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Salting as an intervention to improve water quality

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ABSTRACT : The effectiveness of salting as an intervention to make well water safe was assessed. Water from a covered, ringed well was collected into coloured tap-fitted buckets with lid and salt-NaCl (1% w/v) was added. The pH and bacteriological qualities (total bacterial and coliform counts) of the water samples were monitored under indoor and outdoor storage. Atmospheric conditions: Aerosol optical depths (AOD), relative humidity (RH), sky condition (SC) and total radiation (TR) were also monitored. The pH values ranged between 6.1 and 9.3; it increased during storage. The population of heterotrophic bacteria reduced by 77.53%; while coliform count reduced by 74.74%. Among the eight bacterial species initially isolated only *E. coli*, *Proteus vulgaris* and *Pseudomnas aeruginosa* survived through the 15 days. The bacteriological quality of the water improved but still fell short of the WHO standard for drinking water. The study showed that salting of well water was not an effective point of use intervention to make water safe. Catchment protection, observance of the minimum safe distance (MSD) and regular surveillance would be useful in guarantying safety of well water.

Keyword: Salting, Well water, Total radiation, Point of use intervention, Water right.

Introduction

Water is a basic requirement for the healthy functioning of all world ecosystems and is essential for the well being of mankind. The human right to water (water right) entitles everyone to safe, sufficient, acceptable, physically accessible and affordable water for personal and domestic uses (TWAS 2002). Man's appreciation of the value of water is low, unless and until he finds himself without water. Consumption of unsafe water, and exposure to it, accounts for about 80% of diseases in developing countries; about 88% of diahrrhoeal diseases are attributed to unsafe water supply, inadequate sanitation and hygiene (WWT, 2008). Unsafe water is a leading cause of preventable diseases and death; particularly among low-income children in developing countries. It is estimated that about 3900 children die daily due to unsafe water (Clasen *et al*., 2005).

Safe water and good hygiene are recognized as the best defense against diarrhea and water related diseases; hence one of the water related target of the Millennium Development Goals (MDGs) is improvement in access to safe water (UNESCO, 2006). It has indeed been projected that as many as a third of the MDGs depend on water and even that seven of them could have direct and strong links with provision of safe drinking water (). The importance of water to human health suggests that all the health-related MDGs will, to some extent, have link with provision of safe drinking water. Gender-related MDGs have fairly high links with access to water and sanitation, because of the involvement of women in water sourcing and care giving. According to world water development report (WWDR) problems of poverty are inextricably linked with those of water, it availability, its quantity and its quality.

In providing safe water for small communities, it is generally cheaper to protect a ground water source than to treat surface water. Ground water in its nature state is generally of good quality, and because of the slow movement of subsurface water it is usually easier to control sources of contamination. Globally, tens of millions of families still depend on dug wells (private and public) as source of water (WHO, 2002). There are various types of hand dug-wells; ranging from poorly protected to well protected ones; generally, dug-wells are the worst ground water sources in terms of faecal contamination. Open or poorly covered well heads pose the most common risk to well water quality. In addition, well water can be contaminated by the use of inappropriate water-lifting devices by consumers. The most common physical defects of well that leads to contamination are damage to, or lack of, a concrete plinth and break in the parapet wall and in the drainage channel.

The most significant risk to human health related to drinking water quality is from microbiological contamination; particularly faecal contamination. Bacteriological analysis of water shows the intensity of contamination, and hence the level of risk the consumer is exposed to. The most serious sources of pollution are contamination by human and animal waste from latrines, septic tanks and farm manure. WHO (1997) recommends that well should be cited at a minimum safe distance (MSD) of 10m from source of contamination like latrines. The MSD will differ from area to area depending on geological and hydrogeological conditions, the quantity of faecal matter likely to be discharged, and the number of existing and planned sources of contamination. In practice, 10m is hardly achievable in most of the areas where wells, particularly private ones, serve as source of water.

