Evaluation of salt intended for human consumption for the presence of physical contaminants: microplastics an emerging contaminant in the food area

Avaliação do sal destinado ao consumo humano quanto à presença de contaminantes físicos: microplásticos e contaminantes emergentes na área alimentar

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ABSTRACT
Introduction: The presence of physical contaminants in food goes against the guarantee of the supply of safe products for consumption. Currently, there is an environmental concern with this type of contamination, especially with a class of plastic particles less than 5 mm, called microplastics. The impacts on human organisms are still under discussion, but there is already a relationship between the ingestion and inhalation of these particles and a possible health risk, since, in addition to being derived from macroplatic degradation processes with varied chemical compositions, they can still carry other contaminants. Objective: To value the presence of physical contaminants, such as microplastics in salt intended for human consumption. Method: A quantity of 8 salt samples was acquired in supermarkets in the city of Rio de Janeiro in 2019 and analyzed after dilution in water, according to the coefficient of salt dilution (36g/100mL), heated in plate at 100°C and filtered in filter 0.22µm. Detection was performed with the aid of stereoscope microscope and confirmation was performed under a scanning electron microscope (SEM). Results and Discussion: In 5 samples, the presence of physical contaminants was observed, which due to visual characteristics suggest to be microplastics. The possible presence of microplastics in salt samples is related to contamination of the oceans by microplastics. With this, it is observed the importance of monitoring the quality of human consumption, since it is a by-product of the oceans. Conclusion: Studies in Brazil regarding microplastic contamination is very focused on marine matrices, but it is necessary to think about the study and development of analytical methodologies for detection and identification of these contaminants in food, especially in products of marine origin.

Keywords: plastic, microplastic sticks, human consumption products, microscopy.

RESUMO
Introdução: A presença de contaminantes físicos nos alimentos contraria a garantia de fornecimento de produtos seguros para consumo. Atualmente há uma preocupação ambiental com esse tipo de contaminação, em especial com uma classe de partículas plásticas menores que 5 mm, chamada microplástica. Os impactos sobre os organismos humanos ainda estão em discussão, mas já existe uma relação entre ingestão e inalação dessas partículas e um possível risco à saúde, uma vez que, além de derivarem de processos de degradação macroplática com composições químicas variadas, ainda podem transportar outros contaminantes. Objetivo: Valorizar a presença de contaminantes físicos, como microplásticos, no sal destinado ao consumo humano. Método: Uma quantidade de 8 amostras de sal foi adquirida em supermercados na cidade do Rio de Janeiro em 2019 e analisada após diluição em água, de acordo com o coeficiente de diluição de sal (36g/100mL), aquecida em placa a 100°C e filtrada em filtro de 0,22µm. A detecção foi realizada com o auxílio do microscópio estereoscópico e a confirmação foi realizada sob um microscópio eletrônico de varredura (SEM). Resultados e

Discussão: Em 5 amostras, observou-se a presença de contaminantes físicos, que devido às características visuais sugerem ser microplásticos. A possível presença de microplásticos em amostras de sal está relacionada com a contaminação dos oceanos por microplásticos. Com isso, observa-se a importância do monitoramento da qualidade do consumo humano, pois é um subproduto dos oceanos. Conclusão: Os estudos no Brasil sobre a contaminação por microplásticos são muito focados em matrizes marinhas, mas é preciso pensar no estudo e desenvolvimento de metodologias analíticas para detecção e identificação desses contaminantes em alimentos, especialmente em produtos de origem marinha.

Palavras-chave: plástico, varas de microplástico, produtos de consumo humano, microscopia.

1 INTRODUCTION

Global plastic production has increased significantly in recent decades, from approximately 1.5 million tons in the 1950s to about 335 million tons in 2016 (Plastics Europe, 2017). This increase is mainly due to the properties of versatility, low production cost, lightness, and durability, in addition to other advantages, which have made plastic the most used material by humans in numerous sectors of today's society (Thompson et al., 2004; Wang et al., 2016).

This change in the pattern of production and consumption introduced into the environment a high proportion of plastic from irregular disposal or as a by-product of packaging degradation. It is estimated that, today, the plastic waste produced corresponds to about 60 to 80% of all marine litter (Moore, 2008; Qiu et al., 2016; Wang et al., 2016; Kim et al., 2018; Lebreton et al., 2017; Pinheiro et al., 2017; Revel et al., 2018). Thus, the marine environment ended up being negatively impacted regarding the presence of these contaminants that end up being ingested by animals or depositing in the sediments present in the oceans (Moore, 2008; Qiu et al., 2016; Wang et al., 2016).

