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Investigating the effects of hospital waste on coastal areas: A suitable solution for its sanitary disposal

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Abstract

The purpose of this study is providing an appropriate and basic solution to prevent the mixing of hospital plastic waste, to collect the suspended and floating waste from marine environments, and to manage the floating solid waste. The method used in this research consists of four sections: library studies, field visits, and the collection and aggregation of data and information. Then, based on the existing problems, the design and construction of a safe device for infectious hospital waste was performed by vertical cutting of waste and chemical and mechanical combination of closed reactor. Different samples were selected and used to determine the appropriate composition from different compounds of sodium hydroxide with lime and sodium carbonate with lime. Also, the indicator used in microbial tests was Bacilius subtilis. The results of this study showed that the safe vertical cutting machine for infectious waste is chemically and mechanically effective according to the results of tests performed on the elimination of 98% of bacterial, fungal and infections. The rate of neutralization of bacterial contamination of total and focal coliforms and pathogens of Bacillus subtilis Salmonella and Shigella using the ratio of 30% was related to the chemical compounds of lime and sodium hydroxide, lime and sodium carbonate, respectively. Temperature, humidity and pH played an important role in the composition and effect of chemicals on shredded infectious waste. Therefore, in the designed device, the best conditions of temperature, humidity and pH were determined equal to 15 degrees Celsius, 45% and 12.5, respectively.

Keywords: Floating waste; Marine ecosystem; Marine environmental health.

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1. Introduction

With the end of the First and Second World Wars and the re-entry of thinkers into the economic, social, and environmental spheres, a large part of the problems in human societies that had not been well revealed until then were identified and exposed to public opinion (Pratt, 2015; Shi, 2015). In fact, the 1950s and beyond should be considered the decade of recognizing the damage to the marine environment and changing the perception of global public opinion, especially in developed countries, on the issues related to marine environmental protection (Williams *et al*., 2016; Kiessling *et al*., 2019). That is why governments are now forced to adopt international regulations and develop national laws and regulations to protect the marine environment (Munari *et al*., 2016). Therefore, to completely eliminate deliberate pollution of the marine environment by oil and waste from medical centers and hospitals and other harmful substances, in addition to reducing the accidental dumping of such materials into the sea caused by ships, The International Conference on Marine Pollution in 1973 ratified the International Convention for the Prevention of Pollution from Shipwrecks (Fogarassy *et al*., 2016a; Keswani *et al*., 2016). Five years after the Marple 73 Convention was drafted, the Convention fell far short of the quorum required by governments to enter into force due to economic costs and high technical difficulties for ships and ports to comply with its provisions (Galgani *et al*., 2013; Fogarassy and Neubauer, 2016). For this reason, in February of the same year, the International Conference on Tanker Prevention and Pollution adopted the 1978 Protocol to the Convention in order to amend and facilitate its accession (Jin *et al*., 2019). A total of 143 countries have acceded to the Marple Convention. The membership of the Government of Iran in the Marple Convention of 73/78 and its Annexes I, II and V has been approved by the Islamic Consultative Assembly on December 27, 2001 (Schneider *et al*., 2018; García-Ayllón, 2019).

2. Materials and methods

2.1. International Convention on Prevention of Marine Pollution Marpol

It is the most complex and complete international treaty necessary for the protection of the marine environment against pollution caused by ships (Brouwer *et al.*, 2017). The ultimate goal of the Marple Convention is the complete elimination of intentional pollution of the marine environment and the control of unintentional pollution caused by accidents by ships, fixed and floating drums, and the establishment of a solid waste collection and disposal management system to control the production, conservation and consumption of materials (Jambeck *et al*., 2015; Bergmann *et al*., 2017). Waste collection is of fundamental importance. The operation of this system should be in accordance with health, economics and environmental engineering and should be planned in accordance with other general conditions of society (Olesom *et al*., 2015; Freeman *et al*., 2003). The neglect of the collection and disposal of solid waste in today's society, due to the quantity and quality of materials, the uncontrolled development of cities, restrictions imposed on public services in large cities and lack of appropriate technology, has caused special problems that resolving them is possible only through coordination and lack of experience in the context of proper management (Brennan and Portman, 2017; Löhr *et al.*, 2017). Attention to the environment, including solid waste, is an issue that has received special attention from the world in recent years. Humans and many of the planet's creatures are waste generators in various ways, the control of which is a guarantee of the health and survival of the environment. Historical records, 8 to 9 thousand years ago, showed that man collected and buried his garbage outside and far from his place of residence (Eastman *et al*., 2013; Yu *et al*., 2018). According to the available evidence, the main reason for this is the spread of the disease, the influx of wild animals into residential areas and the stench resulting from the dumping of solid waste in the living environment (Honorato-Zimmer *et al*., 2019; Rayon-Viña *et al*., 2019). Since then, the reflection of pollution and waste-borne diseases has caused the science of waste hygiene and solid waste engineering to be more and more considered by officials and environmental experts (Borrelle *et al*., 2017). Paying attention to environmental pollution and dealing with it through various environmental programs, including solid waste management, is now widely discussed in the world health and economy, and its recycling has revolutionized the application of new technology (Chartier, 2014; Hidalgo-Ruz *et al*., 2018). The rise of incurable diseases such as cancer, recurrent strokes and hundreds of other diseases attributed to environmental pollution, since 1975, has forced many countries around the world to establish strict and rigid laws on solid waste control which adds to the importance of this issue (Hidalgo-Ruz *et al*., 2018; Rayon-Viña *et al*., 2019).

