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Utilization of Ozone and Kefir Whey Probiotics as a Green Technology in Coliform Removal in Health Care Facilities Wastewater

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ABSTRACT

Health care facilities wastewater (HWW), such as hospital, is classified as domestic wastewater according to Minister of Environment and Forestry Regulation No.P68/2016. One of the important parameters is total coliform. The disinfection process using chlorine is effective in reducing the number of coliforms, but it is indicated to cause residues and side effects for other microorganisms in the receiving water bodies. This research is an experimental study by utilizing ozone and probiotics from whey kefir to eliminate coliform bacteria, aiming to determine the strategy for choosing a method for removing total coliform bacteria in HWW using the Analytic Hierarchy Process (AHP) approach. Data processing used Expert Choice 2011 software and it was found that the criteria with the highest score were environmental aspects, namely 0.302 and the priority indicator being minimizing the risk of pollution with the highest score, 0.366. Determination of strategies in the process of eliminating coliform bacteria in HWW by making choices, between the use of chlorine, ozone and a combination of ozone and whey kefir probiotics with five criterias approach (environmental, technological, social, economic, and institutional). Ultimate priority by using ozon was chosen with a score of 0.449; use of ozone and probiotics is the second priority with a score of 0.316; and utilization of chlorine with a score of 0.235.

Keywords: HWW; AHP; ozonation; probiotics; whey kefir; clorine; WWTP.

INTRODUCTION

The increase in land use (Munawir et al. 2019), due to the high population growth resulting from an increase in the area of built-up land (Rusdiyanto and Munawir, 2023). The impact of increasing built-up land (Rusdiyanto et al. 2020a; Munawir et al. 2022b) always has a negative effect on decreasing environmental quality (Munawir et al. 2022d). Decline in environmental quality can be caused by exceeding the threshold for air quality standards (Munawir, 2017), decreased crop production (Munawir et al. 2022a), and high water quality standards (Rusdiyanto et al. 2021). One of the declines in environmental quality that has become the focus of all countries in the world is the increasing waste water (Sharma and Rawal, 2021).

Hospital wastewater (HWW) contains various kinds and numbers of pathogenic microbes, one of the important parameters is coliform/Escherichia coli (Unicef., 2021). Microbial concentrations vary widely and are affected by hospital activities (Emmanuel et al., 2009, Verlicchi et al., 2010 in Mubedi et al. (2013). Hospital wastewater has the potential to become a medium for disease transmission and pollute the environment. Busyairi et al. (2016), stated that the application of 160 ppm chlorine with a contact time of 40 minutes resulted in a residual chlorine of 97.5 ppm, and this indicated that the use of chlorine actually had the potential to cause other microbes in the waters as effluent receiving water bodies to die due to residual chlorine (Prayitno et al., 2018).

Water pollution and the impact caused by HWW is very worrying because it can disrupt water availability, Zhang et al. (2017) stated that it can affect the economic, social and sustainability balance of a country. Efforts to minimize the impact of HWW require a strong wastewater treatment process with minimal effect on the environment. In the wastewater treatment process, there are two factors that need to be considered in the elimination of pathogenic microbes, (1) how long the pathogenic microbes remain in the system and (2) how quickly the pathogenic bacteria can die. Removal of pathogenic microbes in surface water can significantly reduce the risk of disease transmission (Fewtrell, 2005; Fuhrmeister et al., 2015; Tong et al., 2016).

For this reason, environmental management needs to consider institutional, social, environmental and economic aspects (Rusdiyanto et al. 2020b; Munawir et al, 2021), the right solution is to design a strategy for managing waste water in a sustainable manner to ensure environmental management. In this study, HWW was treated with ozon and whey kefir as a source of probiotics to suppress coliform bacteria. Determination of strategies in the process of eliminating coliform bacteria in HWW by making a choice between the use of chlorine, ozone and a combination of ozone and whey kefir probiotics through the AHP approach with five criterias (environmental, technological, social, economic and institutional).

RESEARCH METHODS

Data collection to determine the strategies for eliminating coliform bacteria was carried out by distributing questionnaires to five predetermined experts. The questionnaire used in this study is closed type, that is each question in the questionnaire is equipped with alternative answers that allow respondents to choose according to their expertise. The ultimate goal of using the AHP method is the elimination of coliform bacteria/E.coli in HWW. The questions in the questionnaire were developed from a hierarchy that was built using the AHP approach, in which assessment indicators have been determined between variables. Making a questionnaire in the form of pair-wise comparisons between criteria and sub-criteria. Pairwise comparisons determine the relative priority of alternatives through pairwise comparisons. Respondents must assess the level of importance of one element with other elements that have been arranged in pair-wise comparisons.

