# A Preliminary Physico-chemical Parameter Study of Southern Johor Straits for Microbial Activities

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ABSTRACT

Coastal marine systems are highly dynamic systems which are characterized by periodic fluctuations in environmental parameters. Microbial activities play critical roles in the remineralization of nutrient and primary production in coastal especially intertidal systems. Many of the biological and physico-chemical processes which are mediated by microorganisms occur within microenvironments which can be measured over micrometer spatial scale. This paper emphasised that the influences of physico-chemical fluctuations within coastal systems were addressed in the understanding of small-scale microbial activities.

**Keywords:** Physico-chemical parameter; marine microorganisms

## Introduction

Physical and chemical environment affect directly and indirectly microorganisms activities and function in the marine ecosystem. Sulphate, organic matter concentrations, pH, temperature, salinity, BOD, COD, sedimentation rate and other parameters are the main environmental factors controlling the numbers and distribution of microorganisms (Jorgensen, 1982; Westrich & Berner, 1988).

The marine environment supports a wide range of microorganisms. Surfaces placed in the sea rapidly absorb bacteria, algae and protozoa. The surfaces appear to provide nutrient sinks which enable diverse microbial communities to develop and maintain themselves at high population densities (Marshall, 1992). In natural conditions attached microorganisms are active in nutrient recycling and other essential metabolic processes such as biochemical oxygen demand ($BOD_5$) and chemical oxygen demand (COD) in the ocean.

Microorganisms have important and established roles which may affect large-scale changes within the coastal area especially at intertidal systems. Heterotrophic bacteria, for example, are crucial to the transformation of organic carbon, concentration of oxygen and other physical parameters throughouts oceans (Azam, 1998). Although the net effects of microbial processes could be measured over a range of spatial and temporal scales, most microbial processes are generated within microenvironments having spatial scales, measured in micrometers which are influenced by the surrounding physico-chemical parameters (Krembs et al., 1998).

The objective of this study was to view a physical and chemical information obtained from 6 coastal areas of Southern Johor Straits. The findings are discussed in relation to some of physical and chemical parameter to microbial distribution and survival.

## Materials and Methods

Seawater samples and physical parameter were determined from six stations located in different part of southern Johor Straits. The locations of sampling stations are presented in Figure 1. Pre-sterilised, small-mouth 25 litre capacity polypropylene bottles were used to collect water samples from a 30 cm depth into the water column. Composite samples (three replications) were taken at each sampling site to give a good representation of each site.

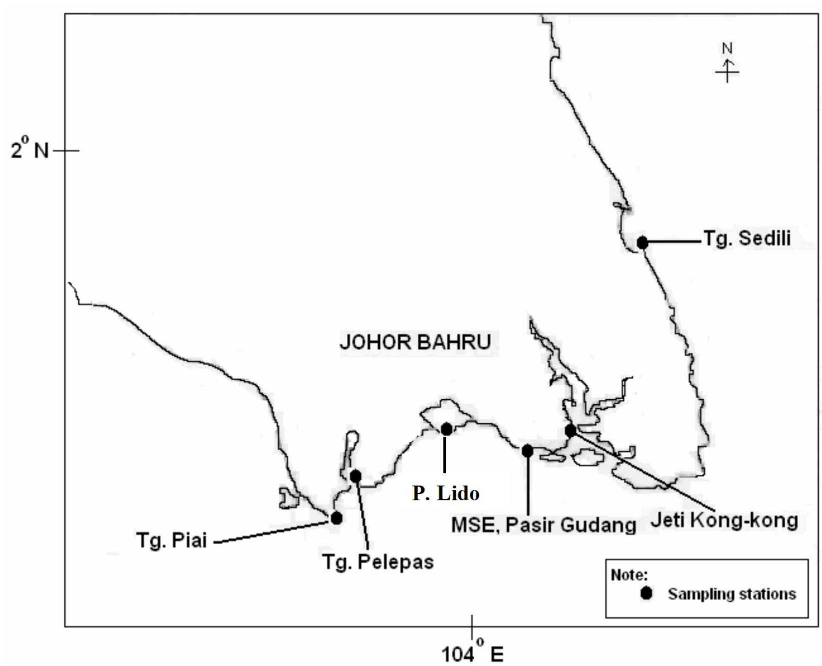


FIGURE 1: Map of the Study Area at the Southern Malaysia Peninsular with Sampling Stations

Samples were stored in a cool room upon collection and analysed within 24 hours of collection. Water temperature, pH, conductivity, DO and salinity were determined in the field by means of a water checker (model U-10). The BOD and COD of samples were analysed as described below.