2.2. Disposing of waste to the seas and oceans

Oil pollution, the entry of municipal, industrial and agricultural sewage into the sea, sometimes cruel fishing and even light pollution threatened this valuable area every time, but the direct discharge of infectious waste from hospitals and treatment centers into rivers leading to the sea and Beaches, on the other hand, have created another environmental disaster that, given its effects, can be considered a dangerous move etc. It is evident in large numbers that it is due to unprincipled and unsanitary disposal of infectious waste from hospitals and treatment centers and their release into rivers that flow into the sea (Eastman *et al*., 2013; Jambeck *et al*., 2015).

Although the marine environment has the property of self-purification, but when the level of pollution in the water exceeds its standard limit, the purification property is disrupted and the negative effects of the spread of pollutants in the environment spread, followed by the occurrence of pollutants in the environment (Jambeck *et al*., 2015; Yu *et al*., 2018). The sea is accumulated and in a continuous cycle between man and the environment is constantly circulating and not only sacrifices natural heritage but also directly affects human health. Lack of management of infectious waste, ecological status, social and will severely affect the region's economy (Olesom *et al*., 2015).

Plastic wastes such as serum and old toothbrushes and toothbrushes, recreational equipment by the sea and other plastic wastes are part of the wastes floating in the middle of the seas and oceans (Eastman *et al*., 2013). According to research, because plastics do not change like organic matter and remain the same, marine currents and tides carry them for thousands of miles. The International Greenpeace Report, entitled "Plastic Waste in the World of Oceans," says that at least 267 species, including seabirds, turtles, jaws, sea lions, whales and fish, have been damaged by being caught in or swallowed by plastic (Löhr *et al.*, 2017; Hidalgo-Ruz *et al.*, 2018). The report states that 80% of this waste originates from land and 20% from the ocean, and its main source is mentioned in four sections: tourism, sewage, fishing and ship and boat waste (Bergmann *et al.*, 2017; García-Ayllón, 2019). Fish and seafood stocks are lost if the fishing and pollution are continued. Plastic waste has become a major problem across the world's seas and oceans. Invasive species cling to garbage (Pratt, 2015; Keswani *et al.*, 2016).

3. Results

The results of waste disposal at 15 °C and humidity of 45% and the weight of waste received 2 kg in the device with an increase of 10% sodium carbonate and 90% lime showed that the pH of destroyed sample was 9.

For this purpose, in the second stage, 20% sodium carbonate and 80% lime Combine and the pH was equal to 11.2. To increase the pH in the third stage, 30% sodium carbonate and 70% lime Combine and the pH value was 12.5. This pH has a better function for removing all microorganisms (total info-focal coliforms and pathogens of Basilus subtilis Salmonella and Shigella (standard method) and causes the destruction of their cell wall (Chartier, 2014; Chauhan and Singh, 2016).

Then, to increase the pH for a better effect on the microorganisms, a combination of 20% sodium hydroxide and 80% lime was used, and the pH of this mixture reached to 11.5. The mixture chamber in the device designed to increase the pH of a mixture of 30% sodium hydroxide and 70% lime was used, as a result of which the pH was 12.3 (Jonidi *et al.*, 2010; Rajendra, 2014).