The validity of the AHP method is determined by the competence of experts so that competent people are selected both theoretically and practically. The experts selected as respondents were experts from academics in the field of environmental health (public health), while experts from practitioners were environmental consultants. Experts from the government is state civil apparatus, the Department of the Environment, the Regional Government of West Bandung Regency, West Java. Experts from the hospital come from the Health and Environment Officer of Hospital “X”, which is the field responsible for implementing HWW operation. The results of the expert's assessment were then processed and analyzed using Expert Choice 11 software. The use of Expert Choice software in the AHP method allows making decisions in evaluating and identifying priority choices based on a series of criteria and sub-criteria, and alternatives (Bagheri et al., 2021). The results of the expert's assessment were then processed and analyzed using Expert Choice 11 software, with the output in the form of graphs and strategy priority scores. The hierarchical chart built is depicted in Figure 1.

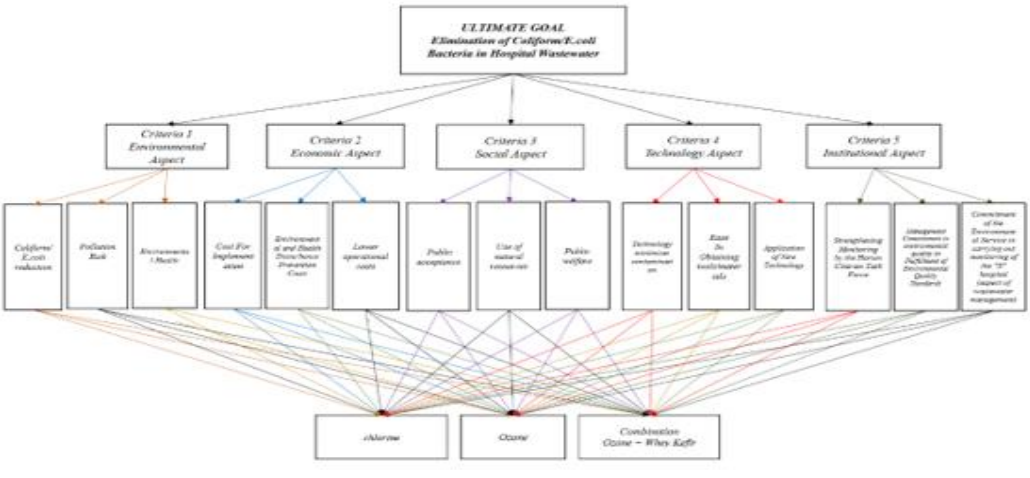

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Figure 1. AHP Design Systematic Diagram

The steps taken in building the AHP hierarchical structure chart are through determining the ultimate goal, criteria and sub-criteria. Goals are the main problem or problem focus that needs to be found a solution and consists of only one element. Criteria is the second level of the AHP hierarchy. Criteria are important aspects that need to be considered in making decisions. The sub-criteria is the third level of the AHP hierarchy.

Respondents provided a comprehensive assessment by filling out a prepared questionnaire, information collected from experts or experts, practitioners (environmental consultants) and people who work and are responsible for managing hospital wastewater, academics, and government officials who understand wastewater hospital and management. The level of importance used is as shown in (Table 3.2). The basic steps involved in AHP are (Saaty, 2006):

1) Decision making is made into simple elements.
2) Placing each element in the proper hierarchical level.
3) Assign scores to subjective judgments.
4) Synthesize the results of the assessment to obtain the final ranking through aggregation of relative scores.

Pairwise comparisons are the most important part of this analysis. In AHP the relative preference is set from 1 - 9 in the following table, where a higher score indicates more importance.

Table 1. Assessment indicators between variables

Score 1	Both factors are equally important in terms of the purpose of determining the choice of coliform/E.coli removal strategy in hospital wastewater.
Score 3	One factor is slightly more important than the other factors in terms of the purpose of determining the choice of coliform bacteria/E.coli elimination strategy in hospital wastewater.
Score 5	One factor is essential or more important than other factors in terms of the purpose of determining the choice of coliform bacteria/E.coli elimination strategy in hospital wastewater.
Score 7	One factor is clearly more important than the other factors in terms of the purpose of determining the choice of coliform bacteria/E.coli elimination strategy in hospital wastewater.
Score 9	One factor is absolutely more important than other factors in terms of the purpose of determining the choice of coliform bacteria/E.coli removal strategy in hospital wastewater
Score 2, 4, 6, 8	Intermediate scores, between two adjacent judgment scores; Score 2 if there is doubt between 1 & 3 Score 4 if there is doubt between 3 & 5 Score 6 if there is doubt between 5 & 7 Score 8 if there is doubt between 7 & 9

Pair-wise comparisons between criteria and sub-criteria will obtain the importance level and measure the consistency index (CI) and consistency ratio (CR). To get optimal results, the consistency index value must be maintained. The results of the AHP analysis can measure the consistency index value of the respondents. If the CR value exceeds 0.10 it indicates an inconsistent assessment. Higher inconsistency scores reflect a lack of understanding or information (Sharma & Rawal, 2021).

$$CI = (\lambda max - n) / (n - 1) \qquad (1)$$

"λmax = Maximum Eigenvalue
N = matrix size

Data Analysis

Data analysis in this study was primary data in the form of quantification results from questionnaires from five experts who were selected according to their expertise.

