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COMPARISON OF *ESCHERICHIA COLI* CONCENTRATION BETWEEN BENGKALIS COASTAL WATERS AND ESTUARY BANTAN TENGAH RIVER

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ABSTRACT

Bengkalis coastal waters and estuary Bantan Tengah River have been evaluated for bacteriological pollution level from November 2000 to April 2001. The objective was to compare Escherichia coli concentration as an indicator organism in the two ecosystems. The results indicated that E. coli concentration was higher in Bengkalis coastal waters than at estuary Bantan Tengah River, either at spring or at ebb tides. E. coli concentration, in Bengkalis coastal waters was higher at spring tide (993 cfu/100 ml) than that at ebb tide (775 cfu/100 ml). On the contrary, the E. coli concentration in estuary Bantan Tengah River was higher at ebb tide (247 cfu/100 ml) than at spring tide (22 cfu/100 ml).

Key words: Comparison, *Escherichia coli*, coastal waters, estuary, spring and ebb tides.

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INTRODUCTION

Coastal waters and estuarine are open ecosystem to the entry of domestic and industrial wastes. These will directly or indirectly influence the coastal and estuarine water quality (Ubbe, 1992). Among the domestic wastes, feces of human and warm-blood animal are dangerous to the life of aquatic animal and human health.

Feces of human contain more *Escherichia coli*, which is pathogen opportune than that of animal. Of 100–150 grams feces produced by human and animal, approximately contain 3 x 10^{11} (300 billions) of coliform bacteria (Suriawira, 1993). Meanwhile, *E. coli* concentration in 1 gram of feces is approximately 10^{7}– 10^{8} organisms (Schaechter, 1992).

E. coli might cause diarrhea with some possibilities: (1) producing enterotoxin that indirectly cause lose of liquid; (2) investing on ephitellia membrane of intestine, which results in allergic syndrome and lose of liquid (Volk and Wheeler, 1990).

Concentration of *E. coli* in coastal waters is assumed distinct to that at estuarine due to various activities along the ecosystems. The research aims to study the different on *E. coli* concentrations between Bengkalis coastal waters and estuarine of Bantan Tengah River in Bengkalis Island of Riau Province.

MATERIALS AND METHODS

Sampling Protocols

A survey method was applied to conduct the research in Bengkalis coastal waters and estuarine of Bantan Tengah River (Appendix 1) started from November 2000 to April 2001. Bengkalis coastal water is located in the western part of Bengkalis Island, while estuary Bantan Tengah River is in the eastern part of Bengkalis Island.

Location of observation in Bengkalis coastal waters (A) were divided into four stations based on activity along the coastal ecosystem, those were A1= coastal waters of Desa Kelapa Pati; A2= Arang river estuarine; A3= Bengkalis harbor, and A4= Bengkalis River estuarine and around docking area. While, observation location in Bantan Tengah River estuarine (B) was determined in six stations based on aquaculture activity in the estuarine. B1 was upstream of Bantan Tengah River and settlement. Stations B2 and B3 were net culture area, and were located 100 m from B1, respectively. B4 was in the left side of river mouth, B5= in the right side of river mouth, and B6 was 100 m from B4 toward the Malacca Straits.

Surface water samples were collected at spring and ebb tides by using Niskin bottles sampler. Triplicate sampling was carried out at each location, then 100 ml of the mixed water samples was immediately analyzed for *E. coli* concentration.

Isolation of *Escherichia coli*

Escherichia coli was enumerated by the Standard Total Coliform and *E. coli* Fermentation Technique based on APHA (1992) and Lay (1994) procedures. The technique includes three steps; first is presumtive test using lactose broth and incubation at 37^{o}C for 48 hours; secondly is confirmative test using EC broth and incubation at 44.5^{o}C for 24 hours, and finally is complete test using EMB agar and incubation at 35^{o}C for 24 hours.

To confirm the presence of *E. coli*, tests were biochemically continued by IMViC (indole, methyl red, Voges-Proskeur and citrate) reactions, acid-alkaline production and gas H_2S formation on TSI agar.

Data obtained were the concentrations of *E. coli* per 100 ml of water from Bengkalis coastal waters and estuary Bantan Tengah. The data were then analyzed as descriptive statistics. Concentration ratio of *E. coli* in the two ecosystems was determined based on the data. *E. coli* concentrations were then compared to Environmental Quality Standard for tourism area and mariculture as stated in the government regulation (MenKLH, 1988).

