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Health risks of irrigation with treated urban wastewater

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For more than three decades, Waste Stabilization Ponds (WSP) effluent has been used by people of Lemara in Arusha Municipal for irrigation of their farms in order to get better crop yields as source of their food and income. This paper attempt to examine the produce quality from wastewater irrigated areas downstream of WSP. The produce from major market and those, which irrigated by water supplied by approved water authority, were also examined.

Results have indicated that despite the wastewater used for irrigation being treated, produce from the irrigated area have shown high level of pollution threatening people's health. Moreover, there is significant pollution of vegetables taking place in the market probably due to poor hygiene practices. Contrary to research expectation, vegetables irrigated by water supply have also indicated faecal contamination although the water itself is bacteriologically safe.

Introduction

Lemara is one of the seventeen (17) wards in Arusha Municipality located in peri-urban areas Northeast of the municipality. It estimated to have a population of about 18,949 (ROSA, 2007) mostly depending on formal and informal business for their living. Urban farming is practiced in Lemara and it is estimated that 24.2% of the population depends on agricultural activities (ROSA, 2007).

Use of wastewater effluent from WSP for agricultural activities has been recognized by people of Lemara for a long time now. At beginning in the 1970's this was due to frequent drought, although later the effluent was found to have potential nutrients for the better yield of produce especially Vegetables, banana and maize. About 57 acres are currently used for the purpose of agriculture with about 100 households in the area being engaged (ROSA, 2007).

Produce from Lemara are either consumed locally in Lemara or sold in major markets at affordable price to many citizens. Besides their affordability in the Arusha municipal community this produce are abundantly available in all seasons (rain and dry) of the year.

This paper attempt to examine the extent of presence of faecal coliforms and heliminth eggs in wastewater irrigated vegetables. The performance of ponds is also evaluated against effluents discharge as per WHO guidelines (WHO, 1996). Moreover, Samples of vegetables from major market and areas irrigated with water supply were examined for comparisons purposes

Objectives

- To assess whether the WSP in Lemara is able to meet WHO water quality guidelines for the safe use of wastewater in agriculture,
- To assess whether the use of final effluent of the WSP in Lemara for crop production leads to an increased health risk and
- To assess the level of health risks associated with vegetables sold in the major market (soko kuu)

Materials and methods

Waste stabilization ponds

The Arusha Municipal WSP are located in Lemara ward at 3^0 21'S, 36^0 38'E (SSWP, 2008). They occupying less than 8 Ha and receive an average of 5,430 m^3/d of municipal wastewater (AUWSA, 2004). The overall retention time of the pond is not exceeding 29 days. The system consists of units of Anaerobic (A), Facultative (B and C) and maturation ponds (D and E) (Figure 1).