RESULT AND DISCUSSION

Results of the AHP Assessment for Priority Indicators

The results of the AHP analysis of the 15 selected indicators produce scores for each indicator. Priority indicators are determined by selecting scores with the middle value from the interval between the lowest score value and the highest score value, which is between 0 – 0.5. The results of calculations using Expert Choice analysis show that the criteria with the highest score is the environment, which is 0.302, where the priority indicator is pollution risk with a score of 0.366. The 2nd highest ranking is the technology criteria, where the priority indicator is technology minimizing pollution with a score of 0.472, the 3rd ranking is a social criteria, where the priority indicator is community welfare with a score of 0.457. While the 4th rank is an economic criteria with a score of 0.161, where the highest priority indicator is reducing the operational costs of waste water treatment with a score of 0.424, and the 5th rank is institutional criteria with a score of 0.118 where the indicator with the highest score is strengthening monitoring by the Citarum Harum Task Force (SATGAS CITARUM HARUM) with a score of 0.609 (Table 2).

Table 2. AHP assessment results for priority indicators

Criteria	Indicator	Ranking	Score
Environment		1	**0,302**
	Coliform/ E.coli reduction		0,315
	Pollution Risk		0,366
	Environmental Health		0,319
Economic		4	**0,161**
	Cost For Implementation		0,253
	Environmental and Health Disturbance Prevention Costs		0,323
	Lower operational costs		0,424
Social		3	**0,145**
	Public acceptance		0,340
	Use of natural resources		0,204
	Public welfare		0,457
Technology		2	**0,273**
	Technology minimizes contamination		0,472
	Ease In Obtaining tools/materials		0,224
	Application of New Technology		0,303
Institutional		5	**0,118**
	Strengthening Monitoring by the Citarum Harum Task Force		0,609
	Management Commitment to environmental quality in Fulfillment of Environmental Quality Standards		0,275

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	Commitment of the Environmental Service in carrying out monitoring of the "X" hospital (aspect of wastewater management)	0,116

Priority Criteria

The aspect criteria is one of the criteria developed in the structure of the strategy for the utilization of ozone and whey kefir probiotics in the elimination of coliforms in hospital wastewater. Aspect criteria include; environmental, social, economic, technological, and institutional aspects. The results of the analysis with a consistency ratio value of 0.02 are included in the consistent category, indicating that environmental aspects are the main priority in the coliform removal strategy in hospital wastewater, followed by technological, social, economic and institutional aspects, as illustrated in Figures 2 and 3 .

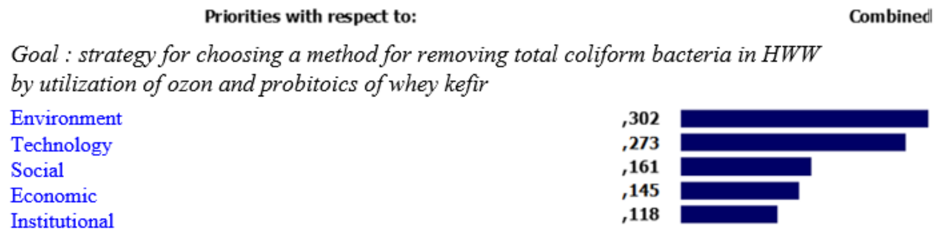

Figure 2. Priority Strategies for Utilizing Ozone and Whey Kefir Probiotics in Eliminating Coliform

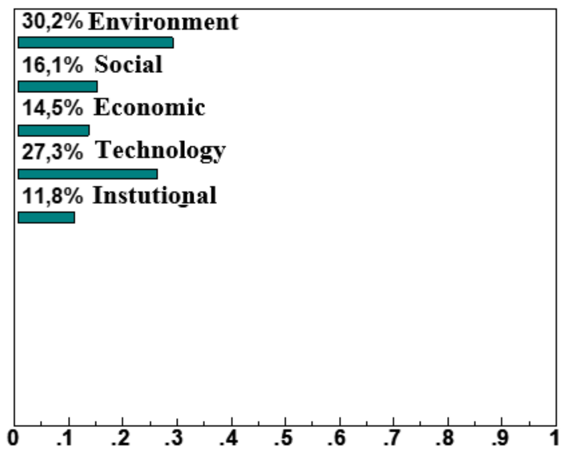

Figure 3. Percentage of Priority Strategies for Utilizing Ozone and Whey Kefir Probiotics in Eliminating Coliform

Priority of Environmental Aspects

The results of the analysis showed that the criteria for environmental aspects received the highest score and priority for sub-criteria for environmental aspects, indicating that the highest was pollution risk with a value of 0.366, environmental health of 0.319, and reduction of coliform/E.coli of 0.315, as shown in Figure 4.