The results of microbial cultures performed in the first experiment showed that the chemical content of 30% lime and sodium carbonate to remove all microorganisms (Total and focal coliforms and pathogens and Basilus subtilis Salmonella and Shigella) was 98% and in the second experiment with 30% sodium hydroxide This rate was also 98% for the removal of all microorganisms (total and focal coliforms and pathogens Basilus subtilis, Salmonella and Shigella). This result shows the better effect of mixing 30% sodium carbonate with lime

Figure 1. Chemical and mechanical device for designing and constructing a hospital waste disposal device

and sodium hydroxide with lime as the most desirable and the designed device was obtained (Figure 1).

This microbial result was also true in the compound used sodium hydroxide. The results of temperature, humidity, and pH changes play an important role in the effect of chemicals on the neutralization of infectious waste (Yousefi and Valizadeh, 2010). As increasing the pH of the environment causes good performance of chemicals and 45% humidity is the most appropriate amount of moisture in the composition of chemicals used to decontaminate waste. The results showed that with increasing the amount of chemical compounds, the pH value increases, so that, in the mixture of sodium carbonate with weight percent of 10%, 20% and 30%, its value was 9, 11.2 and 12.5, respectively, and in the mixture of sodium hydroxide with weight percentage of 10%, 20% and 30%, its values were 9.5, 11.5 and 12.8, respectively. Therefore, due to the fact that high pH values destroy the walls of all bacteria, fungi and pathogenic viruses, therefore, the mixture of 30% sodium carbonate and 70% lime with pH =12.5 and a mixture of 30% sodium hydroxide and 70% lime with a pH of 12.5 were selected as the most suitable mixtures used in the designed device.

4. Discussion

Oil pollution, the entry of municipal, industrial and agricultural wastewater into the Caspian Sea, sometimes brutal fishing and even light pollution threatened this valuable area every time, but the direct discharge of infectious waste from hospitals and treatment centers to the rivers leading to the sea The Caspian Sea and the coast, on the other hand, have created another environmental catastrophe that, given its effects, can be considered a dangerous act (Fogarassy *et al*., 2016b; Jin *et al*., 2019). There are a large number of drugs that are caused by unprincipled and unsanitary disposal of infectious waste from hospitals and treatment centers and their release into rivers that flow into the sea (Schneider *et al*., 2018). Although, the marine environment has its own characteristics, it is self-purification. In addition, when the level of pollution in the water exceeds its standard level, the purification property is disturbed and the negative effects of pollutants in the environment are spread (Olesom *et al*., 2015; Brouwer *et al*., 2017). A related cycle between humans and the environment is constantly evolving, and not just the legacy of medicine, but it directly affects human health. Lack of management of infectious waste will severely affect the ecological, social and economic situation of the region, which will be briefly addressed.

4.1. Ecological situation

Infectious contaminants caused by these wastes are easily and rapidly spread over a wide area of the environment, and with the spread of diseases, human, plant and animal life is in danger of extinction and a crisis occurs. Microbial infections cause fish to die and prevent their eggs from fertilizing (Brennan and Portman, 2017; Löhr *et al*., 2017). Due to the high groundwater level in the northern provinces of Iran, the risk of contamination penetrating into groundwater aquifers is very high, so infectious contaminants easily penetrate the groundwater surface and consequently water sources. The soil of the region is polluted and these pollutants are transferred from one environment to another. The entry of water contaminated with infectious pollutants has affected the agricultural industry of the region and through this microbial contamination enters the food and life cycle. People become (Eastman *et al*., 2013; Honorato-Zimmer *et al*., 2019).

4.2. Social situation

The presence of this waste threatens the natural beauty of the region and affects the tourism industry. The area around Bahnemir beach is much polluted and people are exposed to various diseases while swimming and having fun on this beach, and this can lead to the closure of swimming pools and consequently reduce the number of tourists to this area (Rayon-Viña *et al*., 2019).

4.3. Economic situation

In addition to the fact that the reduction of tourism and the closure of swimming pools cause economic losses to tourism centers, it should be noted that the Caspian Sea and its aquaculture play an important role in the country's economy and are considered important and lucrative resources (Olesom *et al*., 2015). Sea pollution and the extinction of sturgeon offspring will cause irreparable economic damage to the millions of Iranians living on the Caspian coast. Therefore, the prevalence of infectious and microbial contamination in rivers and seas has a direct effect on income generation through fish farming and fishing, and neglecting this will cause irreparable damage not only to the regional economy but also to the country (Borrelle *et al*., 2017; Honorato-Zimmer *et al*., 2019). Unbalanced development of cities, overcrowding in most coastal areas, poor management in relation to proper location and organization of these areas, increasing development of tourism and tourism industry, lack of proper management in relation to urban, industrial and agricultural wastewater disposal are other polluting reasons. Caspian is charged (Hidalgo-Ruz *et al*., 2018).