## Determination of Biochemical Oxygen Demand (BOD)

The $BOD_5$ is the amount of dissolved oxygen in the water sample used by micro-organisms during a breakdown of down organic material over a five day period at 20°C. In this study, collected of seawater sample within 24 hours was diluted in oxygen saturated water or seeded water (sparged with air) and placed in an air-tight bottle. The concentration of dissolved oxygen was measured oxygen during coolection and after 5 days of incubations. The difference in DO between day 0 and 5 for both samples and blank was used to calculate the $BOD_5$. The standard test used a 300 ml BOD bottle and incubation was performed at 20°C over five days in the dark. $BOD_5$ is expressed as follows:

$$\mathrm{BOD}_5 = p[(DO_i - DO_f) - (B_i - B_f)\,f\,] \quad (1)$$

where

$p$ = dilution factor
$DO_i$, $DO_f$ = initial and final DO concentrations of seeded diluted water (sample)
$B_i$, $B_f$ = initial and final DO concentrations of seeded diluted water (blanks)
$f$ = ratio of seed DO in sample to seed in blank

$$= \frac{\%\text{ seed in } DO_i}{\%\text{ seed in } B_i}$$

## Determination of Chemical Oxygen Demand (COD)

The COD test measured the total organic carbon in the sample, with the exception of some aromatics such as benzene which were not oxidised in the reaction. The test determined the amount of oxygen needed to chemically oxidise the organics in seawater. Potassium dichromate in an acid solution was used as a strong oxidising agent to oxidise the organics. The procedure for COD analysis was as given in the Standard Methods (Kiely, 1998). The value of COD was calculated according to the following expression:

$$\text{COD (as a mgO}_2\text{/L)} = \frac{A \times (B \times df) \times M \times 800}{\text{mL sample}} \quad (2)$$

where

A = mL of the (FAS, standard ferrous ammonium sulphate) used in blank
B = mL of the FAS used in sample
M = molarity of the FAS
$df$ = dilution factor

# Results and Discussion

Seawater samples from a number of six within the coastal areas of Southern Malaysia Peninsular were collected and their characteristics were analysed based on the parameters presented in Table 1. The location of these sites are shown in Figure 1. The physicochemical characteristics of seawater collected from these sites would commonly be used to indicate the nature of indigenous microorganism inhabiting in areas of the respective sites

TABLE 1: Characteristics of Seawater Collected from Various Sites in the Coastal Area of Johor

| Location / Parameters | Tg. Piai | Tg. Pelepas | Pantai Lido | Jeti Kong-kong | Tg. Sedili | MSE, Pasir Gudang |
|---|---|---|---|---|---|---|
| pH | 8.56 | 7.49 | 7.72 | 7.25 | 8.14 | 8.67 |
| Temp. ($^oC$) | 31.8 | 29.2 | 30.9 | 30.2 | 30.2 | 30.3 |
| Salinity (%) | 16.1 | 19.0 | 12.5 | 16.8 | 20.5 | 37.0 |
| DO (mg/L) | 4.60 | 5.74 | 4.54 | 5.54 | 5.56 | 9.56 |
| Conductivity (mS/cm) | 27.9 | 30.5 | 21.1 | 27.0 | 24.6 | 60.3 |
| Turbidity | – | – | – | 2.0 | – | 3.0 |
| $BOD_5$ (mg/L)) | 52.90 | 55.3 | 44.0 | 60.7 | 78.6 | 58.3 |
| COD (mg/L) | 247.9 | 281.9 | 257.6 | 267.3 | 262.4 | 273.8 |
| $BOD_5$/COD | 0.21 | 0.20 | 0.17 | 0.22 | 0.30 | 0.21 |

The pH is a measure of the hydrogen ion concentration in the marine ecosystem. The pH is an important parameter due to the narrow range of pH suitable for most biological life. Low pH value may inhibit the growth of certain microorganisms and give advantages for others. Most bacterial were not capable of tolerating pH above 9.5 or below 4.0. Generally, the optimum pH for growth of marine bacteria lies between 6.5 and 7.5 and the pH between 6.8 to 8.5 for microorganisms in open seawater (Sincero and Sincero, 1996). The pH of the sampled seawater ranged from 7.25 (Jeti Kong-kong) to 8.67 (MSE, Pasir Gudang), indicating that the variations in pH seawater also remained within narrow limits.