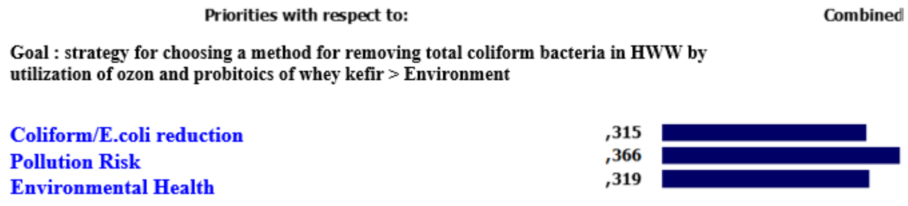

Figure 4. Prioritizing Enviroment Aspects

Prioritizing Technology Aspects

The results of the analysis showed that the criteria for the technological aspect received the second highest score after environmental criteria and the priority sub-criteria for environmental aspects was obtained, indicating that the highest was technology minimizing pollution with a value of 0.472, the application of new technology with a value of 0.303, and ease of obtaining tools and materials with a value of 0.224 , as shown in Figure 5.

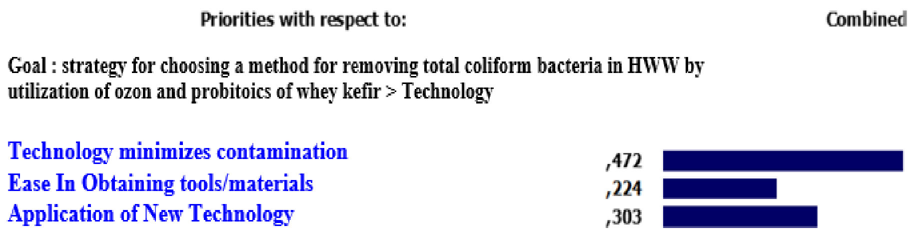

Figure 5. Prioritizing Technology Aspects

Prioritizing Social Aspects

The results of the analysis show that the criteria for the social aspect get the third highest score after the technology criteria and the priority for the social aspect sub-criteria is obtained, indicating that the highest is the social welfare with a value of 0.462, public acceptance of 0.312, and the use of natural resources with a value of 0.227, as shown in Figure 6.

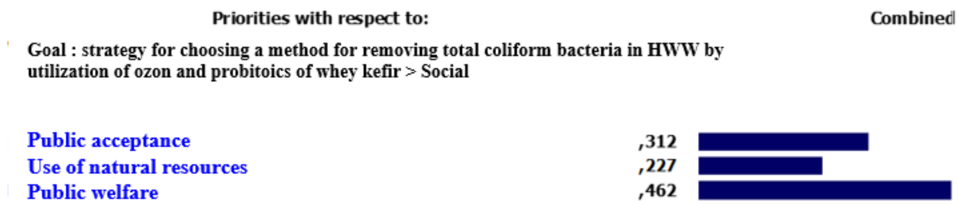

Figure 6. Prioritizing Socail Aspects

Prioritizing Economic Aspects

The results of the analysis show that the criteria for the economic aspect get the fourth highest score after the social criteria and the priority for the sub-criteria for the economic aspect is obtained, indicating that the highest is reducing operational costs with a value of 0.424, the allocation of costs

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for preventing environmental and public health disturbances is 0.323, and the allocation of costs for implementation ozone and whey kefir technology with a value of 0.227, as shown in Figure 7.

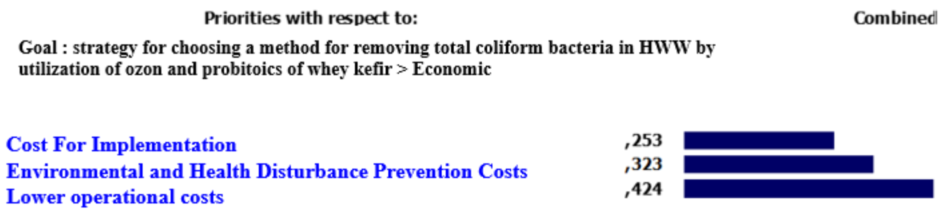

Figure 7. Prioritizing Economic Aspects

Prioritizing Institutional Aspects

The results of the analysis showed that the institutional aspect criteria received the fifth highest score after economic criteria and the institutional aspect sub-criteria was prioritized. hospital monitoring of aspects of waste management) of 0.275, and monitoring strengthening by the Citaram Harum Task Force with a value of 0.116, as shown in Figure 8.

