Identification of pathogenic bacteria (*Vibrio* sp) in the waters of the industrial area of north aceh regency and lhokseumawe city

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Abstract. North Aceh Regency and Lhokseumawe City's waters are mangrove ecosystems, estuaries, fisheries management activities, and industrialization activities. Activities in the industrial areas of North Aceh Regency and Lhokseumawe City have the ability to contaminate waters and affect the chemical and physical composition of the water, which has a direct impact on the abundance of harmful bacteria (*Vibrio* sp). The study looked at the distribution of harmful bacteria (*Vibrio* sp) in water near industrial areas in North Aceh Regency and Lhokseumawe City. The purpose of this study is to investigate the abundance of pathogenic bacteria (*Vibrio* sp.) in the waterways of North Aceh Regency and Lhokseumawe City's industrial areas. This study will also look into the relationship between water quality factors and the abundance of harmful bacteria. The study was carried out in July and August 2023 at four stations placed in marine waters near the industrial area. The research methods used in this research are survey methods and laboratory analysis. Purposive sampling and the ANOVA test were the analysis and sampling techniques employed in this study. The findings demonstrated that there was no discernible variation in *Vibrio parahaemolyticus* between stations 1, 2, 3, and 4. Station 2 saw a strong *Vibrio cholerae* effect ($p > 0.05$), resulting in 87.20 74.36^b CFU/ml. Vibrio total from the four research stations that significantly affected station 2 ($p > 0.05$) were 280.00 167.26^b CFU/ml.

1 Introduction

North Aceh Regency and Lhokseumawe City's waters are near mangrove ecosystems, estuaries, fisheries management activities, and industrialization activities. This coastline area is one of Aceh Province's economic growth areas, having been recognized as a special economic zone (KEK) in which new industries will operate [1]. North Aceh Regency and Lhokseumawe City are Aceh Province regencies/cities with significant potential in the

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marine and fisheries sector, including both large and small pelagic fish. Fish is a popular source of animal protein since it is very inexpensive and easy to procure [2].

Bacteria are naturally occurring microbes in marine settings, and some species are pathogenic [3]. Vibrio species found in estuaries and coastal waters pose the greatest threat to human health worldwide [4]. *Vibrio* sp is an agarolytic marine bacterium commonly found in marine and estuarine habitats [5]. The presence of *Vibrio* sp bacteria is significantly impacted by salinity, ammonia, and water temperature [6]. Many bacteria can proliferate and contaminate the fish as a result of poor management [7]. *Vibrio* sp has caused mass mortality in Indian fisheries (Scylla sp.) [8]. *Vibrio* sp bacteria are frequently found in marine waters. *Vibrio* sp bacteria have been detected on contaminated water surfaces as a result of organic waste disposal [9].

The marine industrial area on the coast of North Aceh Regency and Lhokseumawe City is one of the most important places for aquaculture production, such as shrimp cultivation. *Vibrio* sp is a pathogenic bacterium that causes lethal illness outbreaks and is the most dangerous in shrimp farming [10]. This disease can be fatal [11]. Shrimp farming intensification has resulted in water quality issues and the proliferation of dangerous microorganisms [12]. Shrimp are also extremely vulnerable if exposed to harmful microorganisms [13]. A high *Vibrio* sp bacterial density can make shrimp susceptible to vibriosis [14]. *Vibrio* sp can also destroy dyes like trypan blue [15], remove diesel oil efficiently [16], and prevent the establishment of toxic algae [17]. Alkalinity and organic matter are influenced by environmental conditions [18]. Water contaminants are produced as a result of industrialization, climate change, and urbanization [19].

Currently, fisheries production is declining due to illness infections, one of which is caused by bacteria [20]. Water quality can be harmed by pollution from industry, residential activities, and aquaculture [21]. The huge number of industries emerging and developing in Lhokseumawe and North Aceh Regency can have an impact on the water environment [22]. The purpose of this study is to assess the number of pathogenic bacteria (*Vibrio* sp) in the waterways of North Aceh Regency and Lhokseumawe City, as well as the relationship between water quality measures and the abundance of pathogenic bacteria. It is widely recognized that the objective of the program to increase the value of fisheries production was to increase the annual productivity of fish production in Lhokseumawe City [23]. Decades-long human anthropogenic research has altered the aquatic environment significantly, and assessments of non-metallic contamination sources in the Asin Pusong reservoir, Lhokseumawe City, have also been conducted [24]. Consequently, the aforementioned research must also be conducted in the bodies of water encircling other industrial zones in Lhokseumawe City. To proactively mitigate disasters, environmental conservation is of the utmost importance [25]. Bacteria including V. cholera are prevalent in estuaries, wetlands, rivers, and the ocean [26]. The microbes that frequently contaminate seafood are members of the genus Vibrio. The aforementioned bacteria strain has the potential to contaminate seafood, thereby diminishing its export quality [27]. Flows from river estuaries that transport both inorganic and organic detritus into seawater are the source of the elevated concentrations of nitrate and phosphate in coastal [28].

