A STUDY OF FAECAL COLIFORM AND ESCHERICHIA COLI IN WASTEWATER DISCHARGE AT PUBLIC MARKETS AROUND KOTA BHARU, KELANTAN, MALAYSIA

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ABSTRACT

A study of faecal coliform and Escherichia Coli in wastewater discharge at selected public markets around Kota Bharu was carried. Six sampling sites were selected and there are PasarKubangPasu, PasarGokKapor, PasarSiti Khadijah, PasarBerek 12, PasarWakafCheYeh and PasarPengkalanChepa. Samplings process has been carried out five times at the selected public markets from December 2013 until January 2014. The objective of the study was to determine the significant level of faecal coliform in wastewater discharge from the selected public markets and compare it with the INWQS. Then, to determine the significant difference for levels of faecal coliform in the wastewater discharge during the day time and night time and to detect the present of E. coli in the wastewater discharge from the selected public markets. The results of the study showed that were significant levels of faecal coliform at the selected public markets, at p value <0.001. PasarKubangPasu, PasarGokKapor and PasarBerek 12 had the highest level faecal coliform and exceeded the INWQS level (>5000cfu/100ml). The levels of faecal coliform at all the public markets fall under class IV of INWQS classification. Hence, all the wastewater discharge from the public markets need to undergo the proper treatment before being allowed to flow directly into the surface water. There were also significant difference level of faecal coliform during the day time and night time, at p value <0.001 and there have significant detection of E. coli in the wastewater for all the selected public markets.

INTRODUCTION

According to the Department Of Environment (DOE) (2010), DOE registered 20,348 water pollution point sources comprising mainly sewage treatment plants (10,025: 49.27%) inclusive of 790 Network Pump Stations, manufacturing industries (9,069: 44.57%), animal farms (754: 3.70%) and agro-based industries (500: 2.46%). Sewage is the term used for wastewater that often contains faeces, urine and laundry waste. There are billions of people on Earth, so treating sewage is a big priority. Sewage disposal is a major problem in developing countries as many people in these areas do not have access to sanitary conditions and clean water.

Wastewaters from the public market will ultimate discharge into river. Untreated wastewater that discharge from the public market may contains faeces, urine and laundry wastes. Untreated wastewater from the public market contaminated with faecal coliform, bacteria, viruses and other microorganisms can contaminate the environment and cause public health problem. A study from Mexico showed that there were significant excess of diarrheal disease in children aged 5 - 15 years old, who had contacted with the 10000 - 100000 cfu /100 ml in wastewater as compare to those who had not contacted with the wastewater (Blumenthal, *et al*., 2000).

E. coli is one of the faecal coliforms that may cause diarrheal. Diarrhoea is associated with contaminated water supply and poor sanitation. *E.coli* is one of the best biological water indicators for public health protection (Edberg, *et.al*,.2000). The association faecal polluted water and microbial infections

has led to the development of sensitive methods for routine examination to ensure that water intended for human consumption is free from faecal contamination (WHO, 1996).

The water pollution in Malaysia originates from point sources and non-point sources. Point sources that have been identified include sewage treatment plants, manufacturing and agro-based industries and animal farms. Non-point sources are mainly diffused ones such as agricultural activities and surface runoffs. According the Department of Environment has recorded 17,991 water pollution point sources in 2004 comprising mainly sewage treatment plants, manufacturing industries, animal farm and agro based industries. The 2010 report, Department of Environment has recorded in which 20.348 water pollution points where identified.

Malaysia has a population of 28.3 million based on the 2010 report by the Department of Statistics. The estimated volume of wastewater generated by municipal and industrial sectors is 2.97 billion cubic meters per year (Tuan Mat, *et al*., 2014). Wastewater discharge is the main sources of contaminant of microorganism to the river or any surface water. Based on the information gathered and on-site investigations, Sungai Juru wet market wastewater was one of the causes of the water pollution of Sungai Juru (Guan, 2012). Raw foods in the public market the main sources in wastewater discharge.

The public market facilities are becoming more important to the local community nowadays. The public market as the centre of the local community provides daily essentials sources, such as raw food. Wastewater is generated as a result of the various activities in the public market such as washing and of fish vegetables and raw materials, which can pose a negative impact on the environment and public health if not handled properly before being discharge. In Malaysia, most of wastewater produced in the public market is directly discharged into the drainage system and to the rivers. This may cause surface water to be contaminated with pathogenic contaminations.

Failure to provide adequate protection and effective treatment will expose the surface water or river from the pathogen pollution. Furthermore, the community will risk outbreaks of intestinal and other infectious diseases. Those at greatest risk of waterborne disease are infants and young children, people who are debilitated or living under unsanitary conditions, the sick and the elderly. For these people, infective doses are significantly lower than for the general adult population. The diseases related to the unsafe water drinking are cholera, typhoid fever, dysentery, ameabic dysentery and brainerddiarrhoea. Moreover, the annual four billion cases of diarrhoea are responsible for 5.7% of the global burden of diseases (Barzilay, *et al*., 1999; WHO, 2002; UN, 2005; Clasen, 2010; Nik Rosmawati, *et al*., 2013). Diarrheal disease were reported in children aged 5-15 years old in Mexico, who had contacted with 10000 - 100000 cfu/100 ml of compared to those who had not contacted with the wastewater (Blumenthal, *et al*., 2000).

RESEARCH OBJECTIVE

General Objective

The general objective for this research is to study and analyze the level of faecal coliform and detection of *E. coli* in wastewater discharge from the public markets around Kota Bharu.

Specific Objective

1. To determine the level of faecal coliform in wastewater discharge from the selected public markets around Kota Bharu.
2. To compare the level of faecal coliform in wastewater discharge from the selected public markets around Kota Bharu with Interim National Water Quality Standard.
3. To detect the present of *E. coli* in the wastewater discharge from the selected public markets.

METHODOLOGY

In this study, the samples selection, location of sampling and collection of data and information will be explain that involve in the collection of primary and secondary data. The primary data involve in the collection of wastewater discharge samples in the selected public market around the Kota Bharu area beginning in December 2013 until January 2014. While, the secondary data were collected through report obtained from referring to the DOE and Kota Bharu Council Authorithy.

