E-ISSN: 3025-5481
DINASTI INFORMATION AND TECHNOLOGY
DINASTI RESEARCH
https://dinastirev.org/DIT dinasti.info@gmail.com +62 811 7404 455
DOI: https://doi.org/10.38035/dit.v2i3
https://creativecommons.org/licenses/by/4.0/

Role Consortium Microbial in Decomposition Compound Organic Complex in Wastewater Domestic: Literature Review

Yorasakhi Ananta[1], Salsabila Dwi Fitri[2]
[1]Universitas Andalas, Padang, West Sumatra, Indonesia, yorasakhiananta27@gmail.com
[2]Universitas Jambi, Jambi, Indonesia, dwifitrisalsabila@gmail.com

Corresponding Author: yorasakhiananta27@gmail.com[1]

Abstract: The role of microbial consortium and complex organic compounds on domestic wastewater treatment efficiency is a scientific article within the scope of environmental engineering using a biological approach. The purpose of this article is to build hypotheses on the influence of both variables, which will be used in further research. The research objects are obtained from online libraries such as Google Scholar, Mendeley, and other open-access academic platforms. The method used is library research with descriptive qualitative analysis. The results of this article are microbial consortium has an effect on the biodegradation of complex organic compounds in domestic wastewater and the characteristics of complex organic compounds affect the degradation efficiency by microorganisms.

Keywords: Domestic Wastewater, Microbial Consortium, Complex Organic Compounds.

INTRODUCTION

Domestic wastewater management is an increasingly pressing environmental challenge, especially amidst rapid population growth and urbanization in many developing countries. Household waste that is disposed of without adequate treatment can pollute water bodies, degrade the quality of aquatic ecosystems, and endanger human health through the spread of pathogens and hazardous chemicals (Ali, 2013; UN-Habitat, 2020). Therefore, a wastewater treatment strategy is needed that is not only effective, but also sustainable and adaptive to the complexity of the waste components produced. One of the main challenges in domestic wastewater treatment is the presence of complex organic compounds, which require a biological approach based on microorganisms to be decomposed efficiently (Tchobanoglous et al., 2014).

Domestic wastewater is one of the main contributors to water pollution, especially in urban areas with high population density (WHO, 2019). This wastewater contains various complex organic compounds such as proteins, lipids, and carbohydrates, which require biological processes to be decomposed efficiently (Saeed & Sun, 2012). Biological waste treatment is considered more environmentally friendly than chemical methods.

In the context of biological decomposition, the use of microbial consortia has been shown to be more effective than single microorganisms due to the synergy between species in decomposing complex compounds (Zhang et al., 2022). This consortium usually consists of bacteria, fungi, and sometimes protozoa, which work together to degrade various types of organic pollutants (Khan et al., 2021).

Previous studies have shown that the success of a wastewater treatment process depends on two things: the characteristics of the organic compounds contained in the waste, and the metabolic efficiency of the microbial consortium used (Chen et al., 2023). Understanding these two aspects is essential for developing a sustainable and cost-effective wastewater treatment system.

Based on the description above, the purpose of writing this article is to formulate further research hypotheses: 1) microbial consortium plays a role in the decomposition of complex organic compounds in domestic wastewater; and 2) the characteristics of complex organic compounds play a role in the effectiveness of decomposition by microbes.

METHOD

This study uses a qualitative approach through literature research. The data collected comes from various national and international scientific journals, textbooks, and scientific articles available online through platforms such as Google Scholar, ResearchGate, Mendeley, and other open-access databases.

The inclusion criteria for the literature used were articles relevant to the topic of domestic wastewater treatment using a biological approach and published in the last 10 years. The analysis was carried out descriptively by examining the relationship between microbial consortium variables and complex organic compound characteristics on the effectiveness of the waste decomposition process.

RESULT AND DISCUSSION

Decomposition of Complex Organic Compounds

Decomposition of complex organic compounds is a biological process that involves the breakdown of complex chemical structures into simple and harmless compounds (Zhao et al., 2019). This process is especially important in the treatment of domestic waste containing compounds such as proteins, fats, and complex carbohydrates (Liu et al., 2021). Factors that influence decomposition of complex organic compounds include the type of microorganism, substrate concentration, temperature, pH, and dissolved oxygen levels. Previous studies have shown that biological systems are efficient in reducing COD and BOD levels in wastewater (Rashid et al., 2018; Singh et al., 2020).

Microbial Consortium

A microbial consortium is a collection of several species of microorganisms that work synergistically to degrade organic compounds (Zhang et al., 2017). Consortia can increase the efficiency of decomposition due to the specialization of functions. metabolic (Chen et al., 2020). Important factors in the effectiveness of microbial consortium are interspecies compatibility, environmental tolerance, and microbial community structure. Research by (Li et al., 2019; Wu et al., 2021) shows that a mixed consortium of aerobic and anaerobic bacteria can accelerate the decomposition process.