2 Research methods

The study was conducted in July and August of 2023. Water quality assessments in the Lhokesumawe City and North Aceh Regency industrial waterways were being conducted at the same time as water samples were being taken. The research location points were conducted at 4 stations, with 25 location points at each station. Over the course of two months, one sample of the water was taken every week. Following the determination of the

coordinates using a Global Positioning System (GPS) instrument, the sampling coordinates were determined.

Water samples of *Vibrio* sp. were collected once at each of the one hundred recorded locations. The measurement data indicates the water quality both at the time the data is collected and at the designated collection site, which is the water column or body of water. The sample is subsequently identified through a series of analytical phases in the laboratory. Establishing agar media is the initial step; planting Vibrio, Vibrio TCBS, and Vibrio TSA make up the subsequent three stages, respectively. Following completion of these procedures, the specimen is positioned within an incubator at a temperature range of 35C to 37C for a duration of 24 hours.

With a purposive sampling technique and the ANOVA test, this study used survey methodologies as well as laboratory analyses. The research site is depicted in Figure 1. Purposive sampling was employed to choose the sampling location in order for the data collected afterwards to be more representative [29]. Sampling is an important step in the analysis process [30].

Fig. 1. Location of research sample points

2.1 Statistical data analysis

An ANOVA test was used to evaluate significant variations in water parameters for pathogenic bacteria at the research site. In this study, data was analyzed using SPSS Statistics 20 software to determine the total bacteria in industrial area waters at four locations.

3 Result and discussion

In this research, a study was carried out regarding water quality in industrial areas at each station. The following is data on water quality parameters from 4 research stations located in industrial areas in North Aceh Regency and Lhokseumawe City (Table 1).

Temperature, salinity, brightness, pH, and DO differ dynamically and evenly among the four research locations when compared. At station 1, the temperature ranged from 32.3°C to

20.8°C, with an average of 31.12°C. At station 2, the temperature ranged from 31.9°C to 30.5°C, with an average of 31°C. The average temperature at station 3 was 31.3°C, with a range of 32.3°C and 30.8°C. Additionally, the temperature at station 4 ranged from 32°C to 31°C, with an average of 31.44°C.

Table 1. Data on water quality parameters at the research location

No	Station	Water Quality Data Parameters														
		Temperature			Salinity			Brightness			pH			DO		
		Q	R	X	Q	R	X	Q	R	X	Q	R	X	Q	R	X
1	Station 1	32.3	20.8	31.1	25	20	22	1.1	0.6	0.9	8.1	8.1	8.1	5.5	4.8	5.2
2	Station 2	31.9	30.5	31	25	20	23.4	7	0.5	3,4	8.8	8	8.1	10.9	7.9	8.7
3	Station 3	32.3	30.8	31.3	22	18	20	6	0.8	4.1	8.2	8	8.1	9.8	7.3	7.8
4	Station 4	32	31	31.4	25	16	19.1	6	1	3,4	8.14	8.1	8.1	7.9	6.9	7.4

Information:
T = Height
R = Low
X = Average

At station 1, the salinity parameter ranges from 25 ppt to 20 ppt, with an average of 22 ppt. Station 2 had a salinity range of 25 ppt to 20 ppt, with an average of 23.44 ppt. The average salinity at station 3 was 20.04 ppt, with a range of 22 ppt to 18 ppt. Additionally, with an average of 19.16 ppt, station 4 had the highest 25 ppt and lowest 16 ppt. Table 1 shows the parameters that were measured for this study's pH and DO results.

Temperatures at the four research stations range from 28.2 to 32.2°C, salinity from 18.5 to 24.2, and brightness from 0.7 to 5 meters. According to the research findings of Patty et al., 2020, this is still regarded as normal and beneficial for marine biota if the temperature runs between 28.8 and 30.5°C, the salinity is between 25.0 and 34.0, and the brightness is between 4.5 and 31.5 meters. In addition, the pH and DO from the four sites varied from 8.0 to 8.3 and 8.5 to 6.7 (mg/l), respectively. The seawater quality standard (Minister of Environment Decree No. 51 of 2004) covers the pH range of 7–8.5 and the ideal DO of >5 (m/l), which are the ideal conditions for the flourishing of marine biota. According to Mahbubah et al. [31], the range for water quality is normal. Water security is a crucial concern, according to Yasin et al. [32]. We are all affected by poor water quality, which is one of the most significant indicators of environmental contamination [33].

