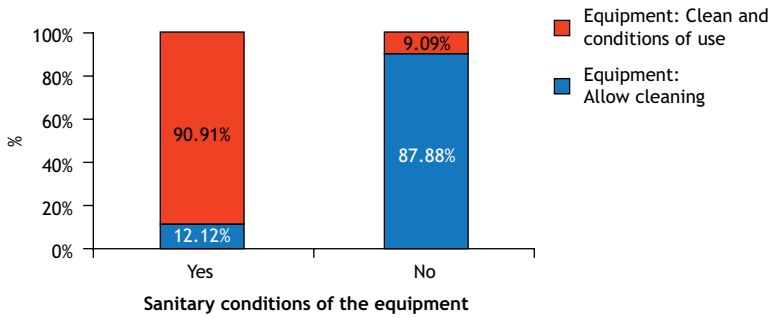
Food handlers

Mixed vessels are restricted settings where passengers and crew stay for long periods together—in the Amazon, this can be days or weeks. They use a common area for the consumption of drinks and food and help themselves to buffets or to their own pans on a common counter or table, sharing the same food source and the same water. There is also interaction between people in the places of food consumption, including outside of meal times. The handling areas—kitchens—are generally small spaces, which hinders the execution of some tasks without crossing flows. Even under these peculiar conditions, standard operating procedures should comply with the GHP determined by Brazilian legislation and also the Hazard Analysis and Critical Control Points (HACCP) system to identify biological, chemical or physical hazards and the points that affect the production of food in order to keep it safe.[19,20] These safety tools in food production have already been used effectively in other countries. Moutchtori et al.[21] studied ferries transporting passengers in Greece and also used a standardized questionnaire focused on identifying the use of HACCP in the interaction between passengers, crew and food and water, surveillance of communicable diseases, drinking water, personnel, food safety, equipment cleaning, sanitary and hand washing



Source: Prepared by the authors, 2020.

Figure 1. Presence of refrigeration equipment on mixed vessels.

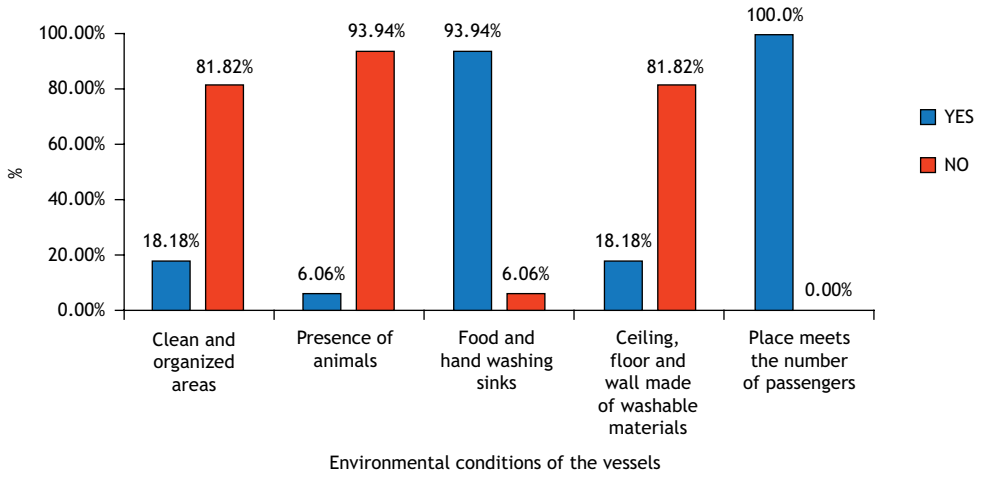


Source: Prepared by the authors, 2020.

Figure 2. Conditions of refrigeration equipment on mixed vessels.

