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A bibliometrics study of plants, animals, bacteria, algae and technologies that reduce, filter and eliminate microplastics from planet earth, ecological solutions for the environment

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ABSTRACT

The world surrounded by plastics generates a lot of uncertainty and the first victims are sea animals, plastic in contact with the sun is able to disintegrate and generate toxins that are harmful to health. It is for this reason that this research in bibliographic review allows us to know the different solutions to counteract microplastics through the analysis of the Scopus database and the VOSviewer tool that allows us to analyze the data, considering the essential characteristics that are plants, animals, bacteria, algae and technologies that allow the disintegration, elimination and purification of microplastics, graphs and tables were obtained which allow us to recognize the analyzed data, the countries that carry out these investigations and the bibliometric maps worldwide. The results allow us to understand that the existence of microplastics generates many negative consequences for planet earth, however, there are different solutions which we can use and apply to counteract these microplastics, also considering that countries like Peru do not find published scientific research relevant to this matter. The purpose of this research is to allow us to make better decisions and not lose heart in the face of microplastics since it can be fought with the different solutions that we find on planet earth, technology and the other objective is to motivate readers to take action in the issue and allow generating change in the use of plastics.

1. Introduction

Globally, deaths of more than 100,000 marine mammals are generated due to plastic particles present in the sea, it also affects more than 45 species of marine mammals and 90% of birds, ingesting these particles is fatal animal poisoning leading to death (Rivas & Garelli, 2021), in Mexico the population of sea turtles dies up to 50% of all species, likewise whales due to plastics (Rivas & Garelli; 2021). The pollution generated by plastic is alarming considering that there are 1.7 million tons of plastics that went to the sea and 6.1 million tons to all means of water transportation, rivers and among others, which is estimated to be a total of 30 Mt in the sea and 109 Mt in the rivers in 2019 (GPOD, 2019), in 2020 there was a production of 370 million tons of plastic worldwide (Tsydenova & Patil; 2021) and it is estimated that more than 13 billion dollars generates in harmful damage to the sea (Grande et al., 2022; Rodríguez; 2023).

The use of plastic is very generic, we find it in different applications, areas and economies, achieving these particles to be present throughout the planet within the sea, rivers, on surfaces and even in the atmosphere (Bitter et al., 2022), highlighting that the entire planet earth generates twice as much waste as decades ago and only 9% of it is recycled according to organizations (OECD, 2019), in addition to the fact that 10% of all the waste generated by man is plastic (Faria et al., 2022).

Plastic is a derivative of fuels and worldwide it represents 6%, which by 2050 is forecast to be 20% (Tsydenova & Patil 2021; Kim et al., 2020), this being alarming news since plastics can be disintegrated into macroplastics, mesoplastics and

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microplastics. They are formed by chains of polymers and carbon atoms, which are harmful since they generate greenhouse gas emissions when they are in contact with the sun (Tsydenova & Patil 2021), likewise there are more than 50 types of plastic particles. present on the planet and the sea, which its great variety allows animals to ingest it, harming the health and well-being of animals, considering that animals are foods for daily consumption in humans, which when ingested generates uncertainty (Kwon et al., 2022) since there are still not enough proven studies, however, nanoplastics have already been found in the blood of donors and in the lungs of real patients. ized through examinations, the damage is still unknown but there is already evidence that it is inside the human body (Parker, 2022).

The solutions that are presented to be able to mitigate the use of plastics and to be able to fight with plastics exist on the planet earth, it has endless solutions, as well as innovation, technology, bacteria and animals that can disintegrate plastics without harming health, or the field around it, as well as plants with aerobic processes manage to reduce microplastics by 99% (Bitter et al., 2022). Likewise bacteria such as alcaligenes, comononas and pseudomonas that manage to degrade polymers exist in the plastics thanks to its effective enzymes and the technology present with filters in different presentations which allows reducing the existence of micro plastics in the water. It is considered the best option for the effective use of the different solutions uniting them and working as a team with each one of them in order to have a better effectiveness and this includes raising awareness in society to innovate solutions that prohibit the use of plastic (Funck et al., 2021).

