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Comparative Bacteriological Assessment of Input and Output Water From Tanker Trucks

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Abstract

Due to inadequate pipe borne water supply, people tend to make up for the shortfalls by buying potable water from tanker trucks. However, most of these tanker trucks are also used for non-potable water, and this poses serious threat to the health of the consumers. This work assesses the bacteriological and physicochemical qualities of input and output water from different tanker trucks. This investigation was carried out at Agba Dam, Ilorin, Kwara State, Nigeria over a period of five weeks within the months of January and February, 2011. Water samples were taken from the overhead source and from the tanker trucks and analyzed for bacteriological and physicochemical characteristics. The pH, residual chlorine, suspended solids and total hardness of the input water ranged from 7.40 - 7.87, 3.55 – 4.40mg/l, 0.01 – 0.02g/100ml, and 64 – 120mg/l respectively before while the corresponding values for output water ranged from 7.39 – 7.87 for pH, 3.55 – 4.40mg/l for residual chlorine, 0.01 – 0.04g/100ml for suspended solids, and 70 – 124mg/l for total hardness. The bacterial, total coliform, and faecal coliform counts of the input water ranged from 1.9×10^1 to 3.8×10^2 cfu/ml, 3 to 48 coliform/100ml, and 0 to 30 cfu/ml respectively while the corresponding values of output water were 8.0×10^1 to 2.4×10^3 cfu/ml, 3 to 28 coliform/100ml, and 0 to 40 cfu/ml respectively. The input and output water from tanker trucks differed in quality. It is more practicable for the consumer to assume responsibility for the safety of water they consume. Point of use interventions can be adopted to ensure portability of the water.

Keywords: truck, water, input, output, Quality

1. Introduction

Potable water must be kept and maintained under clean conditions free from contaminants to ensure product quality and acceptability (Debby and Cloete, 2009). Water is the most valuable natural resources and all life on earth has depended on water since the first single-celled organism appeared 3.3 billion years ago (Olayemi *et al.,* 2007). Human use of water resources include for domestic, agricultural, industrial, recreational and navigational purposes. Water being an essential commodity for the survival of all organisms and it is an

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important life sustaining drink to humans (Wolfe, 2001). Water fit for human consumption is called drinking or potable water, which has been described as water of significantly high quality that can be consumed or used without risk of immediate or long-term harm.

Water quality varies widely from source to source especially in most developing countries like Nigeria, therefore, The National Public Health Services has established certain standards for drinking water (WHO, 2004). Humans require water that does not contain toxic impurities (Luanne and Langley, 2001). The microbiological quality of drinking water is of great importance and the monitoring of bacterial indicators such as total coliforms and thermo-tolerant coliforms should be given the highest priority (WHO, 2003). Verification of microbial qualities of drinking water include test for *E. coli* as an indicator of faecal pollution and should not be present in drinking water. The standard procedure for distribution of treated water from treatment plant is through underground pipes to various end users. However, due to inadequate or damaged pipelines, treated water is also being conveyed by tanker trucks to different households (SON, 2007; WHO, 2008).

This research is justified because there is need to investigate the quality of water conveyed by water tanker trucks being supplied to many homes that lack access to water distribution pipes from the municipal water corporation. All the water samples for this study were collected from tanker trucks that have the inscription, ‘’for treated water only’’ boldly written on their tanks. Hence, these tank trucks were supposed to be used for conveying potable water only. The present work seeks to assess the bacteriological and physicochemical quality of the input and output water from tanker trucks.

2. Materials and Methodologies

Collection of water samples

Different tanker trucks collecting and conveying water from Agba Dam Water Treatment Plant, Ilorin, Kwara State, Nigeria as well as the overhead water input from which the tanker trucks were being fed with water served as the sampling points. The input water from the overhead pipe, and the output water samples from different tanker trucks were collected over a period of 5 weeks according to standard methods (APHA, 1998; Fawole and Oso, 2004). Output water samples were collected only from tanker trucks designated for treated water only by their operators.

Physicochemical Analyses

The pH, total hardness, suspended solid, and free residual chlorine of the overhead input and output water samples from the tanker trucks were determined according to standard methods (APHA, 1998). The pH of the water samples were determined using digital pH meter which was standardized by means of buffers 4, 7 and 9 before using this equipment. The total hardness was determined by titrating 100ml of the water sample with 0.1N EDTA using erichrome black-T as indicator. The end point was reached when the solution turned from purple to light blue. The titre value was multiplied by 100 to get the total hardness in mg/l.

Whatman filter paper was dried in an oven for 1 hour at 105^oC and its initial weight, W_1 was determined. The filter paper was then folded and used to filter 100ml of the water sample. Thereafter, the filter paper was weighed again to obtain W_2. The difference in weight between W_2 and W_1 gives the amount of suspended solids in g/100ml.