Public and global pollution of the oceans by plastic, although not easily seen, is a huge problem. Recently, experts estimated that up to five percent of all man-made man-made materials in the world end up in the sea as waste. In 2010, experts estimated that there were about 12 million tons of plastic wastes in the seas (Galgani *et al*., 2013; Keswani *et al*., 2016). In many cases, plastic enters the sea by river. Also, microplastics are becoming an increasing threat to environmental health. In Europe, about 200,000 tons of microplastics enter the seas every year through sewage. Marine cycle and climatic conditions have a great impact on the accumulation and movement of microplastics (Keswani *et al*., 2016; García-Ayllón, 2019). Microplastics are actually particles less than 5 mm in size that are of growing concern. Not only are they more common than other plastics in the sea, but they also have negative effects on marine species. Garbage dumping, sewage entering and ships sinking at sea can cause plastic to enter the sea, it is estimated that plastic waste entering the seas from coastal countries will increase twenty times by 2025 (Eastman *et al*., 2013; Brouwer *et al*., 2017). The density of plastics determines whether they remain on the surface of the water and return to shore or settle deep in the sea. In addition, climatic conditions and marine cycles play the most important role in the distribution of plastics at sea. Global thinking and local action is a key attitude to reduce such an environmental threat (Brennan and Portman, 2017; García-Ayllón, 2019). Combining law and rising environmental awareness through education seems to be the best solution to solve such environmental problems (Galgani *et al*., 2013).

Conclusion

The result of the present study showed that the sample of the designed device for decontamination of infectious wastes by the combined chemical and mechanical method presented in Figure 1 is appropriate according to the results of experiments obtained to remove all microorganisms in the waste. On the other hand, the device is designed due to its native technology and short decontamination cycle as well as its low production cost can be a good option to replace other devices used. In general, the results of experiments on destroyed waste showed that the simultaneous use of physical and chemical methods can be a suitable method to replace conventional demolition systems.

References

Bergmann, M., Tekman, M. B., and Gutow, L. 2017. Marine litter: Sea change for plastic pollution. Nature, 544: 297.

Borrelle, S. B., Rochman, C. M., Liboiron, M., Bond, A. L., Lusher, A., Bradshaw, H., and Provencher, J. F. 2017. Why we need an international agreement on marine plastic pollution. Proceedings of the National Academy of Sciences of the United States of America, 114: 9994–9997.

Brennan, R. E., and Portman, M. E. 2017. Situating Arab-Israeli Artisanal Fishermen's Perceptions of Marine Litter in a Socio-institutional and Socio-cultural Context. Marine Pollution Bulletin, 115: 240–251.

Brouwer, R., Hadzhiyska, D., Ioakeimidis, C., and Ouderdorp, H. 2017. The social costs of marine litter along European coasts. Ocean & Coastal Management, 138: 38–49.

Chartier, Y. 2014. Safe management of wastes from health-care activities: World Health Organization.

Chauhan, A., and Singh, A. 2016. A hybrid multi-criteria decision making method approach for selecting a sustainable location of healthcare waste disposal facility. Journal of Cleaner Production, 139: 1001-1010.

Eastman, L. B., Núñez, P., Crettier, B., and Thiel, M. 2013. Identification of self-reported user behavior, education level, and preferences to reduce littering on beaches e A survey from the SE Pacific. Ocean & Coastal Management, 78: 18-24.

Fogarassy, C., Kerpely, K., Horvath, B., and Bakos Borocz, M. 2016a. Analysing the attributes of ecological evaluation on local and regional levels via willingness to pay (WTP)—A Hungarian case study. Applied Ecology and Environmental Research, 14: 129-145.

Fogarassy, C., Neubauer, É., Bakosné, M. B., Zsarnóczai, J. S., and Molnár, S. 2016b. Water footprint based water allowance coefficient. Water Resources and Industry 7–8: 1-8.

Fogarassy, C., and Neubauer, E. 2016. Evaluation of the regional water usage in Hungary with water allowance coefficient (WAC). Applied Ecology and Environmental Research, 14: 161-173.

Freeman, A. M., Herriges, J. A., and Kling, C. L. 2003. The Measurement of Environmental and Resource Values: Theory and Methods; Resources for the Future Press: Washington, DC, USA.

Galgani, F., Hanke, G., Werner, S., and De Vrees, L. 2013. Marine litter within the European Marine Strategy Framework Directive. ICES Journal of Marine Science, 70: 1055-1064.