The statistical analysis revealed that there was no significant difference in *Vibrio parahaemolyticus* between stations 1, 2, 3, and 4. Furthermore, *Vibrio cholerae* exhibited a substantial effect ($p > 0.05$) on station 2, namely 87.20 74.36^b CFU/ml. The total Vibrio from the four research sites that had a significant effect on station 2 ($p > 0.05$) was 280.00 167.26^b CFU/ml. The overall Bacterial Count from the four stations had a significant effect on station 2 ($p > 0.05$), with a difference of 301.20 1595.02^b CFU/ml. The overall plankton concentration from the four locations with a significant effect on station 2 ($p > 0.05$) was 24900.0 13439.71^b CFU/ml. Dinoflagellates from the four stations had a substantial effect on station 2, namely 56.13 30.40^b CFU/ml ($p > 0.05$).

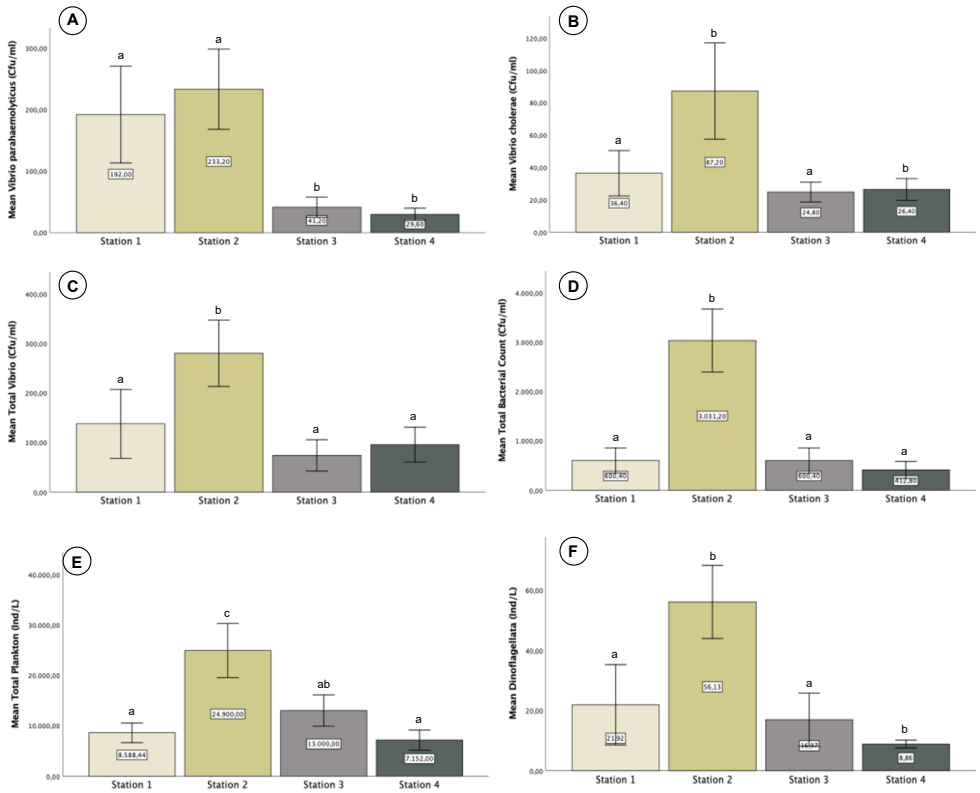

Fig. 2. Graphs (A) *Vibrio parahaemolyticus*, (B) *Vibrio cholerae*, (C) Total Vibrio, (D) Total Bacterial Count, (E) Total Plankton, (F) Dinoflagellates

