International Journal of Bio-resource and Stress Management https://ojs.pphouse.org/index.php/IJBSM

Crossref

IJBSM February 2026, 17(2): 01-07

Article AR6871

Research Article

Natural Resource Management

DOI: HTTPS://DOI.ORG/10.23910/1.2026.6871

Biodegradability Assessment of Aquaculture Effluents: A Comprehensive Analysis of BOD and COD Using Multivariate Statistical Techniques

B. D. Savaliya[1], Jebarson Solomon[2], Tejaswini Karale[3], Ganesh Kumar[4], Tapas Paul[5], Saurav Kumar[1], Saiprasad Bhusare[6], Thangaraj Priyadharshini[7] and Renuka[8]

[1]Dept. of Aquatic Environmental Management, [2]Dept. of Fish Physiology and Biochemistry, [3]Dept. of Fisheries Resource Management, [6]Dept. of Fish Nutrition and Feed Technology, ICAR-Central Institute of Fisheries Education, Mumbai (400 061), India

[4]Dept. of Aquatic Environment Management, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, (284 003), India

[5]Dept. of Aquatic Environment Management, College of Fisheries, Kishanganj, Bihar (855 107), India

[7]Dept. of Aquatic Environment Management, Fisheries College and Research Institute, Thoothukudi, Tamil Nadu (628 008), India

[8]Dept. of Environment and Sustainable Development, Central University of Gujarat, Gandhinagar (391 107), India

Open Access

Corresponding envscinotes@gmail.com

0009-0001-1694-1169

ABSTRACT

The study was conducted during January, 2023 to December, 2024 at Tirunelveli, Tuticorin and Kanyakumari district of Tamil Nadu, India to investigate the biodegradability of effluents collected from semi-intensive aquaculture systems operating in Tamil Nadu based on biodegradability index calculated from Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). BOD indicated the oxygen needed to biologically degrade organic matter; COD measured both biodegradable and nonbiodegradable organic matter. The BOD/COD ratio (Biodegradability index) averaged 0.46, showing that the wastewater exhibited moderate biodegradability, implying that biological treatment was feasible but microbial seeding might enhance efficiency. Seasonal peaks in May correlated with increased feed input and organic waste accumulation; lower values in October and November reflected reduced production. Regression analysis identified a quadratic polynomial as the best predictor of BOD from COD, underscoring the value of mathematical models for monitoring wastewater quality. This study demonstrated that integrating BOD and COD data with statistical tools could improve effluent management. Expanding sustainable aquaculture would require implementing treatment technologies suited to effluents with moderate biodegradability. The findings provided baseline information for designing effluent treatment plants, optimizing microbial consortia and informing policy on discharge standards.

KEYWORDS: Biodegradability index, biological oxygen demand, chemical oxygen demand

***Citation* (VANCOUVER):** Savaliya et al., Biodegradability Assessment of Aquaculture Effluents: A Comprehensive Analysis of BOD and COD Using Multivariate Statistical Techniques. *International Journal of Bio-resource and Stress Management,* 2026; 17(2), 01-07. HTTPS://DOI.ORG/10.23910/1.2026.6871.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 12th December 2025 RECEIVED in revised form on 02nd February 2026 ACCEPTED in final form on 16th February 2026 PUBLISHED on 18th February 2026

