BULETIN VETERINER UDAYANA
pISSN 2085-2495
eISSN 2477-2712
Received: 24 March 2026; Accepted: 27 May 2026; Published: 1 June 2026

LITERATURE STUDY OF ANTIBIOTIC RESISTANCE *ESCHERICHIA COLI* IN RIVER BASINS IN INDONESIA

Studi Literatur *Escherichia coli* Resistansi Antibiotik pada Daerah Aliran Sungai di Indonesia

Roshelmi Talita Subu Taopan[1]*, Novalino Harold Geofrey Kallau[2] , Nemay Anggadewi Ndaong[3], Fhady Riskhy Loe[2]

[1]Undergraduate Student of the Veterinary Medicine Study Program, Faculty of Medicine and Veterinary Medicine, Nusa Cendana University, Jl. Adisucipto, Penfui, Kupang, East Nusa Tenggara 85001, Indonesia

[2]Department of Animal Disease and Veterinary Public Health, Faculty of Medicine and Veterinary Medicine, Nusa Cendana University, Jl. Adisucipto, Penfui, Kupang, East Nusa Tenggara 85001, Indonesia

[3]Department of Anatomy, Physiology, Pharmacology, and Biochemistry, Faculty of Medicine and Veterinary Medicine, Nusa Cendana University, Jl. Adisucipto, Penfui, Kupang, East Nusa Tenggara 85001, Indonesia

*Corresponding author email: rshlmytalitaa@gmail.com

How to cite: Taopan RTS, Kallau NHG, Ndaong NA, Loe FR. 2026. Literature study of antibiotic resistance *Escherichia coli* in river basins in Indonesia. *Bul. Vet. Udayana.* 18(3): 498-504. DOI: https://doi.org/10.24843/bulvet.2026.v18.i03.p01

Abstract

Escherichia coli (*E. coli*) is an important indicator of faecal contamination in aquatic environments and has been increasingly reported as a reservoir of antibiotic resistance in river ecosystems. This study aimed to review the prevalence and antibiotic resistance patterns of *E. coli* isolated from river basins in Indonesia through a literature review approach. Scientific articles published in national journals between 2014 and 2024 were collected and analysed descriptively. The results showed that the prevalence of *E. coli* in river water ranged from 68.51% to 100%. High resistance levels were reported against β-lactam antibiotics, particularly ampicillin and amoxicillin (45-82%), followed by tetracycline (37-71%), streptomycin (73.3%), and tobramycin (57%). In addition, multidrug-resistant (MDR) isolates were identified in several studies, with multidrug-resistant (MDR) prevalence reaching approximately 24% in the Citarum River. These findings indicate that river basins in Indonesia may act as reservoirs for antibiotic-resistant *E. coli*, highlighting the importance of routine environmental monitoring and proper wastewater management to reduce the spread of antimicrobial resistance.

Keywords: antibiotic resistance, *Escherichia coli*, multidrug-resistant, river basin

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

Abstrak

Escherichia coli (*E. coli*) merupakan indikator penting kontaminasi fekal pada lingkungan perairan dan semakin banyak dilaporkan sebagai reservoir resistansi antibiotik di ekosistem sungai. Penelitian ini bertujuan untuk meninjau prevalensi dan pola resistansi antibiotik *E. coli* yang diisolasi dari daerah aliran sungai (DAS) di Indonesia melalui pendekatan studi literatur. Artikel ilmiah yang dipublikasikan pada jurnal nasional tahun 2014–2024 dikumpulkan dan dianalisis secara deskriptif. Hasil kajian menunjukkan bahwa prevalensi *E. coli* pada air sungai berkisar antara 68,51% hingga 100%. Tingkat resistansi tertinggi ditemukan terhadap antibiotik golongan β-laktam, terutama ampisilin dan amoksisilin (45–82%), diikuti tetrasiklin (37–71%), streptomisin (73,3%), dan tobramisin (57%). Selain itu, beberapa penelitian juga melaporkan adanya isolat multidrug-resistant (MDR), dengan prevalensi MDR mencapai sekitar 24% pada Sungai Citarum. Temuan ini menunjukkan bahwa DAS di Indonesia berpotensi menjadi reservoir *E. coli* resisten antibiotik, sehingga diperlukan pemantauan lingkungan secara rutin dan pengelolaan limbah yang baik untuk menekan penyebaran resistansi antimikroba.