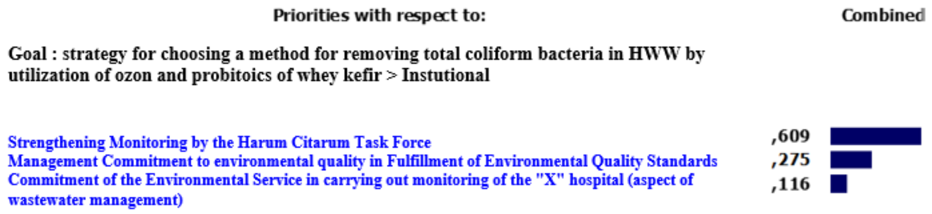

Figure 8. Prioritizing Instutional Aspects

Synthesis of Factors

Determining the strategy in the process of eliminating coliform bacteria in hospital wastewater is to determine the choice between the use of chlorine, ozone and a combination of ozone and whey kefir probiotics with a 5 criteria approach (environmental, technological, social, economic, and institutional) the following analysis results are obtained (Figure 9):

1. Utilization of ozone is a priority with a score of 0.449;

2. Utilization of ozone and probiotics is the second priority with a score of 0.316; and

3. Utilization of chlorine, with a score of 0.235.

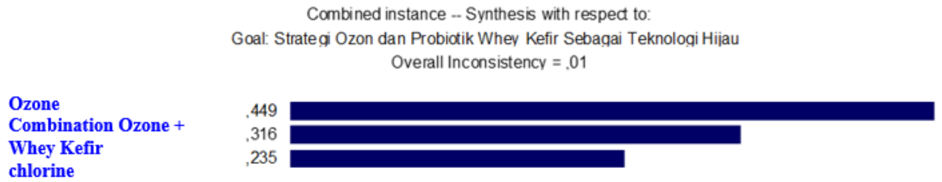

Figure 9. Synthesis of Factors

Discussion

The results of discussions with experts obtained information on various criteria, sub-criteria related to the elimination of coliform bacteria in hospital wastewater which has 4 levels including Ultimate Goal (level 0), Criteria (level 1), Sub-criteria (level 2) and Alternative (level 3).

Environmental aspects

The main priority of the analysis using Expert Choice is the environmental aspect, with the indicator of minimizing the risk of contamination. The environment is the most important aspect to pay attention to because it is a natural resource, supports the survival of humans and other living things, supports economic activities (such as agricultural activities, tourism, industry and other activities) and supports biodiversity. The many stressors to the environment, including microbiological contaminants from hospital wastewater, have the potential to contaminate water resources and increase risks to human health. According to WHO, E. coli (O157:H7), Campylobacter, Cryptosporidium, Shigella and hepatitis E virus (Cotruvo et al., 2004) cause 4 billion cases of diarrheal disease occurring each year, causing nearly 2 million deaths (WHO Regional Office for Europe , 2022). According to the latest WHO and UNICEF reports by 2020, one in four people in the world lack access to safe drinking water and almost half of the world's population does not have safely managed sanitation (Unicef., 2021). One of the causes of poor sanitation is the contamination of various pathogenic microbes in wastewater.

Coliform bacteria are organisms found in HWW and are important parameters. Coliform bacteria are pathogenic and can contaminate surface water, ground water, and also clean water sources. The E. coli bacteria, which represents 80-90 percent of its presence as coliform, can cause serious illnesses, such as gastroenteritis and diarrhea, through water that is contaminated from waste that is not properly treated. Contamination that occurs in water resources by pathogenic microbes and the diseases that accompany them is an environmental problem that is of serious concern throughout the world. The SGDs mandate 17 important points, one of which is clean water and sanitation so that indicators of the risk of contamination by HWW must be a priority to be managed properly.

Studies related to how to control pathogenic microbes that are carried into water resources prove the need for strategic steps so that water resources are not increasingly critical, this shows that environmental aspects are very important. This is important, considering that the environment is a very vital aspect for life on earth, as a support for the survival of humans and other living things, a support for economic sustainability and biodiversity sustainability. Environmental aspects are a top priority to be maintained and utilized according to their carrying capacity and capacity so that they can sustainably support economic growth and improve human welfare today and in the future.

Another thing that makes the environment a priority aspect in the use of ozone technology and whey kefir probiotics in the elimination of coliform bacteria in HWW is due to consideration of the risks caused by pathogenic bacteria, the risk of residues arising from unsafe use of chlorine, from its environmentally friendly nature. from ozone and whey kefir. The wastewater treatment process has two factors that need to be considered in eliminating pathogenic microbes, namely the length of time the pathogenic microbes are in the treatment system and how quickly the pathogenic bacteria can die. But not only how fast bacteria can die, another thing that is also important to consider is the potential risks and residual effects from using synthetic chemical disinfectants, such as chlorine. According to Fewtrell, (2005); Fuhrmeister et al. (2015); Tong et al. (2016), eliminating pathogenic microbes in surface water can significantly reduce the risk of disease transmission.

