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Article Review

Negative Potential of Nuclear Waste on Animal Tissues in the Sea of Japan

Negative Potential of Nuclear Waste on Animal Tissues in the Sea of Japan

Aisyah Ainuur Rohmah1*, Evina Varia Devianti2, Ibrahim Bin Sa'id3
[1,2,3] Department of Natural Science, Faculty of Tarbiyah, Institut Agama Islam Negeri Kediri, East Java, Indonesia
*E-mail correspondenceaisyahainuur@gmail.com

Abstract

On August 2023, Japan released nuclear waste into the Pacific Ocean, which sparked debate in the international community. Many countries questioned Japan's decision to dump waste into the sea. This study aims to further discuss Japan's policy of dumping its nuclear waste into the sea and the potential negative consequences that may arise from such a policy. This study was conducted by collecting data from the literature and leveraging AI chatbots. Based on the study, it can be concluded that although Japan has obtained permission to dump its waste into the sea, potential negative consequences may still occur, such as genetic mutations in marine organisms and bioaccumulation radioactive substances in the food chain. Therefore, monitoring of nuclear waste dumped into the sea is essential to ensure the sustainability of the marine ecosystem and human safety.

Keywords: *Animal Tissue, Sea of Japan, Nuclear Waste, Negative Potential*

Abstract

In August of 2023, Japan released nuclear waste into the Pacific Ocean, causing international debate. Many countries have questioned Japan's decision to dump the waste into the ocean. This research aims to further discuss Japan's policy of discharging its nuclear waste into the ocean as well as the negative potentials that may occur from the policy. This research was conducted by collecting data from the literature and utilizing an AI chatbot. Based on the research conducted, it can be concluded that despite having a license to dispose of its waste into the sea, negative potentials may occur, such as genetic mutations in marine organisms and bioaccumulation of radioactive substances in the food chain. Therefore, monitoring nuclear waste discharged into the sea is very important to maintain the sustainability of the marine ecosystem and human safety.

Keywords*: Animal Tissue, Sea of Japan, Nuclear Waste, Negative Potential*

INTRODUCTION

Nuclear waste is a type of hazardous waste generated from nuclear activities, such as nuclear power generation, nuclear weapons testing, and nuclear research. In recent decades, Japan has faced a concerning situation related to nuclear waste due to the nuclear accident that occurred in Fukushima in 2011. The accident resulted in approximately 1000 tanks of treated wastewater from the Fukushima Daiichi Nuclear Power Plant to . And in August 2023, Japan released the nuclear waste into the Pacific Ocean. The decision has sparked international debate due to the potential danger to human survival and marine ecosystems. In addition, the disposal of this radioactive waste could have far-reaching effects, not only in Japan, but also in neighboring countries. (Nuraini, 2022).

Although this is a common procedure for nuclear power plants to discharge wastewater into the sea under certain regulatory authorizations based on safety and environmental impact evaluations, however, to discharge such a large amount of nuclear waste generated by the Fukushima Nuclear Incident is different from the normal operation of a typical nuclear power plant. Nuclear wastewater from the FDNPP is sourced from cooling water injected with melted defunct cores after the accident, as well as groundwater and rainwater that seep into the reactors (Lu et al., 2021).

Radioactive materials released into the ocean can accumulate in marine organisms and disrupt the balance of the ecosystem. This can cause various potential negative effects on the tissues of animals in the Japanese ocean. Increased concentrations of radioactive substances in the tissues of marine animals can cause DNA damage and genetic mutations in these organisms. In addition, radioactive substances can also damage the vital organs and reproductive systems of animals, disrupt growth and development, and increase the risk of disease and health abnormalities in marine animals.

Based on the above explanation, in this article the author will further review Japan's policy of discharging its nuclear waste into the sea as well as the negative potentials that may occur from this policy. Through a better understanding of the impacts of nuclear waste, hopefully, appropriate actions can be taken to protect biodiversity and the balance of marine ecosystems.