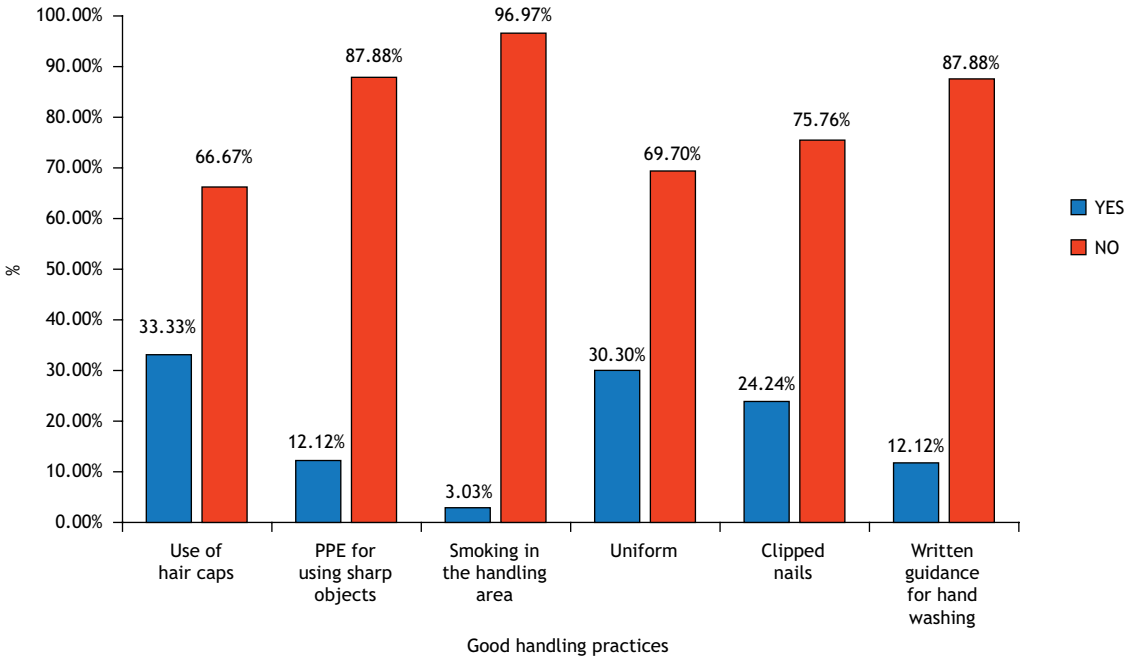
facilities, hazardous substance management and environmental health. The result indicated that the majority of the vessels evaluated (65%) achieved the score of 100% compliance with HACCP concepts. In Italy, Capunzo et al.[22] evaluated Italian merchant ship handlers before and after GHP training. The results showed that the quality of food hygiene improved after the refresher course and worsened after the crew members were replaced by professionals who had not received the training. Continuing education is necessary to ensure good hygiene and food quality. In Brazil, the current legislation, through Joint Board Resolution (RDC) n. 72, of December 29, 2009,[16] deals with health conditions in ports. However, several of its provisions cannot be enforced on board in restricted conditions, such as on mixed vessels, and even though it has been in force for more than 10 years, it is little known among crews in the Amazon region. The RDC n. 216, of September 15, 2004,[19] which deals with GHP in establishments, is also unknown among this group, according to reports obtained during the application of the inspection questionnaire and interviews.

Regarding training, Figure 4 shows that the operational part of good practices regarding the use of personal protective equipment (PPE) achieved only 12.12%, and that 87.88% of the vessels did not have posters with hand washing guidelines. This also worsens the conditions that can cause contamination by respiratory



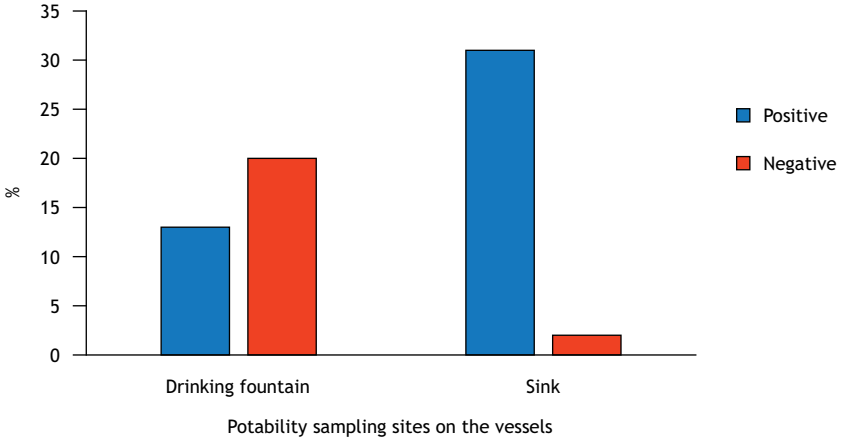
Source: Prepared by the authors, 2020.