García-Ayllón, S. 2019. New Strategies to Improve Co-Management in Enclosed Coastal Seas and Wetlands Subjected to Complex Environments: Socio-Economic Analysis Applied to an International Recovery Success Case Study after an Environmental Crisis. Sustainability, 11: 1039-1065.

Hidalgo-Ruz, V., Honorato-Zimmer, D., Gatta-Rosemary, M., Nuñez, P., Hinojosa, A. I., and Thiel, M. 2018. Spatio-temporal variation of anthropogenic marine debris on Chilean beaches. Marine Pollution Bulletin, 126: 516–524.

Honorato-Zimmer, D., Kruse, K., Knickmeier, K., Weinmann, A., Hinojosa, A. I., and Thiel, M. 2019. Inter-hemispherical shoreline surveys of anthropogenic marine debris—A binational citizen science project with schoolchildren. Marine Pollution Bulletin, 138: 464-473.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., and Law, K. L. 2015. Plastic waste inputs from land into the ocean. Science, 347: 768–771.

Jin, M. L., Juan, Y. X., Choi, Y. J., and Lee, C.-K. 2019. Estimating the Preservation Value ofWorld Heritage Site Using Contingent Valuation Method: The Case of the Li River, China. Sustainability, 11: 1100-1113.

Jonidi, A., Jafaripour, M. R., and Farzadkia, M. 2010. Hospital solid waste management in Qom hospitals. Journal of School of Public Health and Institute of Public Health Research, 8(2): 41-53.

Keswani, A., Oliver, D. M., Gutierrez, T., and Quilliam, R. S. 2016. Microbial hitchhikers on marine plastic debris: Human exposure risks at bathing waters and beach environments. Marine Environmental Research, 118: 10–19.

Kiessling, T., Knickmeier, K., Kruse, K., Brennecke, D., Nauendorf, A., and Thiel, M. 2019. Plastic Pirates sample litter at rivers in Germany–Riverside litter and litter sources estimated by schoolchildren. Environmental Pollution, 245: 545–557.

Löhr, A., Savelli, H., Beunen, R., Kalz, M., Ragas, A., and Belleghem, F. V. 2017. Solutions for global marine litter pollution. Current Opinion in Environmental Sustainability, 28: 90–99.

Munari, C., Corbau, C., Simeoni, U., and Mistri, M. 2016. Marine litter on Mediterranean shores: Analysis of composition, spatial distribution and sources in northwestern Adriatic beaches. Waste Management, 49: 483-490.

Olesom, K. L. L., Barnes, M., Brander, L. M., Oliver, T. A., Van Beek, I., Zafindrasilivonona, B., and Van Beukering, P. 2015. Cultural bequest values for ecosystem service flows among indigenous fishers: A discrete choice experiment validated with mixed methods. Ecological Economics, 114: 104-116.

Pratt, S. 2015. Potential Economic Contribution of Regional Tourism Development in China: A Comparative Analysis. International Journal of Tourism Research, 17: 303-312.

Rajendra, A. 2014. Bio-Medical Waste Management in the Local Planning Area of Mysore City. International Journal of Advanced Research, 2(7): 951-955.

Rayon-Viña, F., Miralles, L., Fernandez-Rodríguez, S., Dopico, E., and Garcia-Vazquez, E. 2019. Marine litter and public involvement in beach cleaning: Disentangling perception and awareness among adults and children, Bay of Biscay, Spain. Marine Pollution Bulletin, 141: 112-118.

Schneider, F., Parsons, S., Clift, S., Stolte, A., and McManus, M. C. 2018. Collected marine litter—A growing waste challenge. Marine Pollution Bulletin, 128: 162-174.

Shi, P. H. 2015. The Comprehensive Contribution of China's Tourism Industry to GDP. China Tourism News, 8 July 2015; B03. (In Chinese)

Williams, A. T., R-Buitrago, N. G., Anfuso, G., Cervantes, O., and Botero, C. M. 2016. Litter impacts on scenery and tourism on the Colombian north Caribbean coast. Tourism Management, 55: 209-224.

Yu, B., Cai, Y. Y., Jin, L. Q., and Du, B. S. 2018. Effects on Willingness to Pay for Marine Conservation: Evidence from Zhejiang Province, China. Sustainability, 10: 2298-2314.

Yousefi, Z., and Valizadeh, M. 2010. Evaluation on applied non-burning and medical waste sterilization methods in Mazandaran Province. In: 13th National Conference on Environmental Health Iran, Kerman University of Medical Sciences (In Persian).