To analyze the different solutions to mitigate microplastics, a bibliographic analysis was carried out with the support of the VOSviewer tool, which allows you to analyze the stratified data globally. The results provided us with the following analyses: biometric analysis of plants that filter microplastics, of technology to filter microplastics, of animals that degrade microplastics, of microalgae that biodegrade microplastics, and of bacteria to reduce microplastics.

2. Materials and Methods

The method used is given through the analysis of bibliographic review that supports the analysis of scientific research, the subject of this research is to publicize innovative solutions such as plants, animals and bacteria that filter micro plastic in the sea, this being a global problem. For the development, scientific tools such as Scopus were implemented, which provides a greater union of investigations.

Firstly, results were analyzed using Scopus, which allows us to know the panorama of the investigations in each item analyzed in addition to providing stratified bibliographic support in order to understand the best innovative solutions to filter microplastics.

Second, it was analyzed using bibliometric maps using the VOSviewer software, which allows us to know in different maps and providing a visual analysis with a minimum of 100 elements to analyze (van Eck & Waltman, 2010), all with the aim of showing the words with greater concurrence in the articles analyzed and showing their graph nodes (van Eck & Waltman, 2010).

All this was obtained through the analysis of Scopus in formats (.csv) everything was analyzed up to the current date of the year 2022, it was analyzed in the following criteria:.

- First, the data was obtained with the following words “plants”, “filter” AND “microplastics” identified from articles, scientific research and critical analysis which was analyzed from different countries.
- Second, the data was obtained with the following words “technology”, “filter” AND “microplastics” identified from articles, scientific research and critical analysis which were analyzed from different countries.
- Third, the data was obtained with the following words “animals”, “degrade” AND “microplastics” identified from articles, scientific research and critical analysis which was analyzed from different countries.
- Fourth, the data was obtained with the following words “microalgae”, “biodegradation” AND “microplastics” identified from articles, scientific research and critical analysis which was analyzed from different countries.
- Fifth, the data was obtained with the following words “bacteria”, “reduces” AND “microplastics” identified from articles, scientific research and critical analysis which was analyzed from different countries.

Different figures were presented with the data obtained. This result allows us to analyze it using the VOSviewer tool, which provides us with the words with the greatest interaction and allows us to better analyze a large number of bibliographic reviews.

3. Results

3.1 Biometric analysis of plants that filter micro plastics

Since 2020, it was possible to carry out related investigations and where 34 documents related to the items “plants”, “filter” AND “microplastics” were found, which in the largest investigations were carried out for institutions in Germany and the United States, such as universities and among others as observed in Fig. 1.

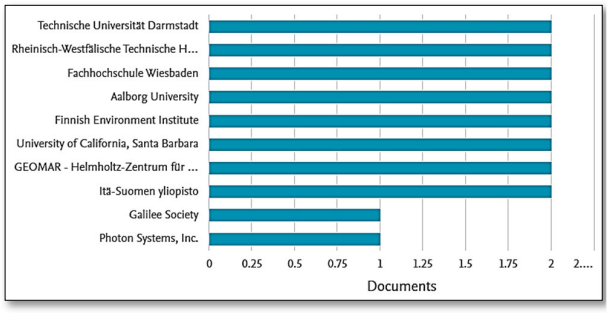

Fig. 1. Institutions that published related to the words "plants", "filter" and "microplastics. Source: Scopus scientific review.

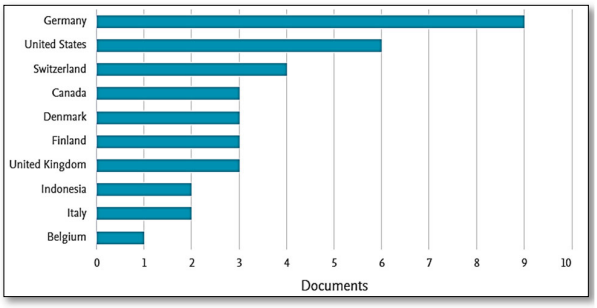

Fig. 2. Countries that published related to the words "plants", "filter" AND "microplastics". Source: Scopus scientific review.