RESEARCH METHODS

This research was conducted by collecting data from the literature. To review theories and research results that are relevant to the research topic. The literature taken is previous studies that have been published and have good quality and reliability. Data obtained from the literature were collected, analyzed, and synthesized to gain a comprehensive understanding of the negative potential of nuclear waste on animal tissue in the Japanese sea. In addition, the author also utilized an AI (Artificial Intelligence) chatbot to help create diction.

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RESULTS AND DISCUSSION

Nuclear Waste

Nuclear waste is material that contains radioisotopes or radioactive isotopes, which can be solid, liquid, or gas and has a high level of radioactivity, so it can cause risks to humans and the environment if not managed properly. This nuclear waste comes from various sources, including nuclear power plants, nuclear research, radiotherapy treatment, nuclear industry, and nuclear weapons testing. Nuclear waste is grouped into several categories based on its nature and level of radioactivity (Government Regulation of the Republic of Indonesia Number 61 of 2013 concerning Radioactive Waste Processing, 2013). The following are some general categories of nuclear waste based on their level of radioactivity:

1. Low Level Nuclear Waste (LLW)
   Is nuclear waste with minimal levels of radioactivity. Involves items such as protective clothing, contaminated tools, and small amounts of radioactive chemicals. It is usually placed in sturdy containers and clearly marked before disposal.
2. Intermediate Level Nuclear Waste (ILW)
   Is nuclear waste with higher levels of radioactivity than LLW. Involves spent components from nuclear reactors, contaminated equipment, and waste from medical facilities. Usually requires additional levels of isolation and stricter management.
3. High Level Nuclear Waste (HLW)
   It is the most dangerous nuclear waste with extremely high levels of radioactivity. Mainly derived from spent nuclear fuel from nuclear power generators. Should be placed in a safe long-term collection accommodation, such as underground storage or geological storage.
4. Transuranium Waste
   It is waste that contains transuranium elements such as plutonium and americium. These elements are very dangerous and require special attention in their management.
5. Natural Nuclear Waste (NORM)
   It is waste derived from natural materials that contain radioisotopes, such as uranium ores or phosphates that may contain radium. Sometimes arises as a by-product of industrial activities.

Nuclear waste management must comply with very strict regulations and take into account the level of radioactivity and half-life of isotopes contained in the waste. The goal is to safeguard humans and the environment from the potential dangers of emission (radiation). Nuclear waste must go through a series of processing steps in order to be disposed of safely. This involves collection, sorting, volume reduction, and changes to its chemical and physical properties, such as concentrating liquid waste. After that, the waste is treated to make it immobile and then packaged before it is finally stored or disposed of (Meilasari & Sutrisno, 2019).

Before choosing a waste treatment strategy, it is important to understand the source of the waste, the rate of waste generation, and its characteristics. Waste characterization provides information about its physical, chemical, and radiological properties, which helps to

in determining appropriate safety requirements and suitable processing options. It also ensures that the waste meets accepted storage and disposal criteria. The waste treatment process consists of three main stages: pre-treatment, treatment, and conditioning.

Pre-treatment involves preparing the waste for further treatment, including sorting and separating contaminated materials from non-contaminated ones. Sometimes, waste is also resized to maximize the efficiency of subsequent treatment. Decontamination is used to reduce the volume of waste, reducing disposal costs.

After waste preparation, the next step is treatment to improve safety and reduce further management costs, such as storage or disposal. This often involves reducing the volume of radioactive waste by separating its radioactive components. There are various waste treatment techniques that can be used depending on the nature of the waste and the requirements of the disposal site. Two common techniques include incineration of solid waste and vaporization of liquid waste.

The third step in the process is conditioning, which converts the waste into a safe, stable and manageable form for transportation, storage or disposal. Conditioning techniques aim to slow the release of radionuclides from the waste into the environment. This often involves packaging the waste in materials such as cement, bitumen, or glass, or over-packaging in specialized containers.

