Water quality and shellfish related gastrointestinal disease cases in Kota Bharu, Kelantan, Malaysia

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Abstract

The sampling of river water and shellfish was conducted three times between 26 February and 20 March 2006 at Sungai Ketereh, Kota Bharu Kelantan. Three sampling stations were identified for water quality and shellfish sampling. The objective of this study is to determine the correlation between water quality, shellfish tissue contaminations and the cases of gastrointestinal diseases in Kota Bharu. There are two stages of shellfish sampling, the first stage was raw "etak" from the riverbed and the second stage was processed "etak". Shellfish was sent to the bacteriology laboratory of the Fisheries Research Institute located in Batu Maung, Penang and water quality analysis was performed by an accredited laboratory. Meanwhile, data on the gastrointestinal disease cases was obtained from the Department of Health, Kota Bharu. The results have shown that, fecal coliform concentrations in the river water recorded was between 214.20-721.50 MPN/100ml (up-stream), 249.50-791.50 MPN/100ml (middle section) and 277.80-574.80 MPN/100ml (down-stream). On the other hand, the bacterial contamination in raw *C. fluminea* or "etak" was found to be higher and the concentration recorded was between 2,450 - 75,000 MPN/100g (up-stream), 1,550-151, 500 MPN/100g (middle section) and 1,200 - 49,000 MPN/100g (down-stream). This was believed due to the filter feeding habit of the shellfish where the pollutants get accumulated in the tissues. The fecal coliform concentrations in processed "etak" tissues was also high in some batches while absent in some of them, and this was believed to be due to the period of smoking process. The longer the smoke the more effective is the elimination of bacteria. Nine (9) samples were analyzed, four (4) of them contaminated with bacteria. The number of bacteria detected in the processed "etak" ranged from 325 MPN/100g to 5,125 MPN/100g. The data obtained on the incidence of gastrointestinal disease from 1998 to 2004 in Kota Bharu district showed that acute gastroenteritis was the highest number of cases recorded ranging from 2500 to 4000 cases per year and this was believed to be due to the consumption of "etak". The results revealed a positive correlation between river quality, shellfish and incidence of gastrointestinal disease in Kota Bharu.

Keywords: *Gastrointestinal; water quality; Ketereh river; shellfish; fecal coliform*

Introduction

Shellfish, or to be specific freshwater mussels or scientifically called *Corbicula fluminea* was one of the faunal filter feeders (Chinabut, *et al.*, 2006; Carlos, *et al.*, 2002; Sarah, *et al.*, 2001). *C. fluminea*, known as 'etak' in the Kelantan dialect, can be found living in the sandy bottom of Kelantan's main river and the other rivers including tributaries. This particular mussel species has become another source of economic activity where the 'etak' is traded either in the fresh and raw form or marinated and smoked before selling them as a snack food. River pollution mainly through untreated sewage and the improper way of preparing 'etak' was the major factors contributing to bacterial contaminations and thus was suspected as the primary cause of gastroenteritis (Thaddeus and Schwab, 2000; Edward and Hunt, 1982). For consumption, 'etak' was usually prepared by smoking and sun drying and therefore can be regarded as half cooked. The source of bacteria contamination normally comes from the untreated and half treated sewage discharge

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from the municipality area and including the wet markets (Department of Environment, Kelantan, 2003). Much of the fresh water was grossly polluted by the discharge of sewage and industrial effluents into the rivers (Formiga-Cruz, *et. al.*, 2002;) and *aeromonas hydrophila* has been recognized as the potential cause of food-associated gastroenteritis outbreaks (Carlos and Wekell, 2007).

Materials and Methods

Study Site. The study area is the Sungai Ketereh in Kota Bharu, which flows through an urban and village area ***(Figure 1)***. Three (3) sampling stations were identified for shellfish collection and determination of river water quality.