The countries most interested in making solutions with plants to filter micro plastics are the countries of Germany and the United States with more research, as can be seen in Fig. 2, which represents more interactions. The database obtained from Scopus is analyzed using the VOSviewer software, where the words with the greatest interaction present in each investigation are analyzed, which are: Microplastics, wastewater, treatment, water pollutant and efficiencies, which allows us to have greater knowledge and understanding. of the investigations, in addition the calorimetry presents us with the analysis in time which goes from 2020 to the year 2022 as observed in Fig. 3.

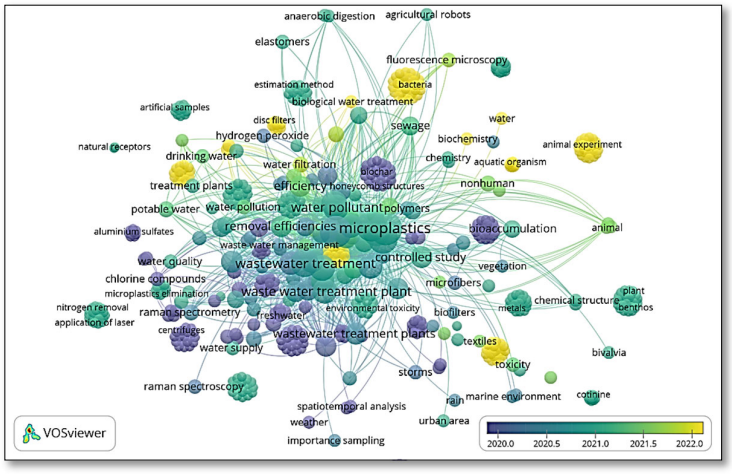

Fig. 3. Database map with the words "plants", "filter" AND "microplastics with the greatest interaction. Source: Obtained from VOSviewer.

3.2 Biometric analysis of technology to filter micro plastics

Since 2017, it was possible to carry out related investigations and where 24 documents related to the items "technology", "filter" AND "microplastics" were found, which in the largest investigations were carried out for the institutions and universities of China and Germany as the ocean of conservation and among others as observed in Fig. 4.

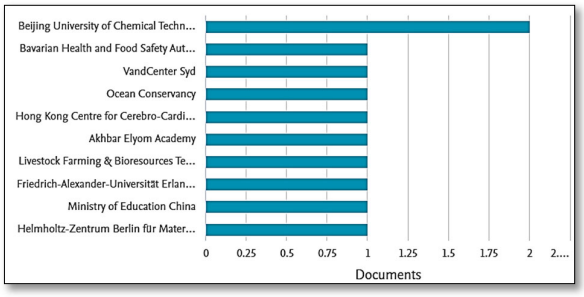

Fig. 4. Institutions that published related to the words "technology", "filter" AND "microplastics". Source: Scopus scientific review

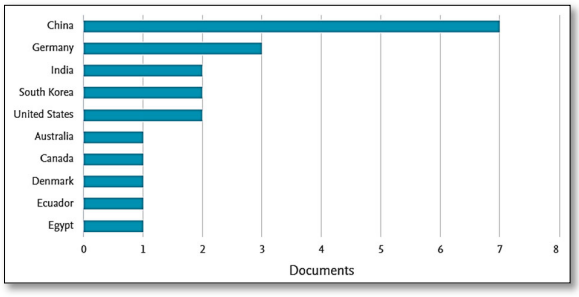

Fig. 5. Countries that published related to the words "technology", "filter" AND "microplastics". Source: Scopus scientific review

The countries most interested in making solutions with technology that filter plastics and microplastics in the sea are China and Germany with more research, as can be seen in Fig. 5, which represents more interactions.

The database obtained from Scopus is analyzed using the VOSviewer software, where the words with the greatest interaction present in each investigation are analyzed, which are: Microplastic, microfiber, water pollution, efficiency and polupropylenes, which allows us to have greater knowledge and understanding of the investigations, in addition the calorimetry presents the analysis in time which goes from 2021 to the year 2022 as observed in Fig. 6.