Study Location

Kelantan is a state of Malaysia. The capital and royal seat is Kota Bharu. Kelantan is positioned in the north-east of Peninsular Malaysia. The main market at the city centre is a top attraction. Sampling locations were determined largely by the availability of public markets in Kota Bharu which were located within reasonable driving distance from laboratory for sample analysis. This study focuses on the public market that is owned, leased or maintained by the Local Council. The public markets involved are under the supervision of Kota Bharu Municipal Council. Seven monitoring sites were selected, the latitude and longitudes and the names of the sites are given in Table 1.1.

Table 1.1: Names of the sampling locations and their coordinates

Station	Name of sampling site	East latitude	North longitudes
1	PasarKubangPasu	102°14’246”E	6°8’101”N
2	PasarGokKubor	102°14’2.641”E	6°8’32.633”N
3	PasarSiti Khadijah	102°14’363”E	6°7’834”N
4	PasarBerek 12	102°15’16”E	6°7’25”N
5	PasarWakafCheYeh	102°14’125”E	6°5’153”N
6	PasarPengkalanChepa	102°15’58”E	6°8’41.97”N

Data Collection

Primary data collection was retrieved through sampling process and laboratory procedures. Sampling process entail the data collection for level of faecal coliform and detection of E. coli in the wastewater includes the observation by check list and laboratory test. Primary data collection was carried out six times for the period of two months from December 2013 until January 2014. The sampling done on day time and night time for the period for all the selected public markets. The day time were determined from the 10.00 am until the 2.00 pm, where the local community starting for searching the raw materials. The night time were determined from the 8.00 pm until 10.00 pm, where the public market already closed and have done clean up by the owners.

The most representative waste discharge sample was from a point where the effluent is thoroughly mixed and close to the discharging premises’ outlet. As for this study, sampling was carried out at the market drainage system outlet before discharge into the drainage system nearby. The first thing that should be done before starting the sampling process is determining the equipments that should be brought during the sampling time. The selection of equipment for sampling should be appropriate with the sampling purpose and techniques. Then, it is essential to ensure that the equipment such as the bottles or the containers for collection of wastewater samples are labelled correctly and properly based on the sampling station before collecting. In addition, the equipment used for onsite observation (Multi Parameter System

Water Quality Parameter Model Yellow Spring Instrument (YSI) 556 and Geographical Positioning System (GPS) should be in good condition and functions well. This portable equipment was calibrated prior to use according to the manufacturer's directions.

The main purpose of onsite testing is to determine and identify the physical characteristic of the wastewater samples. Generally, the on-site measurement entails physical parameters such as temperature and pH value. Meanwhile, the level of faecal coliform and detection of *E. coli* parameter were determined after transferring the samples to the laboratory to be analyzed.

Wastewater Sampling Procedure

The time and day of sampling was chosen based on the day time and night time by randomly choosing the day for the sampling. Guided by a GPS, sampling points were systematically determined. The sampling points were shown in table 1.1 and were chosen due to the easy accessibility and are true representative area for wastewater discharge sample collection. All necessary equipment for the samples collection were prepared and assembled such as, bottles, masks, gloves, sampling sheets and others items required.

Samples of water for bacteriological testing were collected in sterile bottles, and prevented accidental contamination of the water during its collection and transportation to the water testing laboratory. So, for the collection of water samples, glass bottles with capacity 200 ml were used. During at the sampling site, the bottles were immersed about 20 cm below the water surface and filled to the brim. Then, water samples collected were tightly sealed and labelled. Each bottle was labelled in such a way that can be clearly identified and distinguished each other for samples identification. The water samples collected were placed into the icebox to maintain the pH and temperature while on transit to the laboratory. It is also to lower the activities and metabolism of bacteria present in the water samples thus the qualities of samples can be maintained.

In addition, during taking the wastewater samples, some external factors also were take noted such as weather and condition of sampling site or main drain. Climatic factors play an important role because it can be affect the result. The result was different during the rainy and hot days. Condition the sampling sites or the main drain during the samples collection should be noted. Because the drains without maintenance probably will record the high level of faecal coliform and *E. coli* in the wastewater discharge. It will be one of the sources of the increasing the level of faecal coliform and *E. coli* in the wastewater.

MacConker Broth Agar Preparation

For the medium that used in the study, the MacConkey Broth agars was need as the medium for growing the faecal coliform. The MacConkey Broth agar was prepared in the Unit PengurusanMakmalSains, School of Health Science. The step for the MacConkey agar preparation involves, suspending the measured amount of powder (See in the agar bottle and generally 50 gram) in 1 L of purified water and mixed thoroughly. Then, heated with frequent agitation and boiled for 1 minute to completely dissolve the powder. The mixture of agar was then autoclaved at 121°C for 15 minutes. After finishing the autoclave process, the dissolve solution was poured into the plates and allowed to solidify. After that, the plates were incubated for 37°C for 24 hours for quality control (QC). The QC was done by checking for any contaminated agar.

Preparation of Urea Substrate Medium

Urea Substrate medium were used for the detection of *E. coli* in the faecal coliform growth in the membrane filter. The colonies with colour yellow, yellow – green or yellow – brown were *E. coli.* For the preparation

of urea substrate medium, the composition used were 2.0 g of urea, 0.01 g of phenol red and 100 ml of distilled water. All the dry ingredients were added to 100 ml of distilled water in a flask. The mixture was stirred to dissolve and adjusted to pH 3 – 4 with 1 N HCL. The substrate should be a straw yellow colour at this pH.

Techniques for Counting Faecal Coliform and Detection of *E. Coli*

The collected wastewater samples were brought to the laboratory for counting the faecal coliform. The faecal coliform count is the most valuable test for the routine control of water supplies. The faecal coliform level is determined by the membrane filter technique. A 100 ml water sample is filtered through a membrane filter. The membrane, with the coliform organisms on it, was then cultured on a pad of sterile MacConkey agar that contained lactose and anbromocresol purple indicator. After water samples were filtered through the membrane filter, the samples were incubated at 44°c for 22-24 hours.