Kata kunci: resistensi antibiotik, *Escherichia coli*, multidrug-resistant, DAS

INTRODUCTION

Escherichia coli (*E. coli*) is commonly used as an indicator of faecal contamination in river water because its presence reflects contamination originating from human and animal waste. However, studies related to river basins in Indonesia remain limited. Increasing evidence has shown that *E. coli* isolated from aquatic environments, including rivers and other water bodies, exhibits resistance to various antibiotics, indicating that rivers are no longer merely indicators of faecal contamination but also reservoirs of antibiotic-resistant bacteria. For example, a study conducted in river basins in Mexico reported that *E. coli* isolates from surface water showed high resistance to antibiotics such as ampicillin, tetracycline, and streptomycin (Díaz-Zaragoza *et al.*, 2025). Similarly, studies in urban riverine systems demonstrated that *E. coli* isolates from surface water exhibited significant levels of antibiotic resistance, particularly in areas located near wastewater discharge points (Watkinson *et al.*, 2007).

Antibiotic resistance in *E. coli* within aquatic environments such as rivers has major implications for public health and environmental quality. When river water is used for domestic purposes, irrigation, consumption, or recreational activities, the presence of antibiotic-resistant *E. coli* may increase the risk of transmission of resistant bacteria to humans and animals. A systematic review and meta-analysis of *E. coli* isolates from water sources in Africa reported a very high prevalence of resistance to penicillins (penicillin/ampicillin), reaching approximately 93.4% (Ramatla *et al.*, 2023). In addition, studies comparing *E. coli* isolates from river water and sediment demonstrated that both surface water and sediment/biofilm environments may serve as reservoirs of resistant bacteria, thereby contributing to the long-term persistence of antibiotic resistance in river ecosystems (Skof *et al.*, 2024). Therefore, effective waste management strategies, pollution control, and regular resistance monitoring are essential to prevent the spread of antibiotic-resistant bacteria in aquatic environments and to minimize their impact on public health.

This study aimed to conduct a literature review on the prevalence and antibiotic resistance of *Escherichia coli* isolated from rivers or water bodies within river basins in Indonesia. The analysis focused on antibiotic resistance patterns identified in *E. coli* isolates and the potential role of river aquatic environments as reservoirs of antibiotic-resistant bacteria. In addition, this article aimed to provide an overview of the importance of monitoring aquatic environmental quality as part of efforts to control the spread of antimicrobial resistance.

Terakreditasi Nasional Sinta 4, berdasarkan Keputusan Direktur Jenderal
Pendidikan Tinggi, Riset, dan Teknologi No. 158/E/KPT/2021

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

RESEARCH METHODS

Ethical Approval

This study did not require ethical approval because it did not involve humans or animals directly as research subjects. The study was conducted using a literature review approach based on secondary data obtained from various scientific publications regarding the prevalence and antibiotic resistance of *Escherichia coli* isolated from river basins.

Research Object

The research object was *Escherichia coli* isolated from river water or other water bodies within river basins, based on data reported in various scientific publications. The data used were secondary data, including the number of samples, number of *E. coli*-positive samples, prevalence, types of antibiotics tested, and levels of antibiotic resistance.

Research Design

This study was a descriptive literature review conducted by collecting, reviewing, and comparing findings from previous studies regarding the prevalence and antibiotic resistance of *Escherichia coli* in river basins in Indonesia.

Data Collection Method

Literature was obtained through searches of the Google Scholar, PubMed, and ScienceDirect databases using the keywords "*Escherichia coli*", "antibiotic resistance", "river", "watershed", "Indonesia", "resistansi antibiotik", "sungai", and "DAS". The articles included were national and international scientific publications published between 2014 and 2024. Article selection was performed through identification, title and abstract screening, and full-text evaluation based on their relevance to the research topic.

Research Parameters

The parameters analyzed included river basin location, sample type, number of samples, number of *Escherichia coli*-positive samples, prevalence, types of antibiotics tested, levels of antibiotic resistance, and the presence of multidrug-resistant (MDR) isolates reported in each study.

Data Analysis

The collected data were analyzed descriptively by presenting the findings in tables and narrative form to compare the prevalence and antibiotic resistance patterns of *Escherichia coli* among different river basins in Indonesia.

RESULTS AND DISCUSSION

Results

Escherichia coli was detected in all river basins/rivers investigated in Indonesia, with prevalence ranging from 68.51% to 100%. The highest prevalence was reported in the Boyong River, Yogyakarta, and the downstream area of the Bekasi River, both reaching 100%, whereas the Sekanak River, Palembang and the Citarum River, Bandung showed prevalence rates of 70.73% and 68.51%, respectively. Antibiotic susceptibility testing demonstrated that *E. coli* isolates exhibited the highest resistance to β-lactam antibiotics such as ampicillin and amoxicillin (45%-82%), followed by tetracycline (37%-71%), streptomycin (73.3%), and tobramycin (57%). In addition, the presence of multidrug-resistant (MDR) isolates was reported in the Citarum River study, with a prevalence of approximately 24% (Table 1).