1. INTRODUCTION

Aquaculture has experienced significant growth in recent years and now accounts for nearly half of global fish consumption, with production currently at 51 million t (Ogunfowora et al., 2021). To meet the demands of a growing global population, aquaculture is projected to expand significantly in the coming years. In 2022, global aquaculture production of aquatic animals reached 94.4 million t, surpassing capture fisheries for the first time. This trend is expected to continue, with aquaculture's share in global fisheries and aquaculture production projected to grow from 51% in 2022 to 54% by 2032 (Dongyu, 2024). The anticipated growth emphasizes the industry's critical role in ensuring food security and providing a nutritious diet, particularly in developing nations. However, despite the numerous benefits of aquacultures to human nutrition and the global economy, there are increasing concerns about its environmental impact due to inadequate treated by-products. Effluents from aquaculture systems, which include uneaten feed, chemicals, fertilisers and waste, are frequently released into surrounding aquatic environments. These discharges contribute to significant alterations in the physicochemical properties of water bodies and introduce various anthropogenic pollutants that can negatively affect natural aquatic ecosystems (Ahmad et al., 2022; Ogunfowora et al., 2021). The degree of contamination of wastewater is widely determined by two parameters: Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). These indicators are often used to assess the degree of contamination of the water (Onukwugha, 2024). BOD is the amount of oxygen needed by bacteria and other microorganisms in the biochemical decomposition and transformation of organic matter in the presence of oxygen. The incubation period of 5 days have been accepted as the standard for this test (But other incubation periods are also sometimes used) and sometimes can reach 30 days (Saravanathamizhan and Perarasu, 2021). COD is a standard test for water to consume oxygen in the form of potassium dichromate in the breaking down of organic matter and inorganic chemicals such as ammonia and nitrite. The aquaculture industry generates significant quantities of organic and inorganic waste, contributing to water pollution if these wastes are partially or inadequately treated (Turcios et al., 2014). Effluents from aquaculture facilities are typically characterized by elevated levels of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), which serve as critical parameters for evaluating the presence of organic waste and chemical pollutants in aquaculture water (Lv et al., 2024). BOD measures the oxygen required by microorganisms to decompose organic material over a specific period. COD, in contrast, provides a broader assessment of the total oxygen demand needed to oxidize both organic matter and certain inorganic substances, such as ammonia and nitrite, over a shorter timeframe. The primary difference between BOD and COD is that COD measures all the organic material content in terms of both biodegradable and non-biodegradable compounds, while BOD only measures organic material that is or can be biologically degraded (The biodegradable fraction of the wastewater) (Ahmad et al., 2021). Extensive research has been conducted on the biodegradability index in effluents from industries such as sugarcane processing and agro-based byproducts, its application in the aquaculture industry remains limited. This gap is significant because aquaculture facilities employ diverse culture practices, leading to variations in effluent composition. Regulatory bodies emphasize the importance of effluent treatment plants (ETPs) in aquaculture operations to ensure compliance with environmental standards. However, even after treatment, some effluents may retain organic and chemical loads that are not effectively removed by existing ETP mechanisms (de et al., 2021). Assessing the biodegradability index of aquaculture effluents provided a scientific basis for identifying inadequacies in current treatment processes. This evaluation could guide the implementation of additional remedial measures to enhance the efficiency of effluent management systems.

2. MATERIALS AND METHODS

2.1. Collection and analysis of aquaculture effluent water samples

The study was conducted during January, 2023 to December, 2023 at Tirunelveli, Tuticorin and Tanjore district of Tamil Nadu (Table 1). Composite water samples were collected from aquaculture effluent discharge points from semi-intensive aquaculture systems in the Tirunelveli,

Table 1: Cordinates of sampling sites

Sites	Latitude (DMS)	Longitude (DMS)
Site 1	8°33'48.6"N	77°31'02.1"E
Site 2	8°50'03.7"N	77°22'47.2"E
Site 3	8°49'45.8"N	77°21'07.3"E
Site 4	8°36'48.0"N	78°03'18.9"E
Site 5	8°37'26.5"N	78°01'44.4"E
Site 6	10°36'35.5"N	79°14'33.9"E
Site 7	10°36'28.1"N	79°14'16.0"E
Site 8	8°53'45.3"N	77°25'28.1"E
Site 9	8°55'44.9"N	77°19'59.0"E
Site 10	8°53'31.8"N	77°24'22.7"E

*DMS stands for Degrees, Minutes, and Seconds

Tuticorin and Tanjore district of Tamil Nadu (Figure 1). A total of 10 freshwater carp culture unit was selected and composite water samples of effluent water were collected on every month from January, 2023 to December, 2024 and triplicate samples were collected and then combined as homogeneous samples. Effluent samples were collected in thoroughly cleaned bottles and were preserved at approximately 4°C after adding appropriate preservatives to slow biological activity and prevent chemical hydrolysis. For COD analysis, sulfuric acid was added to adjust the pH to 2 before refrigeration. BOD and COD were analysed by following the methods outlined by Anonymous (1986) and Anonymous (2017).