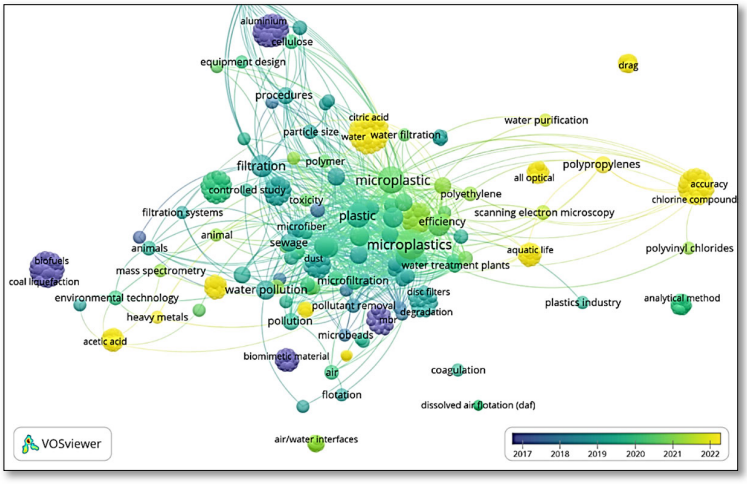

Fig. 6. Database map with the words "microalgae", "biodegradation" AND "microplastics" with the greatest interaction. Source: Obtained from VOSviewer

3.3 Biometric analysis of animals that degrade micro plastics

Since 2019, it was possible to carry out related investigations and where 35 documents related to the items "animals", "degrade" AND "microplastics" were found, which in the largest investigations were carried out for institutions and universities in China and the United States as a ministry of education in China and among others as shown in Fig. 7.

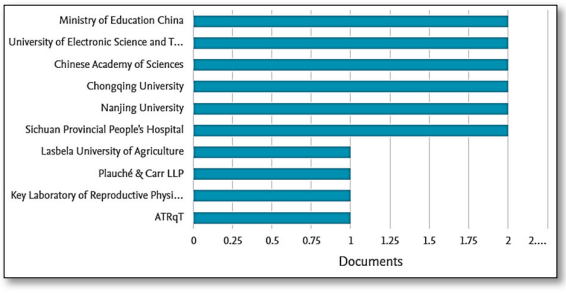

Fig. 7. Institutions that published related to the words "animals", "degrade" AND "microplastics". Source: Scopus scientific review

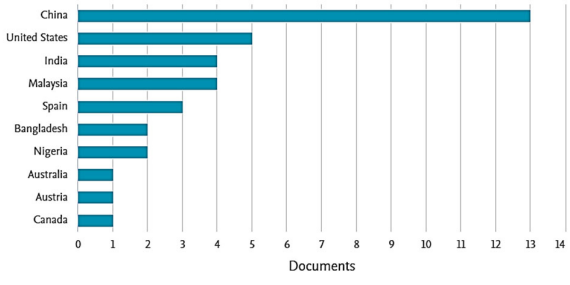

Fig. 8. Countries that published related to the words "microalgae", "biodegradation" AND "microplastics". Source: Scopus scientific review.

The countries most interested in making solutions with animals that can degrade microplastics are the countries of China and the United States with the most research, as can be seen in Fig. 8, which represents the greatest interactions.

The database obtained from Scopus is analyzed using the VOSviewer software, where the words with the greatest interaction present in each investigation are analyzed, which are: Microplastic, animal, polyethylene and metabolism, which allows us to have greater knowledge and understanding of the investigations. In addition, the calorimetry presents the analysis in time which goes from 2019 to the year 2022 as observed in Fig. 9.

