

The effect of Sunlight Exposure on the survival of *Escherichia Coli* in Dredged Marine Soils

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Abstract

A detailed knowledge on the survival of fecal indicator is essential before the dredged marine soil being reused. Microcosms studies have been carried out to find out the relative survival of *Escherichia Coli* (*E. Coli*) in dredged marine soils. Survivals of *E. Coli* were carried out using dredged marine soils collected at Semerak Lagoon, Tok Bali, Kelantan. The experiment was conducted in the flask filled with dredged marine soils and exposed to natural sunlight for 4 hours. Temperature was ranging between 28°C and 35°C. Experiment in the dark was conducted to isolate the effect of sunlight radiation from the other factors, also to determine the effect temperature on the survival of *E. Coli*. The variability of *E. Coli* survival due to the effect of natural sunlight was shown to depend on the variability of the temperature. It is noted that the natural sunlight radiation was found to be one of the factors affecting the survival of *E. Coli* in dredged marine soils.

Keywords: *Escherichia Coli*, dredged marine soils, sunlight exposure, survival

Introduction

Rapid development have resulted in increasing load of waste input into the coastal water. As a result, numbers of pathogenic bacteria enter into the marine environment whereupon contribute to the fecal pollution (Abirosh & Mohamed, 2005). As a result, the survival of *E. Coli* as indicators of fecal pollution in marine environment has been of interest to public health (Dionisio et al., 2000).

In recent years research focused on determining the survival of bacteria under several environmental factors such as sunlight radiation, temperature, salinity, pH and turbidity (Schultz- Fademrecht et al., 2008). It is widely recognised that inactivation of bacteria which incorporate with natural sunlight radiation are more efficient than those that do not (Mayo, 1995). Evidence from a similar field study revealed that sunlight radiation has an effect on the survival of bacteria released into the marine environment (Hughes, 2003). However, there is gap knowledge about the mechanism of sunlight action and its interaction with other environmental factors.

Currently, little information is known about the survival rates of *E. Coli* in dredged marine soils under the exposure to natural sunlight radiation (Hughes, 2005). The present study was conducted to collect information on the survival of *E. Coli* in dredged marine soils in both with and without presence of the natural sunlight radiation, and the relative of one environmental factors at a time.

Materials and Methods

The experiments were conducted with the marine soils, collected during dredging work at Semerak Lagoon, 15 km from Pasir Putih Township (Figure 1). The samples were placed in sterilized container and kept in chilled polystyrene box. The samples were transferred to the laboratory and kept at 4° C prior to analysis.

E. Coli were isolated from the dredged marine soils using streak plate technique. An inoculum was prepared by transferring a loopful of isolated *E. Coli* into Tryptic Soy Broth (TSB) and incubated for 18 hours at 37°C. 1 ml of culture was delivered into 20 g of sterilized marine soils. Enumeration of culturable bacteria was using spread plate technique. The selective media used to enumerate *E. Coli* was Chromocult Agar (CCA). Salmon to red colonies of *E. Coli* were counted after incubation for 24 hours at 37°C and been reported as in Colony Forming Unit per milliliter (CFU/ml).

The dredged marine soils were transferred into sterilized Erlenmeyer Flasks and were exposed to centre at solar noon for sunlight exposure. The experiment was starting from 11 am until 3 pm due to the greatest increased of accumulated light energy which occurred between 4 – 8 h after sunrise (William Burkhardt III et al., 2000). The dark control experiment was conducted to estimate the influence of sunlight on the *E. Coli* survival in the dredged marine soils. The flask wrapped using 3 layers of aluminium foil to prevent the penetration of sunlight radiation (Alonso – Sáez et al., 2006). The flasks were put in the water bath to maintain in situ temperature at 30°C. After the sunlight exposure at 0, 60, 120, 180 and 240 min, the subsamples for both experiments were taken to immediately enumerate the concentration of *E. Coli*.



Figure 1: Sampling sites of Semerak Lagoon, Tok Bali, Kelantan

Results and Discussion

The results are presented in Figure 2. The wide range of bacteria counted number is the outcome of simultaneously effects of several environmental factors on bacterial culturability (Maalej et al., 2003). For this reason, this studies analysis the relationship between single independent variable and dependent variable at a time. The loss of bacteria culturability

cannot be equated with its death (Roszak & Colwell, 1987). Therefore, interpreted number of bacterial in this study signifying only the organism was damaged.

The results indicated a rapid decline in number of *E. Coli* that survive in dredged marine soils with the presence of sunlight within 60 minutes exposures. Towards the later stages of the experiment, *E. Coli* showed some increasing level starting at after 120 minutes, and did not show any further reduction. The finding is in agreement with the observations by Abirosh Chandran et al. (2005) revealed a better survival capacity of *E. Coli* under sunlight radiation after 6h exposures. The observations agree with findings of Sieracki and Sieburth (1986) and Rhodes and Kator (1990) who observed higher mortality during the first 4h of the exposures to the natural sunlight radiation.