RESULTS

Escherichia coli concentration

The concentrations of *E. coli* both at high and low tide on each given location were presented in Table 1. In general, the *E. coli* concentrations were higher in Bengkalis coastal waters rather than in Bantan Tengah River estuarine. The average *E. coli* concentrations in Bengkalis coastal waters were 993 cfu/100 ml at spring tide and 775 cfu/100 ml at ebb tide. Meanwhile, the average values at estuary Bantan Tengah River were 22 cfu/ 100 ml at spring tide and 247 cfu/100 ml at ebb tide.

Human activites were higher at the Bengkalis coastal waters and its surrounding area than those at estuary Bantan Tengah River, although a net-cage culture activity was found in the area. Physical and chemical qualities of aquatic environment influence the growth of *E. coli*; for example, high salinity in B6 location could disturb the growth because

E. coli is not inhabitant of marine environment. The existence of *E. coli* in marine environment is opportunistic, where they will develop in advantageous environmental condition, and available nutrient for the growth.

Water Quality

The average physical and chemical quality of Bengkalis coastal waters and estuary Bantan Tengah River at high and low tides are shown in Table 2. All evaluated parameters influenced the growth and concentration of *E. coli*. Abundance, growth and biochemical reactions of an aquatic microorganism were influenced by environmental factors (Zobell, 1993).

Table 1. *Escherichia coli* concentration in Bengkalis coastal waters, and in estuary Bantan Tengah River.

Observed locations	*E. coli* concentration (cfu / 100 ml)	
	High tide	Low tide
Bengkalis coastal waters		
A1	230	220
A2	1320	1107
A3	1533	673
A4	887	1100
Average	993	775
Bantan Tengah River estuarine		
B1	54	492
B2	44	260
B3	16	250
B4	6	230
B5	6	242
B6	6	6
Average	22	247

Table 2. Average water quality of Bengkalis coastal waters and Bantan Tengah River estuarine at high and low tides (H/L)

Location	Depth (m)	Visibility (m)	Current (m/sec)	Temp. (^oC)	Salinity (o/oo)	PH	DO (ppm)
A1	8,20/6,25	0,57/0,40	0,18/0,23	28/29	23,0/21,0	6,0/7,0	7,0/7,0
A2	3,50/1,42	0,48/0,37	0,16/0,09	28/29	21,0/20,3	6,7/6,7	6,9/6,6
A3	5,50/2,91	0,45/0,37	0,10/0,07	28/29	20,5/23,0	7,0/6,7	7,0/6,9
A4	4,50/2,00	0,50/0,35	0,12/0,14	28/29	21,0/19,6	6,0/7,0	7,0/6,7
B1	4,50/3,20	0,15/0,53	0,12/0,14	28/29	26,0/20,0	6,5/6,0	4,8/4,5
B2	4,70/3,50	0,16/0,61	0,13/0,14	28/29	27,0/25,0	6,3/6,2	4,6/4,5
B3	5,10/3,80	0,15/0,60	0,15/0,15	29/29	28,0/25,0	6,3/6,4	4,4/4,7
B4	5,00/3,90	0,20/0,61	0,20/0,15	30/20	26,0/26,0	6,8/6,6	4,6/5,0
B5	5,90/4,60	0,17/0,61	0,16/0,15	30/30	30,0/27,0	7,0/6,8	5,6/5,6
B6	8,50/7,10	0,54/0,61	0,16/0,16	30/30	30,0/30,0	7,5/7,3	5,7/6,0

Data in Table 2 indicated that water visibility in estuarine was lower than in coastal water, both at high tide, but on reverse occurs at low tide. The difference

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could be caused by a lot of runoff containing suspended particulate matter and solid waste disposed to the river compared to the coastal water. Different measurement period could also contribute to the water visibility values.

Slow current velocity occurred in the coastal waters could be due to Bengkalis coastal waters be categorized into semi-enclosed straits, which is located between Bengkalis and Sumatera islands. On the contrary, high water movement could result in fast current velocity as it was observed in estuary Bantan Tengah River.

Temperature of waters was not too different, which was lower in the coastal water than in the estuarine. This could also be due to condition of climate, which was sunny day at measurement in the estuarine and cloudy in the coastal waters.

Higher salinity was observed in Bantan Tengah River estuarine than in Bengkalis coastal waters. One of differences was due to Bantan Tengah River estuarine toward an open ocean, the Malacca Straits, which was high in salinity. In the contrary, Bengkalis coastal waters is part of the semi-enclosed Bengkalis straits.