Terakreditasi Nasional Sinta 4, berdasarkan Keputusan Direktur Jenderal
Pendidikan Tinggi, Riset, dan Teknologi No. 158/E/KPT/2021

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

Discussion

The high prevalence and antibiotic resistance of *Escherichia coli* in river basins in Indonesia indicate that river waters function not only as indicators of faecal contamination but also as reservoirs for the dissemination of antibiotic resistance in the environment. The findings of this study showed that the highest resistance was consistently observed against β-lactam antibiotics such as ampicillin and amoxicillin, indicating strong antibiotic selective pressure in aquatic environments. The discharge of domestic waste is considered one of the main contributing factors to the high prevalence of *E. coli* and antibiotic resistance in rivers. Untreated household wastewater may contain faecal bacteria as well as antibiotic residues that create selective pressure on environmental microorganisms (Binawati, 2024; Daramusseng, 2021). In addition, livestock activities may also contribute through waste runoff carrying antibiotics and resistant bacteria into water bodies, thereby accelerating the spread of antibiotic resistance in aquatic environments (Karkman *et al.*, 2018).

The high resistance to β-lactam antibiotics observed in this study is consistent with previous reports indicating that these antibiotics are among the most widely used in clinical and livestock practices, thereby increasing the likelihood of resistance development (Laxminarayan *et al.*, 2013). Furthermore, the occurrence of resistance to tetracyclines and aminoglycosides suggests exposure to antibiotics originating from various environmental sources (Mauwalan *et al.*, 2022). The presence of multidrug-resistant (MDR) isolates and the detection of resistance genes such as *blaCTX-M* in several river basins indicate that antibiotic resistance is not only phenotypic but also involves genetic mechanisms. These resistance genes may spread among bacteria through horizontal gene transfer, particularly in aquatic environments rich in microbial communities (Rizzo *et al.*, 2013; Zhang *et al.*, 2020). This finding is further supported by a study conducted in the Bekasi River, which reported the presence of the *blaCTX-M* gene in *E. coli* isolates (Gusti *et al.*, 2024). Compared with studies conducted in other regions, the resistance patterns identified in Indonesia show trends similar to global findings, where water bodies receiving domestic wastewater runoff and wastewater treatment plant effluents exhibit higher resistance levels (Díaz-zaragoza *et al.*, 2025). These findings suggest that antibiotic resistance in aquatic environments is a global issue closely associated with human activities.

In addition to pollution sources, environmental conditions also play an important role in maintaining resistant bacteria in aquatic ecosystems. Slow river flow, the presence of sediments, and biofilm formation may facilitate the accumulation of resistant bacteria and antibiotic resistance genes (Skof *et al.*, 2024). Seasonal factors such as rainfall may also influence the distribution of *E. coli*, as surface runoff during the rainy season can increase the concentration of faecal bacteria in water bodies (Leko, 2023). Nevertheless, this study has several limitations, including heterogeneity among the reviewed studies in terms of methodology, limited quantitative data in several articles, and the predominance of conventional culture-based methods without more comprehensive molecular analyses (Haryani *et al.*, 2019). In addition, the lack of longitudinal data makes it difficult to identify long-term trends in antibiotic resistance in Indonesia. Based on these findings, more comprehensive environmental management efforts are needed, including improvements in domestic and industrial wastewater treatment systems, stricter antibiotic use surveillance, and the implementation of the One Health approach as recommended by the World Health Organization to control the spread of antibiotic resistance in the environment (WHO, 2022; WHO, 2023).

However, the findings of this study should be interpreted with consideration of several limitations. There was substantial heterogeneity among the analyzed studies regarding bacterial isolation techniques, antibiotic susceptibility testing methods, and the types of antibiotics examined, which may have contributed to variations in the reported results and limited direct

Terakreditasi Nasional Sinta 4, berdasarkan Keputusan Direktur Jenderal
Pendidikan Tinggi, Riset, dan Teknologi No. 158/E/KPT/2021

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

comparison between studies. In addition, most reviewed studies relied on conventional culture-based methods; therefore, the possible presence of viable but non-culturable bacteria and broader diversity of resistance genes may not have been fully detected. Limited application of molecular approaches also restricted the comprehensiveness of information related to the genetic mechanisms underlying antibiotic resistance (Rizzo *et al.*, 2013).