After incubation at 44°c for 22-24 hours, the colonies that formed in the membrane filter were the faecal coliform. Then, the number of faecal coliform colonies were counted. Calculation the number of faecal coliform per 100 mL were determined according to the following general formula:

$$\text{Faecal coliform /100 mL} = \frac{\text{Number of faecal coliform} \times \text{dilution factor}}{\text{Volume of sample (mL)}} \times 100$$

Upon completion of the counting of faecal coliform colonies, the membrane filter in the MacConkey agar were transferred from the MacConkey agar to the urea substrate, and any positive colonies which were urea's negative (yellow) were considered as *E. coli.*

Wastewater Data Analysis

The level of faecal coliform data of public market wastewater obtained was analysed descriptively by using Statistical Package for the Social Sciences (SPSS) 20 and Microsoft Office Excel 2007. The significant different level of faecal coliform among the selected public markets were investigated using SPSS by conducting the data analysis using non parametric test, Kruskal Wallis test. The significant differences during the day time and night among the stations were analyzed using non parametric test, Mann-Whitney Test. The 2 – tailed value were used for the *p* value. When the *p* value show <0.05, it indicated the significant result of statistical value. The data were presented in graph and table.

RESULT

The Interim National Water Quality Standard

The analysis of the wastewater discharge from the public markets is an attempt to identify the whether it complies and meets the minimum standard for the wastewater. So, the level of faecal coliform would be compared with the Interim National Water Quality Standard (INWQS). Table 1.2 and 1.3 showed the

Table 1.2: Interim National Water Quality Standard for the faecal coliform

INWQS for the faecal coliform and the INWQS class definition.

Parameters	Unit	Classes					
		I	IIA	IIB	III	IV	V
Faecal coliform	Counts/100ml	10	100	400	5000	>5000	-

Source: (Ministry of Health Malaysia, 2011)

Table 1.3: INWQS class definition

Class	Definition
I	• Conservation of natural environment. • Water supply I - Practically no treatment necessary (except by disinfection or boiling only). • Fishery I - Very sensitive aquatic species.
IIA	Water supply II – Conventional treatment required. • Fishery II - Sensitive aquatic species
IIB	Recreational use with body contact
III	Water supply III – Extensive treatment required. • Fishery III - Common of economic value, and tolerant species; livestock drinking
IV	Irrigation.
V	None of the above.

Source: (Ministry of Health Malaysia, 2011)

Level OfFaecal Coliform By Week In The Wastewater Discharge At The Public Markets Around Kota Bharu

1. PasarKubangPasu

Figure 1.1 shows the level of faecal coliform in wastewater discharge at the PasarKubangPasu for the all trips and during the daytime and night time. During the daytime, first week recorded the highest level of faecal coliform (920000 cfu/100 ml), followed by second week with 760000 cfu/100ml, third week with 630000 cfu/100 ml and fourth week with 590000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in wastewater (450000 cfu/100 ml).

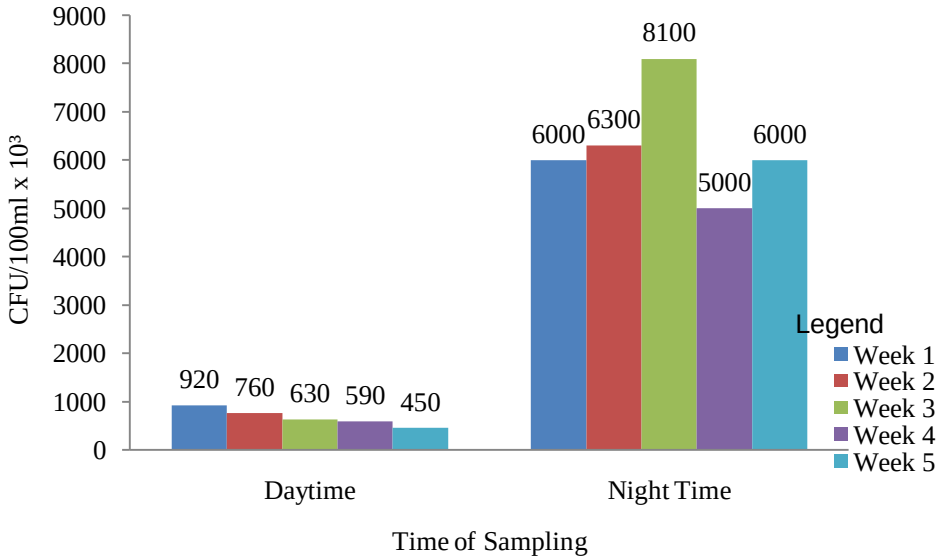

Figure 1.1:Level of Faecal Coliform at PasarKubangPasu

During the night time, third week recorded the highest level of faecal coliform (8100000 cfu/100 ml), followed by second week with 6300000 cfu/100 ml, first week and fifth week with 6000000 cfu/100 ml. While, the fourth week recorded the lowest level of faecal coliform in the wastewater 5000000 cfu/100 ml.

2. PasarGokKapor

Figure 1.2 shows the level of faecal coliform in wastewater discharge at the PasarGokKapor during the day time and night time. During the daytime, first week recorded the highest level of faecal coliform (770000 cfu/100 ml), followed by second week with 730000 cfu/100 ml, third week with 680000 cfu/100 ml and fourth week with 670000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in wastewater during the daytime (630000 cfu/100 ml).

During the night time, fourth week recorded the highest level of faecal coliform (8700000 cfu/100 ml), followed by second week with 8500000 cfu/100 ml, fifth week with 7800000 cfu/100 ml and first week with 4700000 cfu/100 ml. While, third week recorded the lowest level of faecal coliform in wastewater during the night time 4500000 cfu/100ml.