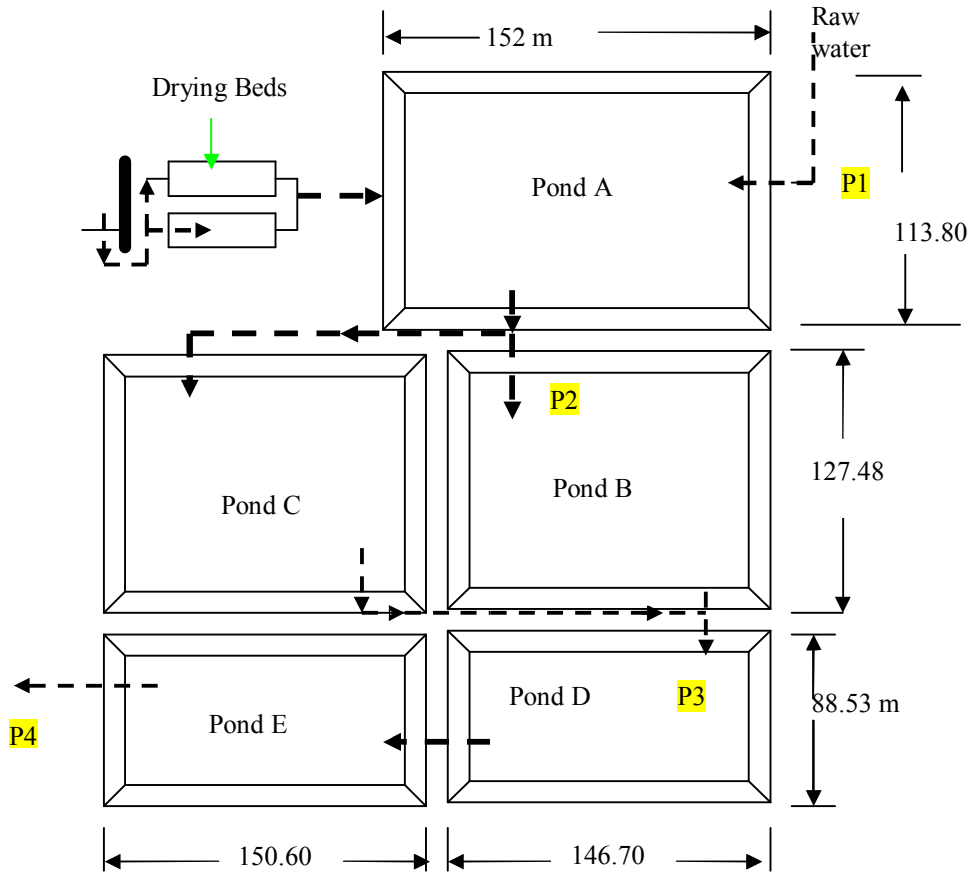

Figure 1. WSP layout in Lemara

Sampling and analysis

Selection of sample points for wastewater in WSP

Grab samples were collected at 4 different points in the pond system (Figure 1)
P1: Influent raw wastewater before entry into the Anaerobic pond system
P2: At the end of the anaerobic pond system before inflow to the facultative pond
P3: At the last facultative before inflow to the first maturation pond
P4: Final effluent before the release of effluent into the stream

Sampling time of wastewater in WSP

In order to determine the time of sample collection; a 24 hour sample schedule (8 samples in total) was set-up for Faecal Coliforms (FC) at the inflow (P1) of the WSP. Geometric mean count was determined and compared to individual count close to it along with its sampling time. Similar exercise was done for

heliminth eggs samples and arithmetic mean count was used as recommended in analysis of wastewater for use in agriculture (Ayres and Mara, 1996).

Analysis of wastewater from WSP

After establishing sampling time, Samples were collected (from P1, P2, P3 and P4) twice a month and analysed for faecal coliforms, Helminth eggs, Total Dissolved Solids (TDS), pH, Electo-Conductivity (EC) and temperature.

Samples for BOD5 and NH3 were collected on monthly basis. Each time during the day when a sample were collected a flow reading at the gauge were made. All samples were analysed based on Standard methods for the Examination of water and wastewater (APHA, 1992). Helminth eggs were analysed by modified Bailenger method (Ayres and Mara, 1996)

Selection of samples for vegetables

To investigate the impact of the WSP final effluent on food quality and consumer safety, vegetable samples were collected from July to October 2008 fortnightly. All vegetable samples collected were analyzed for both the presence of helminth eggs and faecal coliform. Similar vegetables were collected from Kilombero market and from areas irrigated by water supply and analyzed for similar parameters. Only results for green leaved vegetables (mchicha) are presented in this paper.

Analysis of vegetable samples

Composite samples of similar vegetable were collected to approximate 100-200gm. Samples were placed in sterilized plastic bags and stored in cool box transported to the laboratory for analysis. Before analysis for FC and heliminth eggs, vegetable samples were washed in sterile phosphate buffered water. 20-50mls of water was used for FC analysis and the remaining water was used for heliminth eggs analysis using modified Bailenger methods as in wastewater from the pond.