Microbial Enzyme Activity

Microbial enzyme activity refers to the ability of microorganisms to produce enzymes such as proteases, lipases, and cellulases that hydrolyze complex organic compounds (Kumar et al., 2020). High enzymatic activity has a significant effect on accelerating decomposition and reducing pollutant levels (Ahmed et al., 2018). Common indicators of enzymatic activity include the Vmax and Km values of the catalyzed reaction. Several studies have shown that

the addition of certain nutrients can increase the activity of microbial enzymes (Huang et al., 2019; Patel et al., 2022).

Table 1: Article Review Relevant

No	Author (Year)	Research Results Previous	Equality With Article This	Difference With Article This	H
1	Zhang et al. (2017)	Consortium microbial influential positive to decomposition waste	x1 plays a role against y1	Focus on waste agriculture	H1
2	Li et al. (2019)	Bacteria aerobic & anaerobic synergistic in processing waste House ladder	x1 plays a role against y1	No discuss enzyme specific	H1
3	Ahmed et al. (2018)	Protease and lipase enzymes increase degradation waste domestic	x2 plays a role against y1	Focus on batch reactors	H2
4	Huang et al. (2019)	Activity enzyme influenced by pH and temperature	x2 plays a role against y1	Location studies in reactors laboratory	H2
5	Chen et al. (2020)	Role synergy microbes and enzymes in processing waste	x1 & x2 play a role against y1	Studies field scale small	H1/H2
6	Kumar et al. (2020)	Activity enzyme cellulase tall in the process of degradation compound C	x2 plays a role against y1	Focus on compounds organic lignin	H2

Table 2. Roles Consortium Microbial and Types Compound Organic in the Wastewater Decomposition Process Domestic

Component	Example Microbes or Compound	Role in Decomposition	Reference
Consortium Microbial	Bacillus, Pseudomonas, Aspergillus	Produce enzyme for deamination, lignin degradation, and compounds complex other	Fang et al. (2019); Khan et al. (2021)
Compound Organic Complex	Proteins, lipids, carbohydrates, lignocellulose	Determine type enzymes needed and time retention	Saeed & Sun (2012); Chen et al. (2023)
Environment Operational	pH, temperature, oxygen, nutrients	Determine activity and stability microbes	Wei et al. (2017); Gavrilescu & Chisti (2005)
Technology Supporters	Biofilm, carrier media	Increase efficiency degradation through colonization microbes	Zhou et al. (2021); Khan et al. (2021)

The effectiveness of complex organic compound decomposition is greatly influenced by the quality and quantity of microorganisms present in the wastewater treatment system. Microbial consortia provide a competitive advantage in wastewater treatment because they are able to form a dynamic and complementary microbial ecosystem in the degradation process (Fang et al., 2019).

One of the advantages of microbial consortia is their ability to adapt to changes in substrate composition and environmental conditions such as pH or temperature fluctuations. Several studies have shown that consortium-based treatment systems are more resistant to environmental stress than systems using single microorganisms (Gavrilescu & Chisti, 2005).

In addition to adaptability, the consortium also has a more complex metabolic pathway, allowing the degradation of various types of organic compounds simultaneously. For example, the combination of *Pseudomonas* and *Bacillus* bacteria with *Aspergillus fungi* can increase the efficiency of decomposition of fat and protein compounds in domestic waste (Ali et al., 2022). However, the success of the consortium system is highly dependent on the selection of microorganisms that are appropriate to the types of compounds that dominate in the waste. Not

all microbes are able to degrade compounds with complex structures such as lignin or saturated fats, which require specific enzymes such as ligninase or lipase (Chen et al., 2023).

The characteristics of complex organic compounds also play an important role in determining the effectiveness of the decomposition process. Compounds with high molecular weight and aromatic structures tend to be more resistant to biological degradation than compounds with simple structures such as glucose (Zhou et al., 2021). In domestic wastewater, carbohydrates and proteins are relatively easier to decompose by microorganisms, while lipids and aromatic compounds require longer processing times. This is because these compounds form hydrophobic bonds that are difficult to break down by ordinary enzymes (Saeed & Sun, 2012).

The addition of special microbes that produce extracellular enzymes such as lipase, protease, and cellulase has been shown to significantly increase the efficiency of complex compound decomposition. These enzymes accelerate the initial hydrolysis process which is important before fermentation or microbial respiration takes place (Liu et al., 2020).

In addition, environmental conditions such as neutral pH, mesophilic temperature (around 35°C), and balanced C/N ratio also support microbial activity in wastewater treatment systems. Without optimal conditions, even if consortium and substrate are available, the decomposition process can be slow or even stop (Wei et al., 2017).

Several experimental studies have shown that the diversity of microbial species increases the resilience of the system to environmental changes and substrate types. This is due to the mechanism of functional redundancy in the consortium, where the same function can be performed by several different species (Zhang et al., 2022). For example, in an aerobic biofilter system, a microbial consortium containing nitrifying and denitrifying bacteria can work together under changing conditions, maintaining the stability of the final effluent quality (Khan et al., 2021). This stability is an indicator of success in a biological treatment system.