The importance of sunlight radiation in the survival of *E. Coli* has been demonstrated in the experiment without sunlight radiation. In this experiment, the reduction of *E. Coli* in the dredged marine soils were slightly lower than those measured in the presence of sunlight. Hence, the action of sunlight in the survival of *E. Coli* can be modified by other factors including the temperature. The influence of temperatures showed inversely proportion pattern with the number of *E. Coli* within period of exposures. The results of this experiment are given in Figure 3. The number of *E. Coli* were decreased with increased of temperature. In contrast, this result was inconsistent with the studies by Davis-Colley et al. (1999) that report the kinetic inactivation of *E. Coli* were weakly affected by the temperature.

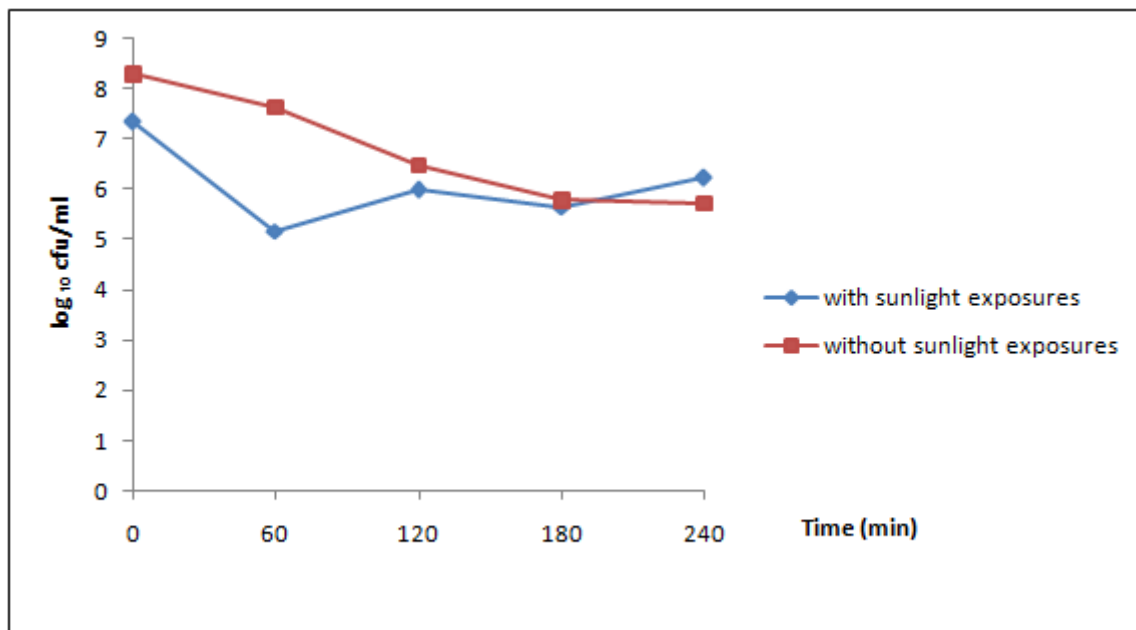


Figure 2: Relative survival curves of *E. Coli* in dredged marine soils with and without presence of sunlight