Vibriosis is a disease caused by the presence of *Vibrio* sp bacteria that has the ability to kill aquatic species [34]. This bacterium thrives in salty environments [35]. Vibriosis illnesses, such as the bacteria *Vibrio parahaemolyticus*, frequently cause large fatalities in grouper fish commodities [36]. N-hexane extract from *R. stylosa* leaves has the potential to be used as an antibacterial agent in tilapia (*Oreochormis niloticus*) against *Vibrio* sp and *A. hydrophila* [37]. *Sargassum* sp. extract was found in the white sea bass diet and was found to alter phagocytic activity when tested with *Vibrio alginolyticus* bacteri [38]. Apart from the primary trigger, *Vibrio* sp dinoflagellates are the cause of white feces sickness [39]. The distribution of phytoplankton is regulated by the physical and chemical characteristics of water, particularly the availability of nutrients [40]. These characteristics include dissolved oxygen, temperature, salinity, pH, suspended solids/SPM, nitrate, and phosphate. Mass shrimp cultivation is susceptible to mortality caused by Vibrio sp., a facultative anaerobic gram-negative bacterium [41]. Plankton abundance is a useful tool for determining the fertility level of the waters in the research area. The presence of garbage contaminates the aquatic ecosystem since it lowers the water's quality and, in particular, the diversity of plankton [42]. The research site is used for brackish water aquaculture, particularly shrimp cultivation, in addition to industrial area activities.

4 Conclusion

The research results of the relative temperature distribution were the highest with a value of 32.3°C and the lowest with a temperature value of 20.8°C. Furthermore, the highest relative seawater salinity is 25 ppt and the lowest is 16 ppt. ANOVA results showed that there was no significant difference in *Vibrio parahaemolyticus* between station 1, station 2, station 3, and station 4. *Vibrio cholerae* had a significant effect on station 2 ($p > 0.05$), namely 87.20 ± 74.36^{b} CFU/ml. The total Vibrio from the four stations at the research location which had a significant effect on station 2 ($p > 0.05$) was 280.00 ± 167.26^{b} CFU/ml. The total Bacterial Count from the four stations had a significant effect on station 2 ($p > 0.05$) showing a significant difference, namely 301.20 ± 1595.02^{b} CFU/ml. The total plankton from the four stations that had a significant effect on station 2 ($p > 0.05$) was 24900.0 ± 13439.71^{b} CFU/ml. Dinoflagellates from the four stations had a significant effect on station 2 ($p > 0.05$), namely 56.13 ± 30.40^{b} CFU/ml.

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References

1. W. Komarawidjaja, A. Riyadi, Y.S. Garno. Jurnal Teknologi Lingkungan **18**(2) 251-258 (2017)
2. F. Riana, A.S. Junaedi, M. Zainuri. Jurnal Kelautan Tropis. **24**(3) 353-363 (2021)
3. K. Mahardika, I. Mastuti, R. Septory, D. Roza, Z. Zafran, A. Nasukha. Jurnal Riset Akuakultur **16**(1) 49-59 (2021)
4. B. Meena, L. Anburajan, T. Sathish, A.K. Das, N.V. Vinithkumar, R. Kirubagaran, G. Dharani. Marine pollution bulletin **144** 105-116 (2019)
5. V. Letchumanan, W.S. Tan, W.F. Yin, K.G. Chan. Progress In Microbes & Molecular Biology **3**(1) (2020)
6. A. Pariakan, M. Rahim. Journal of Fisheries and Marine Research **5**(3) 547-556 (2021)
7. B. Ihsan. Jurnal Pengolahan Hasil Perikanan Indonesia. **24**(1) 89-96 (2021)
8. S. Saha, A.D. Dash. Uttar Pradesh Journal of Zoology **42**(19) 48-58 (2021)
9. F. A. Fitri, F. Feliatra, D. Yoswati. Asian Journal of Aquatic Sciences **3**(2) 189-192 (2020)
10. L.A. Prastiti, A.H. Verdian, N. Fatimah, K. Fathurohman, A.F. Siburian. Intek Akuakultur **6**(2) 148-157 (2022)
11. I. Fatmala, H. Pranggono, L. Linayati. Jurnal Litbang Kota Pekalongan **16** (2019)
12. B. Widigdo, M. Yuhana, A. Iswantari, C. Madonsa, I.D. Sapitri, Y. Wardiatno, A.A. Hakim, F. Nazar. Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management) **11**(1) 130-140 (2021)
13. M.D. Sani, A.Y. Maharani, M.I. Riandy, R. Joko, K. Susilo, P.A. Wiradana, A. Soegianto. Ecology, Environment and Conservation. **26**(3) 1271-1275 (2020)
14. S.H. Amrullah, K. Mar'iyah, A.A. Afandi. Indigenous Biologi: Jurnal Pendidikan dan Sains Biologi **6**(1) 8-14 (2023)
15. S.D. Khandare, N. Teotia, M. Kumar, P. Diyora, D.R. Chaudhary. Biocatalysis and Agricultural Biotechnology **51** 102802 (2023)