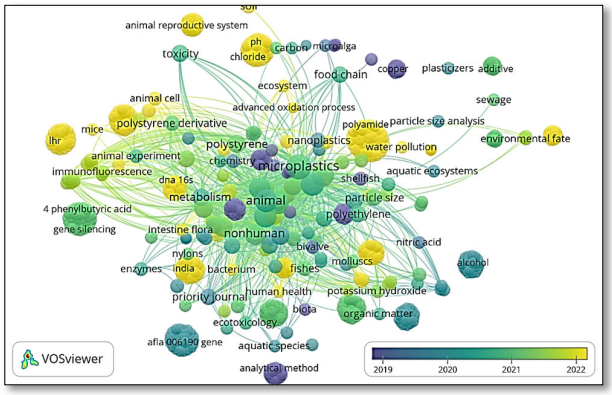

Fig. 9. Database map with the words "microalgae", "biodegradation" AND "microplastics" with the greatest interaction. Source: Obtained from VOSviewer

3.4 Biometric analysis of microalgae that biodegrade microplastics

Since 2016, it was possible to carry out related investigations and where 21 documents related to the items "microalgae", "biodegradation" AND "microplastics" were found, which in the largest investigations were carried out for institutions and universities in China and Indonesia and among others. as observed in Fig. 10.

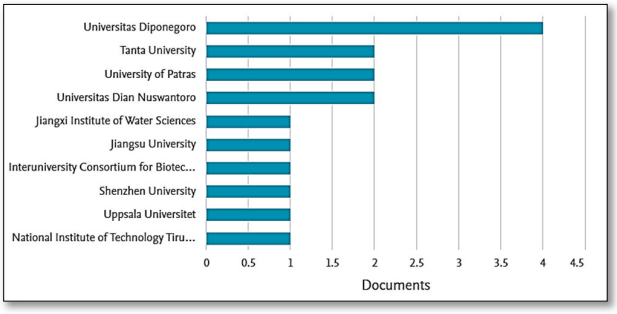

Fig. 10. Institutions that published related to the words "microalgae", "biodegradation" AND "microplastics". Source: Scopus scientific review

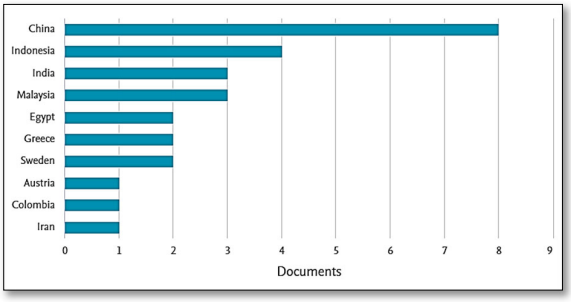

Fig. 11. Countries that published related to the words "microalgae", "biodegradation" AND "microplastics". Source: Scopus scientific review

The countries most interested in making solutions with microalgae for the biodegradation of microplastics are China and Indonesia with the most research, as shown in Fig. 11, which represents the greatest interaction. The database obtained from Scopus is analyzed using the VOSviewer software, where the words with the greatest interaction present in each investigation are analyzed, which are: Microalgae, biodegradation, plastic and pollution effect, which allows us to have greater knowledge and understanding of the investigations. In addition, the calorimetry presents the analysis in time which goes from 2016 to the year 2022 as observed in Fig. 12.

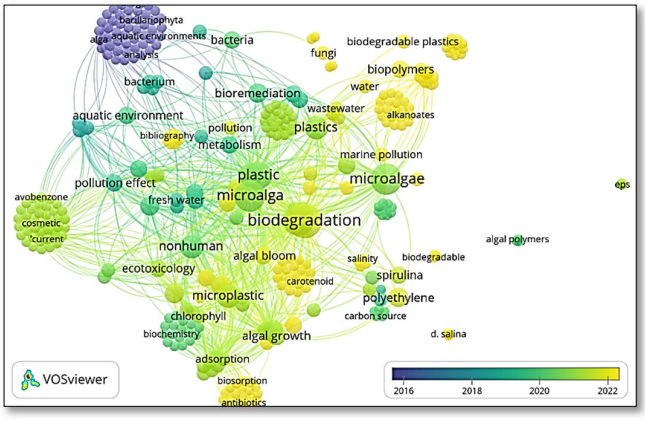

Fig. 12. Database map with the words "microalgae", "biodegradation" AND "microplastics" with the highest interaction. Source: Obtained from VOSviewer

3.5 Biometric analysis of bacteria to reduce micro plastics

Since 2019, it has been possible to carry out related investigations and where 30 documents related to the items "bacteria", "reduce" AND "microplastics" were found, which in the largest investigations were carried out for Chinese institutions such as the Chinese Ministry of Education and among others as observed in Fig. 13.