Background of Japan's Nuclear Waste Disposal into the Sea

The handling of this nuclear waste is highly regulated by international treaties as well as strict environmental regulations. Countries with nuclear waste are generally stored with great care and adhere to strict guidelines to prevent the impact of marine pollution or damage to the marine environment. However, it is common to dump nuclear waste into the water to empty full waste storage sites. Here are some of the reasons Japan dumped its nuclear waste into the sea:

1. **Discharging treated wastewater into the sea is a common practice at nuclear power plants.**

   Naturally, the sea has the power to neutralize contaminated substances that penetrate into it. Nuclear power plants usually use seawater to cool their reactors. The seawater that has been used for cooling is then discharged back into the sea (Cahyana, 2011). If these substances exceed the capacity of the sea to neutralize them, as well as exceed the threshold of pollution, then such conditions cause pollution (Mawaddah et al., 2023). Therefore, the limit of tritium content in liquids is set so that the tritium content in waters does not exceed the limit. WHO itself sets the limit of tritium content at 10,000 becquerels per liter (Ferreira et al., 2023).

   For example, in Canada, the country's three largest reactors are located along the Great Lakes coast. The highest tritium concentration levels were reported along the northern shore of Lake Ontario at 8.4 Bq L-1, more than double the concentration in offshore waters at 3.5 Bq L-1. Then in France, tritium concentration levels ranged from 3 to 4 Bq L- 1 in coastal rivers not affected by nuclear facilities. However, in the Rhône River, which has a high density of nuclear facilities, tritium concentrations fluctuate between 2.50 and 12.85 Bq L-1, with an average of 6.31 Bq L-1.

   While in Fourmile Branch, the United States, which is an area that receives contaminated waste from nuclear weapons material production facilities,

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tritium concentrations in water from ponds adjacent to the contaminated river ranged from 1570 to 1920 Bq L-1, with an average concentration of 1790 Bq L-1, or about times higher than the average 70 Bq L-1 measured above the river (Ferreira et al., 2023).

2. **Treated nuclear waste storage tanks are full**

On March 11, 2011, Japan was hit by an earthquake and tsunami that caused explosions and leaked four nuclear reactors at Fukushima. Since then, the Tokyo Electric Power Company (TEPCO) has supplied a lot of water to reduce the temperature of the fuel rods of the exploded nuclear reactors. The cooling process produces water contaminated with nuclear radioactive substances, which is stored in giant tanks. There have been at least more than
1,000 tanks containing contaminated water, and Japan expressed the need for land to build new safe facilities to retire the power plant. In addition, Japan is also worried that the tanks will collapse in the event of a natural disaster (Mawaddah et al., 2023). The Japanese government also said that the nuclear waste storage space will soon be full, leaving them with no choice but to start draining the wastewater into the Pacific Ocean.

Although the disposal of treated nuclear waste into the sea is quite common, there are still cons voiced by critics. They say that the Fukushima nuclear disaster has produced an unprecedentedly significant amount of radioactive waste. According to critics, in the current situation, Japan should keep the treated wastewater in tanks. This is considered a move that will give scientists time to develop new technologies that can reduce radioactive levels in nuclear waste (Mawaddah et al., 2023).

3. **Nuclear waste disposal has obtained a license from the International Atomic Energy Agency / IAEA (International Atomic Energy Agency)**

TEPCO is treating contaminated water from the Fukushima NPP using the *Advanced Liquid Processing System* (ALPS). This technology can reduce radioactive levels in the waste, except for tritium and carbon-14. These two substances are derived from hydrogen and carbon and are not easily released from water. Tritium and carbon-14 are naturally occurring radioactive substances found in nature, water or even in the human body. The radiation released by these two substances is fairly low, but can still be risky if consumed in large quantities (Wong, 2023).

