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Full Length Research Paper

Effect of *Eichhornia crassipes* on coliforms load in small water bodies within Lake Victoria basin, Kenya

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The study investigates the effects of *Eichhornia crassipes* (water hyacinth) infestation based on coliform loads which are pollution indicator organisms. These dams have fish and the waters are commonly used for domestic purposes without any treatment hence it is necessary to check their status. Sampling was done on 25 small water bodies and from which water samples were taken for microbial determination. Membrane filtration method was used to enumerate fecal coliforms by use lauryl sulphate broth and incubated at 44 ± 0.5°C for 18 to 24 h. The results show that water bodies infested by water hyacinth harbored higher levels of fecal coliforms compared to those devoid of the weed. The high fecal coliform levels have negative impacts on the lives of communities using these water bodies. In addition, it reduces native species and disrupts food chains and nutrient cycle. The small water bodies within the Lake Victoria basin need frequent monitoring in order to give the relevant authorities concrete information for proper sensitization to the communities. Water hyacinth should also be properly managed so that it does not chock dams that are used for domestic and fishing activities.

Key words: Coliform load, infestation, pollution, local community, *Eichhornia crassipes.*

INTRODUCTION

Most of the small water bodies in the Lake Victoria basin, Kenya, were constructed by colonial government in the far flung areas to provide water for the adjacent population and their animals (Kaufman, 1992). Currently, others have risen after excavation pits left over after quarry activities especially during road constructions, and then filled with water during rainfall seasons. Besides provision of water, recent studies have revealed that these ecosystems also form important refugia for some biota, some of which are not found in Lake Victoria. Currently, water hyacinth has found its way into a number of these habitats either chocking them or displacing the

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native macrophytes. Water hyacinth (*Eichhornia crassipes*) has been grouped as one of the top 10 worst weeds in the world (Shanab et al., 2010; Gichuki et al., 2012; Patel, 2012). It is characterized by rapid growth rates, extensive dispersal capabilities, large and rapid reproductive output and broad environmental tolerance (Gichuki et al., 2010; Zhang et al., 2010). In Africa for example, water hyacinth is listed by law as a noxious weed in several countries, it is the most widespread and damaging aquatic plant species. The economic impacts of the weed in seven African countries have been estimated at between US$20 to 50 million every year. Across Africa costs may be as much as US$100 million annually (UNEP, 2012). *E. crassipes* is considered a health hazard because it is associated with several pathogenic organisms and vector diseases (Sitoki, 2001). The ecological status of an aquatic body is a function of the type and diversity of aquatic biota, the water quality and pollution while the high counts of fecal coliforms reflect the presence of other dangerous pathogenic micro-organisms that may threaten lives of the water users (Getabu et al., 1999). Since these dams are great importance to the local communities, their status in terms of portability needs to be well known. This study thus was a step towards providing baseline data on the quality of these waters and the potential health problems that may await the consumers. In doing so, total feacal coliform which is the most basic test for bacterial contamination in water pollution (Gram, 1997) was used.

MATERIALS AND METHODS

Study area and Sampling stations

All the small water bodies (SWBs) sampled were within Lake Victoria basin and were carefully selected to represent both high and low altitude. They were found at both southern and northern parts of the basin (Figure 1).

Sampling

During the expedition, a total of 25 small water bodies were surveyed and their representative samples collected for microbiological analysis. A dinghy was used to access the water bodies for the sampling of various parameters.

Microbial determination

The membrane filtration method was used during sample analysis for enumeration of coliform bacteria. A standard amount of sample/aliquot of 1 to 100 ml depending on the water turbidity was filtered through a 0.45 µm pore size sterilized membrane filter pad and the filter placed face up on the culture plate containing lauryl membrane sulphate broth and incubated at 18 to 24 h at 44°C with the use of Del agua water testing kit (OXFAM Delagua). The bacterial colonies growing on the cultured membranes were counted, and bacteriologically characterized. The coliform counts were expressed in colony forming units/ 1000 ml.