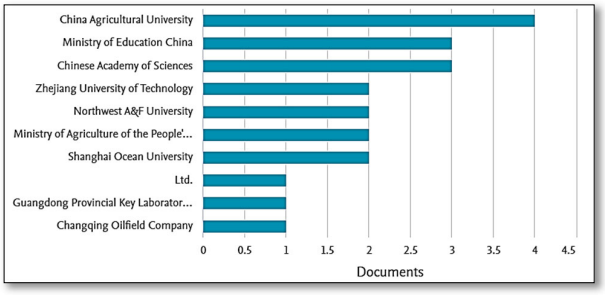

Fig. 13. Institutions that published related to the words "bacteria", "reduce" AND "microplastics. Source: Scopus scientific review

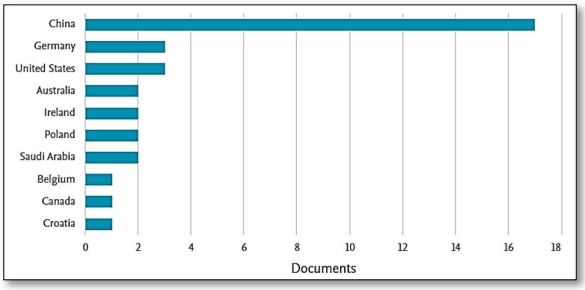

Fig. 14. Countries that published related to the words "bacteria", "reduce" AND "microplastics. Source: Scopus scientific review

The country most interested in making solutions with microalgae is the country of China with the most research, as shown in Fig. 14. The database obtained from Scopus is analyzed using the VOSviewer software, where the words with the greatest interaction present in each investigation are analyzed, which are:

Micr Microplastics, bacteria, biodegradation, polythylene, which allows us to have greater knowledge and understanding of the investigations, in addition the calorimetry presents us with the analysis in time which goes from 2019 to the year 2022 as observed in Fig. 15.

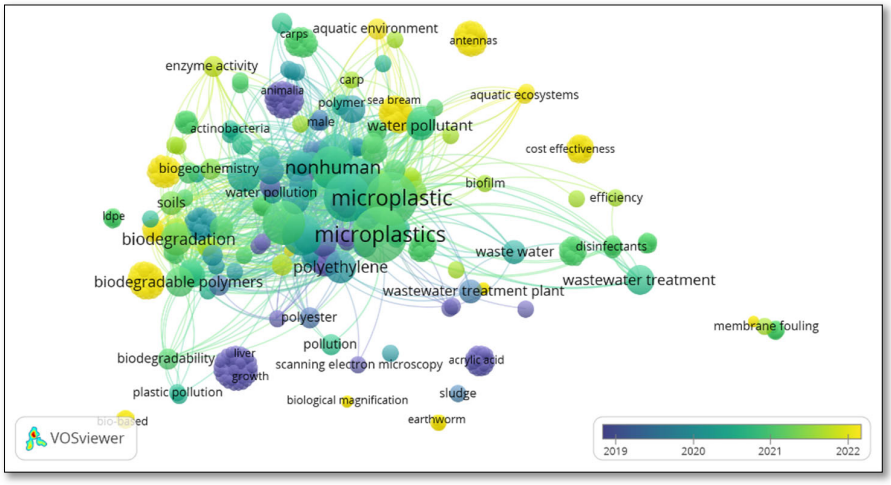

Fig. 15. Database map with the words "bacteria", "reduces" AND "microplastics with greater interaction. Source: Obtained from VOSviewer

4. Discussion

Plastics are and will continue to be present because they have become part of daily use in the world, however, the elimination process with the sun generates pollutants (Shen et al., 2021) to the environment, this biodegradation generates nano plastics (Chandra & Singh, 2020), meso plastics and micro plastics, that is to say, they are divided into particles, foams, fiber yarn and granules (Durak, 2021), all of these are found in different materials such as polyethylene, polystyrene, polyvinyl chloride and nylon which come from garments (Ypganandhan et al., 2019) when clothes are washed, the fibers disintegrate, which produce plastic particles (Chandra & Singh, 2020), highlighting that polyethylene is a frequently used polymer and the most dangerous (Faria et al., 2022) for the environment.