Materials that are strong in the process of eliminating bacteria in HWW but do not cause side effects on the environment are very important considerations. Utilization of ozone and whey kefir probiotics is a necessity. Referring to the results of laboratory data analysis, it shows that the utilization of ozone and whey kefir probiotics in the removal of coliform bacteria/E.coli is significant with a removal efficiency level of more than 98.97% for total coliform and E.coli has a removal of 99.22% with a duration of ozonation for 45 minutes and incubated for 48 hours after being given whey kefir. This is possible because ozone has a strength 2800 times greater than chlorine, and is able to overcome the problem of pathogenic microbes. As stated by Guzel-Seydim et al, (2004) in Li et al. (2020) that ozone is a very strong oxidant and disinfectant agent, however it easily decomposes in water to form free radicals (HO2) and hydroxyl (OH). These free radicals have great oxidizing

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properties and are very effective in the disinfection process (EPA., 1999; Muruganandham et al., 2014). Apart from not leaving chemical residues and not producing harmful chlorinated by-products, ozone can significantly act as a micro-flocculant and produce dissolved oxygen in wastewater, so that ozone technology is classified as environmentally friendly (Hajiali & Pirumyan, 2018). According to Ferdes et al., 2018 ozone has a large enough antimicrobial effect so that ozone is able to have a lethal effect on E.coli.

Likewise with the effect of whey kefir on the elimination of pathogenic bacteria, it is known that the utilization of whey kefir in wastewater treatment provides several benefits for the environment, including: (a) safer environment and sustainable wastewater treatment practices, (b) use of chemicals can omitted; (c) utilization of whey kefir does not require special equipment, (d) whey kefir is natural, contains probiotics so that it will not undergo transformation in any form so that it can affect the quality of processed water and receiving water bodies. This shows that the use of kefir whey can reduce the cost of purchasing chemicals.

Kefir contains a consortium of Lactic Acid Bacteria (Arslan, 2015) and Lactic Acid Bacteria (LAB) are a group of bacteria that produce antimicrobial substances and are able to inhibit the growth of pathogenic bacteria (Ismail et al., 2018). LAB has been shown to be able to produce metabolites with specific antagonists and antibacterial activity, such as antifungal compounds and bacteriocins, which can inhibit various types of pathogenic microbes. BAL isolate kefir can produce active compounds, such as Diacetyl, Hydrogen Peroxide (H2O2), Reuterin, Bacteriocin, and Organic Acids and is able to suppress the growth and development of pathogenic bacteria (Putu et al., 2021). LAB can inhibit the growth of pathogenic bacteria or microbes which may be caused by the production of organic acids, hydrogen peroxide, acetaldehyde, diacetyl, carbon dioxide, or bacteriocins (Shen et al., 2018).

Aspects of technology

The development of science and technology for wastewater treatment leads to effective and efficient waste treatment so that it becomes better and environmentally friendly. The results of data analysis through Expert Choice are known, that environmental criteria with technology indicators minimizing contamination is the highest indicator aspect. The demand for the use of safe technology in wastewater treatment is increasingly urgent, especially in terms of reducing the risk of contamination by pathogenic microbes.

Judging from the water quality standard according to the Minister of Environment and Forestry Regulation No. P68 of 2016, it is stated that the maximum limit for total coliform is 3000 MPN/100ml. Efforts to reduce total coliform in HWW often do not pay attention to the safety level of using disinfectants, such as chlorine, which causes residues in the receiving water bodies. Even though the maximum limit allowed according to PP No. 22/2021, Appendix VI, Class 2.3 water is 0.03 mg/l. Many biological high risk pollutant (BPHPs) control technologies are used in the wastewater treatment process, especially in the efficiency of biological pollutant removal, one of which uses ozone (Yin & Zhang, 2020). For decades, the use of conventional technology in the process of eliminating pathogenic bacteria has been used even today with considerations of practicality and low cost. However, the use of chlorine in the disinfection process is indicated to cause other problems, such as residual effects and the death of good microorganisms in the waste receiving water. Improper use of disinfectants can cause environmental damage. The study conducted by Busyairi et al. (2016), showed that chlorination at a dose of 160 ppm with a contact time of 40 minutes caused the number of coliform bacteria to decrease by 98.83% (from 160,000 MPN/100 ml to 1866 MPN/100 ml) and it was found that there was a residual chlorine of 97.5 ppm.

The use of environmentally friendly technology aims to provide convenience in overcoming the potential impacts of HWW. Environmentally friendly technology is technology that in the process of making and implementing it uses environmentally friendly raw materials, making it more effective and efficient and minimizing the impact and risk of environmental pollution. This is in line with one of the missions of the Sustainable Development Goals (SDG's), to conserve and utilize natural resources and protect the environment. The choice of ozone is because ozone is a green technology in wastewater treatment (Azimi, 2016), as well as the use of whey kefir which is very rich in probiotic bacteria in it so that it will be safe if used in sustainable wastewater treatment. Whey kefir contains lactic acid bacteria, which are a group of bacteria that produce antimicrobial substances and are able to inhibit the growth of pathogenic bacteria (Ismail et al., 2018), where the inhibition of the growth of pathogenic bacteria is due to LAB being able to produce organic acids, hydrogen peroxide, acetaldehyde, diacetyl, carbon dioxide , or bacteriocins (Shen et al., 2018).