Data analysis

Statistical analysis was performed by using Minitab version 14 and PAST statistical softwares. Descriptive statistics was first done to determine the central tendency and dispersion of the data. The results for descriptive statistics were represented in table and charts. The coliform counts per station were then log transformed and subjected to one way analysis of variance (ANOVA) to test if the variation between the dams was significant at 95% confidence level. Duncan's Multiple Range Test was further done for the purpose of pairwise comparison and to test if water hyacinth actually caused a variation.

RESULTS AND DISCUSSION

Out of the 25 sampled small water bodies, 4 SWBs had water hyacinth with feacal coliform counts >300 cfus 1^{-1}, 8 SWBs had other water weeds with feacal coliform counts < 100 cfus 1^{-1} and the rest had neither water hyacinth nor weeds with no feacal coliform counts recorded. The four water hyacinth infested SWBs with high bacterial counts were, Korowe (1075 cfus), Kobodo (1795 cfus), Stella (845 cfus), and Kachila (TNTC). The 8 SWBs infestated with other water weeds and low bacterial counts were, Yenga, Mauna, Mwer, Kalenyjuok, Oyombe, Bande, Kosiga and Achune. The remaining thirteen non-infestated SWBs did not record any bacterial count (Table 1).

None of the dams without water hyacinth recorded a count exceeding 200 $cful^{-1}$. While all dams with hyacinth recorded counts above 800 $cful^{-1}$ (Figure 2). The low Coliform count dams were either infested with other water weeds or reeds with exception of Achune dam that did not have any buffer zone and had very high infiltration and siltation effect.

One way ANOVA on the log transformed data showed significant variation between the stations with water hyacinth ($F = 18.33$, $P = 0.0001$). Post hoc test grouped the SWBs with water hyacinth (Kobodo, Korowe, and Stella dams) in one sub-set while the rest were scattered in other sub-sets. This is possibly an indication that there is a common factor influencing the three. The variation in numbers between hyacinth infested and non-infested dams can be a clear indication of hyacinth influence together with other factors like surface run-off for the case of non-buffered ones. According to the World Environmental Protection Agency, surface water bodies infested by water hyacinth are at risk of being contaminated by pathogenic and non-pathogenic micro-organisms. The results obtained from the study agrees with EPA's (1989), research findings, because the calculated mean results from the tested bacteriological parameters (Korowe, Kobodo, Stella and Kachila) produced > 300 cfus in the mentioned dams (Figure 2), thus unfit for human drinking.