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4.1 Plants that filter microplastics

The flora of the sea such as microbes, zooplankton and phytoplankton are at risk due to the constant microplastics that exist in the sea (Chandra & Singh, 2020) this is due to the plastic industry that generates amorphous polymers and heavy metals caused by microplastics all of this generates toxic effects on algae and sea animals (Wan, 2018), for this reason it is necessary to have solutions in plants such as biopolymers than macromolecules obtained from plants, proteins, lipids, polysaccharides and among other natural sources that allows it to be sustainable in time since they manage to retain high levels of micro plastics which represents enormous potential to solve these problems (Faria et al., 2022), likewise micro algae that play an important role that act as bioremediation of pollutants, as potential medicines and they are food for marine species (Wan, 2018), as well as birch trees that observe microplastics through their Its roots, likewise, woody trees also have the effectiveness of absorbing microplastics, this being important since microplastics also exist in greater quantities in the earth (Austen et al., 2022; Yoganandhan et al., 2019).

4.2 The technology that filters microplastics

Technology plays an important role in resolving the reduction of existing microplastics, this is how in different technological investigations deep and continuous filtrations were found that allow them to eliminate crystalline microplastics applied to wastewater treatment plants (Bitter et al., 2022). and these recent technological investigations are:

- The aluminosilicate filter and the surfactants that throughout its chain can capture microplastics since these have negative charges and thus manage to be cationic surfactants when generating contact (Shen et al., 2021), for this purpose quartz sand is used. which acts as a filter since these are located at the beginning and end of the filtering processes and the disadvantage of this is that it generates large scales to be effective, at the same time it increases the cost.
- Sand filters are a solution to reduce microplastics in water treatment plants, the use of the RSF filter which had an elimination of microplastics of the smallest dimensions and tire flakes resulted in 90% (Sembiring et al. al; 2021), has the sale of being more economical and effective for drinking water treatment plants, since this filter has silica sand due to its lower porosity and the ease of obtaining it at a lower cost (Sembiring et al., 2021), Likewise, there are disc filters that retain microplastics larger than the pore size of the filter but the removal process does not make it as efficient (Kwon et al., 2022), however there are other aluminosilicate filters modified with cationic surfactant, i.e. aluminum ion (AIC3) and iron ion (FeCL3) to form wastewater colloids that can improve the efficiency in removing microplastics (Shen et al., 2021) using it as a tool Secondary tool to remove microplastics from water treatment plants.

- The development of pearl microspheres, this is born thanks to the sea mussels that provide a polyphenolic protein that allows sticking to the rocks by means of metal ions and with the union of pearls, chitosan, tamic acid, sodium chloride and others Due to this, microspheres are born with the ability to capture living cells and absorb microplastics (Murray & Örmeci, 2020), however these microspheres reduce photosynthesis upon contact with algae, being an adverse effect to provide a solution (Wan , 2018).

- The technological tool Raman spectroscope / prunda UV fluorescence allows to measure, detect and quantify the great variety of contaminants in the water, for this it makes use of a conventional neural network that allows obtaining spectral data in real time (Post et al., 2021) and at the same time it it depends on the measurement time, distance to the sample and the position of the polymer. (Post et al., 2021) in order to be effective.

- There are different components such as activated carbon nanotubes that have a high removal rate, however they can be released and will require many surfactants and absorbents (Shen et al., 2021), however biochar filtration is low cost and also turns out to be effective.