Almost there was no difference of pH values between in Bengkalis coastal waters and estuary Bantan Tengah River. However, it was rather more acidic in the estuarine at low tide, which might be due to influence of acidic compounds, such as lignin and tannin produced by mangrove forests grown along the river band.

Dissolved oxygen concentration was higher in Bengkalis coastal waters than in estuary Bantan Tengah River. This might be resulted from higher water visibility in the coastal waters, which allows photosynthetic process that produces higher oxygen concentration in comparison to low water visibility in the estuary.

DISCUSSION

Concentration of *Escherichia coli*

The results showed that *E. coli* concentration was higher in Bengkalis coastal waters than that in estuary Bantan Tengah River (Figure 1 and 2). The highest *E. coli*

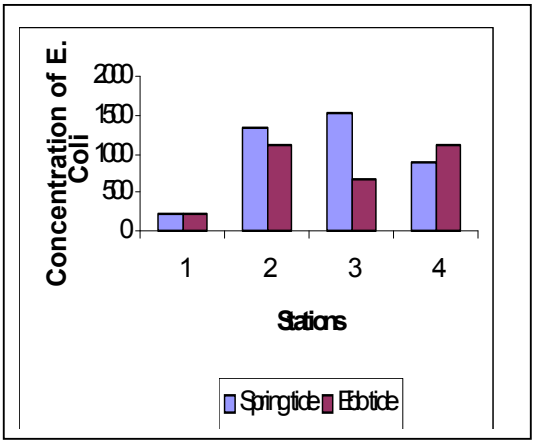

Fig. 1. *E. coli* concentrations at Bengkalis Coastal waters

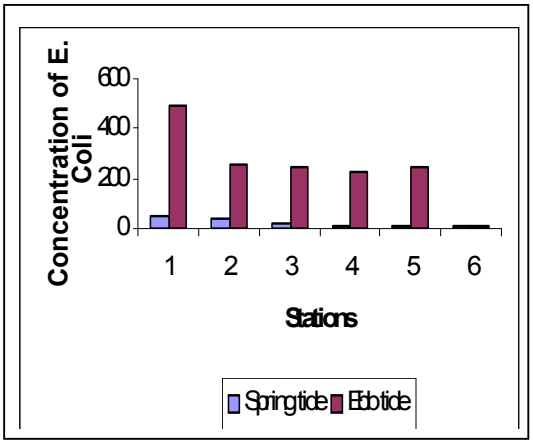

Fig. 2. *E. coli* concentrations at estuary Bantan Tengah River

concentration (1533 cfu/100 ml) was found in station A3 (at spring tide) and the lowest value (6 cfu/100 ml) was observed in station B4, B5 (at spring tide) and B6 (at spring and ebb tides). The highest *E. coli* concentration was mainly caused by the

activities surrounding of commercial port. In addition, this station was close to traditional market and densed settlement area. The second higher *E. coli* concentration was found in station A2 (1320 cfu/100 ml). The area was influenced by wastes of human and poultry in villages along Arang River. *E. coli* concentration at station A4 (887 cfu/100 ml) was lower than that of station A2, due to less of number of population and animal husbandry in the area. The lowest *E. coli* concentration was found in station A1 because the location was far from settlement. The coastal area has been grown by mangrove vegetation such as *Rhizophora* sp. and *Avicennia* sp. Existence of *E. coli* in the waters is due to current and wave movement which distribute the bacteria from other stations.

E. coli concentrations at estuary Bantan Tengah River were higher at the spring tide than those at the Ebb tide. This might be due to input of the bacteria from other area, in addition to input from inland activity. The highest *E. coli* concentration, from this ecosystem was found in station B1 (54 cfu/100 ml and 492 cfu/100 ml at spring and ebb tides). This area was very close to settlement, which may dispose a lot of waste containing bacteria directly or indirectly into the river. River flow at ebb tide could distribute *E. coli* from upstream until to estuarine. This resulted in high *E. coli* concentrations at stations B2 (260 cfu/100 ml), B3 (250 cfu/100 ml), B4 (230 cfu/100 ml) and B5 (242 ml/100 ml). Activity of net-cage culture as it was found at stations B2 and B3, especially feeding, caused accumulation of feed in the bottom. This could accelerate the growth of *E. coli* in the waters. On the contrary, high salinity suppresses the growth, as a low value (6 cfu/100 ml) was found at stations B4 and B5 (at spring tide) and at station B6 (at spring and ebb tides).

