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Full Length Research Paper

Assessment of health risks associated with wastewater irrigation in Yola Adamawa State, Nigeria

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The study was conducted to assess the health risks from the use of wastewater for irrigation to ensure a sustainable and safer agricultural production. Samples of wastewater and lettuce wash-water were analyzed to determine the faecal coliform count and the presence of helminth eggs. Besides, the opinion of the public was seeked through the use of questionnaire. The data collected were analysed using some statistical analysis (ANOVA), correlation analysis and simple statistics. The result shows that there were significant differences ($p \geq 0.05$) among the faecal coliform counts in the wastewater of the study area. However, in the case of the lettuce wash-water, there were no significant differences ($P \geq 0.05$) among the values of the faecal coliform in the area except that of Bajabure which differed significantly from the rest. The result also shows that there was no correlation ($r = - 0.15$) between the faecal coliform in the wastewater and that in the lettuce wash-water. Helthminth eggs were found to be present in some of the wastewater and the lettuce wash-water of the study area.

Key words: Wastewater, health risk, coliform, helminth, irrigation, lettuce.

INTRODUCTION

The use of wastewater in growing crops is normally associated with some problems. One of such problems is the health hazards posed to the farmers/farm workers, crop handlers, consumers and residents around the wastewater irrigated fields. It is to be noted that wastewater normally carry a potentially dangerous loads of pathogenic organisms and other contaminants such as heavy metals that have the potentials to pose some risks to public health.

Health risks from the use of wastewater can include; the spread of infectious disease by bacteria (typhoid fever, dysentery, and tetanus), worm infections (round worm, whipworm, and tapeworm) and other diseases (Saxena and Frost, 1992). Raw wastewater frequently contains high number of faecal coliform bacteria. Blumenthal et al. (1996) reported figures as high as 200 to 300 eggs/L in Japan, 38 to 670 eggs/L in Brazil and 18 to 840 eggs/L in Morocco.

These figures indicate that the health risks associated with wastewater irrigation varies with different communities depending on the population, industrialization and life style of the people.

In communities where wastewater treatment is inadequate or non-existent (as in Adamawa state), people could be infected by drinking contaminated water, juices made with contaminated water or other beverages made with contaminated water or ice; eating food improperly handled by infected people or carriers; eating vegetables and fruits contaminated by irrigation with polluted water or fertilized with untreated sewage; eating meat or drinking milk from animals that grazed on contaminated pasture or drank contaminated water; eating fish grown, caught or harvested in contaminated water; and eating food exposed to flies or vermin that feed on or come into contact with sewage (Taylor et al., 1996).

Farmers, their families and crop consumers might be at risk, because the vegetable grown in wastewater irrigated fields are mostly eaten uncooked. Therefore, the pathogens present in wastewater can contaminate these

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vegetables and pose a health risk to consumers (Blumenthal et al., 1996). In a study in Pakistan (Feenstra et al., 2000) reported that, untreated wastewater used for irrigation contained a concentration of helminth eggs, faecal coliforms and bacteria that exceeded the WHO guideline, (WHO, 1996). These posed a high potential health risk to both farmers and crop consumers. Farmers are at higher risk because in addition to the consumption of some of the uncooked products, they had intensive contact with wastewater, as they do most of the fieldwork manually and barefooted. A significantly higher prevalence of Entamoeba hystolitica infections and diarrhoea in children was also observed in a wastewater-irrigated area in Mexico (Feenstra et al., 2000).

In evaluating health impacts of wastewater, it should be known that, it is the actual risk that make people fall ill that must be quantified and not merely the presence of pathogens in water (potential risk). Whilst potential risk may be high, the actual risk according to Feenstra et al. (2000), in addition to personal hygiene, societal and environmental factors, could depend on the time of survival of pathogen in waste water; infective dose; host immunity; and the microorganism’s ability to cause disease (Pathogenicity). The health risks are in the following order; helminthes infection > bacteria > protozoa and lastly virus (Swartzbrod, 1995; Blumenthal et al., 2000; van der Hoek et al., 2000; Dalsgard, 2001; van der Hoek et al., 2002).