Currently, researchers warn of greater concern in relation to those with sizes smaller than 5 mm, called microplastics (Galgani et al., 2013; Amaral-Zettler et al., 2015; Barboza et al., 2018a; Kunz, A. et al., 2016). These have a characteristic such as long environmental persistence, reduced size (<5 mm - 1 μm), high surface/volume ratio, besides the ability to penetrate cells and induce adverse effects. (Barboza et al., 2018c; Cole et al., 2014; Iñiguez et al., 2017).

Microplastics found in the environment may originate from biological, photo and/or mechanical degradation that promote successive breaks and alterations of larger plastic parts that are disposed of irregularly in nature. Another way is the direct entry of plastic in the form of micro and nano particles that are widely used in industrial processes and in the manufacture of a wide variety of products of daily use (Andrady, 2011; Cole, 2016; Cole et al., 2014; Cole et al., 2011; Van Cauwenberghe and Janssen, 2014).

Several studies have been published proving the contamination of the seas by microplastic, which in addition to its known toxic properties, may be associated with other xenobiotics incorporated during their production process that can increase toxicity and aggravate toxic effects on both the environment and human health (Karami et al., 2017; Wright and Kelly, 2017; Yang et al., 2015; Batel et al., 2016; Wright et al., 2013b). In addition, several report the contamination present in foods of marine origin, such as commercial products for human consumption (Gundogdu, 2018; Iñiguez et al., 2017; Karami et al., 2017; Kim et al., 2018; Kosuth et al., 2018; Renzi and Blašković, 2018; Seth and Shriwastav, 2018; Yang et al., 2015).

Human consumption salts are one of the most common seasonings in the daily lives of humans worldwide and are used in food preservation methods. Each individual ingests small amounts of salt in various food items, such as ultra-processed, pickled foods, such as fruits, cheese and cereals (WHO, 2012), as well as some beverages (D. Peixoto, et al.,2019). These salts consumed by man and the salts of the lake are usually produced through a crystallization process in which sea water or brine is evaporated by heat and wind.

Therefore, the pollutants found in these waters, including microplastics, reach the final product, i.e., cooking salt. Considering the long-term human consumption of commercial health from marine and terrestrial sources, and the presence already reported in the literature of the presence of microplastics in human consumption and the potential implications for human health of exposure through consumption of this product, the objective of this study was to evaluate the presence of microplastics in human consumption commercial salts purchased in supermarkets in the city of Rio de Janeiro in 2019.

2 MATERIAL AND METHODS

A total of 8 samples of different brands and types of salt were randomly acquired in supermarkets in the city of Rio de Janeiro in 2019. Salts were named from 1 to 8, where 1 was refined salt with lower sodium content; 2 and 8 were sea salts; 3 and 7 were refined salts; 4 and 5 were salt flower and 6 was pink Himalayan salt.

The samples were weighed on an analytical scale (model) with weights of approximately 2.5g of each salt and these were diluted in deionized water, respecting the solubility coefficient of sodium chloride (36g/100mL). Then the samples were heated in a heating plate at 100°C for 30 minutes. The saline solution was filtered in a vacuum system with a 0.22 μm filter in order to promote the physical separation of the microparticles that were possibly present in the samples. (Yang, D. *et al* ., 2015; Karami, A. *et al.*, 2017).

After filtration, the filter papers of each salt were packed in Petri dishes, covered with a lid and sealed with adhesive tape. As a control, a filter (0.22μm) was used in which only deionized water used in the preparation of samples was filtered. (Karami, A. *et al.*, 2017).

Each filter paper was analyzed with the aid of a Stereo microscope, model Stemi SV 6 ZEISS, with 0.8X ~ 5X zoom and 8X ~ 200X increases for particle detection and their location. For confirmation, the scanning electron microscopy (SEM) model FEI Nova Nanolab 600 working under kev (2kV) was used to reduce load and damage to the samples. In addition, the samples were also coated with carbon to reduce the load effects.

3 RESULTS AND DISCUSSION

Of the 8 samples analyzed, 5 samples presented impurities in the form of microscopic particles that could not be present in the airs for human consumption (Table 1). Among the particles found, all presented fragment profile, which Karami et al. (2017) defines as particles cut with often irregular shape and surface.

Table 1. Analysis of the presence of microscopic particles in the samples of salts collected in the city of Rio de Janeiro in 2019.

Samples	Characteristics of the	Shard Detection
1	Refined salt with lower sodium content	Present
2	Sea salt	Present
3	Refined salt	Present
4	Flower of salt	-
5	Flower of salt	-
6	Himalayan Rose	-
7	Refined salt	Present
8	Sea salt	Present

- No physical contaminants detected

In samples 1, 2 and 7 a single contaminant was found (Figure 1). The fragments found in these samples were not analyzed by SME. In salt 3, two types of fragments were identified as shown in Figure 2. In sample 8, six fragments were found, as shown in Figure 3. A characteristic found in the fragments was the colors observed by stereo microscope, in which it was possible to observe colorless, red, bluish, and orange fragments. Unfortunately, it is not possible to observe the colors in the photos clearly.