Figure 3. Environmental conditions on mixed vessels.



Source: Prepared by the authors, 2020.
PPE: personal protective equipment

Figure 4. Good handling practices among food handlers on mixed vessels.



Source: Prepared by the authors, 2020.

Figure 5. Potability on mixed vessels in the city of Manaus-AM for the presence of *Escherichia coli*.

diseases. As for SARS-CoV-2 prevention, basic recommendations include frequent hand washing, disinfecting objects and surfaces, maintaining physical distance and not touching eyes, nose or mouth.[23] On the other hand, long-term face-to-face contact, complex population flows, lack of medical care facilities and faulty infrastructure on board vessels can make an environment conducive to spreading disease. This has already been observed and reported on cruise ships by Zhang et al.,[24] when the authors reported that hand washing is an important factor to prevent the spread of viruses among passengers. Hadjichristodoulou et al.[25] reported that the implementation of corrective actions after pilot inspections increased the level of compliance with hygiene regulations on passenger ships sailing within European Union waters and, consequently, improved the hygiene conditions of the vessels. Communication contributed to improved outbreak identification and better management through rapid sharing of public health information, allowing for more timely and coordinated response. After drawing a comparison with the data obtained in this study, we suggest that the digital channels of health surveillance bodies (for example: their homepage) share educational materials for passengers and crew in order to prevent diseases, since the population in general has more access to information.

Water potability

All the boats we studied had water tanks/reservoirs. However, none (0.00%) had chlorine dispensers. As for potability, positive microbiological contamination was observed in 13 (39.39%) samples of drinking water and 31 (39.39%) were negative for *E. coli* (Figure 1). According to Brazilian legislation, *E. coli* should be absent in 100 mL of water (Figure 5).

Sanitary aspects in port activities in the Manaus area had already been reported by Caldas and Pozetti[26] as unsatisfactory, and this included the lack of water potability in 77.8% of the samples analyzed. According to the authors, the non-compliant aspects found could be related to the lack of routine evaluations of water quality and distribution systems and supply points that fail to comply with the legislation. In this work, the people in charge of the vessels reported that water is supplied from wells. In the state of Amazonas, Castro et al.[27] evaluated samples in the municipality of Humaitá, where the presence of *E. coli* was not verified in any analyzed sample. According to Araújo et al.,[28] wells are important sources of water supply for human consumption by populations that do not have access to the public supply network in Manaus. The samples of this work were obtained from vessels that are supplied with water from artesian wells in the cities/ports where they are berthed and this would explain the contamination of the sink water samples. As for the contamination of drinking fountains, we observed that the use of poorly washed reservoirs (drums and carboys) can be another source of contamination, thus justifying the positive results found. Therefore, using a water chlorination system could help vessels ensure potability through daily monitoring of the chlorine content. In addition to chlorination, proper cleaning of the carboys is necessary to prevent cross contamination. Unfortunately, none of the vessels had a water chlorination system. Water is essential in food preparation activities in the boat's kitchen, as well as for washing utensils, and its potability must be ensured to prevent it from being a source of contamination. For example: Passos et al.[29] reported that, in water samples from a cruise ship, positive results for coliforms were observed at 35ºC during the investigation of an FBD outbreak.

CONCLUSIONS

Based on our observation, we concluded that there is a need to define more specific monitoring requirements for this type of transportation, for example, through legislation on food storage and preparation items for more effective inspection, as well as more frequent evaluations of drinking water and ice. There is also a clear need for a policy to raise awareness and sensitize crews about the importance of adopting GHP in food preparation. Mixed vessels have some particularities in comparison with larger ships, so specific legislation and a targeted approach are needed to manage the health risks identified in this study. More efficient ways of communicating risks to passengers and crew on mixed vessels in the Amazon are also required to help prevent the spread of diseases.

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Authors' Contribution

Kluczkovski A, Kluczkovski-Junior A – Conception, planning (study design), data interpretation and and writing of the manuscript. Pinto S – Data acquisition, analysis and interpretation. Pinto M – Conception and planning (study design). Caldas J – Conception, data acquisition and interpretation. Waitman A – Data interpretation. All authors approved the final draft of the manuscript.

Disclosures

The authors report that there is no potential conflict of interest with peers and institutions, nor political or financial conflicts in this study.