Methodology. The sampling of the river water and shellfish was conducted three times during the 26 February to 20 March 2006 period. The mussels or *C. fluminea* was scooped from the river bed from a boat in deep water by using a specially designed scoop, or on the river bank in shallow waters before segregating them from pebbles. Approximately 1kg of the mussel was collected per station where this was then divided into two portions of 500g each, one as fresh and raw sample and the other as sample to be smoked and sun dried. The fresh and raw 'etak' was then washed and placed in a sealed sterilized plastic bag while the other portion was smoked and sun dried as a processed 'etak' sample. All samples were then kept in ice box with temperature maintained at 4°C before they were sent to the Fisheries Research Institute in Batu Maung, Penang for analysis. The analysis method adopted was that as given in the APHA Compendium of Methods for the Microbiological Examination of Foods (Department of Fisheries, Malaysia, 2001; APHA, 1992; Water Resources Institute, North Carolina State University, 1988). For the determination of water quality, sterilized plastic bag was used to store river water sample and kept with ice cubes in a box at approximately 4°C before sending to the laboratory for analysis. Only one parameter was tested in the analysis carried out that is the presence of fecal coliform bacteria in the river by using the APHA 9222 Method. Data on food borne diseases for the period from 1998 to 2004 was obtained from the Kota Bharu District Health Department.

Results and Discussion

In the first sampling conducted during the end of the wet (raining) season, fecal coliform in fresh 'etak' tissue was extremely high in concentration ranging from 49,000 MPN/100g to 151,500 MPN/100g. This was believed to be due to the sewage and sullage discharged from the urban area and the surrounding villages located in Sungai Ketereh catchment area that compounded with surface run-off. However, when the second sampling was done, two to three weeks after the onset of dry weather, the bacteria concentration dropped markedly where the fecal coliform bacteria in the fresh 'etak' tissue ranged from 1,200 MPN/100g to 2,450 MPN/100g but was found to increase significantly to between 4167 MPN/100g to 4,750 MPN/100g when the third sampling was carried out following continuous rain for two to three days ***(Figure 2)***.

With respect to smoked 'etak' as shown in ***(Figure3)***, fecal coliform concentrations in four out of nine batches exceeded the microbiological limits for shellfish, especially when compared to that of the USEPA Standards of less than 230 MPN/100g and that with the EC Directive of less than 300 MPN/100g (USEPA, 1986; EC Directive, 2000). The lowest bacteria concentration in fresh 'etak' recorded was five times higher than the USEPA standard and four times higher than EC Directive. The results of the first sampling revealed that out of three batches of smoked 'etak, one batch, which was sampled upstream of Sungai Ketereh, was still contaminated with bacteria (325 MPN/100g). The results also showed that, even though the bacteria concentration in fresh 'etak' from the middle and downstream stations was high all the bacteria were eliminated during the smoking process. In the second sampling, the results obtained were similar to those of the first sampling where the bacteria was still present in one of the processed batches but this time the concentrations of bacteria was more than eight times higher than the first one (2800 MPN/100g). Results from the third sampling also showed similar features as previously, except that this time the bacteria concentration was much higher than before and two of the batches showed the presence of bacteria in the tissues. The smoked

batches of the mussels obtained from the upstream and middle section of Sungai Ketereh gave concentrations of 5125 MPN/100g and 4967 MPN/100g, respectively ***(Figure 3).***

From the analysis of the river water quality similar trends as that exhibited by fresh 'etak' was evident where the concentration of bacteria in the river water from the first sampling ranged between 214 MPN/100 ml to 277 MPN/100 ml and the concentration dropped in the second sampling to between 82 MPN/100 ml to 93 MPN/100 ml. The concentration increased in the third sampling to between 501 MPN/100ml to 791 MPN/100 ml (Figure 4). The bacteria concentrations was well below the Class II category of the Interim National Water Quality Standard (INWQS) for Malaysia except for the third sampling which fell under the Class III category (Department of Environment, 1992;1995). From the results shown it can be inferred that the lower concentration of bacteria in water possibly was offset by the high concentrations observed in the mussel tissues and was most probably 10 to 30 times greater than the concentrations in water where the mussels were collected. This can be explained by their feeding habits and being filter feeders over a long period of time accumulate most of the bacteria while leaving relatively lower concentrations in the water. The quality of water in terms of fluctuation in bacteria concentrations in riverbeds populated by the mussels can be used as an indicator to estimate the bacteria concentration before collecting them to avoid consumption of the shellfish with high bacteria content. Data obtained from the Department of Health, Kota Bharu showed that for the period from 1998 to 2004, the cases of acute gastroenteritis were the highest for food born diseases followed by cholera and dysentery ***(Figure5)***. The number of such cases exceeded 3,000 every year except for 1998, where the number of cases was 2579.