- The microplastics in the sea go through sedimentation, that is, they fall according to their density and come to share on the sea surface. In this process, coagulation is intervened, which determines the force of the sea, which causes these particles to remain suspended by a lot of time at sea (Sembiring et al., 2021)

4.3 Animals that degrade microplastics

Animals are exposed to micro plastics since they manage to ingest them as well as earthworms, mussels, amphipods, fish and others, which generates the absorption of contaminants that plastic has such as polychlorinated, heavy metals, ethers and among others (Kuehr et al. ; 2022), likewise these animals as well as the marine copepod that, when exposed to PM,

caused difficulties in developing their eggs and reduced the dimensions of the egg during its growth stage (Yuan et al., 2022), these micro plastics they generate a false satiety causing digestive problems and hinders the development of production and growth of the animals (Shen et al., 2021).

One solution is to have elimination alternatives through marine living beings in order to have a counterattack towards micro plastics, this is how larvaceans have the facility to eat plastics, this is because they produce a mucus that surrounds and absorbs plastics. with a length of one and a half meters in diameter (Innaturale, 2021), likewise earthworms have the potential to degrade microplastics, particularly polylactic acid and polyethylene (Hong et al., 2020).

4.4 Microalgae that biodegrade microplastics

Just as algae play an important role since I determine several types of algae that allow the elimination of microplastics from the sea such as the microalgae (Fucus Vesiculosus) that thanks to its alginate compound, a polysaccharide substance allows it to adhere to the surface of the seaweed. algae also the other green algae (Pseudokirchneriella Subcapitata) that thanks to its positive charges allows microplastics to bind to them (Durak, 2021) thus reducing microplastics, likewise mosses are a solution to absorb microplastics, these mosses are used for biomonitoring of rivers and there are aquatic mosses such as f. antipyretica (Carrieri et al., 2022) that manage to absorb contaminants from the water, however, it does not generate much effectiveness, the membranes also fulfill the function of separating microplastics since they have pores of 90 microns (Durak, 2021) this allows them to absorb microplastics studies show an elimination of 99.9%, this being effective.

4.5 Bacteria that reduce microplastics

Bacteria have aroused interest as an effective solution to reduce microplastics, for example, komagataeibacter has the physicochemical property that allows it to form nanofibrils, microfibrils and generates the hydrogel, becoming more porous in order to absorb microplastics from water (Faria et al., 2022), likewise the erythrobacter bacteria and lignin with a variety of oxidizable microbial polymers have the property of degrading plastics (Chandra & Singh, 2020), also biopolymer bacterial cellulose is an ecological solution that thanks to its membranes is can rehydrate and the degradation throughout the filtration is shown to be effective in the elimination of microplastics (Faria et al., 2022) and the enzymes that manage to degrade the polymers are from the following bacteria Alcaligenes, Comamonas, Pseudomonas achieve their effectiveness in a month (Chandra & Singh, 2020). All bacteria show a small significance in the elimination of microplastics due to the secretion of enzymes, however they have the difficulty of the weight of the plastic, the larger it is, the more difficult to decompose it.

5. Conclusión

The interpretation of this research allows us to make better decisions in order to solve the problem that microplastics generate on the planet, the results obtained allow us to understand the different solutions that can be found to mitigate, reduce and eliminate microplastics from the planet, there are different solutions in plants such as biopolymers that mitigate microplastics in an ecological way, microalgae and algae that also contribute to the degradation of these particles; in technological solutions such as aluminosilicate filters, sand filters, circular filters and among other technologies that allow the elimination of microplastics from the sea, all this depends on the great variety of applications and depending on the investment that is made; likewise we find animals as well as larvaceans, worms that have the purpose of degrading microplastics; algae also play a role of disintegrating and absorbing microplastics to 90% which are green algae, micro algae and mosses, finally we have bacteria that also fulfill the function of eliminating as well as erythrobacter, lignin, enzymes of bacteria such as pseudomonas and among others, all these solutions are thanks to the analysis that could be compiled through the bibliographic review in Scopus. At this time we need to take action on the matter due to the great problems that plastics generate on planet earth, considering that animals are the first to be affected by diseases and extinctions, after which we will be humans. We conclude that we have different ways to solve the existence of microplastics, which we need to use them all and work as a team to generate a greater impact. This implies that governments make drastic decisions and begin to prohibit the use of plastics in their different forms, adding to Therefore, we insist that more research be generated analyzing the different consequences that will harm animals and humans.

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