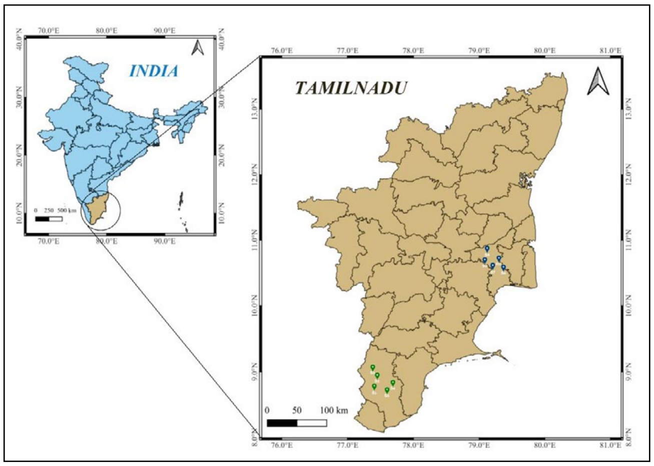

Figure 1: Sampling points of semi-intensive aquaculture farms in Tamil Nadu

2.2. Biodegradability index

The biodegradability index, commonly expressed as the BOD/COD ratio, was an indicator used to assess the potential for biological treatment of wastewater. This ratio reflected the ease with which organic matter in the wastewater could be degraded by microorganisms (Rudaru et al., 2022). When the BOD/COD ratio was greater than 0.6, the waste was considered readily biodegradable and could be effectively treated with standard biological processes (Diwyanjalee et al., 2024). If the ratio falls between 0.3 and 0.6, biological treatment was still possible, but seeding with specific microorganisms might be required to help initiate the process, as natural degradation might be slower. If the BOD/COD ratio was below 0.3, the waste was not suitable for biological treatment (Wei et al., 2023).

2.3. Statistical analysis

The statistical software package (Statistical Package for Social Science, Version 7.5) called SPSS was used to calculate the correlation coefficients (r values) between COD and BOD. The regression parameters a and b of the linear equation Y=a+bX was determined using the method of least squares to fit the experimental data (Wonnacott, 1981). Correlation was used to determine the extent to which parameters were linearly dependent. Regression analysis was used for estimating the average relationship between parameters which provided some way to predict the value of one or more dependent variables in terms of independent variables. The correlation coefficient between two variables X and Y (Trivedy and Goel, 1984).

Mean Relative Quadratic Error (MRQE) was calculated using the equation

$$MRQE= ((\sum(BOD_{Experimental}-BOD_{Calculated}))/(n-1))^{1/2}$$

where n was the number of data points.

3. RESULTS AND DISCUSSION

The monthly COD and BOD values of aquaculture effluents, recorded over a 12-month period collected from 10 different aquaculture systems effluent outlet (Figure 3 and 4), were presented in Table 2. The effluents showed a peak COD value in May (93.2 mg l^{-1}) and a minimum in October and November (48.2 mg l^{-1}). Similarly, BOD was highest in May (34 mg l^{-1}) and lowest in October and November (24 mg l^{-1}) (Figure 4 and 5). The increased organic load in May likely reflected the high feed input and organic waste accumulation typical of the warmer season, which could elevate microbial activity and oxygen demand (Chapra et al., 2021). The variations in BOD and COD throughout the year suggested seasonal influences on aquaculture effluents, with notable increases in COD and BOD levels during the high-production months (Figure