In addition to the risks posed to public health by pathogens, ponds and canals used for handling wastewater may also serve as habitats for disease vectors such as mosquitoes and snails. All of these health issues have to be addressed in order to make agricultural wastewater use safer and sustainable.

In Adamawa State, irrigated agriculture is not new to the various communities that inhabit the riverbanks. They practice irrigation during the dry season to provide food crops and fresh vegetables (Ray and Bashir, 1999). However, due to increase in the discharge of wastewater and the competing demands of freshwater, the use of wastewater irrigation has become more pronounced and is now very common at the outskirts of some major towns in the state. Crops grown are mostly vegetables, such as; lettuce, cabbage amaranthus, spinach, and okra.

During the peak consumption periods of these products, there used to be outcry of rampant cases of water-related diseases and this has always been attributed to lettuce and other products from the wastewater-irrigated fields. This study is therefore conducted to access the health risks from wastewater irrigation.

MATERIALS AND METHODS

Study area

Yola (Jimeta) the Adamawa state capital is located between longitude 12° 26' E and Latitude 9° 16' N (http://www.en.wikipedia.org/wiki/Jimeta) along the banks of the River Benue (Adebayo, 1999). The state is in the Sahel region of Nigeria generally Semiarid with low rainfall, low humidity and high temperature. The climate is also characterized by high evapotranspiration especially during the dry season (Adebayo, 1999). Yola the state capital being an urban centre has an estimated population of about 200,000 people. There is high water demand for domestic as well as industrial and agricultural purposes. This explains the large amount of wastewater being produced from the town. The sources of the wastewater for the Shinco, Doubeli, Geriyo and Mayanka is from Yola (Jimeta) through some interconnected drains to the floodplain near River Benue where the wastewater is used for irrigation, while that of Bajabure is partly from the town and partly from the River Benue. The samples were collected at the point of application. The number of farmers could not be ascertained due to lack of records and the farmers practiced basin method of irrigation.

Data collection

Two methods were used for this purpose

(i) Laboratory analysis.
(ii) Determination of (excess) case of associated diseases in the study area.

Laboratory analysis

Five sampling areas were identified; they are Shinco, Doubeli, Geriyo, Mayanka and Bajabure. These areas were designated as A, B, C, D, and E.

Measurement of faecal coliform counts

From wastewater samples

From each sampling area, twenty (20) samples of one litre each were randomly collected from different points. The collected samples from each sampling points were then thoroughly mixed to get a representative sample of each area. The samples were collected during the irrigation season once a week for four weeks (26 January, 2006 to 16th February, 2006). From each representative sample, three samples of one litre each were collected in some sterile screw capped bottles rinsed with the wastewater. The samples were taken to Microbiology Laboratory of Federal University of Technology (now Modibbo Adamawa University of Technology) Yola, Nigeria in less than twenty minutes.

The samples were analysed using the membrane filtration method. Samples were filtered through a membrane filter with a pore size of 0.45 µm. the membrane filter was then placed on a pad saturated with growth medium incubated for 24 h. During the incubation, each faecal coilform bacterium developed into a yellow colony that was visibly seen. After the incubation, the yellow colonies were counted and the count per 100 ml was calculated (Table 1).

From lettuce wash-water sample analysis

Twenty (20) grams of lettuce were randomly collected from five points in each of the sampling areas. The collected samples for each of the sampling area were mixed together as representative samples of the respective sampling areas. These representative samples were taken in some sterile plastic bags immediately (less than 20 min) to the Microbiology Laboratory of Modibbo Adama University of Technology Yola. In the Laboratory each representative sample of the lettuces were washed in four litre of

Table 1. Faecal coliform bacteria in wastewater samples.

Location	Number of faecal coliform / 100 ml				
	Week 1	Week 2	Week 3	Week 4	Mean/week
Shinco	370	270	280	287	300[b]
Doubeli	337	327	317	284	316[a]
Geriyo	234	240	190	234	225[e]
Mayanka	277	254	227	247	251[d]
Bajabure	301	275	258	307	285[c]
LSD(0.05)	46.0	41.0	60.0	34.3	45.3

Mean with the same letters are not significantly different at $P \geq 0.05$.