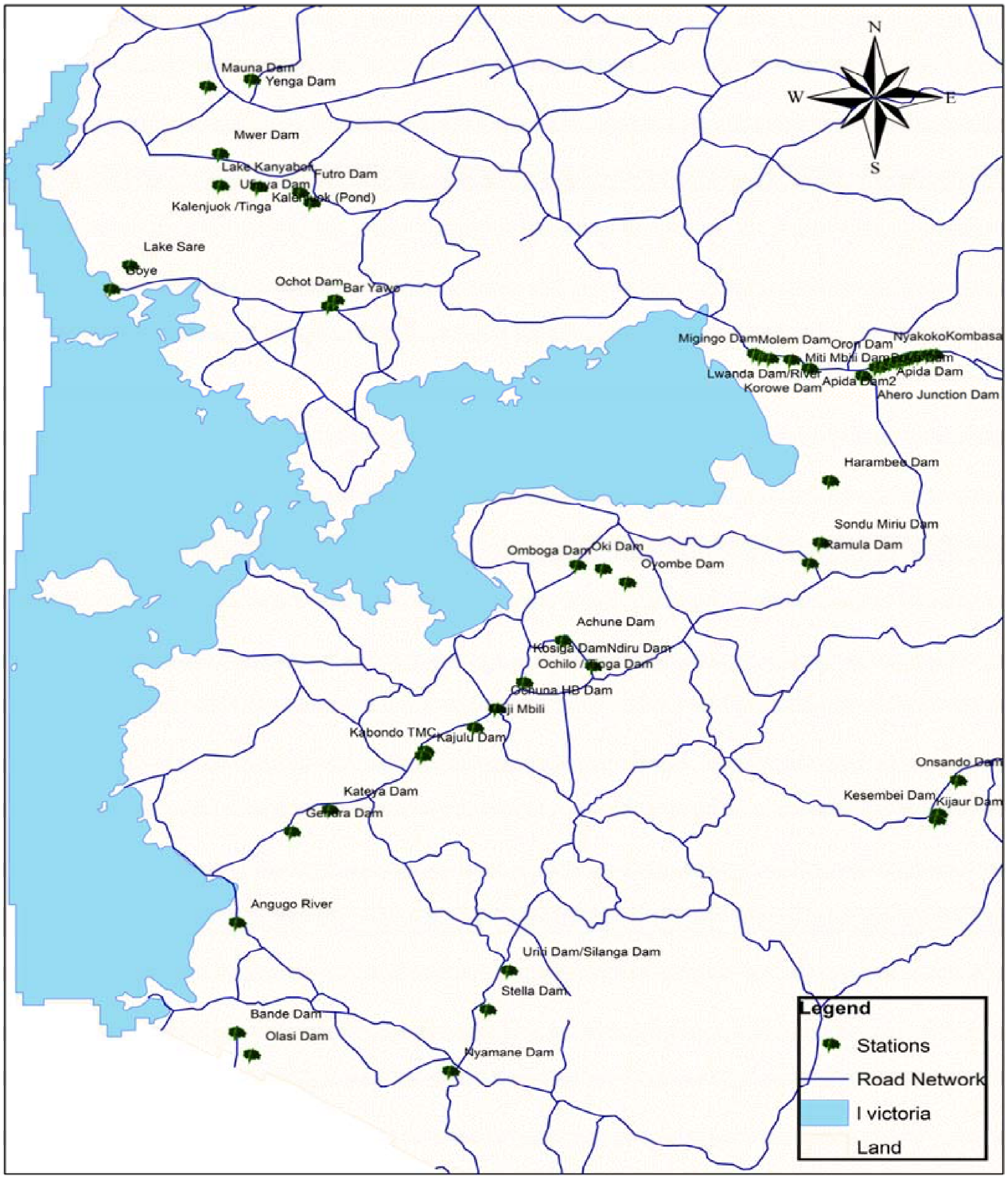

Figure 1. Map of Lake Victoria basin showing the small water bodies (SWBs) surveyed.

Based on human drinking water specifications (FAO and WHO), the values in all the dams that recorded the bactarial counts were on the higher side because coliform bacteria in drinking water should be zero coliform per 100ml of water.

The low bacteriological counts in samples from other dams (Achune, Oyombe, Bande, Kosiga, Mwer, Mauna Kalenyjuok and Yenga) infested by other aquatic plants was attributed to several factors. Some of the possible factors include presence of algae and absence of water hyacinth. According to Villamagna (2009) and Parhad and Rao (1974), water hyacinth causes decrease in algae in the system and inturn decreases pH and dissolved oxygen concentration thus, resulting in the increase of fecal coliforms. The absence of water hyacinth therefore leads to increase in algae which inturn reduces coliform loads. The presence of feacal coliforms in these dams could have thus been attributed to lots of pollutants brought in through anthropogenic activities such as domestic washing and crop cultivation. Other possible sources are very high infiltration and siltation effect, and lack of buffer zones observed around some of these water bodies. The results concur with findings reported by Mujingni (2012), FAO, (2009), and Narayan and Parveev (2000) that water hyacinth infested water bodies harbour higher number of microorganisms than

Table 1. Number of coliforms in each dam sampled (Yes and No means presence or absence of hyacinth respectively while TNTC, means the growth was too numerous to count).