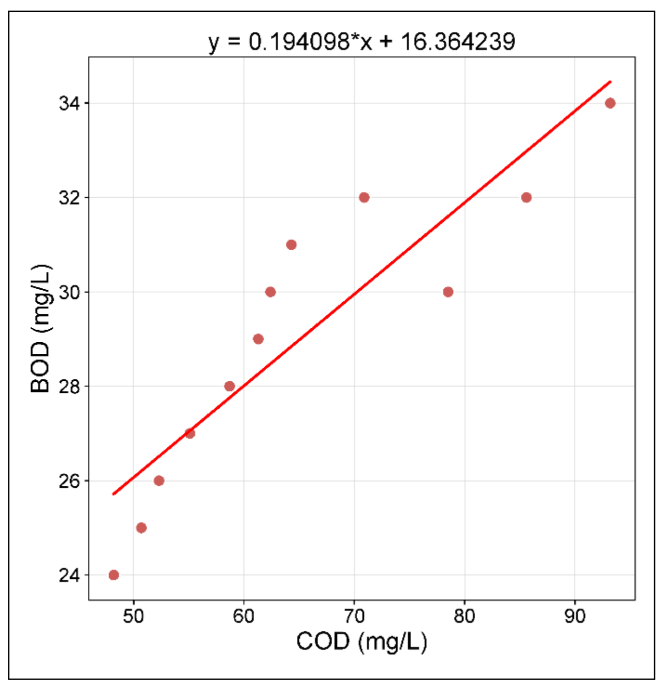

Figure 2: Simulated values of BOD and COD

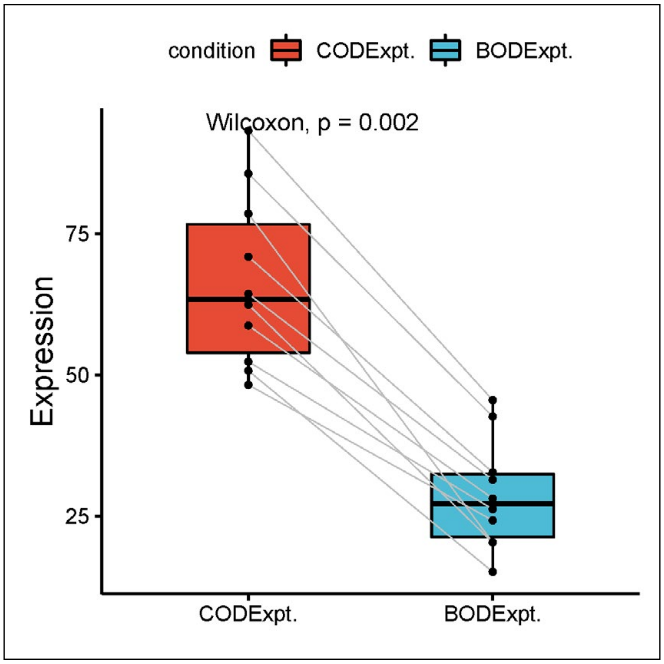

Figure 3: Box plot showing the mean variation of COD and BOD across 10 sampling stations

4). During these periods, the effluents contained elevated levels of organic material from uneaten feed, fecal matter, and residual chemicals. This organic material increased the oxygen demand in receiving waters, potentially impacting the surrounding ecosystem. This condition was specific to the selected farm, as it strategically managed its culture cycle so that peak feeding occured between March and May. Additionally, other environmental factors might have contributed to the elevated COD values observed during

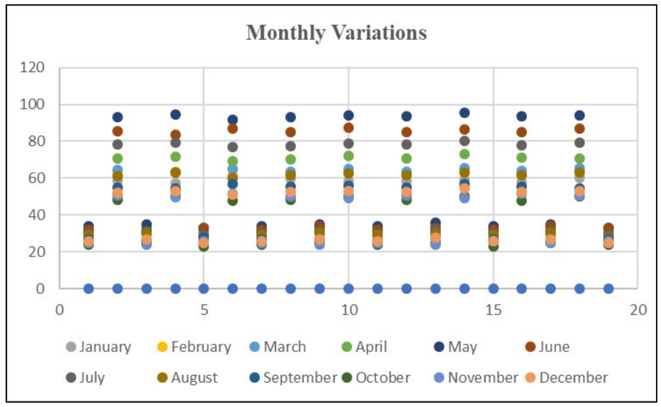

Figure 4: Variation of COD and BOD values in different months

this period. Despite similar seasonal trends, COD and BOD values did not follow a linear relationship. This pattern might be attributed to the complex mixture of organic and inorganic compounds present in the aquaculture effluents (Niu et al., 2022). These effluents contained a variety of substances with differing degrees of biodegradability. For example, compounds in aquaculture systems might vary widely in their breakdown rates, depending on their origin (e.g., feed additives, antibiotics, or naturally occurring organic matter). As a result, BOD fluctuates more than COD, reflecting the varying proportions of biodegradable and non-biodegradable substances in the effluent stream. The non-linear relationship between COD and BOD in aquaculture effluents suggested that the composition of effluents was influenced by multiple factors, including feed practices and water management (Figure 2) (Park and Daniels, 2017). Due to the diverse nature of these

Table 2: Experimental COD and BOD (mg l^{-1}) values for different months and sampling stations (2023)

