DETERMINATION OF HEAVY METALS AND ENTERIC BACTERIA IN WATER SERVED FOR HAND-WASHING PURPOSE BY FOOD VENDORS IN ILARO

Faparusi, Foluso
Science Laboratory Technology Department, Federal Polytechnic, Ilaro, Ogun State
Corresponding author: foluso.faparusi@federalpolyilaro.edu.ng, Phone: 08057896944

ABSTRACT

Water served as hand-washing-water by food vendors in Ilaro metropolis was assessed for presence of heavy metals and enteric bacteria. Twenty (20) water samples were collected from ten popular food vending sites in Ilaro town, and each site was sampled twice. The food vendors were classified into four categories based on the type of vending sites: roadsides, open air, closed/roofed and restaurants. The bacteriological analysis of the water samples was carried out using pour plate technique while assessment of the samples for heavy metals was by atomic absorption spectroscopy (AAS). The total viable count (TVC) and total coliform count ranged from 4. 0 x 10^5 - 2.2 x 10^7 cfu/ml and 2.4 x 10^2 - 4.0 x 10^3 cfu/ml. respectively. The Salmonella-Shigella count ranged from 0.2 x 10^2 - 1.0 x 10^2 cfu/ml. Presence of Lead (0.015 – 4.70 mg/l), and Cadmium (0.13 – 0.23 mg/l) was recorded in some of the water samples but there was no presence of Copper. *Escherichia coli*, E*nterobacter* sp. and *Salmonella* sp. were isolated from some of the water samples. The presence of these bacteria and heavy metals in the water samples is of public health concern. Therefore, the food vendors should be educated by the relevant agency of government, about the health implication of this to their customers and long term effect on their businesses.
Keywords: Food, water, metals, bacteria, health implication.

Introduction

Water is a free gift of nature and plays important roles in the life of living things (Faparusi *et al*., 2011). The quality of water is determined by its chemical and microbial components, although water cannot be totally free from metals/ion and microorganism but those could adversely affect humans should within the acceptable limit. According to the WHO Guidelines, water for drinking must devoid of anything can affect the health of the consumer over a lifetime of consumption (WHO, 2011). The uses or consumption of water should not pose any challenge to humans' wealth being. Therefore for water to be adjudged safe for drinking, such water must be colourless, tasteless, and free from harmful chemicals as well as other suspended materials and most importantly should be devoid of disease-causing organisms. Consumption of contaminated water or food may result in foodborne illness, which remains a major public health problem affecting about one-third of the population in developed countries (Berhanu *et al*., 2021).

Waterborne pathogens are usually enteric microorganisms which include most bacteria, viruses, protozoa and helminthes.

Enteric organisms are those organisms that are associated with intestinal tract of human and animals; they include the pathogenic and nonpathogenic types. Most enteric bacteria are not pathogenic. The presence of nonpathogenic enteric is usually used to indicating the likelihood of enteric pathogen(s) in water and foods. Enteric bacteria include *Escherichia coli, Klebsiella, Enterobacter, Salmonella, Shigella, Clostridium* and *Campylobacter jejuni*. Most times enteric bacteria enter the body through oral route by consumption of water or foods contaminated with faecal material. Enteric bacteria also enter the body through indirect means such use of contaminated water to wash hands or plates. Enteric bacteria are the major causes of food-borne gastroenteritis in humans and remain important public health issues across the globe (Getie *et al*., 2019).

The health burden caused by chemical constituent of water is not the same as that of biological constituents, they cause adverse health problems after prolong periods of exposure. More so, there are other chemical constituents of water that can lead to disease condition after singe exposure (WHO, 2008). The chemical constituents of water that adversely affect humans' health are the heavy metals. These metallic elements are naturally occurring in water and have atomic weight greater than 40.04 and are toxic or poisonous at low concentration (Ming-Ho, 2005). Examples of heavy metals include mercury (Hg), cadmium (Cd), zinc (Zn) arsenic (As), thallium (Ti) and lead (Lb). The distribution of metals in the environment is governed by the properties of the metal and influences of environmental factors (Khlifi & Hamza-Chaffai, 2010). Heavy metals enter the environment by natural and anthropogenic means. The effects of exposure heavy metals on human health are diverse but are not limited to, neurotoxic and carcinogenic actions (Jomova & Valko, 2011). Most times emphasis is usually on foods and drinking water safety without required attention on water for washing hands, this study aimed at determining the quality of water for washing hands in public places.