Social aspect

Population growth in Indonesia continues to increase from year to year, until September 2021 the population is 273 million people. The number of people who are sick and undergoing hospitalization is 38.64% in 2021, while the number of health service facilities in Indonesia until 2020 is 2423 public hospitals, 536 special hospitals and 10.205 health facilities centers (Puskesmas). (BPS, 2020). All health service facilities produce wastewater with varying volumes and concentrations according to ongoing daily activities, and needs to be treated before being released into the environment so as not to pollute the environment.

Regulation of the Minister of Environment and Forestry No. P68/2016 states that HWW is classified as domestic wastewater, has the potential to pollute the environment, so it needs to be treated before being released into the environment. In treating hospital wastewater, a safe technological approach is needed as mandated by WHO. Handling hospital waste needs serious attention, one of which is by managing hospital waste safely (WHO, 2017; WHO-UNICEF, 2020). Efforts to protect and manage the environment in general are regulated in article 3 of Law Number 32 of 2009, which guarantees the protection and sustainability of ecosystems from pollution and guarantees the safety, health and survival of humans and other living things.

The use of materials that are safe for the environment and have the ability to overcome the problem of microbiological contamination is a must. The use of chlorine has been proven to be able to overcome coliform/E.coli bacteria but has the potential to leave residues which actually cause disruption to the good microorganisms in the water of the receiving water body. Giving chlorine to WWTP effluent does not necessarily reduce the number of pathogenic microbes, instead it has the potential to cause other microbes in the waters as effluent receiving water bodies to die due to residual chlorine (Prayitno et al., 2018). The study conducted by Busyairi et al. (2016) application of 160 ppm chlorine with a contact time of 40 minutes resulted in a residual chlorine of 97.5 ppm. Escherichia coli bacteria in HWW proved to be resistant even though it had been chlorinated even at a concentration of 100 ppm. This situation indicates that hospital wastewater treatment systems are generally not able to effectively eliminate pathogenic bacteria (Lingga et al., 2019). Utilization of wastewater treatment technology must also be able to reduce the potential risk of environmental pollution through the use of safe materials. The use of ozone and kefir whey in this study indicated a positive effect on the removal of coliform bacteria in hospital wastewater, with a removal efficiency rate of more than 99%.

The ability of ozone and kefir whey to remove high coliform/E.coli bacteria needs to be socialized so that public acceptance of this method is better. Internalization of ecological values in the context of public acceptance of efforts to eliminate coliform/E.coli bacteria in hospital wastewater using ozone and kefir whey can help raise human awareness in environmental management broadly. Public acceptance is generally through the process of observational learning (Observational learning). Observational learning is a learning process where most of the knowledge is obtained from observation and not doing it yourself. Someone will consider imitating, duplicating, or determining his behavior through consideration of previous experience.

According to Bandura (1977, 1986), that the process of observational learning goes through four steps namely, attention, retention, production, and motivation. Production (i.e. opportunities to engage) and motivation (i.e. positive reinforcement for engaging), then predicted by retention (i.e., observation of what others do), then predicted by attention (i.e., physical, verbal, and cognitive engagement) . Bandura's four-step observational learning process (1986) is in line with how attitudes from social criteria with indicators of public acceptance are more dominant than other indicators (Morse et al., 2019; Munawir et al. 2022c). Public acceptance of the method of eliminating coliform/E.coli bacteria using safe and environmentally friendly materials is indicated by the results

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of AHP analysis through social criteria. Determining the choice in the process of eliminating coliform bacteria in hospital wastewater shows that the utilization of ozone is a priority with a score of 0.449, followed by alternative utilization of ozone and probiotics which is the second priority with a score of 0.316; and utilization of chlorine with a score of 0.235.

Economic aspects

Utilization of environmentally friendly technology is a necessity in reducing the amount of waste released into the environment. The results of the AHP analysis show the economic criteria, with the indicator of reducing operational costs getting the highest score. The strategy for selecting green technology by utilizing ozone and kefir whey can be considered. Some of the advantages of using ozone in wastewater treatment include:

1. Ozone is more effective than chlorine in destroying viruses and bacteria, 2800 times stronger (Svebrant et al., 2021).
2. The ozonation process takes a shorter time, so it saves electricity and is safer.
3. Ozone decomposes very quickly into dissolved oxygen, so that after the ozonation process takes place, no residue will form (Svebrant et al., 2021).
4. Ozone can increase the biodegradability of wastewater (Ahmed et al., 2021)
5. Ozone is easily generated and can be produced on site and is effective in overcoming the problem of pollutant contamination in hospital wastewater on-site (Svebrant et al., 2021).
6. Ozone is able to decompose organic and inorganic materials in a wide pH range
7. Ozone only requires 1/10 of the use of chlorine (Hussain et al., 2022).