Month	Site 1		Site 2		Site 3		Site 4		Site 5	
	BOD	COD	BOD	COD	BOD	COD	BOD	COD	BOD	COD
January	28	58.7	27	57.3	29	60.1	28	59.8	27	58.2
February	30	62.4	31	63.5	29	61.8	30	62.1	31	63.7
March	31	64.3	30	63.1	32	65	30	63.4	31	64.8
April	32	70.9	33	71.8	31	69.5	32	70.3	33	72
May	34	93.2	35	94.5	33	91.8	34	93	35	94.2
June	32	85.6	31	83.7	33	86.8	32	84.9	34	87.3
July	30	78.5	31	79.3	29	76.8	30	77.6	31	79
August	29	61.3	30	63	28	60.1	29	61.5	30	62.8
September	27	55.1	26	54.3	28	56.7	27	55.4	27	55.9
October	24	48.2	25	50.1	23	47.6	24	48.4	25	50
November	25	50.7	24	49.5	26	51.8	25	50.3	24	49.2
December	26	52.3	27	53.2	25	51	26	52.5	27	53.1

Table 2: Continue...

Month	Site 6		Site 7		Site 8		Site 9		Site 10	
	BOD	COD	BOD	COD	BOD	COD	BOD	COD	BOD	COD
January	28	58.5	29	59.2	27	57.6	29	60.3	28	58.9
February	30	62.8	32	64.3	30	62.2	31	63.9	29	61.7
March	30	63.7	32	65.5	31	64	32	65.3	30	63.5
April	32	70.6	34	73.2	33	71.1	32	70.7	31	69.8
May	34	93.7	36	95.3	34	93.6	35	94.1	33	91.9
June	32	85.2	33	86.5	32	84.8	34	87	33	86.1
July	30	78.2	32	80.3	30	77.8	31	79.2	29	76.7
August	29	61.6	30	63.2	29	61.7	30	63.1	28	60.4
September	26	54.8	28	57.1	27	55.6	26	54.5	27	55.3
October	24	48.3	25	50.4	23	47.8	25	50.2	24	48.5
November	25	50.5	24	49.4	26	51.6	25	50.6	26	51.7
December	26	52.7	28	54.3	26	52.8	27	53	25	51.4

compounds, accurately determining the exact composition and biodegradability of each component was challenging. Therefore, attempts were made to establish the best possible relationship between COD and BOD to predict organic load patterns more accurately and assess the impact on water quality. The different polynomial equations that represent the relationship between the BOD and COD were fitted to the experimental data. The BOD was expressed in term of measured COD and gave a best fit polynomial equation of quadratic, cubic, fourth and fifth order polynomial were fitted was given in Table 3.

Table 3: Order of polynomials and the equational relation

Order of polynomials	Equations with COD (X) and BOD (Y)
Quadratic order	$Y=0.0093X^2-0.854X+42.99$
Cubic order	$Y=0.0009X^3-0.1876X2+12.55X-253.88$
Fourth order	$Y=-2\times10-5X^4-0.0054X^3-0.6495X^2-33.511X-603.91$
Fifth order	$Y=-1\times10-5X^5+0.0033X^4-0.455X^3+30.743X^2-1022.8X+13425$

Table 4: Variation of errors between experimental and polynomial-calculated BOD

$COD_{Expt.}$ (mg l^{-1})	$BOD_{Expt.}$ (mg l^{-1})	Errors between experimental and calculated BOD			
		Quadratic order	Cubic order	Fourth order	Fifth order
58.7	28.1	3.19	9.67	6166.75	528.97
62.4	20.3	5.61	2.86	6857.56	691.97
64.3	31.4	4.87	14.68	7252.88	807.74
70.9	32.7	3.51	19.05	8707.39	1275.87
93.2	45.5	1.32	30.66	15294.97	4585.66
85.6	42.6	4.57	32.31	12734.97	3071.41
78.5	20.3	12.96	9.68	10628.85	2036.30
61.3	29.1	3.51	11.30	6654.13	645.62
55.1	27.3	3.13	8.67	5537.24	398.62
52.3	26.2	2.44	8.11	5081.44	315.96
50.7	15.1	8.50	2.37	4823.45	264.31
48.2	24.2	0.77	8.23	4464.93	215.77

The errors between the experimental and calculated BOD values derived from the correlation between BOD and COD were presented in Table 4. Given that the estimation errors varied across all methods, we calculated the Mean Relative Quadratic Errors (MRQE) for each to enhance clarity in result interpretation. The quadratic-order polynomial fit demonstrates the lowest error, indicating it as the most accurate model for estimating BOD from COD in this dataset (Tao et al., 2019). Both the experimental and simulated BOD and COD values using the best-fit equations, confirming through graphical analysis that the quadratic-order correlation offers the best fit for this data. The average BOD/COD ratio was found to be 0.46, indicating moderate biodegradability of the wastewater (Table 5). This value suggested that biological treatment was possible, but the process might be slow initially (Abdalla and Hammam, 2014). To improve the efficiency of treatment, seeding with specific microorganisms could be beneficial, as it would help speed up the acclimatization of the microbial community to the waste. Overall, while the organic matter