The residual chlorine content of the water sample was determined by adding 2ml of 5% potassium chromate indicator to 100ml of the water sample and the resulting yellow solution was titrated with 0.1N $AgNO_3$ until faint pink end point was obtained. The titre value obtained was multiplied by 3.55 to obtain the residual chlorine content in mg/l (BP, 1993).

Bacteriological Analyses

The bacterial, total coliform and faecal coliform counts of the overhead input and output water samples from the tanker trucks were determined according to standard methods (Fawole and Oso, 2004; Willey *et al.,* 2008). The bacterial counts were determined by standard plate count using nutrient agar while the total coliform counts were determined by most probable number (MPN) method using MacConkey broth. The faecal coliform counts were determined by pour plate technique with eosin methylene blue agar as the choice medium.

Statistical Analyses

The input water and output water from each tanker truck were sampled three times in order to determine variations in their physicochemical and bacteriological characteristics. The mean coupled with standard error of mean for each parameter determined was computed using SPSS 15.0 statistical analysis package. The means obtained were analyzed statistically using students' T-test to determine the level of significance between the input and output water samples.

3. Results and Discussion

Physicochemical characteristics

The physicochemical properties of the different water samples: pH, residual chlorine, suspended solids and total hardness are as shown in Table 1. It was observed that the pH, residual chlorine, suspended solid, and total hardness of the input water ranged between 7.40 - 7.87, 3.55 – 4.40mg/l, 0.01 – 0.02g/100ml, and 64 – 120mg/l respectively while their corresponding values for output ranged between 7.39 – 7.87, 3.55 – 4.40mg/l, 0.01 – 0.04g/100ml, and 70 – 124mg/l respectively. The values of the different physicochemical parameters of the water samples tend to be the same or higher in the output water in at least 50% of the water samples. The results obtained were significantly different statistically. These could be attributed to contamination of the tanker trucks by physical, chemical or biological agents. Also, contamination of the hoses of the water tank by the operator is a major cause of turbidity in the water especially when they dragged it on the floor during linking or dismantling of the hoses. Furthermore, some of the operators might be using the same truck meant for treated water for collection of water from non-potable sources like a river. Gibbs (1990) reported that as the suspended solids, and organic matter in water increases, the number of bacteria also increases. The hardness of the water samples are in compliance with the standards of SON (2007) which is 150mg/l for potable water. According to SON (2007), the maximum permitted level for pH is 6.5 to 8.5; total solids 0.05g/100ml (which is equivalent to 500mg/l); and residual chlorine content 0.2 to 2.5 mg/l for potable water. The values of pH and suspended solids of the water samples were within the limit allowed. In a study Sule et al. (2009) obtained a pH range of 6.59 - 7.43 and residual chlorine contents which ranged from 0.92 – 1.07 mg/l for treated water samples within Ilorin metropolis, Nigeria. The high values of residual chlorine obtained in this present study are undesirable and it might be done deliberately to cope with the anticipated high level of contamination due to poor sanitary conditions.

Table 1: Physicochemical characteristics of the input and output water samples from the tanker trucks

Water sample	pH		Residual Chlorine (mg/l)		Suspended solid (g/100ml)		Total hardness (mg/l)	
	BF	AF	BF	AF	BF	AF	BF	AF
A	7.71[a] ±0.01	7.47[b] ±0.02	3.98[a] ±0.01	3.98[a] ±0.02	0.01[a] ±0.002	0.01[a] ±0.001	70[a]±1.0	76[b]±2.0
B	7.80[a] ±0.02	7.80[a] ±0.01	4.40[a]± 0.02	4.40[a]± 0.01	0.01[a] ±0.003	0.01[a]± 0.002	80[a]±4.0	120[b]±10
C	7.73[a]± 0.02	7.73[a]± 0.01	3.55[a]± 0.01	3.55[a]± 0.02	0.01[a]± 0.002	0.02[b]± 0.001	84[a]±4.0	70[b]±3.0
D	7.69[a]± 0.01	7.69[a]± 0.02	3.69[a]± 0.02	3.91[b]± 0.01	0.01[a]± 0.001	0.01[a]± 0.002	70[a]±2.0	70[a]±3.0
E	7.87[a]± 0.01	7.85[b]± 0.02	3.91[a]± 0.02	4.12[b]± 0.01	0.02[a]± 0.001	0.02[a]± 0.002	64[a]±2.0	70[b]±3.0
F	7.83[a]± 0.02	7.87[b]± 0.01	3.98[a]± 0.01	4.12[b]± 0.02	0.01[a]± 0.002	0.02[b]± 0.001	76[a]±2.0	70[b]±4.0
G	7.46[a]± 0.01	7.49[b]± 0.02	4.33[a]± 0.02	3.83[b]± 0.01	0.01[a]± 0.001	0.01[a]± 0.003	70[a]±2.0	84[b]±4.0
H	7.53[a]± 0.01	7.43[b]± 0.02	3.83[a]± 0.02	3.55[b]± 0.01	0.02[a]± 0.002	0.04[b]± 0.001	84[a]±3.0	80[b]±2.0
I	7.43[a]± 0.02	7.39[b]± 0.01	3.83[a]± 0.01	3.55[b]± 0.02	0.01[a]± 0.002	0.01[a]± 0.001	120[a]±5.0	116[b]±3.0
J	7.40[a]± 0.01	7.40[a]± 0.02	3.83[a]± 0.02	3.98[b]± 0.01	0.01[a]± 0.002	0.02[b]± 0.001	116[a]±2.0	124[b]±3.0

Mean ± standard error of mean

Mean values followed by different alphabets for the same parameter are significantly different at 95% confidence level using T- test statistical analysis.