Furthermore, limited quantitative data and inconsistent reporting among studies hindered more in-depth analyses, particularly in accurately determining the prevalence of antibiotic resistance. Most of the analyzed studies were cross-sectional in nature and therefore unable to adequately describe temporal dynamics or long-term trends of antibiotic resistance in aquatic environments. Measurable environmental factors, such as antibiotic residue concentrations, water quality parameters, and population density surrounding the river basins, were also rarely analyzed comprehensively in the reviewed studies. Considering these limitations, future studies are recommended to adopt more integrated approaches, including genomics-based molecular analyses, longitudinal study designs, and quantitative environmental assessments, in order to provide a more comprehensive understanding of the dissemination of antibiotic resistance in aquatic environments.

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the literature review, *Escherichia coli* was detected in various river basins in Indonesia, with prevalence ranging from 68.51% to 100%. *E. coli* isolates showed the highest resistance to β-lactam antibiotics such as ampicillin and amoxicillin, followed by tetracycline, streptomycin, and tobramycin. In addition, several studies also reported the presence of multidrug-resistant (MDR) isolates. These findings indicate that river waters in Indonesia have the potential to serve as reservoirs of antibiotic-resistant bacteria influenced by anthropogenic activities, particularly domestic waste and livestock activities.

Suggestions

Routine monitoring of the presence and antibiotic resistance of *Escherichia coli* in river waters in Indonesia is needed as part of environmental quality surveillance. Management of domestic, industrial, and livestock waste should also be improved to reduce contamination by antibiotic-resistant bacteria in water bodies. Future studies are recommended to apply molecular approaches and longitudinal study designs to obtain more comprehensive information regarding the dissemination of antibiotic resistance in aquatic environments.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to all parties who provided support during the preparation of this manuscript, especially to the supervisors for their valuable guidance and suggestions. The authors also thank their families and colleagues for their prayers, motivation, and support throughout the research and writing process of this article.

REFERENCES

Binawati, A. P. R. D. K. (2024). Potensi cemaran bakteri coliform, coliform fekal, dan resistensinya terhadap antibiotik di Sungai Kalimas. *Jurnal Kesehatan Lingkungan, 17*, 55–67.

Daramusseng, A. (2021). Studi kualitas air Sungai Karang Mumus ditinjau dari parameter *Escherichia coli* untuk keperluan higiene sanitasi. *Jurnal Kesehatan Lingkungan, 20*(32), 1–6.

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

Díaz-Zaragoza, M., Rodriguez-Preciado, S. Y., Hernández-Ventura, L., Ortiz-Covarrubias, A., Castellanos-García, G., Sifuentes-Franco, S., Pereira-Suárez, A. L., Muñoz-Valle, J. F., Montoya-Buelna, M., & Macias-Barragan, J. (2025). Evaluation of antibiotic resistance in *Escherichia coli* isolated from a watershed section of Ameca River in Mexico. *Journal of Water and Health*, 1–15.

Gusti, L. H., Priadi, C. R., Rahmatika, I., & Vega, Y. (2024). Analysis of the presence of the blaCTX-M genes in *Escherichia coli* isolated from downstream of the Bekasi River. *E3S Web of Conferences*, 04002.

Haryani, Y., Susanti, E., & Amelia, H. R. (2019). Kekerabatan genetik dan indeks resistensi antibiotika *Escherichia coli* dari air DAS Siak Provinsi Riau. *Jurnal Sains Farmasi & Klinis, 6*(2), 141–146. https://doi.org/10.25077/jsfk.6.2.141-146.2019

Karkman, A., Do, T. T., Walsh, F., & Virta, M. P. J. (2018). Antibiotic-resistance genes in waste water. *Trends in Microbiology, 26*(3), 220–228. https://doi.org/10.1016/j.tim.2017.09.005

Leko, L. L. (2023). Pengaruh curah hujan terhadap kualitas air berdasarkan parameter mikrobiologi di DAS Kali Dendeng. *Envirotechsains: Jurnal Teknik Lingkungan, 1*(1), 33–37.