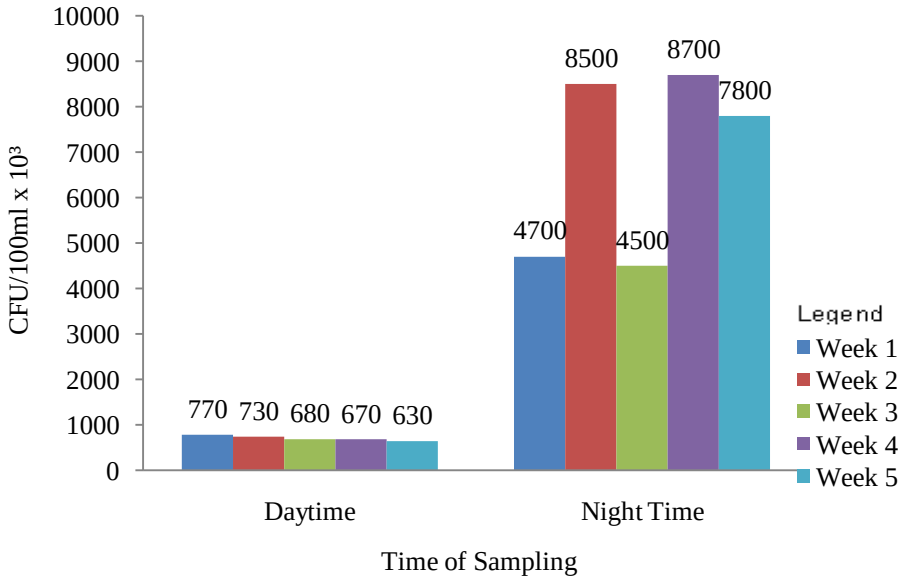

Figure 1.2: Level of faecal coliform in wastewater discharge at PasarGokKapor

3. PasarSiti Khadijah

Figure 1.3 shows the level of faecal coliform in wastewater discharge at Pasar of Siti Khadijah during the day time and night time. During the day time, fourth week recorded the highest level of faecal coliform (96000 cfu/100 ml), followed by third week with 87000 cfu/100 ml, second week with 72000 cfu/100 ml and first week with 69000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in the wastewater discharge (33000 cfu/100 ml).

During the night time, fourth week recorded the highest level of faecal coliform (860000 cfu/100 ml), followed by first week with 780000 cfu/100 ml, second week with 760000 cfu/100 ml and third week with 670000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in the wastewater discharge (540000 cfu/100 ml).

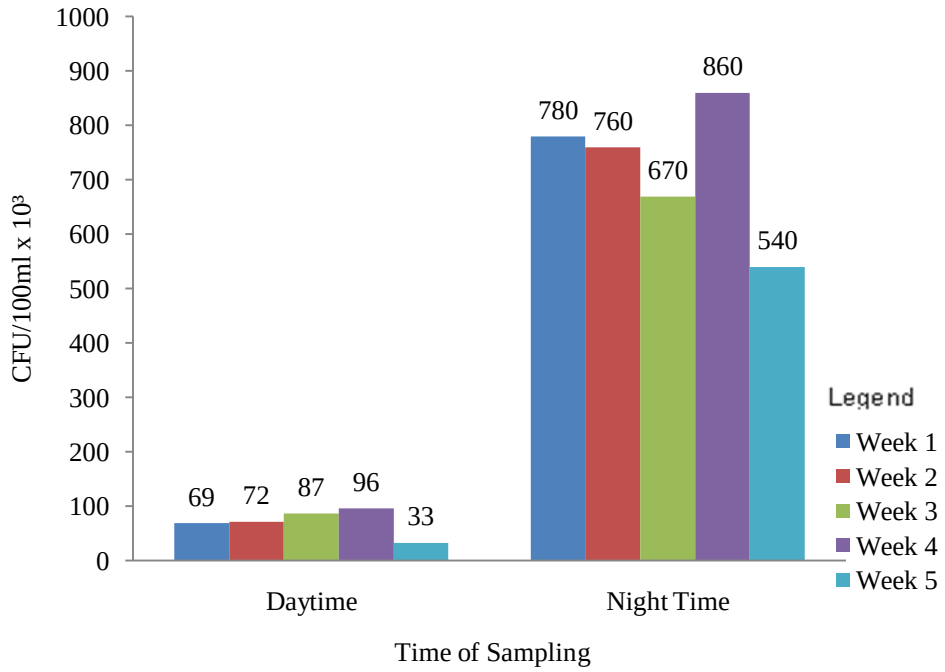

Figure 1.3:Level of faecal coliform in wastewater discharge at PasarSiti Khadijah

4. PasarBerek 12

Figure 1.4 shows the level of faecal coliform in wastewater discharge at PasarBerek 12 during the daytime and night time. During the daytime, first week recorded the highest level of faecal coliform (890000 cfu/100 ml), followed by second week with 780000 cfu/100 ml, third week with 740000 cfu/100 ml and fifth week with 670000 cfu/100 ml. While, fourth week recorded the lowest level of faecal coliform in wastewater discharge (630000 cfu/100 ml).

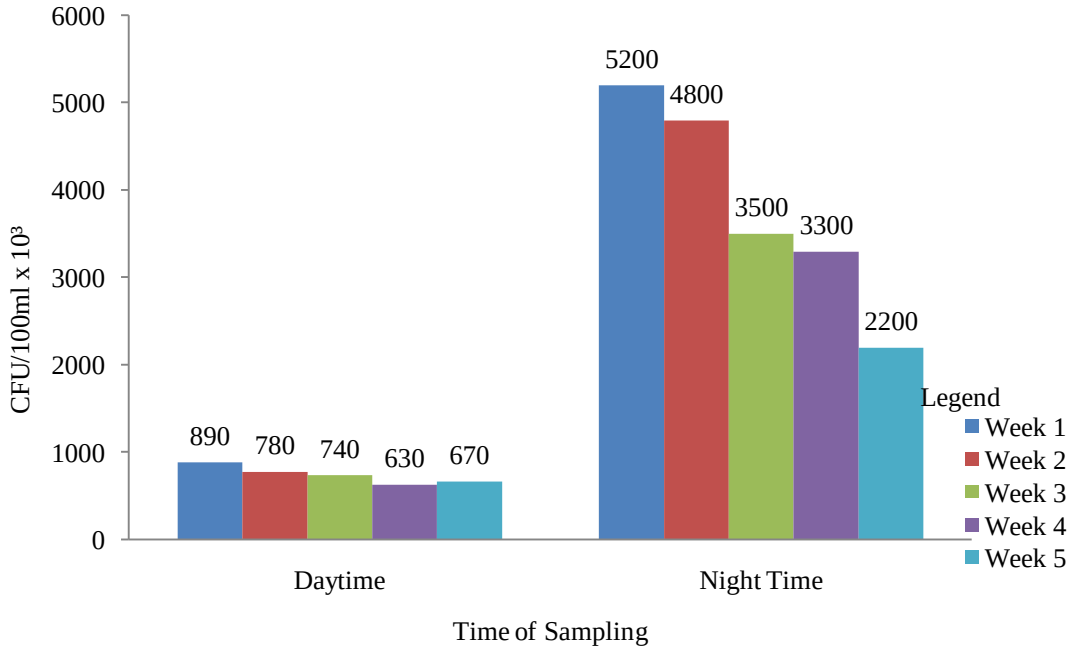

Figure 1.4: Level of faecal coliform in wastewater discharge at PasarBerek 12

During the night time, first week recorded the highest level of faecal coliform (5200000 cfu/100 ml), followed by second week with 4800000 cfu/100 ml, third week with 3500000 cfu/100 ml and fourth week with 3300000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in wastewater discharge during the night time (2200000 cfu/100 ml).