The International Atomic Energy Agency (IAEA) stated that the release of treated water from the Fukushima nuclear reactors is not harmful to humans and the environment. The statement was made by IAEA Director General Rafael Mariano Grossi to Japanese Prime Minister Fumio Kishida on July 4, 2023. The statement is based on the results of research that has been carried out for nearly two years by a team of IAEA nuclear experts from 11 countries (BAPETEN Statement and Attitude on the Release of Treated Water from Fukushima Daiichi Nuclear Power Plant in Japan, 2023).

Japan decided to limit the concentration of tritium in nuclear wastewater released from the Fukushima Daiichi nuclear power plant to one-seventh (1,500 Bq/L) of

standard set by the World Health Organization for clean water (10,000 Bq/L). Routine testing by the plant showed that the concentration of tritium in the wastewater was below the limit. Tritium discharged into the environment is a common occurrence in nuclear power plant operations. Japan has decided that the discharge of tritium is 22 Trillion Bq/year. This is smaller than the average annual tritium discharge at other countries' nuclear power plants.

Because Japan's nuclear waste has met international safety, Japan has obtained permission from the UN Nuclear Regulatory Agency (IAEA). The waste disposal that will be carried out is not immediately all flowed into the sea, but is carried out in stages. This waste disposal process will take at least the next thirty years, although some other experts state that this process could take longer due to the waste still being produced (Blume, 2023).

TEPCO also revealed that it will continue to monitor the level of radioactivity of the processed water, including the seawater of the discharge site. TEPCO has installed emergency valves to prevent wastewater leakage. In the event of an earthquake or tsunami, these valves can also be closed manually by personnel (Wong, 2023).

Based on the above reasons, the Japanese government has started the process of discharging the nuclear wastewater into the Pacific Ocean on August 24, 2023. It is estimated that the entire process of discharging treated water will last for approximately 30 years.

Negative Potential of Nuclear Waste Disposal on Animal Tissues

Although the Japanese claim that the disposal of this nuclear waste has gone through a very strict process, we as humans must still be vigilant about the negative potential of discharging this waste into the sea. Through some literature studies that the author has done, here are some potential negative effects that may occur due to the disposal of nuclear waste into the sea on animal tissue.

The negative potential of nuclear on marine organisms and maritime ecosystems as a whole is significant. One of the most striking effects is the presence of nuclear radiation, which has the potential to damage marine organisms (Dewita & Alimah, 2015). This radiation may cause genetic mutations in marine organisms, disrupt their natural development and even affect reproductive processes. As a result, marine organisms exposed to nuclear radiation may face serious problems in terms of their health.

Moreover, nuclear waste also has the potential to cause gradual accumulation of radioactive substances in the bodies of marine organisms (Mukanthi et al., 2021). Bioaccumulation itself means the process by which toxic or radioactive substances accumulate in organisms over time. In the context of radioactive substances, bioaccumulation occurs when organisms absorb, accumulate and store radioactive substances in their tissues. This primarily occurs in the food supply of marine animals and has the potential to affect humans who consume marine products. When nuclear waste is discharged into the ocean, its radioactive substances can be absorbed by plankton and other marine organisms, starting the process of bioaccumulation. Small marine organisms exposed to these radioactive substances are then eaten by fish and other marine animals. Over time, radioactive substances can build up in the tissues of these marine animals. This affects top-level predators such as large fish and marine mammals, which can have higher levels of radioactive substances because they eat marine animals that have bioaccumulated.

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The impact of nuclear waste on human skin tissue when humans consume marine animals that have been exposed to nuclear radiation, such as fish or crustaceans contaminated with radioactive substances, can potentially cause negative effects on skin tissue and overall health. Nuclear radiation has a variety of effects, including skin redness and irritation to more serious risks such as radiation burns and increased risk of skin cancer, depending on the level of exposure and type of radiation involved (Pandi et al., 2023). In the long term, this radiation exposure can lead to a variety of radiation-related diseases, including skin tissue damage, damage to blood cells, as well as immune system disorders. Therefore, it is important to implement strict nuclear waste management and avoid unnecessary radiation exposure in order to maintain healthy skin and human body.