Domestic waste enters marine environment primarily as human and animal feces. Coliform, *E. coli* and fecal streptococcus usually occurred numerously in the waste (Schaechter, 1992). Pulau Bulan waters, which was loaded by waste produced from pig farming, contained 0.17 – 0.54 x 10^3 cfu/100 ml of *E. coli* (Silaban, 2001).

E. coli concentration was lower in estuary Bantan Tengah River compared to that in Bengkalis coastal waters. This might be due to mangrove ecosystem that affects the growth of *E. coli*. Tannin produced by the mangrove forest could inhibit the bacterial growth at concentration 10 % and of *Staphylococcus aureus* at concentration 2 % (Yuniarti, 1991).

Comparison ratio of *E. coli*

A ratio of 1 : 45 was obtained at spring tide from the comparison of *E. coli* concentration between at estuary Bantan Tengah River and in Bengkalis coastal waters. Lower comparison ratio (1: 3) was resulted in the comparison of pollution indicator bacteria from the two ecosystems at ebb tide. Those ratios indicated that exposure of coastal waters to living activity could decrease the environment quality, as it was evaluated using *E. coli* as a bacteriological indicator. Comparatively, estuary, which is lightly influenced by inland activities, resulted in less contaminated by the indicator bacteria. Therefore, it can be concluded that inland activity influence pollution level of coastal waters and estuarine.

Effect of Water Quality on *E. coli* Concentration

Nutrient and environmental factors influence the growth and survival of *E. coli* in seawater. The bacteria needs water, carbon, energy and minerals for the growth (Hadioetomo, 1993). Abundance, growth and biochemical reactions of an aquatic

microorganism were influenced by environmental factors (Zobell, 1993). Environmental factors which influence the survival in seawater are physical parameters such as light intensity, water temperature, salinity as well as chemical parameters such as pH and dissolved oxygen (Rheinheimer, 1992).

Visibility of Bengkalis coastal waters and estuarine Bantan Tengah were very low which varied from 0.15 m to 0.61 m. Those values were lower than the standard of seawater visibility as stated for tourism which is > 10 m (MenKLH, 1988). Water visibility affects the life of aquatic organisms (Rheinheimer, 1992). However, sunlight destroys cell membrane of coliform and fecal coliform and inhibits the growth, because these organisms do not posses photosynthetic pigment.

Temperature difference was not too significant between the two ecosystems (± 1^{o}C), that varies from 28^{o}C to 30^{o}C. *E. coli* includes in mesophilic bacteria, which grows in range of temperature 15 – 50^{o}C, and grows well at 25 – 40^{o}C.

Water salinity determines living community. *E. coli* is tolerant to salt, and is found in large or low number in all inland waters. However, it is found in larger number in sewage and river and lake heavily contaminated (Rheinheimer, 1992). Junidar (1996) observed that number of fecal coliform in estuary Dumai River decreased as salinity increased.

Range of pH in Bengkalis coastal waters were from 6.0 to 7.0. The values are appropriate for the growth of *E coli*, that the range of pH was 4.4 – 9.0 and the optimum pH values were from 6.0 to 7.0 (Lay and Hastowo, 1992). Similar condition was found estuary Bantan Tengah River. However, pH values in station B6 was higher than others, which were 7.3 – 7.5. The values are lightly higher than the optimal pH for the growth, this might result in low number of *E. coli* in station B6.

Concentration of dissolved oxygen (DO) did not influence the growth of *E. coli* in waters, because coliform and fecal coli are facultative anaerobic, which can grow in the presence or absence of oxygen.

CONCLUSIONS

Escherichia coli concentration was higher in Bengkalis coastal waters than at estuary Bantan Tengah River. In Bengkalis coastal waters, the average value was found higher at spring tide than that at ebb tide. On the contrary, the average value in estuary Bantan Tengah River was higher at ebb tide than that at spring tide. The comparison ratio of *E. coli* between the estuary and coastal waters was 1: 45 at spring tide and 1: 3 at ebb tide.

E. coli concentrations in estuarine Bantan Tengah were lower than standard quality for marine biota or mariculture based on MenKLH (1988) which is < 1000 cells/100 ml. However, higher values than standard quality (<1000 cells/100 ml) for tourism (bathing, swimming, diving) were found in Bengkalis coastal waters.

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