Table 2. Faecal coliform bacteria in lettuce washwater.

Location	Number of faecal coliform / 100 ml				
	Week 1	Week 2	Week 3	Week 4	Mean/week
Shinco	90	110	124	97	105[a]
Doubeli	90	104	120	104	104[a]
Geriyo	97	97	104	104	100[a]
Mayanka	97	107	110	97	103[a]
Bajabure	27	37	37	37	35[b]
LSD(0.05)	19.3	16.9	16.7	16.7	17.3

Means with the same letters in the same column are not significantly different at $P \geq 0.05$.

distilled water. Three potions of the washed-water from each representative sample were collected and analysed as described for the wastewater. The result is presented in Table 2.

Determination of helminth eggs

For this purpose the presence-absence tests was adopted to determine the level of contamination.

Determination of (excess) cases of associated diseases in the study area

Questionnaire administration

Two hundred questionnaires aimed at seeking the public opinions on the health risk related to wastewater irrigation were administered with the help of some trained personnel. The questionnaires were directed towards the following target groups, Farmers/farm workers; crop handlers; health personnel; and general public (consumers).

Fifty questionnaires were randomly distributed to each of the above target groups.

Method of data analysis

Analysis of variance ($p \geq 0.05$), correlation analysis and simple percentages were used to analyse the data collected from which inferences were drawn.

RESULTS AND DISCUSSION

Faecal coliform counts

The faecal coliform counts in the water samples of the study area (Table 1) indicated that there were significant differences ($p \geq 0.05$) among the values of coliform counts. Wastewater from Doubeli had the highest value of faecal coliform counts (316 FC /100 ml) while Geriyo had the lowest value (225 FC/100 ml), this is similar to the results obtained by Ensink et al. (2002).

The faecal coliform counts in the lettuce wash-water (Table 1) ranged between 35 and 105 FC/100 ml. The result indicates that lettuce samples collected from Bajabure recorded the lowest value (35 FC/100 ml) and this differ significantly from the ones collected in other sampled areas. Shinco lettuce had the highest coliform counts (105 F.C/100 ml) but the value does not differ significantly from those in Doubeli, Geriyo and Mayanka.

Microbial analysis carried out also indicated presence of helminth eggs in the wastewater and the corresponding lettuce wash-water except the one from Bajabure.

Though it was gathered from the public in the study area that wastewater irrigated vegetables could be among the major causes of water borne diseases (Table 5); the correlation analysis (Table 3) shows that there is a

Table 3. Correlation analysis between wastewater samples and Lettuce wash-water samples.

Source	Water sample	Lettuce sample
Wastewater sample	1	-0.149
Lettuce wash-water sample	- 0.149	1

Table 4. Presence of Helminth eggs.

Source	Shinco	Doubeli	Geriyo	Mayanka	Bajabure
Wastewater	Present	Present	Present	Present	Absent
Lettuce wash-water	Present	Present	Present	Present	Absent

Table 5. Data from the questionnaires on Health risk of Wastewater Irrigation.

Respondents	Level of agreement				
	Strongly agree	Agree	Disagree	Strongly disagree	Row total
Farmers	16(28.75)	10(6.25)	20(11.00)	4(4.0)	50
Crop handlers	14(28.75)	8(6.25)	22(11.00)	6(4.0)	50
Health personnel	45(28.75)	3(6.25)	2(11.00)	0(4.0)	50
Consumers	40(28.75)	4(6.25)	0(11.00)	6(4.0)	50
Total	115	25	44	16	200

Source: Field Survey (2006).

weak or near no correlation (r = - 0.15) between the faecal coliform counts in the wastewater samples and the amount of coliforms in the corresponding lettuce. This may mean that faecal coliform in the wash-water could be as a result of contamination during handling or due to the method irrigation practiced. Hence consumption of the wastewater irrigated vegetables could not be one of the causes of the water bone diseases.