The environmental temperature is directly related to the ability of the organisms to function. However, many microorganisms grow better at temperatures ranges from 10 to 20$^oC$ above the environmental temperature from which they were isolated. During the study, the temperatures was recorded ranged from 29.2 $^oC$ (Tanjung Pelepas) to 31.8 $^oC$ (Tanjung Piai) were recorded. The study beingdone during the sunny days which could cause high mean spatial temperature ranges. The sea surface conductivity ranged between 21.1 to 60.3 mS/cm at the Southern Malaysia Peninsular. Conductivity of seawater may cause a large distance between anode and cathode in electrochemical reaction (Gubner and Beech, 1996). Dissolved oxygen values recorded were relatively high, i.e. ranges from 4.54 mg/L (Pantai Lido) to 9.56 mg/L (MSE, Pasir Gudang).

Seawater is for the bacterial species of an environment, which is uniquely constant with respect to its ionic composition. Marine bacteria require ions in marine waters to maintain proper membrane functions; for example, sodium and chloride are required for active transport. Those organisms indigenous to the sea not only have the capacity to function and to grow in this habitat but many also show an obligate adaptation to their salinity. Salinity values ranged from 12.25% at Pantai Lido to 37.0 at MSE, Pasir Gudang. Salinities of marine habitats are normally in the range of 33% - 37%, with an average of 35% (Ross, 1970). Salinity was implicated from the salt contained in the seawater particularly for sodium chloride. Chloride in seawater will increase the critical concentration for accelerated localised corrosion attacks on metals.

The organic content of the seawater ecosystem characterised based on the biochemical oxygen demand ($BOD_5$), the chemical oxygen demand (COD), and the ratio of the COD to the $BOD_5$. The $BOD_5$ test measures the biodegradable organic carbon and, under certain conditions, the biologically oxidisable nitrogen present in the wastewater. The $BOD_5$ is the quantity of oxygen required for the stabilisation of the oxidisable organic matter present after five days of incubation at 20 °C. The oxygen consumed in the $BOD_5$ test is the sum of (i) oxygen used for the biodegradation of the organic matter for energy and biosynthesis of new cell, and (ii) endogenous respiration of the microbial cells (Eckenfelder, 1989). Table 1 shows that the average BOD value of the seawaters ranged from 44.0 mg/L at Pantai Lido to 78.6 mg/L at the Jeti Kong-Kong, Masai.

In this study, the content of organic compounds in the seawater was determined by the value of COD and $BOD_5$. Based on the individual value of $BOD_5$ and COD, the quality of water did not comply with the standard proposed by DOE (Department of Environment). The high COD and BOD values indicated the high content of organic compounds in the sample. However the organic contents in the seawater were found to be non biodegradable as indicated by the values of $BOD_5$/COD ratios which were generally less than 0.3 (Table 1). The COD measure of total organic contents in the seawater, which were chemically oxidised (Eckenfelder, 1989). On the other hand, the $BOD_5$ measured the amount of oxygen consumption by microbes for the degradation of organic compounds in the seawater within five days at 20°C (Kiely, 1998).

The $BOD_5$/COD ratio frequently varied for open seawater compared with polluted areas. The $BOD_5$ /COD ratio as shown in Table 1 ranged from 0.17 at Pantai Lido to 0.30 at Tanjung Sedili. The values generally differed only slightly amongst the study areas. The lowest values of $BOD_5$ /COD ratio obtained for the sample from Tanjung Sedili indicated that the water quality in this area was relatively better compared to other areas studied. The values of $BOD_5$ /COD ratio showed in Table 1 could conclude that Tanjung Sedili was the least polluted area while Pantai Lido was the most polluted area.

## Conclusions

The physicochemical characteristics of seawater would commonly be used to indicate the nature of indigenous microorganism inhabiting in the areas of the respective sites. In conclusion, all seawater samples analysed showed similar results for all parameters except those for conductivity and dissolved oxygen (DO) concentration which were approximately two to three times higher in the area of MSE Pasir Gudang.

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