Figure 1. Shows the contaminants physical. (A)- contaminant found in sample 1; (B) contaminant found in sample 2 and (E)- contaminants found in sample 7 all identified by stereo microscope, model Stemi SV 6 ZEISS

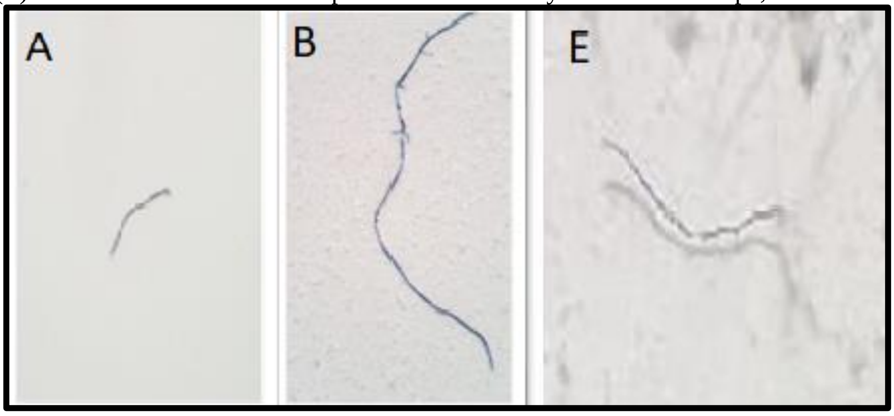


Figure 2. Shows the contaminants physical (C-D), found in sample 3, identified by stereo microscope, and confirmed by SEM.

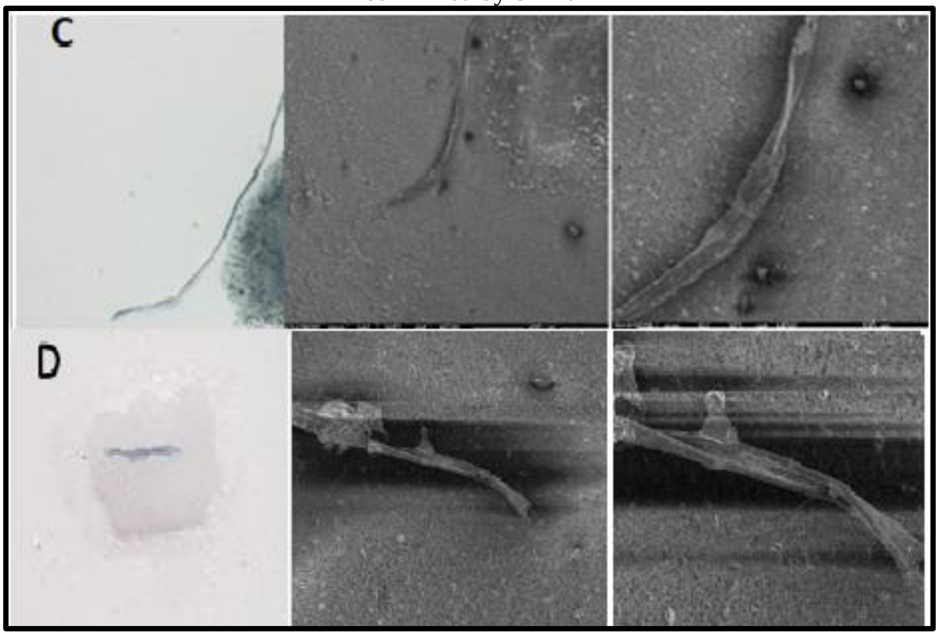
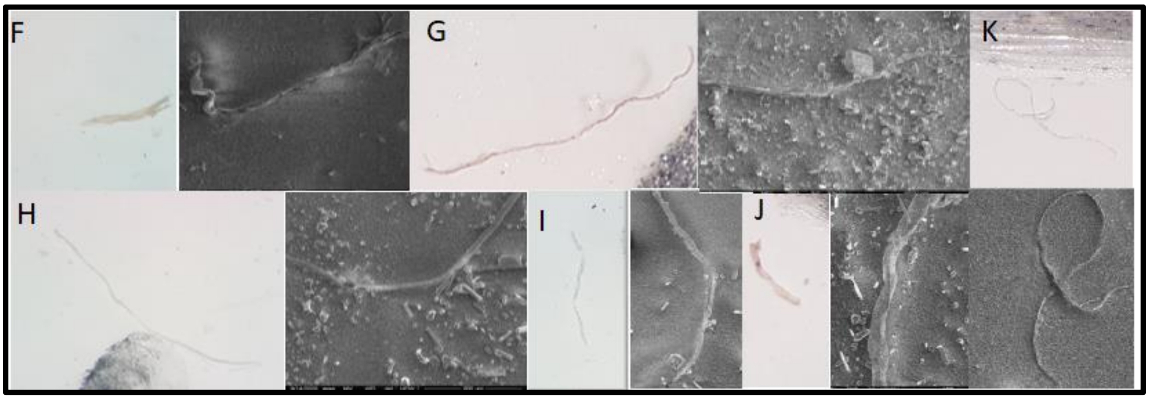


