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INITIAL STUDY ON BACTERIAL COUNT FOR TWO BEACHES IN PENINSULAR MALAYSIA

MUHAMMAD AIZUDDIN, M. Z.*, NUR FARAH AQILAH, Z., AND FAUZIAH, S. H.

Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur.

**Corresponding author: aizuddinzailani@yahoo.com*

Abstract: Studies on marine bacteria have revealed that, microbes essentially influence the ocean proficiency to sustain life on earth. However, in order to meet the demands of the tourism sector, rapid development has been done in the coastal area. As a result, many natural habitats and marine life being affected including marine bacteria which are also a key factor in ensuring the stability of the marine ecosystem. Thus, this study was conducted to examine how marine bacteria were affected by coastal development in Peninsular Malaysia by comparing the bacterial counts between developed and undeveloped beach. At the same time, considering the effects of coastal development on marine ecosystem. Triplicates water samples at several sampling points were collected from Teluk Kemang Beach, Negeri Sembilan (developed) and Pandak Beach, Terengganu (undeveloped) for analysis. By using the Plate Count Agar (PCA), total count method was adopted to determine the bacterial counts. Physico-chemical such as dissolve oxygen (DO), pH, temperature, salinity and nutrients concentration was evaluated to assess their relationship with the bacterial counts. It was found that, bacterial count at Teluk Kemang was recorded lower than that of Pandak beach with 1.13 ± 0.48 x 10^8 CFU/ml and 2.55 ± 0.49 x 10^8 CFU/ml respectively. This is due to poor water quality at developed beach such as Teluk Kemang compared to Pandak beach. Since bacterial counts were significantly correlated with water qualities mainly DO and ammonium in this study (correlation coefficient, $r > 0.5$), thus it can be concluded that, bacterial counts at developed beaches were negatively affected due to disturbed seawater quality.

KEYWORDS: Water quality, anthropogenic activity, coastal.

Introduction

In marine environment the existence of microorganisms are very diverse in terms of their population and species. The diversity of bacteria leads to the variety of their roles in the marine ecosystem (Munn, 2011, USEPA, 2010, Breitbart, 2012) such as the agent for nutrient cycling (Munn, 2011) and degrading and bioremediation (Hailiang *et al.*, 2010). The balance in population of these microorganisms is also an important part in the large food web (Munn, 2011). Thus, many seawater bacterial groups have been manipulated for commercial or industrial used (Breitbart, 2010). However, the growth of this group was very complex and dynamics that favours in-depth study for better understanding (Jannasch, 1967 and Krause *et al.*, 2012). In most cases, different coastal region will show different bacterial abundance and population (USEPA, 2010). The reason for this is because certain costal region exerted different condition of physico-chemical characteristic of seawater the mainly oxygen level (Falkowski, 2012, Ratkowsky *et al.*, 1982, Wetzel, 2001) and nutrient concentration (Munn, 2011, Hailiang *et al.,* 2010, Krause *et al.*, 2012).

As in the case of Peninsular Malaysia, huge parts of its coastal region have been developed and commercialized to fulfil the need in tourism industry. This has attracted high anthropogenic activity which in turn affects the seawater quality (Krause *et al.*, 2012). As discussed earlier, this condition will also influence bacterial growth and cause imbalance in marine ecosystem (Talley, 2000). Thus, this study was conducted to see the effects of coastal development towards marine bacteria by comparing the bacterial counts between

developed and undeveloped beach, while considering several factors such as physico-chemical parameter and anthropogenic activity. So, bacterial counts were used to represent the abundance of bacteria at the sampling site. It was expected that bacterial count at developed beach was lower than undeveloped beach.

Methodology

For the purpose of the study, the consecutive activities were carried out:

Sampling – The water samples were collected in triplicates at several points along the selected Teluk Kemang Beach, Negeri Sembilan to represent the developed beach and Pandak Beach, Terengganu to represent the undeveloped beach. Water samples were preserved in ice box prior to laboratory analysis. In this study, it involved 3 times sampling while considering monsoon.

Bacterial count – Total count method was adopted to obtain the marine bacterial count. So, 100 ml samples were filtered and the filter membrane was inoculated into normal saline solutions for 3 hours incubation time. After that, the samples were diluted and inoculated onto media known as Plate Count Agar (PCA) with addition of 5% sodium chloride (NaCl) solutions. All plates were observed and bacterial counts were recorded after incubation at 32 ± 1 ^{o}C for 18-24 hours.