5. PasarWakafCheYeh

Figure 1.5 shows the level of faecal coliform in wastewater discharge at PasarWakafCheYeh during the daytime and night time. During the daytime, first week recorded the highest level of faecal coliform (72000 cfu/100 ml), followed by fifth week with 71000 cfu/100 ml, fourth week with 70000 cfu/100 ml and third week with 69000 cfu/100 ml. While, second week recorded the lowest level of faecal coliform in wastewater discharge (68000 cfu/100 ml).

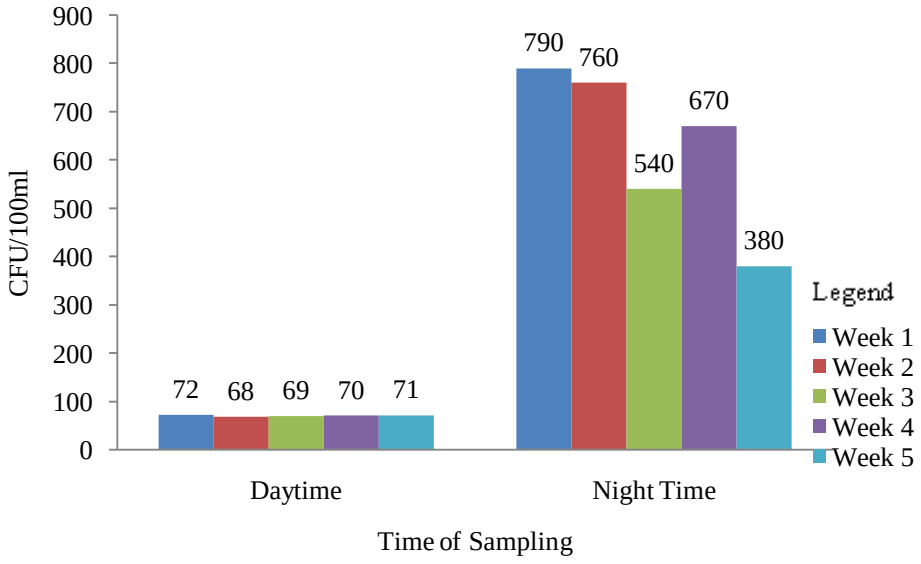

Figure 1.5:Level of Faecal Coliform In wastewater discharge at PasarWakafCheYeh

During the night time, first week recorded the highest level of faecal coliform (790000 cfu/100 ml), followed by second week with 760000 cfu/100 ml, fourth week with 670000 cfu/100 ml and third week with 540000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in wastewater discharge (380000 cfu/100 ml).

6. PasarPengkalanChepa

Figure 1.6 shows the level of faecal coliform in wastewater discharge at the PasarPengkalanChepa daytime and night time. During the daytime, first week recorded the highest level of faecal coliform (82000 cfu/100 ml), followed by fourth week with 73000 cfu/100 ml, second week with 68000 cfu/100 ml and fifth week with 63000 cfu/100 ml. While, third week recorded the lowest level of faecal coliform in wastewater discharge (61000 cfu/100 ml).

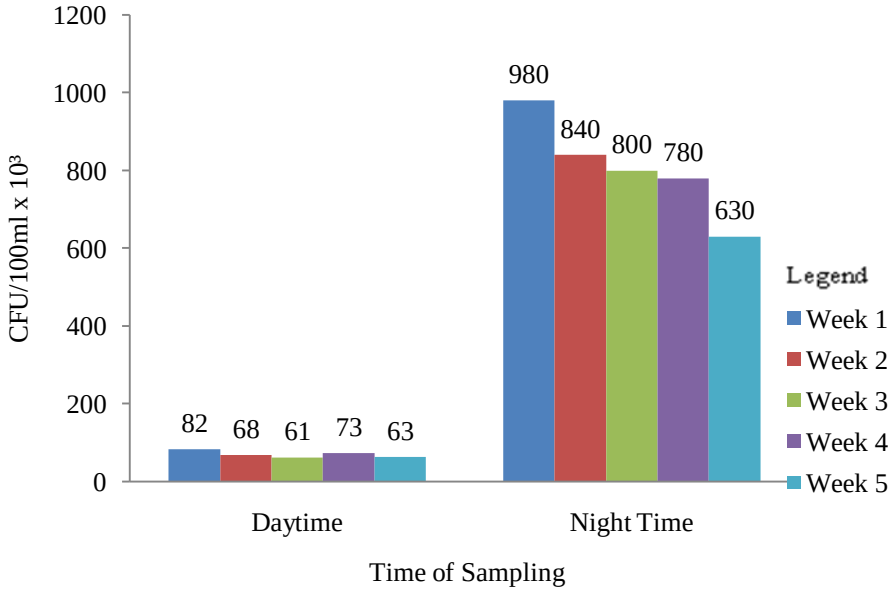

Figure 1.6: Level of Faecal Coliform in wastewater discharge at PasarPengkalanChepa

During the night time, first week recorded the highest level of faecal coliform (980000 cfu/100 ml), followed by second week with 840000 cfu/100 ml, third week with 800000 cfu/100 ml and fourth week with 780000 cfu/100 ml. While, fifth week recorded the lowest level of faecal coliform in wastewater discharge (630000 cfu/100 ml).

Comparison Level OfFaecal Coliform In Wastewater Discharges At The Public Markets.

After the data was analyzed and recorded, the comparison of the mean level of faecal coliform were made to determine the highest level of faecal coliform among the selected public markets. Figure 1.7 shows the mean level of faecal coliform during daytime and night time for all the sampling points. PasarGokKapor recorded the highest mean level of faecal coliform (696000 cfu/100 ml) compare to the all sampling points at the daytime, mean while, PasarKubangPasu (670000 cfu/100 ml), PasarBerek 12 (742000 cfu/100 ml), PasarWakafCheYeh (70000 cfu/100 ml) and PasarSiti Khadijah (71400 cfu/100 ml). While, PasarPengkalanChepa recorded the lowest level of faecal coliform (69400 cfu/100 ml) compare to all sampling points.