Figure 3. Shows the contaminants physical in sample 8, identified by stereo microscope, and confirmed by SEM.



In the samples 4, 5 no fragments were found. These samples are of the salt flower type which forms on the surface of sea water and that does not pass through any method of refinement, processing, or addition of chemical and artificial components during its production process. The evaluated studies did not address the investigation of physical fragments in this type of salt, this can be justified by price and because it is considered a spice in cooking.

The sample 6 is the pink salt of the Himalayas, this rock salt is extracted mainly from the salt mines of Khewra, located in Jhelum district, Punjab city (Pakistan), In addition, it has different minerals such as Ca, Fe, Mg and differents colors, such as transparent, white, pink and reddish, which vary according to the place of extraction and minerals contained therein. The reddish-pink coloration is the most used for commercial purposes, being responsible for this color the presence of iron oxide in its composition (Bastos et al., 2017). During the sample preparation process, the filter paper was covered with pink pigments, making it impossible to visualize and identify physical fragments in this sample.

In this study, the proposal was to analyze the presence of microplastics in samples of human consumption, since numerous studies around the world have found such particles in this product so consumed by humans. The results found are compatible with the studies already published on the subject, since in these previous studies showed the presence of microplastics in human consumption coffees originating in 29 different countries (Yang et al., 2015; Karami et al., 2017; Iñiguez et al., 2017; Renzi, M. & Blašković, 2018; Gündoğdu, S., 2018; Seth, C. K. & Shriwastav, A, 2018; Kim et al., 2018).

The study conducted by Yang et al. (2015) investigated the presence of microplastics in 15 commercial salt brands available to consumers in Chinese supermarkets, during the period from october to november 2014. At the end of the studies, the researchers observed that in all samples analyzed there was the presence of microplastics. In another study conducted in 2017, Karami and collaborators identified the presence of mycoplastics in 17 different salt brands from eight countries (Australia, France, Iran, Japan, Malaysia, New Zealand, Portugal and South Africa). In 2018, the work developed by Seth and Shriwastav was published in which they analyzed eight brands of sea salt from India and microplastics were identified in all samples.

Comparing the results mentioned above with the results of the present study, contamination of commercial products for human consumption is very common. However, it will not be possible to affirm that the fragments found are actually microplastic, since a chemical confirmation analysis was not performed, it is only known that they emit signal in the SEM that present carbon in its structure. The fragments found in the salt samples analyzed are similar to those found in the literature, reinforcing the importance of this type of investigation.

Another important factor is that most humans consume food products that contain commercial salt throughout their lives, and some foods may contain considerable concentrations of salts. Therefore, salt consumption represents a route of exposure to long-term physical fragments for the population, as well as others such as air and water. Therefore, several adverse effects have already been reported in different animal species, from chronic to transgenerational effects. (Barboza et al., 2018d, 2018e, 2018c; Horton et al., 2017; Magni et al., 2018; Martins and Guilhermino, 2018; Mohsen et al., 2019; Pacheco et al., 2018; Wang et al., 2019).

Thus, this long-term exposure by several routes of exposure has generated concern regarding the potential adverse effects that microplastics and associated chemicals may have on human health and well-being (Barboza et al., 2018b; Ferreira et al., 2016; Guilhermino et al., 2018; Ma et al., 2019; Martins and Guilhermino, 2018; Mintenig et al., 2019; Mohsen et al., 2019; Neves et al., 2015).

4 CONCLUSION

Due to their low density and slow degradation, plastics are becoming the main contaminant that crosses borders, and often travels far from their original source. Thus, the microplastics found in the salt samples of one country may have been produced by another country thousands of miles away. A potential solution to this global dilemma requires an important commitment from all countries to make an effective improvement in the disposal and recycling of plastics.

The results of this study showed the importance of analyzing this type of physical contamination. In addition, one of the chemical analyses of the particles could complement the study in order to confirm the composition of the particles found. The growing trend of plastic use and disposal, however, can lead to the gradual accumulation of MPs in the oceans and lakes and therefore in products from aquatic environments. This should require regular quantification and characterization of MPs in various marine products.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest

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