Table 5: Biodegradability index (BOD/COD ratio)

$COD_{Expt.}$ (mg l^{-1})	$BOD_{Expt.}$ (mg l^{-1})	BOD/COD ratio
58.7	28.1	0.48
62.4	20.3	0.48
64.3	31.4	0.48
70.9	32.7	0.45
93.2	45.5	0.36
85.6	42.6	0.37
78.5	20.3	0.38
61.3	29.1	0.47
55.1	27.3	0.49
52.3	26.2	0.50
50.7	15.1	0.49
48.2	24.2	0.50
Mean	0.47	

in the wastewater shows potential for biological breakdown, certain components were likely more resistant, requiring additional support to optimize the treatment process (Kumar et al., 2024).

4. CONCLUSION

COD and BOD values of aquaculture effluents could effectively predict the quality of water discharged into natural waters. It highlighted that a quadratic-order equation best correlated these parameters and stresses the need for reliable polynomial models for wastewater management. Moreover, the study emphasized that the BOD/COD ratio indicated biodegradability and suggested seeding to enhance biological treatment of aquaculture effluents, ensuring sustainable and environmentally friendly aquaculture practices.

5. ACKNOWLEDGEMENT

The authors express heartfelt thanks to the Director, Tamil Nadu Fisheries Department and Rani Lakshmi Bai Central Agricultural University, Jhansi, U.P, for providing the necessary facilities to conduct the research work.

8. REFERENCES

Abdalla, K.Z., Hammam, G., 2014. Correlation between biochemical oxygen demand and chemical oxygen demand for various wastewater treatment plants in Egypt to obtain the biodegradability indices. International Journal of Sciences: Basic and Applied Research 13(1), 42–48. Available at: https://www.gssrr.org/JournalOfBasicAndApplied/article/view/1382.

Ahmad, A., Abdullah, S.R., Hasan, H.A., Othman, A.R., Ismail, N.I., 2021. Aquaculture industry: Supply and demand, best practices, effluent and its current issues and treatment technology. Journal of Environmental Management 287, 112271. https://doi.org/10.1016/j.jenvman.2021.112271.

Ahmad, A., Kurniawan, S.B., Abdullah, S.R.S., Othman, A.R., Hasan, H.A., 2022. Contaminants of emerging concern (CECs) in aquaculture effluent: Insight into breeding and rearing activities, alarming impacts, regulations, performance of wastewater treatment unit and future approaches. Chemosphere 290, 133319. https://doi.org/10.1016/j.chemosphere.2021.133319.

Anonymous, 1986. Method by method statistics from water pollution (WP) laboratory performance evaluation studies. Quality Assurance Branch, Environmental Monitoring and Support Lab., Cincinnati, Ohio. Available from: https://nepis.epa.gov/Exe/ZyNET.exe/940099ZO.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt%5C00000038%5C940099ZO.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL. Accessed on: 2023.

Anonymous, 2017. Standard methods for the examination of water and wastewater. In: Standard Methods for the Examination of Water and Wastewater, pp. 1000–1000. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://yabesh.ir/wp-content/uploads/2018/02/Standard-Methods-23rd-Perv.pdf. Accessed on: 2024.

Chapra, S.C., Camacho, L.A., McBride, G.B., 2021. Impact of global warming on dissolved oxygen and BOD assimilative capacity of the world's rivers: modeling analysis. Water 13(17), 2408. https://doi.org/10.3390/w13172408.

de Vasconcelos, V.M., de Morais, E.R.C., Faustino, S.J.B., Hernandez, M.C.R., Gaudêncio, H.R.D.S.C., de Melo, R.R., Bessa Junior, A.P., 2021. Floating aquatic macrophytes for the treatment of aquaculture effluents. Environmental Science and Pollution

Research 28(3), 2600–2607. https://doi.org/10.1007/s11356-020-11308-8.