Where water quality is poor, there is an immediate threat to public health; it may be necessary to recommend emergency precautions at household level. The microbiological quality of drinking water can be substantially enhanced by protecting the source and treating the raw water. In the case of ground water, the source and the catchment need to be protected for the water supplies to remain potable (WHO, 2006). In biblical accounts, the Prophet Elisha cast salt into the sources of water in Jericho and healed the waters (2Kings 2: 19-22). In South-west Nigeria; public and in private wells are common as source of water for domestic use; salt is usually poured into newly dug-well with the assumption that it makes the water fit for consumption. It is recognized that household intervention technologies are crucial in providing safe water (WHO, 2007). However, for interventions to be effective in improve water supply service; it should include community education, management training and advising on all types of remedial action. This study examines the effect of salting as an intervention to improve water quality with a view to educate people that depend on wells as source of drinking water.

Material and Methods

The study was carried out using water from a covered ringed-well in Ilorin (8°28′N 4°38′E). Water was collected from the well as described by WHO (1997) into disinfected tap-fitted buckets, which were filled to 3cm from the rim of the buckets (15 litres). A total of 16 buckets consisting of three coloured: purple (4), orange (4) and blue (4) bucket and one transparent bucket (4) were used. The filled buckets were separated into two sets and salt was added to one set of bucket (0.1%w/v), while the other set was without salt. One set of each of the samples was stored indoor and the other stored outdoors for 15 days.

Atmospheric conditions were determined at the Baseline Surface Radiation Network (BSRN) station, University of Ilorin, Nigeria. Sky condition was taken by Synoptic observation; the relative humidity was monitored using HMP45C temperature and relative humidity probe. The aerosol optical depth was measured using Microtops II Sun photometer and the total radiation was measured using Eppley radiometer. Samples were taken from the bucket through the tap and analyzed daily. The pH of the samples was determined as described by APHA (1992). The total heterotrophic bacterial count was determined by pour plate technique using nutrient agar as medium (APHA, 1992). The coliform count was determined as Most probable number (MPN) (Olutiola *et al*., 1991; WHO 2009).

Results

The sky was clear, relative humidity varied between 34.0% and 70.0%, aerosol optical depth varied between 0.450 and 1.688 and the total radiation varied between 2.049 and 2.359Wm^{-2} (Table 1). The pH of the samples varied between 6.1 and 9.3. The initial heterotrophic bacteria population of 8.9×10^{3} cfu/ml was reduced by between 68.6% and 77.5% in the salted samples and by between 46.1% and 73.0% in the unsalted samples. The eight

bacterial species encountered survived for between 5 to 10 days except *Micrococcus luteus*, which was eliminated by the fifth day, and *E. coli*, *Proteus vulgaricus* and *Pseudomonas aeruginosa*, which survived for 15 days (Tables 2-5). Other bacteria encountered are: *Bacillus subtilis*, *Citrobacter freundii*, *Enterobacter* sp, *Klebsiella* sp.

Table 1: Atmospheric conditions during Study Period

Storage period (day)	Total Radiation (Wm-2)	Aerosol Optical depth	Sky condition
0	2.049	0.587	Clear
5	2.141	1.688	Clear
10	2.359	0.839	Clear
15	2.049	0.450	Clear

Table 2 Survival times of bacteria in well water stored in transparent buckets

Isolate	Length of Survival Time (days)			
	Indoor		Outdoor	
	Salted	Unsalted	Salted	Unsalted
Bacillus subtilis	5	5	5	5
Citrobacter freundii	15	15	10	10
Enterobacter sp	10	10	10	10
E. coli	15	15	15	15
Klebsiella sp.	10	10	10	10
Micrococcus luteus	0	0	0	0
Proteus vulgaricus	15	15	15	15
Pseudomonas aeruginosa	15	15	15	15

Table 3 Survival times of bacteria in well water stored in Blue buckets

Isolate	Length of Survival Time (days)			
	Indoor		Outdoor	
	Salted	Unsalted	Salted	Unsalted
Bacillus subtilis	5	5	5	5
Citrobacter freundii	15	15	10	10
Enterobacter sp	10	10	10	10
E. coli	15	15	15	15
Klebsiella sp.	10	10	10	10
Micrococcus luteus	0	0	0	0
Proteus vulgaricus	15	15	15	15
Pseudomonas aeruginosa	15	15	15	15

