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Bacteriological Water Quality Assessment Of Nkenye Stream In Meru South In Tharaka Nithi County, Kenya

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ABSTRACT

Access to portable water remains a major global concern due to increased rate of water pollution contributed for by climate change and human. Destruction of riparian zones has exposed the rivers and streams to toxic and pathogenic pollutants released from untreated organic and inorganic waste. Exposure of river and stream used for drinking water to pollution is detrimental to aquatic plants, animals, and human consumers who depends on such valuable ecosystem. Nkenye stream that originates from Nkenye wetlands in Chuka, Meru South provide water that is used in fish ponds, irrigation and water for domestic use in homestead. Despite of the significance of Nkenye stream, little attention has been accorded to ascertain its water quality given its location. Study was conducted to determine the bacteriological water quality of Nkenye stream based on the feacal and total coliform count. Samples were collected at designated locations using ecological survey method and taken to Chuka University for evaluation. Coliform analysis of water samples was done by most probable number method using Macconkey purple broth at botany laboratory, Chuka University. The results of coliform counts obtained were subjected to the analysis of variance using General linear model (GLM) on Statistical analysis system (SAS) version 9.4. The significance coliform means were separated by Least significance difference (LSD) [alpha = 0.05]. Feacal coliform count of Nkenye stream did not conform to WHO standards of 0 cfu/100 ml as the mean of 10 cfu/100 ml was observed for the entire stream. The occurrences of these bacteria in water indicate water deterioration and the presence of many water-borne pathogens that needs immediate attention. The study recommends that local authorities particularly Tharaka Nithi county government should provide waste management disposal systems and policies that prohibit direct discharge of untreated effluents to Nkenye stream.

Keywords: Water quality, Coliform bacteria, Nkenye Stream, Meru South, Kenya

1. INTRODUCTION

Water quality is determined by its chemical, physical and biological properties (Kebede *et al.,* 2020). Water is an important physiological requirement for animals, plants and for human (Musa *et al*., 2020). However, deteriorating water quality particularly microbial contamination poses a threat to human's health (Bain *et al*., 2014; Haque, 2019; Zoua *et al.,* 2020). Rapidly growing population, transformation of small cities into urban and the absence of sound effluent management policy have put pressure onto water bodies which has been turned into dumping and discharge points (Ifi *et al*., 2019). As much effluent and waste water get their ways into our rivers and streams, their fundamental role of providing clean water gets compromised (Tamungang *et al.*, 2016; Enerijiofi *et al.,* 2018). Biosolids, the principle biological water contaminant that introduces coliforms among other pathogenic bacteria in portable water may be part of effluent and waste waters (Maru et al., 2017; Palansooriya et al., 2019). Most rural communities living along rivers still source their water for domestic use from river (Nwabor *et al.,* 2016; Musa *et al*., 2020). Since most of these waters may be heavily contaminated

by biosolids, diseases such as cholera and typhoid are becoming a burden to most house hold (Somani *et al*,. 2014). Therefore, there is a need to evaluate water quality of water bodies in areas surrounding towns to determine their quality (Chen *et al*., 2016; Loucif *et al.*, 2020). Microbiology water quality assessment may be evaluated using methods such as the most probable number among other methods. The presence or absence of microorganisms in water may indicate water quality status (Flura *et al*., 2016).

The Nkenye stream is located in in Chuka ion Meru South within Tharaka Nithi County in Kenya. Water that flow into the Nkenye stream Nkenye wetlands which receives water from rainfall and wastes water discharged from Chuka market, households located near the stream and run off from farms next to the swamp. The stream is used by surrounding community for pond, watering crops and for and domestic purposes such as cooking and drinking. This study aimed at evaluating the bacteria water quality of the stream's water by most probable number method.

2. MATERIALS AND METHODS

2.1 STUDY AREA

The study was conducted in Nkenye stream that is found in meru South within Tharaka Nithi County. Tharaka Nithi County borders the Embu County to the South and South West, Meru County to the North and North East, Kirinyaga and Nyeri to the West and Kitui to the East and South East. The county lies between latitude 000 07' and 000 26' South and between longitudes 37° 19' and 37° 46' East. The highest altitude of the county is 5,200 m while the lowest is 600 m, Eastwards in Tharaka. The average annual rainfall of 717 mm. The lower regions receive low, unreliable and poorly distributed rainfall unlike high-altitude areas. Temperatures in the highland areas range between 14°C to 30°C while those of the lowland area range between 22°C to 36°C. Major towns in Tharaka Nithi County include Chuka which is highly populated with 45,882 residents and Chogoria with a lower population of 33,378 residents (Kenya National bureau of Statistic (KNBS), 2010). The area accommodates diverse industries; hospitals, hotels, garages, schools and markets.