Conclusion

Fecal coliform contamination in fresh *C. fluminea* was found to be higher in numbers (ranging from 1200 MPN/100g to 151,500 MPN/100g) and exceeded most of the standards compared to the smoked mussel which ranged from 325 MPN/100g to 5,125 MPN / 100g. Even though bacterial contamination was lower in the smoked mussels compared to the fresh ones the concentration for some batches was still high and exceeded the recognized international microbiological standards. The level of bacteria concentrations found is not safe for consumption especially for those who have never eaten this particular type of mussels. Bacterial concentration in smoked mussel tissues depends on how long is the smoking process; the longer the lower is the concentration. Irrespective of the length of the smoking process the possibility of bacteria contamination is very high because the smoking process is conducted in a very traditional way without really ensuring whether the mussel is properly cooked or not. Because of the inconsistent smoking process employed by the same operator different batches of smoked mussel produced different degree of bacterial contamination where some batches can be found to be free from the bacteria because the heating temperature used might be appropriate (exceeding 55°C) while some batches may have the presence of the fecal coliform bacteria. More over, different operators operate differently during the smoking process and the possibility of bacterial contamination is always present. It is highly probable that the highest incidence of acute gastroenteritis recorded in Kota Bharu was presumably due to the consumption of 'etak'. The study revealed that there was a positive correlation between river water quality, mussel and incidence of gastrointestinal disease in Kota Bharu.

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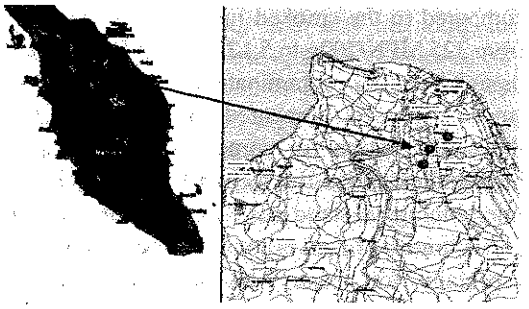

Figure 1: Sampling stations at Sungai Ketereh, Kota Bharu, Kelantan, Malaysia

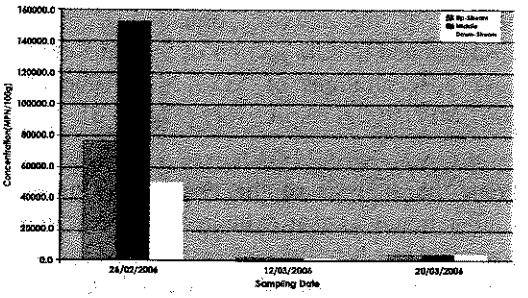

Figure 2: Fecal coliform concentrations in fresh mussels obtained from Sg Ketereh

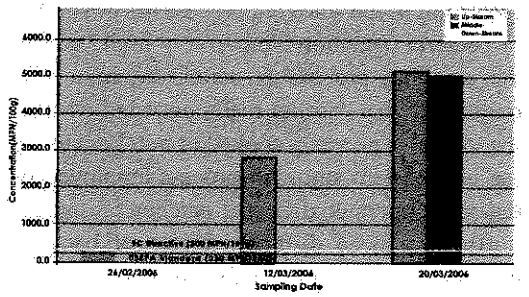

Figure 3: Fecal coliform concentrations in smoked mussels obtained from Sg Ketereh

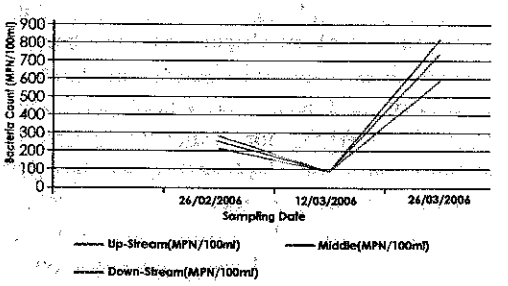

Figure 4: Fecal coliform concentrations in Sungai Ketereh

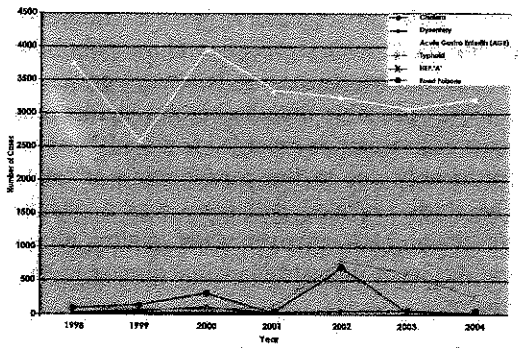

Figure 5: Food borne disease cases in Kota Bharu from 1998 to 2004

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