16. H. Zhou, L. Jiang, K.Li, C. Chen, X. Lin, C. Zhang, Q. Xie. Science of The Total Environment **793** 148529 (2021)
17. Y. Wang, S.Li, G. Liu, X.Li, Q. Yang, Y. Xu, Z. Hu, C.Y. Chen, J.S. Chang. Bioresource technology **295** 122246 (2020)
18. C. Handayani, A.D. Pahlewi, A. Listriyana. Zona Laut: Journal of Ocean Science and Technology Innovation 56-61 (2023)
19. C. Zamora-Ledezma, D. Negrete-Bolagay, F. Figueroa, E. Ni, M. Zamora-Ledezma, F. Alexis, V.H. Guerrero. Environmental Technology & Innovation **22** 101504 (2021)
20. S. Haryanto, M. Ansari. Buletin Teknik Litkayasa Akuakultur **18**(2) 153-156 (2020)
21. S.R.P. Maresi, P. Priyanti, E. Yunita. Al-Kauniyah: Jurnal Biologi **8**(2) 113–122 (2015)
22. A.A.F. Harahap, K. Khairunnisa, V. Novalia. Jurnal Glosains **3**(2) 79-86 (2022)
23. S. Sufi. Negotium: Jurnal Ilmu Administrasi Bisnis **3**(2) 96-119 (2020)
24. R. Ezraneti, S. Syahrial, E. Erniati. Jurnal Kelautan Tropis **24**(1) 34-44 (2021)
25. D.A. Rahman, M.B. Abubakar, A. Zulhilmi, M. Muchlis, M. Rizwan. Jurnal Malikussaleh Mengabdi **2**(1) 201-213 (2023)
26. J.F. Mehrabadi, P. Morsali, H.R. Nejad, A.A.I. Fooladi. Journal of infection and public health **5**(3) 263-267 (2012)
27. S.R. Sari, A. Baehaki, S.D. Lestari, E. Arafah. Jurnal Pengolahan Hasil Perikanan Indonesia **23(**3) 542-547 (2020)
28. F. Musafiraand, K. Khairunnisa. Jurnal Kelautan dan Perikanan Indonesia **3**(2) 66-78. (2023)
29. T.F.Z. Aufar, K. Kunarso, L. Maslukah, D.H. Ismunarti, A. Wirasatriya. Indonesian Journal of Oceanography **3**(2) 189-196 (2021)
30. C. Scapuzzi, B. Benedetti, M. Di Carro, E. Chiesa, N. Pussini, E. Magi. Applied Sciences **12**(6) 2951 (2022)
31. N.U. Mahbubah, I. Wirawan, S.O. Madyowati. Jurnal Ilmiah Kelautan dan Perikanan **4**(3) 264-272 (2023)
32. S.N.T.M. Yasin, M.F.M. Yunus, N.B.A. Wahab. Journal of Educational and Learning Studies **3**(1) 14 (2020)
33. I. Yaroshenko, D. Kirsanov, M. Marjanovic, P.A. Lieberzeit, O. Korostynska, A. Mason, I. Frau, A. Legin. Sensors **20**(12) 3432 (2020)
34. K.N. Ambat, I.W. Abida, R. Maherlina. Jurnal Ilmiah Kelautan **3**(3) 66-72 (2022)
35. P. Kusumaningsih. Food Scientia: Journal of Food Science and Technology **2**(1) 99-118 (2022)
36. R.A. Zulfaizi, G.I. Setiabudi, I. Mastuti, K. Mahardika. Jurnal Perikanan Unram **12**(3) 378-388 (2022)
37. S.R. Rahayuningsih, S.S. Patimah, T. Mayanti, M.M. Journal of Marine Research **12**(1) 1-6 (2023)
38. M. Azuwarita, R. Wulandari, A. Zahra. Intek Akuakultur **5**(1) 27-39 (2021)
39. M. Adam, I. M. Widiastuti, A.Y. Yayan, E. Insivitawati, R.F. Pakaya, A. Soegianto, A. Khumaidi. Jurnal Ilmiah Perikanan dan Kelautan **14**(1) (2022)
40. S. Abubakar, N. Akbar, A. Baksir, H. Umasangadji, N. Najamuddin, I. Tahir, R.E. Paembonan, F. Ismail. Jurnal Kelautan: Indonesian Journal of Marine Science and Technology **14**(2) 149-163 (2021)

41. F.R. Mahulauw, A. Lamadi, M. Mulis. Nike: Jurnal Ilmiah Perikanan dan Kelautan **10**(1) 031-039 (2022)
42. S. Safnowandi. Jupe: Jurnal Pendidikan Mandala **4**(5) 195-201 (2019)