Laxminarayan, R., Duse, A., Wattal, C., Zaidi, A. K. M., Wertheim, H. F. L., Sumpradit, N., Vlieghe, E., Levy Hara, G., Gould, I. M., Goossens, H., Greko, C., So, A. D., Bigdeli, M., Tomson, G., Woodhouse, W., Ombaka, E., Peralta, A. Q., Qamar, F. N., Mir, F., ... Cars, O. (2013). Antibiotic resistance—the need for global solutions. *The Lancet Infectious Diseases, 13*(12), 1057–1098. https://doi.org/10.1016/S1473-3099(13)70318-9

Mauwalan, Y. E., Kallau, N., & Laut, M. M. (2022). Kajian *Escherichia coli* resisten antibiotik pada lingkungan air di Indonesia. *Jurnal Veteriner Nusantara, 5*(1), 23–30.

Megantara, I., Muhtado, A. R., Pradini, G. W., Goenawan, H., & Sylviana, N. (2023). Multidrug resistance *Escherichia coli* in the Citarum River, Greater Bandung Area, Indonesia. *Biodiversitas, 24*(1), 181–188.

Ramatla, T., Ramaili, T., Lekota, K. E., & Ndou, R. (2023). A systematic review and meta-analysis on prevalence and antimicrobial resistance profile of *Escherichia coli* isolated from water in Africa (2000–2021). *Heliyon, 9*(6), e16123. https://doi.org/10.1016/j.heliyon.2023.e16123

Rizzo, L., Manaia, C., Merlin, C., Schwartz, T., Dagot, C., Ploy, M. C., Michael, I., & Fatta-Kassinos, D. (2013). Urban wastewater treatment plants as hotspots for antibiotic resistant bacteria and genes spread into the environment: A review. *Science of the Total Environment, 447*, 345–360.

Sasongko, H. (2014). Uji resistensi bakteri *Escherichia coli* dari Sungai Boyong Kabupaten Sleman terhadap antibiotik amoksisilin. *Biogenesis, 2*(1), 25–29.

Skof, A., Koller, M., Baumert, R., Hautz, J., Treiber, F., Kittinger, C., & Zarfel, G. (2024). Comparison of the antibiotic resistance of *Escherichia coli* populations from water and biofilm in river environments. *Antibiotics, 13*(1), 1–15.

Verawaty, M., Apriani, N., Tarigan, L. R., Aprian, E. T. R. I., & Laurenta, W. C. (2020). Antibiotics resistant *Escherichia coli* isolated from aquatic ecosystems in Palembang, South Sumatra, Indonesia. *Biodiversitas, 21*(1), 86–97. https://doi.org/10.13057/biodiv/d210113

Watkinson, A. J., Micalizzi, G. B., Graham, G. M., Bates, J. B., & Costanzo, S. D. (2007).

Volume 18 No. 3: 498-504
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p01

Antibiotic-resistant *Escherichia coli* in wastewaters, surface waters, and oysters from an urban riverine system. *Applied and Environmental Microbiology, 73*(17), 5667–5670. https://doi.org/10.1128/AEM.00763-07

World Health Organization. (2023). *Antimicrobial resistance*. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

World Health Organization. (2023). *WHO research priorities for antimicrobial resistance in human health*. https://www.who.int/news/item/22-06-2023-who-outlines-40-research-priorities-on-antimicrobial-resistance

Zhang, Q., Zhang, Z., Lu, T., Peijnenburg, W. J. G. M., Gillings, M., Yang, X., Chen, J., Penuelas, J., Zhu, Y., Zhou, N., Su, J., & Qian, H. (2020). Cyanobacterial blooms contribute to the diversity of antibiotic-resistance genes in aquatic ecosystems. *Communications Biology*, *3*(1), 1–10. https://doi.org/10.1038/s42003-020-01468-1

Table

Table 1. Prevalence and antibiotic resistance profile of *Escherichia coli* in various river basins in Indonesia

No.	River Basin/ River Location	Year	Sample Type	Prevalence (%)	Antibiotics Tested	Resistance (%)	MDR	Reference
1.	Boyong River, Yogyakarta	2014	River water & household water	100	Amoxicillin, streptomycin	80%; 73.3%	Not reported	(Sasongko, 2014)
2.	Sekanak River, Palembang	2020	River water	70.73	Ampicillin; Tetracycline; Tobramycin	82%; 71%; 57%	Not reported	(Verawaty *et al.*, 2020)
3.	Citarum River, Bandung	2023	River water	68.51	Ampicillin; Tetracycline; Azithromycin	45%; 37%; 29%	±24%	(Megantara *et al.*, 2023)
4.	Bekasi River (downstream)	2024	River water	100	–	–	*blaCTX-M*	(Gusti *et al.*, 2024)

Terakreditasi Nasional Sinta 4, berdasarkan Keputusan Direktur Jenderal Pendidikan Tinggi, Riset, dan Teknologi No. 158/E/KPT/2021