Physico-chemical of seawater – In-situ measurements were carried out for physical parameters of seawater such as temperature, and dissolved oxygen (DO) using multiprobe (YSI Pro-plus Handled Multiparameter). Nutrient analysis such as ammonium, were carried out upon reaching the laboratory by using the spectrophotometer. Total suspended solid (TSS) was measured by drying the pre-washed membrane filter at 105 ^{o}C for 1 hour and weighed. 100 ml sample were filtered through filtration unit and the filter membrane was fried in an oven for 1 hour at 105 ^{o}C. Upon completing the drying process, filter paper was weighed and TSS was calculated.

Baseline study – The physical conditions of the study area such as the presence of sewer, constructions activity, hotel, resort and anthropogenic activities which occur at the beach were also observed and recorded.

Results and Discussion

From bacterial count, it was found that both beaches show different bacterial abundance. Teluk Kemang beach recorded 1.13 ± 0.48 x 10^{8} CFU/ml of bacterial abundance which is lower compared to Pandak beach which is 2.55 ± 0.49 x 10^{8} CFU/ml (Figure 1).

This trend followed the hypothesis in which developed beaches such as Teluk Kemang will show low bacterial counts compared to undeveloped beaches (Pandak beach). From this data, it was suspected that, seawater quality at Teluk Kemang have been interfered due to the developing activities and affect the bacterial abundance. In Figure 2, it can be seen that DO and ammonium show a huge difference between these two beaches. DO was recorded lower at Teluk Kemang beach compared to Pandak beach, with 4.71 ± 0.50 mg/L and 6.36 ± 0.92 respectively. For ammonium, it was also recorded higher at Teluk Kemang beach (0.22 ± 0.02 mg/L) compared to Pandak beach, which was as low as 0.05 ± 0.01 mg/L (Figure 2).

The Malaysian Department of Environment (DOE) have set 5 – 7mg/L as a standard for DO and 0.04 – 0.05 mg/L for ammonium in seawater. When this data were compared with both beaches it was found that DO and ammonium at Teluk Kemang did not follow the standard. As suspected earlier, this data proves that the water quality at Teluk Kemang beach was interfered. Studies by Kemker (2014) and Pytan (2006) explain DO in seawater will be reduced if the suspended particles were very high in seawater. This is because the particles will absorb more heat and increase seawater temperature. Since warmer water cannot hold as much oxygen, the DO will drop (Todd, 2004). Thus, TSS was measured and recorded as in Figure 3.