Results and discussion

WSP performance

From the 24 hours sampling, it was found out that appropriate sampling time was from 10 am to 1 pm. Based on sampling made between July and October 2008, it was observed that wastewater effluent from the pond system in Lemara is not meeting the WHO guidelines (WHO, 2006) for irrigation (Tables 1 and 2). This is posing health risks to the farmers and consumers.

Table 1. Mean values of Physical parameters and chemical parameters from WSP wastewater

Parameters	P1	P2	P3	P4	WHO
pH	7.3	6.8	7.3	7.6	6.5-8.5
Temperature (^{o}C)	21.4	20.5	20	20	-
EC (µS/cm))	1036	1515	1390	1355	-
TDS (mg/l)	642	793	781	694	-
Turbidity (TU)	722	293	254	313	-
NH3 (mg/l)	50	73	66	59	-
BOD_5 (mg/l)	705	225	135	85	<30

Table 2. Mean values of bacteriological parameters from WSP wastewater					
Parameters	**P1**	**P2**	**P3**	**P4**	**WHO**
FC (No/100mls) x 10^6	23	2.77	1.97	0.405	<0.001
Total AscarisLumbricoide (eggs/l)	166	5	3	2	<1
Total Hookworm (eggs/l)	85	11	2	1	
Hymonolepis nana (eggs/l)	63	3	2	1	
Taenia (eggs/l)	108	2	1	1	
Total triuchuris trichiura (eggs/l)	33	1	-	-	

Vegetables quality

In all cases, vegetables from the Wastewater irrigation, Vegetables from the market and vegetables from the water supply irrigation, a significant amount of FC and helminth eggs were observed. Table 3 shows the extent of presence of helminth eggs and FC in green leaved vegetable, which is highly grown in all areas of Arusha Municipal in all seasons (rain and dry).

Table 3. Mean values of bacteriological parameters for vegetable from different sources			
Bacteriological parameters (helminth eggs and FC)	**Source**		
	WSP irrigated	Market	Water supply irrigated
FC (No/100mls) x 10^3	50.9	9.5	-
Total AscarisLumbricoide (eggs/l)	-	3	4
Hookworms (eggs/l)	4	5	35
Hymonolepis nana (eggs/l)	-	-	-
Taenia (eggs/l)	-	-	-
Total triuchuris trichiura (eggs/l)	-	-	5

The presence of helminth eggs in green leaved vegetable has posed questions about possible other sources of contamination since the water supply, which is used for the purpose, was analysed and found not to have any bacteriological contamination. The pollution of vegetable in the market is associated with hygiene practice in the market whereby most of the vegetables are probably washed by water, which is not safe. Vegetables also in some cases are placed on the ground at the market before being sold to the customers.

Conclusion

From the preliminary results presented, it has been found out that WSP in Lemara is not discharging effluent, which meets WHO guidelines for irrigation. This necessitates the necessary steps to be taken by the authority in adding more ponds units (preferably maturation).

The pollution level of vegetables from Lemara is highly associated by WSP effluent, which has extremely high FC contents. The vegetables in the market are polluted by poor hygienic practices in the market probably due to poor sanitation. There are only a few water points in the market and most of the time there is no water in the taps making improper washing of vegetables. The number of toilets in the market is also questionable as compared to number of people selling their good in the market who need toilet services.

Moreover, due to high cost of acquiring the place for selling vegetables in the market (stalls), most of the vegetables, which are cheaply sold in the market, are placed on the ground making them vulnerable to contamination thorough wastewater flowing around the market due to poor drainage system.

Transportation practices to the market from Lemara and other sources are another cause of vegetable at market found to have high contamination. Vegetable are transported by either open buckets carried by people on their head or pushcarts.

Keywords

Urban farming, Waste Stabilization Ponds, wastewater irrigation, WHO guidelines

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