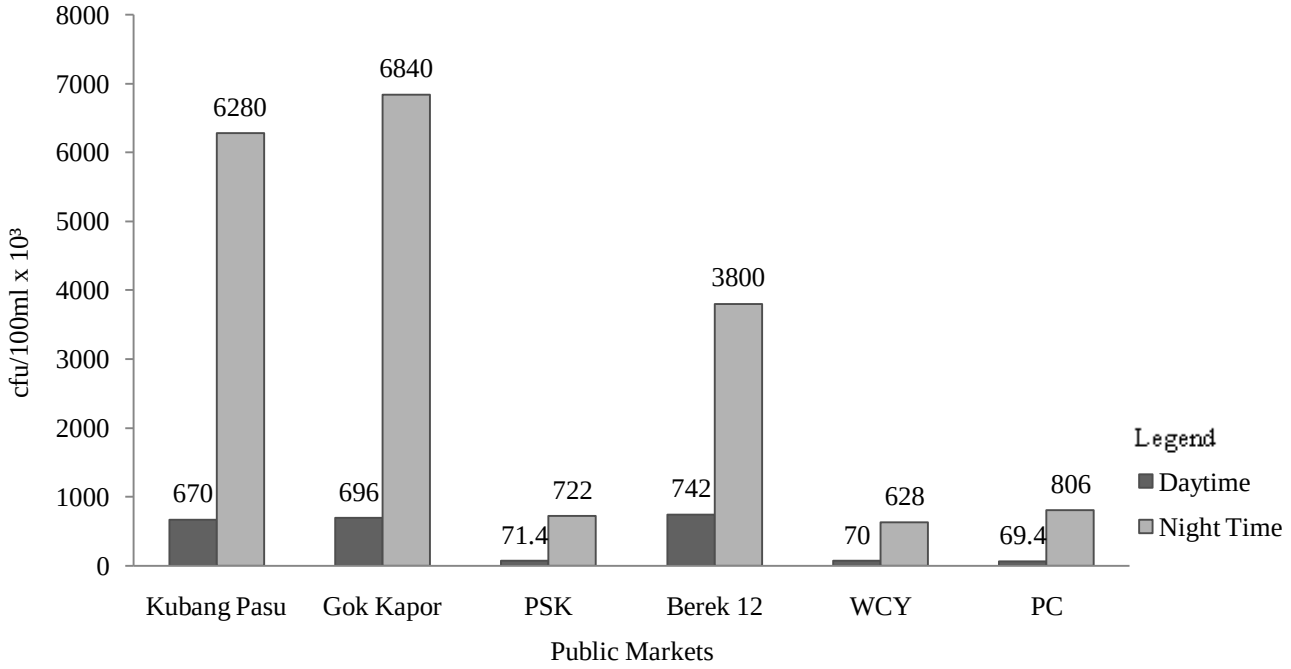

Figure 4.6:Mean level of faecal coliform between day time and night time

During the night time, PasarGokKapor recorded the highest mean level of faecal coliform (6840000 cfu/100 ml). Followed by the PasarKubangPasu with 6280000 cfu/100 ml, PasarBerek 12 with 3800000 cfu/100 ml, PasarPengkalanChepa with 806000 cfu/100 ml and PasarSiti Khadijah with 722000 cfu/100 ml.While, PasarWakafCheYeh recorded the lowest level of faecal coliform (628000 cfu/100 ml).

Table 1.4: The median level of faecal coliform level in wastewater discharge at the selected public markets

Location	**Median (IQR) cfu/100ml x 10^3**		***P* value**
	Day Time	**Night Time**	
PasarKubangPasu	630 (320)	6000 (1700)	0.000
PasarGokKapor	680 (100)	7800 (4000)	
PasarSiti Khadijah	72 (40.5)	760 (215)	
PasarBerek 12	740 (185)	3500 (2250)	
PasarWakafCheYeh	70 (3)	670 (315)	
PasarPengkalanChepa	68 (15.5)	800 (205)	

*Significant different at $p<0.05$, statistical test Kruskal Wallis test

Table 1.4 shows the median level of faecal coliform in the wastewater discharge at the public markets around Kota Bharu. The *p* value is <0.001, which is <0.05. There is a significant difference of median level of faecal coliform in the wastewater discharge at the public markets. Therefore, reject the first null hypothesis and the result is significant. After the post hoc test, result show the significant difference between the level of faecal coliform at the PasarKubangPasu, PasarGokkapor, PasarBerek 12 with the PasarSiti Khadijah, PasarWakafCehYeh and PasarPengkalanChepa.

Classification Of Wastewater Discharge From The Public Markets

In comparing all the mean levels of the faecal coliform at the public markets with the Interim National Water Quality Standard, it shows that all the selected public markets have exceeded 5000 CFU/100 ml of faecal coliform. Thus, in this respect, the level of faecal coliform for all the public markets fell under class IV of Interim National water Quality Standard classification. The wastewater discharge needs to undergo the extensive treatment before been allow to flow into the surface water. Directly discharge into the surface water could decrease the water quality and bring harm to human health.

Significant Different Level OfFaecal Coliform During Day Time And Night Time

Table 1.5 shows the comparison level of faecal coliform during day time and night time at the public markets around Kota Bharu. The level of faecal coliform showed significantly different between the day time and night time for all selected public markets, when the *p* value is <0.001 (Table 1.3). The level of faecal coliform during the night time recorded the highest median level compared to the day time. The second null hypothesis is rejected. Therefore, there were the significant differences between the level of faecal coliform during the day time and night time at all the selected public markets.

Table 1.5:The median level of the faecal coliform during day time and night time

Variable	Median (IQR) cfu/100ml x 10^3		*p* Value*
	Day time	Night time	
Faecal Coliform	273 (622.75)	1590 (4640)	0.000

*Significant different at $p<0.05$, statistical test Mann Whitney test

Detection Of*E. Coli*

Feacal coliform bacteria include genera that originate in faeces, for example *E. coli* and as well as genera not of faecal origin (*Enterobacter, Klebsiella, Citrobacter*). The assay is intended to be an indicator of faecal contamination, more specifically of *E. coli* which is an indicator microorganism for other pathogens that may be present in faeces. Table 1.6show the detection of *E.coli* in the wastewater for all the selected public markets.