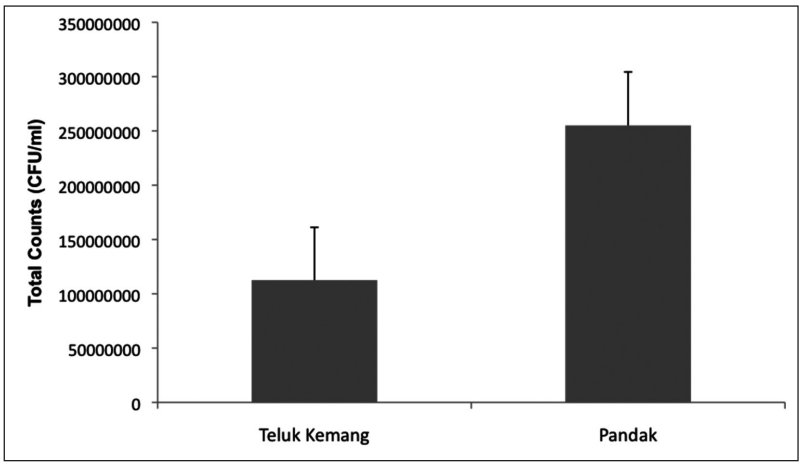

Figure 1: Bacterial Abundance (CFU/ml) at Teluk Kemang and Pandak Beach

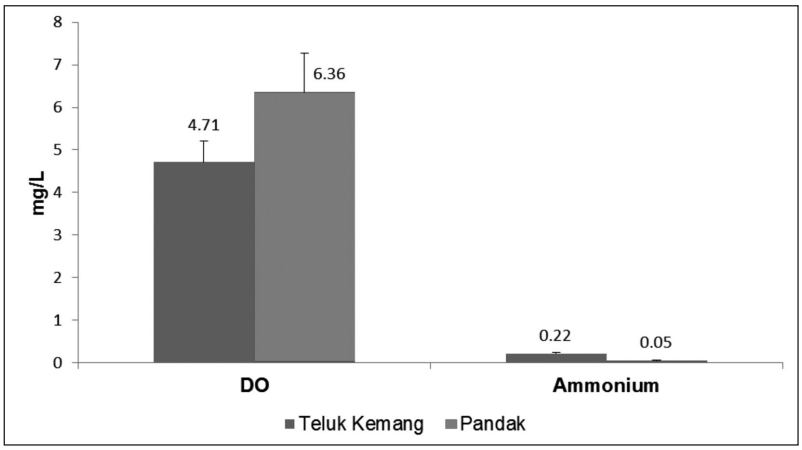

Figure 2: Dissolved Oxygen and Ammonium (mg/L) at Teluk Kemang and Pandak Beach

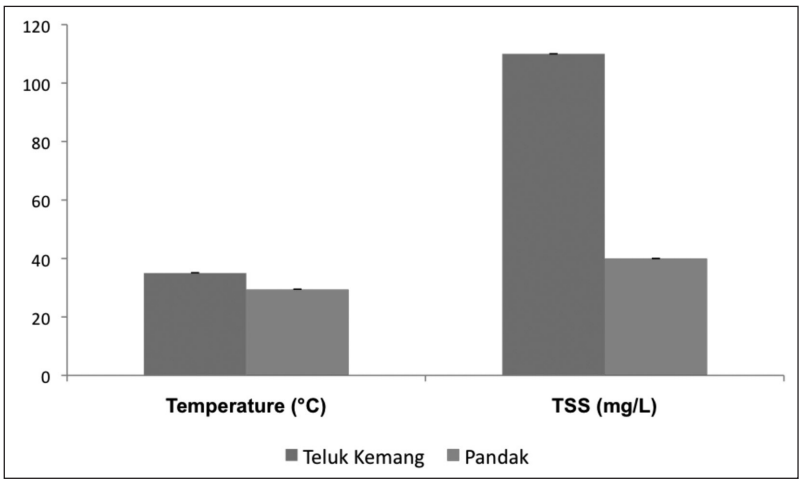

Figure 3: Temperature (°C) and TSS (mg/L) at Teluk Kemang and Pandak Beach

High TSS was observed at Teluk Kemang (110 mg/L) compared to Pandak beach (40 mg/L). In addition the temperature at Teluk Kemang was also recorded higher than Pandak beach with 35 ^{o}C and 29.4 ^{o}C respectively. This findings was parallel with Kemker (2014) and Paytan (2006), since a lot of development and commercialization have taken place at Teluk Kemang, it receives high tourist attraction. As a lot of constructions and activities contact with water such as picnic, boating and bathing occurs, it will introduce particles into seawater and increase the TSS. As mentioned earlier, high TSS will increase the seawater temperature resulting in lower DO in Teluk Kemang. Too much existence of hotels, chalet and restaurants at Teluk Kemang has led to illegal sewage discharge. Most of the hotels and restaurants discharge their sage directly to the open seawater. This situation was suspected to the major source of high ammonium in seawater at Teluk Kemang instead of anthropogenic activity. High amount of ammonium can lead to algal bloom which provides unpleasant environment for bacteria to grow in limit oxygen supply. As a result bacterial number tends to be lower.

Compared to Pandak beach, the beaches are still not to be disturbed by major development and commercialization, thus very low anthropogenic activity were observed including the weekend. Most of the parameters measured such as DO, ammonium temperature and TSS followed the standard set by DOE. So this will create optimum environment for bacterial to grow and aid in balancing marine ecosystem. This is also supported by the correlation analysis for DO and ammonium with bacterial abundance at both beaches. Both DO and ammonium show strong correlation with bacterial abundance at Teluk Kemang beach with coefficient r = 0.6051 and r = 0.8928 respectively. This is also the same with Pandak beach, strong correlation were also shown by DO (r = 0.9178) and ammonium (r = 0.8560) with bacterial abundance. Thus, it explains that, beach development can harm seawater quality which influences bacterial growth.

Conclusion

By comparing these two beaches, it was found that beach development and commercialization has created disturbance towards seawater quality. Development of beaches attract more tourists which in turn affect the water quality through their activities. Poor water quality provides unfavourable condition for bacterial to increase its number. Thus, low bacterial count was observed at developed beaches compared to undeveloped beaches.

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