Materials and Methods

Samples Collection

A total of twenty (20) water samples were collected from ten popular food vending sites in Ilaro town, in Yewa-South Local Government of Ogun State. Each site was sampled twice. Samples of bacteriological analysis were collected using sterile bottles of 500 mL capacity. The samples bottles were properly coded to reflect the sites of collection. The food vendors were classified into four categories based on the type of vending sites: roadsides, open air, closed/roofed and restaurants. Samples for the analysis of heavy metals determination (copper, cadmium, and lead) were collected in polyethylene bottles, cleaned and rinsed with distilled water several times. The samples were transported to the laboratory in a portable icebox within 6 h and stored at 4^{o}C in a refrigerator until chemical, and bacteriological analyses were carried out.

Digestion of Samples and Determination of Heavy Metals

The sample (500ml) was measured into kjeldahl flask using measuring cylinder and 5ml of concentrated HNO_3 was added to the sample and boiled using heating mantle. When the sample volume has been reduced to 50ml, it was then removed from the heating mantle and placed in 50ml standard flask and make up to mark with distilled water and finally placed in a plastic sampling bottle and labelled (APHA, 1998). Lead, copper and cadmium content of the samples were determined using atomic absorption Spectrometer (Model: Bulk 210 VGP) according to APHA, 1998.

Bacteriological Analysis

The bacteriological analysis of the samples was carried using pour plate method as described by Okonko *et al*. (2009). The samples were plated on Nutrient agar (Total Viable Count, TVC), MacConkey agar (Total Coliform Count), and *Salmonella*/*Shigella* agar (*Salmonella* and *Shigella* count) under aseptic condition. The plates were incubated at $35\pm^{o}$C for 24 h. The colonies were enumerated using colony counter and the colonies were subculture in order to obtain pure culture, and maintained on agar slant (4^{o}C) until further analysis. The pure isolates were identified using conventional method on the basis of their colonial, physiological and biochemical characteristics. Bergey's Manual of Determinative Bacteriology was used as reference (Holt *et al*., 1994)

Results

The results of bacteriological analysis and heavy metals determination are presented in Table 1. The total viable count (TVC) and total coliform count ranged from 4. 0 x 10^5 to 2.2 x 10^7 cfu/ml and 2.4 x 10^2 to 4.0 x 10^3 cfu/ml respectively. The least TVC (4. 0 x 10^5 cfu/ml) was recorded in sample D1 while the highest TVC (2.2 x 10^7 cfu/ml) in sample J2. Samples D2 and J2 showed least and highest total coliform counts respectively. The Salmonella-Shigella count ranged from 0.2 x 10^2 - 1.0 x 10^2 cfu/ml, sample B2 recorded the least count while the highest total coliform count was in sample F1. Only samples B2, C2, D2, E1, F1, G1, J1 and J2 showed presence of *Salmonella*. Presence of Lead (0.015 – 4.70 mg/l), and Cadmium (0.13 – 0.23 mg/l) was recorded in some of the water samples but there was no presence of Copper. Lead was present in sample A1, A2, F1, G1, and G2. More so, cadmium was found in samples A1, A2, B1, B2, D1, D2, G1, G2, I1 and I2. Samples with different alphabet were collected from different sites. *Escherichia coli*, E*nterobacter* sp. and *Salmonella* sp. were isolated from some of the water samples.