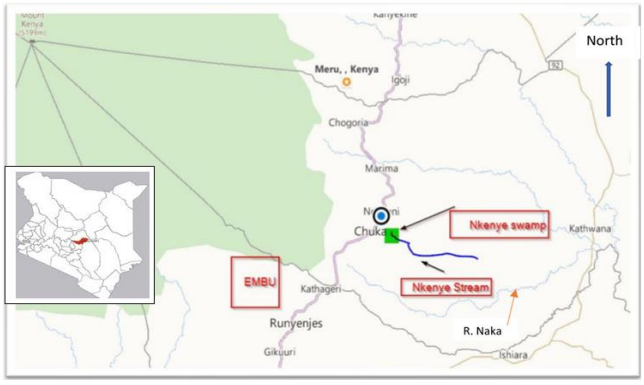

Figure 1: Map of Tharaka Nithi County showing Nkenye Stream in Chuka

2.2 RESEARCH DESIGN

The study used ecological survey and laboratory experiment designs for water sample collection and bacterial analysis respectively. Using belt transects of 1000 meters long, and 20 sampling points were laid along the belt using quadrant (1x1 m) where water was collected.

2.3 WATER COLLECTION

Water samples from the stream were collected in 1000 ml plastic bottles using grab method along the selected points established within Nkenye stream. The water Samples were collected during the dry season in the month of February, March and April 2019.A total of 20 water samples was collected for this study in triplicate totaling to 60 water samples. All the samples were appropriately labeled, stored in cool box for transport to the laboratory at Chuka University. Samples were stored at 4^{o}C prior to laboratory analysis.

2.4 COLIFORM ANALYSIS

Coliform analysis was done for both total coliform and feacal coliform using most probable method and MacConkey purple broth. Coliform study involved media preparation, sample preparation, inoculation and incubation as described below.

2.5 PREPARATION OF CULTURE MEDIA

Prior to media preparation, all the glassware was sterilized in a hot air oven (Memmert UNB400 Model; Chuka University) for 2 h at 260^{o}C. Culture media was prepared by adding 20g and 40 g of MacConkey purple broth into 500 ml then distilled water for single and double strength respectively. Upon addition of media into the water, the media was dispensed in the McCartney bottles in different concentrations. The concentrations of Macconkey purple broth were distributed in pre-sterilized 5 ml (in 10 ml bonjour bottles [5 bottles]) of single strength MacConkey purple broth, 10 ml (in 25 ml McCartney bottles [5 bottles]) of double strength MacConkey purple broth and another set of 5 ml (in 10 ml bonjour bottles [5 bottles]). In every bottle one Durham tube was in cooperated in an inverted position. Once the Durham tubes were placed in all the bottles, the media were autoclaved in an autoclave model X280Aat 121^{o}C for 15 minutes at Chuka University microbiology laboratory. The culture media was cooled down at 50^{o}C prior to labeling and inoculation.

2.6 SAMPLE PREPARATION

Inoculum samples for total coliform and feacal coli form test were prepared from water samples. Water sample collected from Nkenye stream were serial diluted up to dilution of $10^{-3}$for each of the 20 water samples collected in triplicate that totaled to 60 samples.

2.7 SAMPLE INOCULATION FOR TOTAL COLIFORM TEST

McCartney bottles with sterilized media were labeled using the laboratory generated accession numbers that correspond to samples. Every sample had total of 15 McCartney bottles (5 bonjour bottles with single strength, and 5 McCartney bottles containing 10 ml double strength of the media. The first single strength series were

inoculated with 1ml of the sample, the second series of the 5 ml single strength were inoculated with 0.1 ml of prepared 10^{-3}serial dilution of the sample while the 10 ml double strength bottles was inoculated with 10ml of the inoculums. The treatment was repeated for every inoculums prepared. Incubation of all the samples carried out 37.5^{o}C for 48 h in an incubator Memmert TYP INB200 at the microbiology laboratory, Chuka University. All the samples which were positive for total coliform were re-evaluated for the feacal coliform using the same procedure for total coliform but were incubated at 44 ^{o}C for 48 hr. the bottles which turned yellow and had gas trapped in the Durham tubes were considered positive for both feacal and total test in respective procedures.