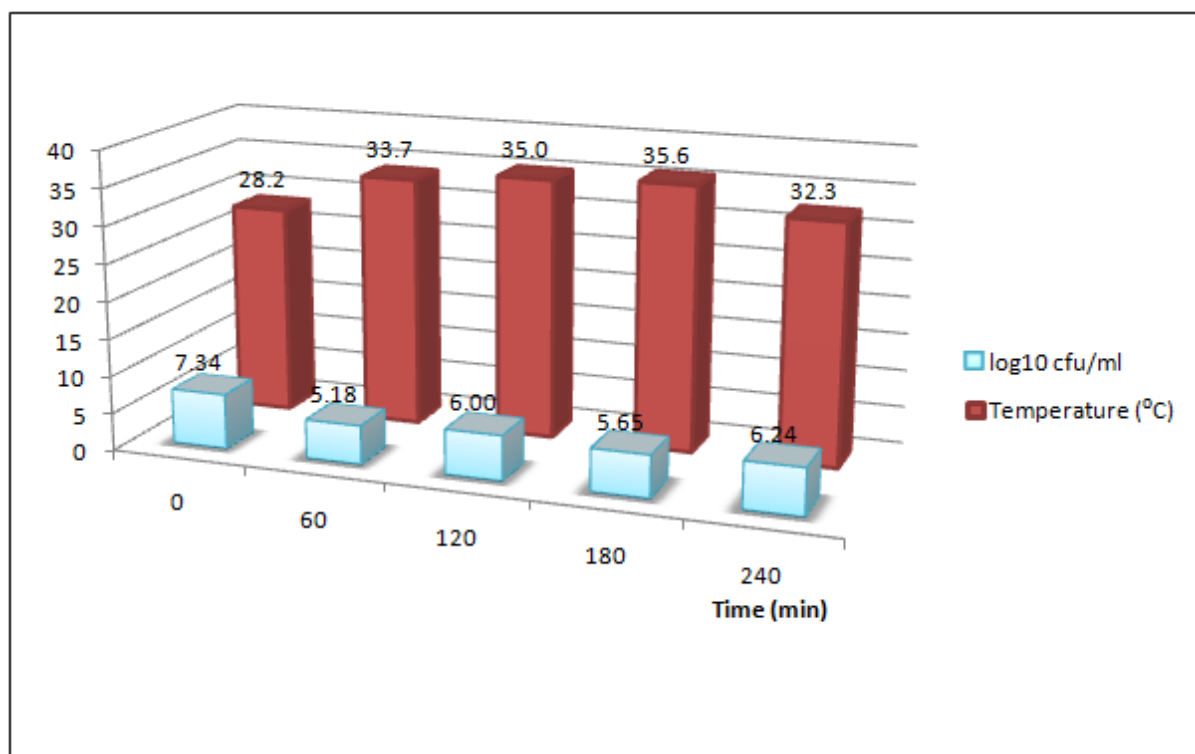


Figure 3: Temperatures effects on the survival of *E. Coli* in dredged marine soils with the presence of sunlight

Conclusion

The results of present studies revealed that sunlight is one of the most important factors in survival of *E. Coli* in dredged marine soils. This finding indicated better survival ability of *E. Coli* in the dredged marine soils without presence of sunlight. These result obtained in this study, at least explained the relationship between independent variable which is temperature and dependant variable as in natural sunlight exposures at a time. With regard to the result, by identifying the factors that affecting survival of *E. Coli*, it will be tested in the treatment of the dredged marine soils for potential reused material.

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References

- Abirosh Chandra, A.A., & Mohamed, H. 2005. Relative survival of *Escherichia Coli* and *Salmonella typhimurium* in a tropical estuary. *Water research*, 39, 1397-1403
- Alonso- Sáez, L., Gasol, J.M., Lefort, T., Julia, H., & Sommaruga, R. 2006. Effect of natural sunlight on bacterial activity and differential sensitivity on natural bacterioplankton groups in Northwestern Mediterranean coastal waters. *Applied and environmental microbiology*, 72, 5806 – 5813

- Burkhardt III, W., Calci, K.R., Watkins, W.D., Rippey, S.R., & Chirtel, S.J. 2000. Inactivation of indicator microorganisms in estuarine waters. *Water research*, 34, 2207 – 2214
- Davis-Colley, R.J., Donnison, A.M., Speed, D.J., Ross, C.M., & Nagels, J.W. 1999. Inactivation of faecal indicator microorganisms in waste stabilisation ponds: interactions of environmental factors with sunlight. *Water research*, 33, 1220-1230
- Dionisio, L.P.C., Joao, M., Ferreira, V.S., Fidalgo, M.L., Garcia Rosado, M.E., & Borrego, J.J. 2000. Occurrence of *Salmonella* spp in estuarine and coastal waters of Portugal. *Antonie van Leeuwenhoek*, 78, 99-106
- Huges, K.A. 2005. Effect of Antarctic solar radiation on sewage bacteria viability. *Water research*, 39, 2237 - 2244
- Hughes, K. 2003. The influence of seasonal environment variables on the distribution of presumptive fecal coliforms around an Antarctic research station. *Applied environmental microbiology*, 69, 4884-4891
- Maalej, S., Mahjoubi, A., Elazri, C., & Dukan, S. 2003. Simultaneous effects of environmental factors on motile *Aeromonas* dynamics in an urban effluent and in the natural seawater. *Water research*, 37, 2865-2874
- Mayo, A.W. 1995. Modelling coliform mortality in waste stabilisation ponds. *Journal environmental engineering*, 121, 140-152
- Rhodes, M.W., & Kator, H.I. 1990. Effect of sunlight and autochthonous microbiota on *Escherichia Coli* survival in an estuarine environment. *Curr. Microbiology*, 21, 67-73
- Rozsak, D.B., & Colwell, R.R. 1987. Survival strategies of bacteria in the natural environment. *Microbiological reviews*, 51, 65 – 79
- Schultz-Fademrecht, C., Wichern, M., & Harald, H. 2008. The impact of sunlight on inactivation of indicator microorganisms both in river water and benthic biofilms. *Water research*, 42, 4771-4779
- Sieracki, M.E., & Sierbuth, J.M. 1986. Sunlight induced growth delay of planktonic marine bacteria in filtered seawater. *Marine ecology progress science*, 33, 19-27