Key: BF= water input into tanker truck; AF= water output from tanker truck.

Table 2: Bacteriological counts of the input and output water samples from the tanker trucks

Water sample	Bacterial count (cfu/ml)		Total coliform count (MPN/100ml)		Faecal coliform count (cfu/ml)	
	BF	AF	BF	AF	BF	AF
A	$50^{a}±5.0$	$2400^{b}±50$	$7^{a}±1.0$	$28^{b}±2.0$	$0^{a}±0.0$	$20^{b}±2.0$
B	$220^{a}±20$	$360^{b}±15$	$7^{a}±2.0$	$28^{b}±1.0$	$0^{a}±0.0$	$24^{b}±2.0$
C	$170^{a}±10$	$210^{b}±10$	$48^{a}±3.0$	$3^{b}±1.0$	$0^{a}±0.0$	$10^{b}±3.0$
D	$380^{a}±20$	$1900^{b}±50$	$14^{a}±3.0$	$7^{b}±1.0$	$0^{a}±0.0$	$0^{a}±0.0$
E	$80^{a}±10$	$150^{b}±5$	$3^{a}±1.0$	$7^{b}±2.0$	$0^{a}±0.0$	$0^{a}±0.0$
F	$19^{a}±3$	$80^{b}±5$	$3^{a}±1.0$	$9^{b}±2.0$	$10^{a}±3.0$	$20^{b}±4.0$
G	$280^{a}±10$	$470^{b}±20$	$20^{a}±3.0$	$28^{b}±2.0$	$30^{a}±5.0$	$40^{b}±4.0$
H	$160^{a}±10$	$340^{b}±20$	$7^{a}±1.0$	$7^{b}±2.0$	$24^{a}±4.0$	$24^{b}±3.0$
I	$100^{a}±10$	$150^{b}±20$	$3^{a}±1.0$	$7^{b}±3.0$	$0^{a}±0.0$	$20^{b}±2.0$
J	$120^{a}±10$	$220^{b}±20$	$3^{a}±1.0$	$9^{b}±2.0$	$0^{a}±0.0$	$16^{b}±2.0$

Mean ± standard error of mean

Mean values followed by different alphabets for the same parameter are significantly different at 95% confidence level using T- test statistical analysis

Key: BF=water input into tanker truck; AF= water output from tanker truck

Bacterial counts of the water samples

The total coliform counts of the water samples ranged from 3 to 48 and 3 to 28 coliform/100ml before and after being fed into tanker trucks while their corresponding faecal coliform counts ranged from 0 to 30 and 0 to 40 cfu/ml respectively (Table 2). The bacterial counts ranged from 1.9×10^1 to 3.8×10^2 in the input water and 8.0×10^1 to 2.4×10^3cfu/ml in the output water (Table 2). In all the water samples, the bacterial loads of the output water from the tanker trucks were higher than the input loads. Similarly, the total and faecal coliform loads of the output water from the tanker trucks were equal to or higher than the input loads in at least 80% of the water samples. Thirty percent of the input water and ten percent of the output water met SON (2007) which permitted 100cfu/ml for heterotrophic bacterial count. None met the established standard of Standards Organization of Nigeria (SON) for total coliform, which required zero cfu/ml but some conformed with the standard of (WHO, 2003) which permitted presence of coliform not greater than 10 coliform/100ml of water. Only 70% of the input water samples and 20% of the output water fulfilled the zero faecal coliform standard. Contamination is responsible for the variation in bacterial, total, and faecal coliform counts of the analyzed water samples.

4. Conclusion

The quality of the output water from the tanker trucks are far below those obtained in the overhead water source. Therefore, the operators of the water tanker trucks should ensure that they do not use these trucks meant for potable water to collect non-potable water from sources such as rivers etc. Remedial actions such as boiling of the water, addition of water guard to improve the residual disinfectant level of the water may be done before considering such water for drinking. The sanitary condition of the tanker truck is very important as this could serve as a major focal point of recontamination of the treated water. Maintaining the safety of the treated water from tanker trucks by regular washing and disinfection of the water tanker trucks, replacement of old worn out tanks and hoses, sensitization of water tanker truck crews on the danger inherent in contaminated water should be done to ensure effective and continuous sanitary state of the water.

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