Evaluation of heath impact of wastewater as irrigation water

The values of the faecal coliforms in wastewater in all the study area are within the WHO guideline for restricted irrigation of <=1000 F.C./100 ml (WHO, 1996; Pescod, 1992). The values are, however above the potential risk values of 100 to 105 F.C. / 100 ml for the unrestricted irrigation (WHO, 1996, Blumenthal et al., 2001). This indicates that the wastewater in the study areas has low potential risk values that could pose risk to public health. However, the faecal coliform of the lettuce wash-water (taken as the actual risk) in most of the areas are below the World Health Organization potential risk values (WHO, 1996). This shows that the wastewater can be safely used for irrigation under good management, such as; the use of furrow method of irrigation, the use of waste stabilization pond or the use of wetlands with aquatic plants, which should be supplemented by other health protection measures (Blumenthal et al., 2001).

From the survey, 70% of the respondents are of the opinion that wastewater irrigation posed risk to public health, this result is similar to that obtained in Sangodoyin (1992). Most of those that agree with the statement “wastewater irrigation pose risk to public health” are the health personnel and the consumers. This can be attributed to their knowledge of human health and their experiences in water related ill-health. Those that disagreed with the statement are mostly the farmers and crop handlers. These are into the business that involves irrigating with wastewater.

From the study (Tables 1 to 5 and Figure 1), farmers, consumers, health personnels have diverse opinion on the health risk of using wastewater for irrigation.

Conclusion

The prevalence of water borne diseases during the irrigation season is a major concern. But this could not be linked to the consumption of wastewater irrigated crops, unless assessments of other risk factors are made.

The study revealed that, wastewater in the study area has low actual risk values and could not be the major cause of the water borne and water related diseases during the irrigation season. Hence the wastewater could be used for wastewater irrigation and the crops so produced can be consumed with proper handling and good preparation. The study also revealed that the faecal coliform found in the wash-water (actual risk values) could be as a result of contamination through handling and the use of basin irrigation method by the farmers in

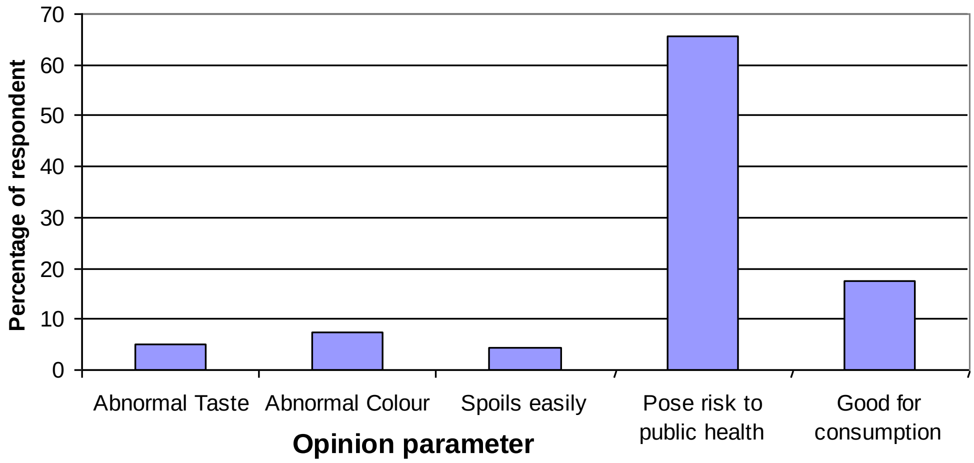

Figure 1. Personal opinion on crops irrigated with wastewater.

the study area. This encourages intimate contact between the lettuce and the wastewater.

RECOMMENDATIONS

(i) Furrow methods of irrigation are recommended instead of the present basin (the sunken bed) method to reduce the level of product contamination.
(ii) Harvesting of crops irrigated with wastewater should be done four days to one week after irrigation. This will ensure that harvesting is done when the soil is not wet.
(iii) Farmers and crop handlers should ensure frequent use of protective covers (for example, hand gloves) and other health protective measures.
(iv) Sound environmental and personal hygiene should be observed.
(v) Ensure that vegetables from the wastewater irrigated areas are washed thoroughly (with brine) before consumption.
(vi) Similar study could be undertaken in almost every community for sustainable wastewater irrigation.

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