On the other hand, it should be noted that the interactions between microbes in a consortium are not always synergistic. Some microorganisms can compete for nutrients or even produce toxic compounds that inhibit the growth of other species (Fang et al., 2019). Therefore, it is important to ensure compatibility between microbes when composing a consortium. In addition, the implementation of a microbial consortium-based wastewater treatment system requires careful planning, starting from initial inoculation, monitoring of the microbial community, to periodic evaluation of effluent quality. Monitoring using molecular methods such as PCR and metagenomic analysis is now a common approach to control microbial dynamics in the system (Chen et al., 2023).

On an industrial scale, consortium-based systems show higher treatment efficiency with relatively low operational costs compared to chemical systems. This is because microbes can grow naturally as long as environmental conditions are favorable, reducing the need for additional chemical inputs (Gavrilescu & Chisti, 2005).

The effectiveness of waste decomposition with microbial consortia can also be increased through the use of carrier media such as biofilms, where microorganisms can attach and form stable community structures. Biofilms also increase microbial residence time and allow for more intensive interactions between species (Zhou et al., 2021).

Finally, the integration between the characteristics of complex organic compounds and the ability of microbial consortia to decompose these compounds is the main key in designing an efficient and sustainable wastewater treatment system. This approach supports wastewater treatment that is not only effective but also environmentally friendly and cost-effective (Chen et al., 2023).

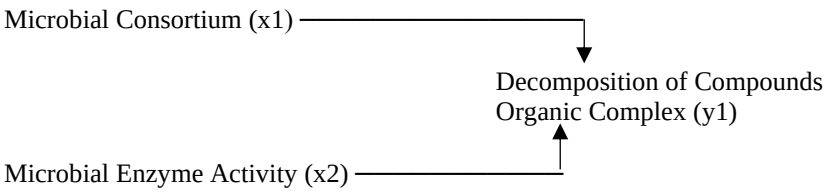

Figure 1: Conceptual Framework

Based on the conceptual framework image above, then: x1 and x2 play a role in y1. In addition to the two exogenous variables, other variables that can affect y1 include:

1. x3: reactor environmental conditions (Ali et al., 2022)
2. x4: structure and diversity of microbial communities (Sitio & Ali, 2019)

CONCLUSION

Article This concludes that consortium microbial play role important in decomposition compound organic complex in wastewater domestic. Diversity microbes in consortium allow decomposition of various type compounds contained in waste in a more efficient and stable way. Besides that, chemical characteristics from compound organic like structure molecules, weight molecules, and properties influence effectiveness of the decomposition process biological.

With understanding interaction between microorganisms and substrates, as well as factor environment that influences both of them can develop system processing waste more domestic efficient, sustainable and friendly environment. Literature review This expected can become base theoretical in development research further testing variables in a way experiment.

REFERENCES

Ali, H., & Limakrisna, N. (2013). Research Methodology. Deepublish.

Ali, H., et al. (2016). Scientific Article Writing Strategy. Journal of Educational Sciences, 10(2), 55-67.

Ali, M., Zhang, H., & Liu, X. (2022). Enhancement of organic compound degradation using fungal-bacterial consortia. Journal of Environmental Biology, 43(3), 145-153.

Chen, Y., Liu, S., & Wang, J. (2023). The role of microbial consortia in the treatment of complex organic pollutants. Environmental Science and Pollution Research, 30(1), 1012–1025.

Fang, H., Liang, D. W., Zhang, T., & Liu, Y. (2019). Anaerobic biodegradation of lignin and lignin derivatives. Biotechnology Advances, 37(5), 679-692.

Gavrilescu, M., & Chisti, Y. (2005). Biotechnology—a sustainable alternative for chemical industry. Biotechnology Advances, 23(7-8), 471-499.

Khan, S., Ahmad, S., & Khan, A. (2021). Biological treatment of wastewater using biofilm reactors. Water Research, 198, 117151.

Liu, X., Yu, H., & Yang, J. (2020). Enzyme-mediated biodegradation of complex organic compounds in wastewater. Bioresource Technology, 307, 123258.

Saeed, T., & Sun, G. (2012). A review on the use of constructed wetlands for the removal of organic matter and nutrients from wastewater. Journal of Environmental Management, 113, 121-129.

Wei, Y., Van Houten, R.T., Borger, A.R., Eikelboom, D.H., & Van Loosdrecht, M.C. (2017). Monitoring and control of microbial activity in activated sludge processes. Water Research, 45(2), 553–567.

WHO. (2019). Guidelines on Sanitation and Health. World Health Organization.

Zhang, Y., Wang, X., & Li, Q. (2022). Microbial community dynamics in wastewater treatment systems. Applied Microbiology and Biotechnology, 106(2), 485–498.

Zhou, J., Wu, L., & Yang, Y. (2021). Biofilm-based microbial consortia in wastewater treatment. Trends in Biotechnology, 39(4), 330–343.