Table 1.6: Detection of *E. coli* in wastewater discharge

*/= detection*of E.coli*

All the selected public markets recorded the significant level detection of the *E. coli* in the wastewater discharge. Most of the faecal coliform are consists of *E. coli* in the wastewater discharge. Most of the faecal coliform changes the colour from the colourless to the yellow colonies formation after dip into the urea substrate medium.

DISCUSSION

Pattern Changes Level OfFaecal Coliform In The Wastewaster Discharge At Selected Public Markets

All the data were recorded and interpreted in the graph for looking the pattern of changes level of faecal coliform in the wastewater discharge. Based on Figure 1.1 and Figure 1.3, PasarKubangPasu show the

highest level of faecal coliform on the week one during day and night time. Based on the observation, the sampling point or main drain collection of the wastewater at the PasarKubangPasu near with the solid waste collection site and the roadside.The distance of the main drain from the solid waste collection site around 3 meters and 1 meter from the roadside. There have the runoff water and leachate flow into the drainage system from the near solid waste collection site and the roadside.

Runoff water is one of the factors that incline the level of faecal coliform (Alachua Country Environmental Protection Department, 2007). The runoff water have the greater possibility that mixed with the faecal contaminants at the solid waste collection or the roadside. Various sources of the solid waste contributed the leachate that contaminated with the faecal contaminants. The runoff water and leachate contribute the incline of faecal coliform in the wastewater discharge from the public markets.

Based on Figure 1.2, 1.4 and 1.5, PasarGokkapor show the highest level of faecal coliform at the night time. Based on the observation and information from the sellers, the cleanup activities at the PasarGokKapor do not conducted on the week 2, week 4 and week 5. There could be seen the condition of drain that blocking with the waste and surrounding of the markets that messy and the waste do not manage properly. The cleanup of campsite that contributed the faecal coliform in the San Lorenzo River, contributed to the decrease of level faecal coliform in the San Lorenzo River. The rarely conducted of cleanup activities at the public market, contributed to the production of faecal coliform. Dirty environment help in the production of faecal coliform. The cleanup activities by the contractors could be applied with this condition. The cleanup activities help in decreasing the faecal coliform survival and production

Significant Different Level OfFaecal Coliform Between The Highest And The Lowest Group Of Public Markets

Based on the results that recorded in Table 1.4, there were two group levels of faecal coliform, the highest median group of faecal coliform and lowest median group of faecal coliform. Three of the public markets which recorded the highest median level of faecal coliform, were PasarKubangPasu, PasarGokKapor and PasarBerek 12. While, there public markets that recorded the lowest median level of faecal coliform were PasarWakafCheYeh, PasarPengkalanChepa and PasarSiti Khadijah.

Location	Detection of E. coli in wastewater discharge at public market									
	DAYTIME					NIGHT TIME				
	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5
PasarKubangPasu	/	/	/	/	/	/	/	/	/	/
PasarGokKapor	/	/	/	/	/	/	/	/	/	/
PasarSiti Khadijah	/	/	/	/	/	/	/	/	/	/
Pasar Berek12	/	/	/	/	/	/	/	/	/	/
PasarWakafCehYeh	/	/	/	/	/	/	/	/	/	/
PasarPengkalanChepa	/	/	/	/	/	/	/	/	/	/

1. The Highest Level of Faecal Coliform Group.

PasarKubangPasu, PasarGokKapor and PasarBerek 12 were categorized as the highest level offaecal coliform group. Figure 1.6 and Table 1.4 show the top 3 of public markets that have the highest mean and median of faecal coliform. PasarKubangPasu, PasarGokKapor and PasarBerek 12 have almost similar conditions and environments, for example similar drainage system problem. Poor maintenance and construction of the drainage system were form to contribut the risk of exposure to microorganism and other harmful bacteria (British Columbia Ministry of Health, 2007). For example, PasarGokKapor and PasarKubangPasu showed the worst drainage system. Much solid waste were found in the drain during the sampling time. Most of the drain at the public markets were blocked and clogged by solid waste and organic matter. Periodic maintenance of drainage system can decrease the faecal coliform level in the wastewater discharge.

The decay organic matter contributed to the production of faecal coliform in the wastewater (Lee, 2008). PasarKubangPasu, PasarGokKapor and PasarBerek 12 have problem with the improper managing of the organic waste matter from sellers. There were many organic matter in the drain. Most of the sellers were not aware on the importance of proper managing of waste.

Leachate from the solid waste collection site was one of the factors that contributed to the production of the faecal coliform. Most of the main drains of PasarKubangPasu, PasarGokKapor and PasarBerek 12 were located near the solid waste collection sites. It was reported that leachate that mixed with the sanitary waste and other types of wastes contributed to the production of faecal coliform (Michigan State University, 2013). The solid waste collection sites in the public markets were not managed properly because there were mixed with sanitary waste from the public. Faecal coliform originated from the faeces or sewage of human or warm blooded animal. The leachate that mixed with sanitary waste those from the waste collection site contributed to the highest level of faecal coliform in the wastewater discharge at the public markets.

Another important source of faecal coliform is pet waste. From the report by the Jiang and Worthington (2005), animals waste were one of the contributors for the faecal coliform in the wastewater. Cats are the common animals found around the PasarKubangPasu, PasarGokKapor and PasarBerek 12. During sampling, there were faeces in the drain, which were not properly managed. This condition contributed to the production of faecal coliform in the wastewater at the public markets. The sources of the faecal coliform naturally from faeces of human or warm blooded animal and also non-human contributed such as dogs and cats (Rhew, 2009).

2. The Lowest Level of Faecal Coliform Group.

PasarSiti Khadijah, PasarWakafCheYeh and PasarPengkalanChepa have been categorized as the lowest level of faecal coliform group. Based on the results in Figure 1.6 and Table 1.4, show the top 3 of public markets that had the lowest mean and median of faecal coliform.

Comparison with the highest level of faecal coliform group, the public markets with the lowest level of faecal coliform were cleaner and more systematic. PasarSiti Khadijah, PasarWakafCheYeh and PasarPengkalanChepa conducted clean up activities more frequently and compared to the PasarKubangpasu, PasarGokKapor and PasarBerek 12. Clean up planning is important to reduce the production of faecal coliform in water (Barreca& Seiders, 2001). When clean up activities were not handled properly and regularly, the physical environment were more likely to be contaminated with faecal coliform. Hence, the clean up activities are important to help in reducing of faecal coliform in the wastewater discharge from the public markets.