Table 1: Bacterial loads, heavy metals and isolates from water samples

Sample	Average Bacterial Load (cfu/ml)			Heavy Metal (mg/ml)			Isolate			
	TVC	Coliform	S/S	Pb	Cd	Cu	*Esc.*	*Ent.*	*Shig*	*Salm.*
A1	$3.1x10^5$	Nil	Nil	0.020	0.20	Nil	–	–	–	–
A2	$2.0x10^6$	$2.5x10^2$	Nil	0.020	0.15	Nil	+	–	–	–
B1	$2.3x10^6$	Nil	Nil	Nil	0.20	Nil	–	–	–	–
B2	$2.1x10^6$	$2.1 x10^3$	$2.0 x10^1$	Nil	0.21	Nil	+	–	–	+
C1	$4.0x10^6$	Nil	Nil	Nil	Nil	Nil	–	–	–	–
C2	$2.1x10^6$	$3.0 x10^3$	$3.0 x10^1$	Nil	Nil	Nil	+	+	–	+
D1	$3.0x10^5$	Nil	Nil	Nil	0.13	Nil	–	–	–	–
D2	$3.2x10^5$	$2.4 x10^2$	Nil	Nil	0.14	Nil	+	+	–	–
E1	$1.2x10^7$	$2.6 x10^2$	Nil	Nil	Nil	Nil	–	–	–	–
E2	$4.0x10^5$	Nil	Nil	Nil	Nil	Nil	–	–	–	–
F1	$4.2x10^5$	$4.0 x10^3$	$1.0 x10^2$	Nil	Nil	Nil	+	–	–	+
F2	$2.1x10^7$	Nil	Nil	0.015	Nil	Nil	–	–	–	–
G1	$2.0x10^7$	$3.0 x10^3$	$4.0 x10^1$	4.700	0.17	Nil	+	–	–	+
G2	$3.0x10^6$	Nil	Nil	4.650	0.13	Nil	–	–	–	–
H1	$3.1x10^6$	Nil	Nil	Nil	Nil	Nil	–	–	–	–
H2	$3.4x10^6$	Nil	Nil	Nil	Nil	Nil	–	–	–	–
I1	$2.1x10^7$	Nil	Nil	Nil	0.20	Nil	–	–	–	–
I2	$5.0x10^6$	Nil	Nil	0.015	0.23	Nil	–	–	–	–
J1	$4.2x10^6$	$3.0 x10^3$	Nil	Nil	Nil	Nil	+	+	–	–
J2	$2.2x10^7$	$4.0 x10^3$	$3.0 x10^1$	Nil	Nil	Nil	+	+	–	+

Key: Esc: *Escherichia coli*, Ent: *Enterobacter* Shig: *Shigella*, Salm: *Salmonella*, TVC: Total viable count, S/S: Salmonella/Shigella count, +: present and –: absent

Discussion

Most of the water samples showed high total bacterial load, this might be due to improper treatment. Although the water samples were collected food sites that use the water for hand washing, high microbial load recorded above standard for potable water (5×10^5 cfu/ml) in most of the samples is of great concern to the costumers that patronized the food Vendor. Since the hands that are supposed to be washed are being inoculated with microorganisms and indirectly the organisms will find their ways into the body during eating. High microbial load recorded in most of the water sample could be due contamination of the water sources or post contamination. Various authors have reported high microbial loads in water used for various purposes. High microbial load could due to biofilm formation in the storage tanks used by the vendors. Improper hand washing can lead to food borne diseases (Bryan *et al*., 1988).

More so, the presence of coliforms in some of the water sample in an indication of faecal contamination and poor personal hygiene. Since coliforms were present in some of the samples is an indication that the water used by the vendors is not safe for hand washing, it might lead to foodborne illnesses. Likewise present of *Salmonella* in some of the water sample is of great concern; *Salmonella typhi* and *Salmonella paratyphi* are etiology agents of food infections.

Presence of Pb and Cd in the water samples could also be due to human activities and runoff. Heavy metals are responsible of neurotoxic and carcinogenic problems (Jomova & Valko, 2011).

Conclusion

High microbial load was recorded in most of the water samples that is above the microbiological standard for potable water. The presence of *Salmonella* and heavy metals in some of the water samples could pose a great threat to people that patronize the food vendors. Therefore emphasis should also be put into provision and use of potable water for hand washing by the vendors and customers that patronized them in order to guide against foodborne infection.

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