Another impact involves population declines of certain marine organisms as a result of exposure to nuclear radiation, which in turn can disrupt the balance of marine ecosystems. In this case, nuclear radiation can cause certain marine organisms to experience significant population declines, disrupting predator-prey relationships and complex ecosystem interactions. For example, species exposed to radiation may experience declines in numbers that could affect other species that depend on them in the food chain.

Pollution of the marine environment is also a serious impact that needs to be considered. Nuclear waste can contaminate seawater and sediments, resulting in increased concentrations of harmful substances in the marine environment. This can affect marine organisms living near polluted areas and also marine organisms that migrate to those environments. As a result, larger-scale maritime ecosystems may be affected, with potential long-term impacts on various species and components of the marine environment (Phispal, 2013).

It is therefore important to carefully understand and address these impacts, through strict nuclear waste management and robust marine environmental conservation efforts. This is necessary to protect marine organisms, maintain ecosystem balance, and minimize the human health risks of possible exposure to nuclear radiation through seafood consumption.

Urgency of Nuclear Waste Monitoring

Japan's monitoring of nuclear waste discharged into the ocean has great urgency. This is because the impact of nuclear waste on marine ecosystems and surrounding animal life can be very significant. , continuous research and monitoring of the effects of nuclear waste is necessary to maintain the sustainability and preservation of marine ecosystems both in Japan and in the waters of other countries.

Long-term integrated monitoring of coastal waters should be conducted through close international collaborative research. Although the Japanese government claims that radioactive materials other than tritium can be removed, independent monitoring of each waste storage facility should continue to ensure the removal of all radioactive contaminants. At the same time, long-term collaborative research program should be launched, detecting radioactive elements in seawater, seabed and marine ecosystems,

investigate the transfer of radioactive pollutants between different media, and analyze their impacts on ecosystem health and human health. The health hazards of these radioactive materials due to the Fukushima accident should be given long-term attention (Lu et al., 2021).

The Japanese government has committed through the Ministry of Environment to continuously monitor the water release area and routinely announce the monitoring results every week. Similarly, the IAEA has sent a special team to the Fukushima NPP to reduce public anxiety and ensure that waste disposal is carried out safely and transparently (Aulia, 2023).

The Nuclear Energy Regulatory Agency (BAPETEN) believes that Japan's disposal of treated nuclear wastewater will not have a negative impact on human health and the environment, provided that the concentration of tritium in the treated wastewater remains below the set standard. However, this depends on the ability of the management of the Fukushima Daiichi NPP to ensure that the concentration of tritium in the discharged treated water does not exceed the predetermined limit. Indonesia will continue to monitor the development of this situation and cooperate with the IAEA and other world nuclear regulatory bodies to ensure that the discharge of nuclear wastewater meets safety standards (BAPETEN Statement and Attitude on the Release of Treated Water from Fukushima Daiichi Nuclear Power Plant in Japan, 2023).

CONCLUSIONS

Japan has decided to discharge treated nuclear waste into the sea, especially exposed water from the Fukushima Daiichi nuclear reactors, for reasons such as general policy at nuclear plants, running out of storage space, and permission from the UN Nuclear Regulatory Agency (IAEA).Although Japan has ensured that the treated wastewater will meet safety standards, there are still potential negatives to marine ecosystems and human health, such as genetic mutations in organisms, bioaccumulation of radioactive substances in the food chain, and impacts on the health of humans who consume contaminated marine products.

Monitoring of nuclear waste discharged into the ocean has an important urgency to maintain the sustainability and preservation of marine ecosystems and ensure human safety. International cooperation and independent monitoring are needed to ensure transparency and safety in the nuclear waste disposal process.

Japan's Nuclear Power Administration (BAPETEN) and the IAEA are committed to monitoring the situation and ensuring that the release of treated water meets established safety standards.

As such, Japan's decision to dump nuclear waste into the ocean is a complex one with many considerations, including risks to the marine environment and human health, as well as the important role of strict monitoring and policies in managing nuclear waste.

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