Significant Different Level OfFaecal Coliform Between Day Time And Night Time

The mean levels of faecal coliform showed the significantly difference between the day time and night time, at p value <0.001. The level of faecal coliform during the night time recorded the highest level compared to

the day time. The high level of faecal coliform during the night time resulted from the lack of sunlight encouraged control production of faecal coliform. Lack of sunlight is the dominant influence on the cultural densities of faecal indicator bacteria (Liu, 2002). Sunlight inhibits the faecal coliform from increasing continuously. Sunlight is one of the natural sources of UV and many treatment plan have used sunlight for disinfection of water. Sunlight appears to be the most important inactivation mechanism to treat sewage microorganism especially the faecal coliform (Sinton, *et al*., 2002).

The effect of sunlight is believed to play a main role in deactivation of microorganism in the water. Percentages of removal faecal coliform increased when the period of exposure to the sunlight increase (Hina, *et al*., 2013). The wavelength of sunlight could damage the DNA of microorganism cause by absorption of light energy which deactivates cell.

During day time sunlight in controlls the production of faecal coliform, while during the night time there was no sunlight to inactivate the production of faecal coliform. Hence, the faecal coliform could produce rapidly during the night time. If no maintenance and cleaning process were done during the day time. The survival of faecal coliform in an aquatic environment depends upon their ability to tolerate a set of alien biological, physical and chemical conditions.

DETECTION OF *E. COLI*

The coliform bacteria group consists of several general of bacteria belonging to the family *enterobacteriaceae*(Lui, 2002). These mostly harmless bacteria live in soil, water and the digestive system of warm-blooded animals. Faecal coliform bacteria, which belong to this group, are present in large numbers in the faces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste (Lui, 2002). *E. coli* is the principal component of the faecal coliforms group. Scott (2000) found that 100% of faecal coliform in dairy wastewater was *E. coli*, suggesting that faecal coliform net decay rates determined in dairy wastewater may represent *E. coli* net decay rates.

All the selected public markets recorded significant levels detection of the *E. coli* in the wastewater discharge. Based on Table 1.6, most of the faecal coliform consisted of *E. coli* in the wastewater discharge. Faecal coliform bacteria exist in the intestine of warm blooded animal and humans, and found in the bodily waste, and animal dropping. *E. coli* is one of the faecal coliform bacteria (British Columbia Ministry of Health, 2007).

Furthermore, most of the public markets sell the raw material of chicken, fish and beef, which contributed to the level of faecal coliform in the wastewater discharge. *E. coli* found in meats from the wet markets in Thailand (Sutheienkul, *et al*., 1990). The raw materials could have contributed to the increasing production of *E. coli* in the wastewater. *E. coli* were reported in the raw meats from chickens, turkey, pork and beef from the markets (Zhao, et al., 2001). Faeces from the raw materials were possible sources of *E. coli* contamination in the wastewater discharge. For example, PasarGokKapor is popular with the fresh fish, and most of the sellers sell the raw material such as chicken and beef.

The wastewater that contaminated with the *E. coli* and others faecal coliform flow into the drainage system without undergoes the proper treatment with eventually lead to the degradation of water quality. Direct flow of wastewater into the surface water can be contaminated the sources of water. For example, PasarGokKapor provided the drainage system that directly flows into the Sungai Kelantan. This can be degradation of water quality of Sungai Kelantan.

DOE have confirmed that Sungai BatuFerringhi was contaminated with an alarmingly high level of the *Escherichia coli* or *E. coli* bacteria (New Straits Times, 2014). Samples collected by the DOE had faecal coliform and *E. coli* readings at a staggering 16,000 cfu/100ml (New Straits Times, 2014). The samples were exceeding the permissible standard of *E. coli* for the marine, which is 100 cfu/100ml. From the observation, they found that three Laundromats, car was and others factors that cab contributor to the contaminated of faecal coliform and *E. coli* in the Sungai BatuFerringhi. Blackish effluent discharge from the Indah Water Konsortium (IWK) also claimed as the factor of contaminated. Human activities could be affected the water quality.

The improper treatment and managing of wastewater discharge can be the contributor of contaminated faecal coliform and *E. coli*. Most of the wastewater from the public markets was flow directly into the irrigation or river at the Kota Bharu. If there have no properly treatment that can be do, it could be reduce the water quality and affected the human health.

Potential Sources OfFaecal Coliform At The Public Markets

From the study undertaken, the major factors that contributed to the problem were improper drainage system into the wastewater discharges. Most of the public markets have the same problem where drains were blocked and clogged. PasarGokKapor and PasarKubangPasu showed the worst drainage system. Most of the selected public markets did not maintain the drain to allow the flow of wastewater properly. Most public markets have drainage system, but the condition of the drainage were filled with waste and mixed with the faeces from animals. Much solid waste can be found in the drain during the sampling time. Periodic maintenance of drainage system could decrease faecal coliform level.

Furthermore, most of the sellers did not take responsibilities on the cleanliness of the public markets. Most of them just depended on the third party for the cleanup activities. Some sellers just threw solid waste into the drainage system instead of throwing them into dustbins. During sampling, there were drippers, raw material, plastics and others into the drain. This could block the runoff of the wastewater. Most public were not aware on the impact of their hygienic behaviour on the environment and their health life. They often chose the easier way to dispose off their wastes.

CONCLUSSION

High level of faecal coliform in wastewater discharge in all public markets around Kota Bharu. All the wastewater samples exceeded the Interim National water Quality Standard (5000cfu/100 ml). Thus, the level of faecal coliform for all the public market fall under class IV of INWQS classification. The wastewater was only suitable for irrigation. There are indicated of improper drainage system at the public markets. Most of the drainage system in public markets at the Kota Bharu, flow directly into the surface water or river. This condition would decrease the water quality and affect human health. The wastewater discharge from the public markets needs to be treated with the extensively before being allowed to flow into surface water.

There were also significant different level of faecal coliform between the day time and night time. High level of faecal coliform during the night in wastewater discharge in all public markets around Kota Bharu. There are indicated the lack of awareness and attitude of sellers in conduction of clean up activities. All the selected public markets recorded the significant detection of the *E. coli* in the wastewater discharge. Most of the faecal coliform are consists of *E. coli* in the wastewater discharge.

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