Site	Status/hyacinth infestation	Mean cfu./1000 ml
Yenga Dam	No	55
Mauna Dam	No	65
Mwer Dam	No	50
Kalenjuok Dam	No	155
Ufinya Dam	No	0
Lake Kanyaboli	No	0
Lake Sare	No	0
Ochot Dam	No	0
Opoda Dam	No	0
Korowe Dam	Yes	1075
Oyombe Dam	No	75
Kobodo Dam	Yes	1795
Bande Dam	No	10
Olasi Dam	No	0
Kokech Dam	No	0
Stela Dam	Yes	845
Uriri Dam	No	0
Kosiga Dam	No	15
Achune Dam	No	110
Gesibei Dam	No	0
Kijauri Dam	No	0
Damside Dam	No	0
Harambee Dam	No	0
Ahero Dam	No	0
Kachila Dam	Yes	TNTC

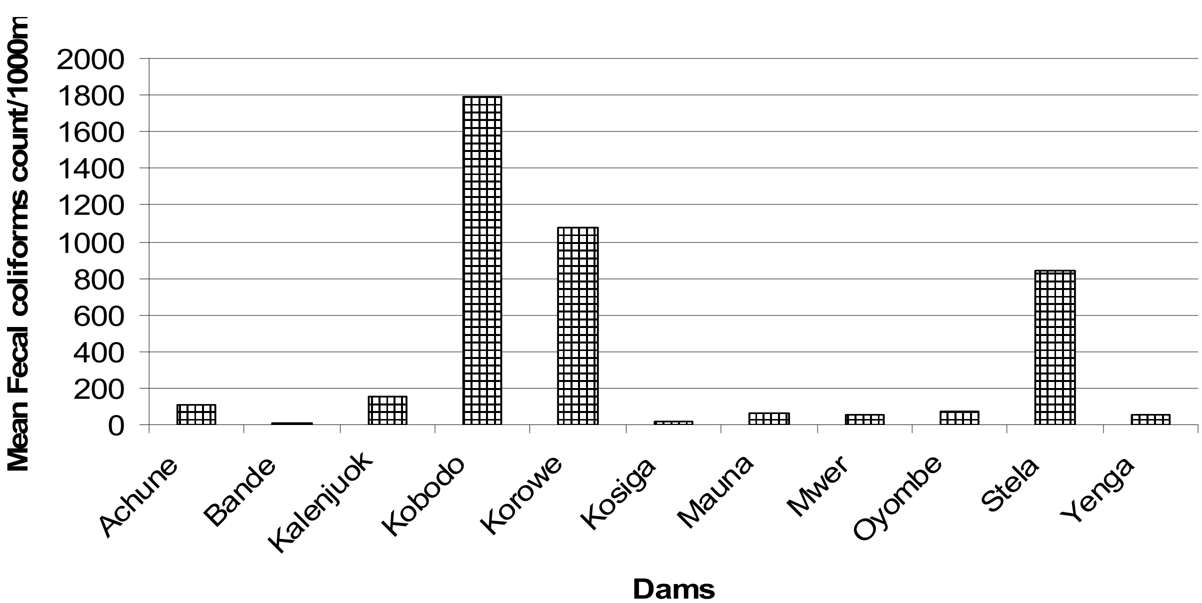

Figure 2. Coliform counts of some dams sampled within Lake Victoria basin (Dams not represented in the figure did not have any Colony Forming Units).

non- infested waters.

Conclusion and Recommendation

From the results, it is clearly seen that water hyacinth infestation had a direct influence on coliforms levels. It is therefore recommended that:

1. Water hyacinth in these four dams be removed and water treated for the safety of the consumers,
2. An experimental survey be done to check colonization pattern, rate and microbial diversity shifts.

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