3. RESULTS

3.1 CONCENTRATION OF COLIFORM IN WATER

The total coliform in water samples were significantly different ($p < 0.05$). The highest mean of total coliform concentration was recorded at location 18 with mean of 521 cfu/100 ml followed by location 20, location 10, location 17 and location 19 with means of 480 cfu/100 ml, 361 cfu/100 ml, 355 cfu/100 ml and 532 cfu/100 ml respectively. The lowest mean for total coliform in water was location 2, followed with location 3, location 1, location 4 and location 7 with means of 8 colony forming unit, 11 colony forming unit, 16 cfu/100 ml, 19 cfu/100 ml and 22 cfu/100 ml. The difference between the highest mean and the lowest mean of total coliform in water was 499 cfu/100 ml. The overall mean of total coliform in water was 178 cfu/100 ml. Eight out of the twenty water sample locations sampled had means of total coliform bacteria in water higher than the overall mean (Table 1).

The feacal coliform in water samples were significantly different ($p < 0.05$). The highest mean of feacal coliform concentration was recorded at location 20 with mean of 68 cfu/100 ml followed by location 19, location 9, location 18 and locations (13 and 17) with means of 19 cfu/100 ml, 18 cfu/100 ml, 12 cfu/100 ml and 11 cfu/100 ml respectively. The lowest mean for feacal coliform in water was location 1, 2 and 5 both recording means of 0 cfu/100 ml followed with location 15, location 3, location 4 and location 12 with means of 1.67 cfu/100 ml, 1.83 cfu/100 ml, 4.00 cfu/100 ml and 4.33 cfu/100 ml respectively. The difference between the highest mean and the lowest mean for feacal coliform in water was 4.33 cfu/100 ml. The overall mean of total coliform water was 9.99 cfu/100 ml. Seven out of the twenty water sample location sampled had means of feacal coliform bacteria in water higher than the overall mean (Table1).

Table1: Table of mean Separation for the Concentration of Total and Feacal coliform in flowing Water in ppm

Location	Total coliform (Tcl) in Water (CFU)	Feacal coliform (Fcl) in Water (CFU)
20	480.33^{a}	68.33^{a}
18	521.00^{a}	12.00^{bc}
17	355.00^{ba}	11.00^{bcd}
19	351.67^{b}	19.00 ^{bc}

10	360.67[b]	10.33[abc]
12	239.00[c]	4.33[d]
07	21.67 [def]	5.67 [bcd]
14	90.00 [def]	4.00 [d]
16	328.00 [bc]	9.67[abc]
15	285.00 [bc]	1.67[d]
04	19.33 [ef]	4.00[d]
09	101.67 [de]	18.00 [bc]
13	83.33 [def]	11.00[bcd]
08	81.67 [def]	5.33[cd]
02	8.00 [f]	0[d]
06	46.67 [def]	5.27 [c]
03	10.67 [f]	1.80[d]
05	56.67 [def]	0[d]
01	16.00 [ef]	0[d]
11	111.67 [ef]	7.00 [bcd]
Mean	178.40	9.19
LSD($p<0.05$)	90.34	81.19
CV	**30.64**	**13.41**

Means followed by the same letters in columns are not significantly different at 5% probability level.

4. DISCUSSION

4.1 COLIFORM CONCENTRATION IN WATER SAMPLES

The concentration of both total coliform and fecal coliforms varied from one location of samplimg of the Nkenye stream. The highest concentration of total coliform was 521 cfu/100 ml while the least concentration was 8 cfu/100 ml with an overall mean of 178 cfu/100 ml for the whole stream. The highest mean for the feacal coliform was 68 cfu and the lowest concentration 2 cfu/100 ml with the overall mean of feacal coliform for the whole stream being 93 cfu/100 ml. The results indicated that coliform bacteria particularly feacal coliform was above the WHO standards which dictate that drinking water should have no (0 cfu/100 ml) incidence of feacal coliform. This study agrees with the finding by Ombaka *et al*. (2013) who reported that coliform bacteria were higher at Nkenye stream. Contamination of stream water by pathogenic feacal coliform is also supported by those of Karthe *et al*. (2017) and those of Olagoke and Awojobi, 2018). The higher numbers of coliform are not unusual in streams and surface water particularly where urban or agricultural runoff are channeled into the stream. The occurrences of these bacteria in water not only indicate water deterioration but also an indication of the presence of many water-borne pathogens that needs immediate attention.

5. RECOMMENDATIONS

- The local authorities particularly Tharaka Nithi county government should provide waste management disposal systems and policies that prohibit direct discharge of effluents or any industrial based wastes at the stream course.

– The county government should impose policies that outlaw cultivation along the stream or any activity that endangers the riparian zones of Nkenye stream.

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