Table 4 Survival times of bacteria in well water stored in Orange buckets

Isolate	Length of Survival Time (days)			
	Indoor		Outdoor	
	Salted	Unsalted	Salted	Unsalted
Bacillus subtilis	5	5	5	5
Citrobacter freundii	15	15	10	10
Enterobacter sp	10	10	10	10
E. coli	15	15	15	15
Klebsiella sp.	10	10	10	10
Micrococcus luteus	0	0	0	0
Proteus vulgaricus	15	15	15	15
Pseudomonas aeruginosa	15	15	15	15

Table 5 Survival times of bacteria in well water stored in Purple buckets

Isolate	Length of Survival Time (days)			
	Indoor		Outdoor	
	Salted	Unsalted	Salted	Unsalted
Bacillus subtilis	5	5	5	5
Citrobacter freundii	15	15	10	10
Enterobacter sp	10	10	10	10
E. coli	15	15	15	15
Klebsiella sp.	10	10	10	10
Micrococcus luteus	0	0	0	0
Proteus vulgaricus	15	15	15	15
Pseudomonas aeruginosa	15	15	15	15

Discussion

The quality of water obtained from the well demonstrates that well water may be unsafe sometimes. It also highlights the need for intervention to make the water safe for consumption. The presence of *E. coli* is suggestive of any of the following: faecal contamination, presence of bacterial nutrient or presence of unsuitable materials in the water (WHO, 2006). *E. coli*, and species of *Citrobacter, Proteus* and *Pseudomonas aeruginosa* are recognized pathogens or opportunistic pathogens (Stainer et al., 1987; Talaro and Talaro, 1993); their presence indicates the water is not portable. The WHO drinking guideline requires that water intended for consumption should be free of pathogens and organisms indicative of faecal contamination (WHO, 2006).

The reduction in bacterial count in all the samples is consistent with observations that storage for 10 to 12 days improves the bacteriological quality of water (Maggy et al., 2003; Olayemi et al., 2005 and Eniola et al., 2006). This has been attributed to gravitational sedimentation and depletion of nutrients among others. This suggests that the initial storage of well water in reservoir in addition to guarantying a continuous supply of water; could be helpful in improving the bacteriological quality of the water. WHO (2006) observed that storage for 48 hours provides a

degree of safety in schistosomiasis endemic areas; and suggested that the number of microorganisms in water could be significantly reduced by storage for more than a week.

The microbiological quality of drinking water can be substantially enhanced by protecting the source and treating the raw water. In the case of wells, where the source of contamination may not be obvious or easy to locate, treatment is the preferred option. The addition of salt to wells is usually intended to achieve disinfection; which is the most effective means of reducing the numbers of microorganisms in drinking water. In this study it is observed that there was no significant difference in the reduction in bacterial counts of salted and unsalted water. This suggests that salting was not an effective intervention to produce portable water. Although salt is used in preservation by virtue of the osmotic stress it produces, such effect cannot be reproduced in water without altering the taste of the water. However, if the initial bacterial load is small, it is not unlikely that portable water may be produced by a synergy between salting and storage.

There was marked difference in disinfection between samples stored indoors and those stored outdoors. Eniola *et al*. (2007) demonstrated that outdoor storage of water in coloured containers affected its bacteriological quality; storage in transparent material gave the best result. They suggested the involvement of solar radiation in disinfecting the water called solar disinfection (SODIS). The atmospheric conditions; high total radiation and clear sky, during the study period were suitable for application of SODIS (Oates et al., 2003; Me´ndez-Hermida et al., 2005 and IDRC, 2007). There appeared to be a synergy between salting and solar disinfection in reducing the bacterial load of the water. This is likely to be due to physiological stressing of the organisms due to osmotic pressure created by salt or due to ionic dissociation of the salt, which would affect the ion balance and metabolism of the organisms.

People who depend on wells as source of drinking water should ensure that, as much as possible, the MSD is observed and the catchment of the well is protected against obvious sources of contamination. In addition, the well water should be examined on regular basis as recommended (WHO, 2004). Water from the well should be retained in storage for at least 2 weeks before use. Water filters can also be fitted along the supply pipe leading into the house. Well that are confirmed to be contaminated should be treated by chlorination following standard procedure.

Conclusion

Salting of the well water could not produce safe water; hence it is not an effective point of use intervention. It may be used as complimentary intervention, but should not be depended upon as sole intervention in producing drinking water. This study shows that the claim that adding salt to well produces water fit for drinking lacks verifiable scientific base and is not correct.

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