Utilization of kefir whey, which is actually a by-product or in some industries is classified as waste (Febrisiantosa et al., 2013) from the process of making kefir, cheese, yogurt, but is actually very rich in probiotic bacteria (Soyer & Tunalı, 2020). Utilization of kefir whey in wastewater treatment provides many benefits for the environment and costs. These advantages include: (a) a safer environment and sustainable wastewater treatment practices, (b) the use of chemicals can be eliminated; (c) utilization of whey kefir does not require special equipment, (d) whey kefir is natural, contains probiotics so that it will not undergo transformation in any form so that it can affect the quality of processed water and receiving water bodies.

Based on the above considerations, the use of ozone and kefir whey in the elimination of coliform bacteria in HWW can reduce the environmental costs of a hospital. The environmental cost of a hospital is highly dependent on the processing technology used, the volume and concentration of pollutants in it. A study conducted by Norsita (2021) stated that environmental costs for ABC hospitals were 0.48% of the total hospital operations, where the largest routine expenditure was for the purchase of tools and materials needed (including the purchase of bacteria and chlorine) for wastewater treatment reaching 19, 30% of the total environmental costs.

Institutional aspect

Awareness to manage the environment properly is a priority for environmental policies run by a hospital. Hospitals have an obligation to treat wastewater generated from daily activities. The legal basis for efforts to manage and treat hospital waste is the Constitution of Republic of Indonesia No. 32 of 2009, the Government Regulation no. 22 of 2021 concerning protection and management of the environment and the Regulation of Minister of Environment and Forestry No. P.68 / 2016 concerning domestic wastewater quality standards. Based on these laws and regulations, hospitals have an obligation to carry out wastewater treatment by taking into account technical aspects and the sustainability of treatment technology. The hospital's commitment to fulfilling quality standards is a must in carrying out hospital activities, this is stated in the hospital's standard operating procedures.

The results of AHP's analysis related to institutional criteria, especially the indicator of hospital management's commitment to carrying out the obligation to fulfill environmental quality standards, are the choices with the highest score, compared to monitoring indicators by state agencies, such as the Environment Agency and the Citarum Harum Task Force. The waste treatment technology used determines the quality of the processing results, one of which is the obligation to reduce the number of coliform bacteria in the wastewater. In accordance with Minister of Environment and Forestry No. P68/2016, the amount of coliform bacteria contained does not exceed 3000 MPN/100 ml. "X" hospital managers have been using chlorine to reduce coliform bacteria. Based on the analysis of the results of wastewater treatment at the wastewater treatment plant (WWTP), the total coliform content in the effluent was known to average total coliform: 503 MPN/100 ml, with a removal efficiency rate of 79.87%, where based on the t test showed a difference significantly on the total amount of coliform between influent and effluent. Even though the efficiency level of removal of coliform bacteria reaches more than 70%, it does not mean that these conditions are safe for the aquatic environment because based on a study conducted by Prayitno et al. (2018), indicated that the provision of chlorine actually has the potential to cause other microbes in the waters as effluent receiving water bodies to die due to residual chlorine. In line with the results of a study conducted by Lingga et al. (2017), that the current hospital wastewater treatment process is not effective in controlling bacteria. The population of bacteria tested from influent samples, chlorination tanks and effluents was still high. Elimination of the number of Coliform and E.coli increases by giving greater concentration of chlorine and vice versa. This statement is reinforced by Zerva et al. (2021), Chlorination as a secondary waste disinfection method shows that pathogenic bacteria grow after the chlorination process.

The commitment of the management of WWTP "X" hospital to consider the use of other materials that are more effective and efficient in eliminating coliform bacteria because hospital waste has the potential to become a medium for transmitting various diseases. Determining the strategy in the process of eliminating coliform bacteria in hospital wastewater by making a choice between the use of chlorine, ozone and a combination of ozone and whey kefir probiotics using the 5 criteria approach (environmental, technological, social, economic, and institutional) obtained the following results:

1. Utilization of ozone is a priority with a score of 0.449;
2. Utilization of ozone and probiotics is the second priority with a score of 0.316; And
3. Utilization of chlorine, with a score of 0.235.
4. This indicates that the method of eliminating bacteria in hospital wastewater is a promising option. In line with what was stated by (Yin & Zhang, 2020), that many high-risk biological pollutant control technologies are used in the wastewater treatment process, especially in the efficiency of biological pollutant removal, one of which uses ozone.

CONCLUSION

Determination of strategies in the process of eliminating coliform bacteria in hospital wastewater through a priority approach to environmental aspects with sub-criteria minimizing environmental pollution, the next priority being technology, social, economic and institutional). Utilization of ozone, combined treatment of ozone and whey kefir is a priority over the use of chlorine from an environmental aspect approach.

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