Diwyanjalee, G.R., Bellanthudawa, B.K.A., De Silva, D.K.N.S., Gunawardena, A.R., 2024. Biodegradability index (BDI) as an indicator for effluents quality measurement: A case study based on different industry sectors in Matara District, Sri Lanka. Water Practice & Technology 19(8), 3092–3108. https://doi.org/10.2166/wpt.2024.183.

Dongyu, Q., 2024. 2024. The state of world fisheries and aquaculture-blue transformation in action. The State of World Fisheries and Aquaculture, 1–232. https://doi.org/10.4060/cd0683en.

Kumar, G., Kumar, S., Paul, T., Pal, P., Shukla, S.P., Kumar, K., Jha, A.K., Pradeep, S., 2024. Ecotoxicological risk assessment of triclosan, an emerging pollutant in a riverine and estuarine ecosystems: A comparative study. Marine Pollution Bulletin 205, 116667. https://doi.org/10.1016/j.marpolbul.2024.116667.

Lv, Z., Ran, X., Liu, J., Feng, Y., Zhong, X., Jiao, N., 2024. Effectiveness of chemical oxygen demand as an indicator of organic pollution in aquatic environments. Ocean-Land-Atmosphere Research 3, 0050. https://doi.org/10.34133/olar.0050.

Ogunfowora, L.A., Iwuozor, K.O., Ighalo, J.O., Igwegbe, C.A., 2021. Trends in the treatment of aquaculture effluents using nanotechnology. Cleaner Materials 2, 100024. https://doi.org/10.1016/j.clema.2021.100024.

Onukwugha, E.R., Iwuchukwu, E.I., 2024. Biochemical oxygen demand prediction model from chemical oxygen demand cum-extra principle parameters values in selected fish ponds wastewater around Nekede. UNIZIK Journal of Engineering and Applied Sciences 3(3), 927–945. https://journals.unizik.edu.ng/ujeas/article/view/4031/3281.

Park, J., Daniels, H.V., 2017. Changes in BOD, COD, Chlorophyll-a and solids in aquaculture effluent with various chemical treatments. Journal of Marine Life Science 2(2), 49–55. https://doi.org/10.23005/KSMLS.2017.2.2.49.

Rudaru, D.G., Lucaciu, I., Fulgheci, A.M., 2022. Correlation between BOD5 and COD biodegradability indicator of wastewater. Romanian Journal of Ecology & Environmental Chemistry 4(2), 80–86. https://doi.org/10.1016/B978-0-12-821881-5.00006-4.

Niu, S., Chen, R., Hageman, K.J., McMullin, R.M., Wing, S.R., Ng, C.A., 2023. Understanding impacts of organic contaminants from aquaculture on the marine environment using a chemical fate model. Journal of Hazardous Materials 443, 130090. https://doi.org/10.1016/j.jhazmat.2022.130090.

Saravanathamizhan, R., Perarasu, V.T., 2021. Improvement of biodegradability index of industrial wastewater using different pretreatment techniques. In: Wastewater Treatment. Elsevier, 103–136. https://doi.org/10.1016/B978-0-12-821881-5.00006-4.

Tao, H., Bobaker, A.M., Ramal, M.M., Yaseen, Z.M., Hossain, M.S., Shahid, S., 2019. Determination of biochemical oxygen demand and dissolved oxygen for semi-arid river environment: application of soft computing models. Environmental Science and Pollution Research 26, 923–937. https://doi.org/10.1007/s11356-018-3663-x.

Trivedy, R.K., Goel, P.K., 1984. Chemical and biological methods for water pollution studies. Environmental publications, 1–22. https://www.scirp.org/reference/referencespapers?referenceid=34341.

Turcios, A.E., Papenbrock, J., 2014. Sustainable treatment of aquaculture effluents-what can we learn from the past for the future? Sustainability 6(2), 836–856. https://doi.org/10.3390/su6020836.

Wei, G., Wei, T., Li, Z., Wei, C., Kong, Q., Guan, X., Qiu, G., Hu, Y., Wei, C., Zhu, S., Liu, Y., 2023. BOD/COD ratio as a probing index in the O/H/O process for coking wastewater treatment. Chemical Engineering Journal 466, 143257. https://doi.org/10.1016/j.cej.2023.143257.

Wonnacott, T.H., 1981. Regression; a second course in statistics. The Canadian Journa of Statistics 9(1), 133–135. https://doi.org/10.2307/3315306.