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# ASSESSMENT OF BACTERIOLOGICAL QUALITY OF DRINKING WATER TRANSPORT BY WATER VENDORS (DONKEY CARTS) IN KUSTI TOWN, SUDAN.

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## ABSTRACTS

Unsafe drinking water is one of the health problems of Sudan in general and in Kusti town in particular, where water related diseases are widely spread. This study is aimed to identify drinking water quality and its associated problems within Kusti town. **Methods:** Study design: it is a descriptive cross-sectional study. Study population: water samples were collected seasonally. **Water quality analysis: Bacteriological analysis:** Seventeen samples per season were collected randomly from water vendors totaling 51samples. **Results:** The main findings of the study were: The results of bacteriological analysis of samples collected seasonally from water vendors showed high coliform counts beyond WHO guidelines and Sudanese standards. **Conclusion:** The supplied water quality in Kusti town varied seasonally with different health impacts. Water vendors provide water to 61.80% of the study area population from the White Nile direct or from untreated water (Matrat) or from the end of network outlet and transport such water in containers of bad conditions for distances more than 1000 meter.

**Based on the research findings**, the study suggests the followings **Recommendations: Health** authorities should regulate and improve the transportations means of water from treatment point to consumption areas (water vendors).Secure ample supply of chemicals necessary for water treatment. Prohibit water vendors from direct supply of raw untreated water to public.

**KEYWORDS:** Unsafe drinking.

## INTRODUCTION

### Vended water

Vended water is common in many parts of the world where scarcity of supplies or lack of infrastructure limits access to suitable quantities of safe drinking water. Although water vending is more common in developing countries, it also occurs in developed countries (**WHO, 2011**). Water vending may be undertaken by formal bodies, such as water utilities or registered associations, by contracted suppliers or by informal and independent suppliers (**WHO, 2011**).

### Water quantity

To promote community health an easily accessible water supply should be available that provides sufficient, safe water to meet community needs (**WHO, 2002**). Community water supply is capital intensive utility. An important factor influencing the cost of water supply system is intended level of services which are in turn related to per capita consumption. Per capita domestic water is influenced by a number of factors such as availability and convenience of supply, socioeconomic conditions of the community, cultural and hygienic habits, and climatic conditions and whether water is charged for. Water for a domestic purpose is needed for drinking, food preparation, and cooking, ablution, bathing, washing, flushing, and houses cleaning. Water use and consumption are frequently expressed in liters per capita (Head) per day (Lcd) (**WHO, 1993**). Household water needs can be estimated by questioning community members about their daily water use. If this is not possible, minimum water needs can be calculated by assuming that average persons uses 25 Lcd, for drinking, cooking and personal hygiene (**WHO, 2002**).

In rural areas, many people collect water of dubious quality from unprotected wells or surface water sources, often at a great distance from their homes, deterring them from collecting sufficient quantities. Toilets are often seen as unnecessary or unaffordable. In urban areas, low-income groups particularly those living in informal settlements - often lack access to adequate water supply and sanitation. Piped water supplies and sewers seldom cover informal areas, which mean that people living there access water from a variety of generally inadequate water supply options, such as wells built close to latrines

or from small-scale water providers, such as door-to-door water vendors, whose water supplies may not be of good quality.

An improved water source refers to sources that are likely to be safe, such as household connections, boreholes or public standpipes. Sources such as rivers or ponds or vendor-provided water are assumed unsafe. A household is only determined to have access to an improved water source if the source is within 100 meters of the home **(COHRE et al., 2007).**

**Sampling techniques of water samples from vendors**

Seventeen samples were selected randomly from the water vendors. The total number of water vendors in the Kusti town according to Kusti locality estimated by 241. Collected samples examined for bacteriological test (Total coliform (TC), Coliform test (CT), Thermotolerant (TT) and *E.coli* (EC). All samples are to be dealt with according to the standard methods for the examination of water and wastewater (**APHA etal., 1998, 2005**). The number of sample was determined according to the (**Subodh, 2004**) by the following formula:

$$N = (t\,S/U)^2$$

Where,

N = Number of samples.

t = Student' - statistics for a given confidence level, 95% = 1.96.

S = overall standard deviation = 0.5.

U = acceptable level of uncertainty (error) =0.24.

$N = (1.96 * 0.5/0.24)^2 = 16.67 = 17$ samples.

**Table 1: Distribution of bacteriological sample from water vendors (donkey carts).**

| Season | Summer | Winter | Rainy | Total |
|---|---|---|---|---|
| Number of samples | 17 | 17 | 17 | 51 |

**RESULTS**

**Table 2: The seasonal variation of bacteriological quality of water samples collected from water vendors (donkey carts), Kusti town-Sudan.**

| Season | Number of samples | Coliform test (CT) | | Thermotolerant test (TT) | | *E.coli* test (EC) | | % of +ve | Residual chlorine mg/l |
|---|---|---|---|---|---|---|---|---|---|
| | | -ve | +ve | -ve | +ve | -ve | +ve | | |
| Summer | 17 | 0 | 17 | 0 | 17 | 2 | 15 | 88.23 | 0 |
| Rainy | 17 | 0 | 17 | 0 | 17 | 0 | 17 | 100 | 0 |
| Winter | 17 | 0 | 17 | 0 | 17 | 7 | 10 | 58.82 | 0 |
| Total | 51 | 0 | 51 | 0 | 51 | 9 | 42 | 247.05 | 0 |
| Percentage | 100 | 0 | 100 | 0 | 100 | 17.64 | 82.35 | 82.35 | |

(n = 17, 51).

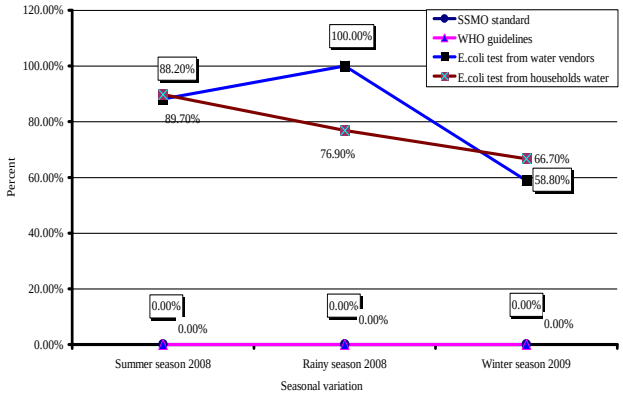


**Figure 1: Percentage of samples contaminated by E.coli, for water samples collected from water vendors (donkey carts) and household's water according to the seasonal variation, compared with WHO guidelines and SSMO standards, Kusti town –Sudan.**

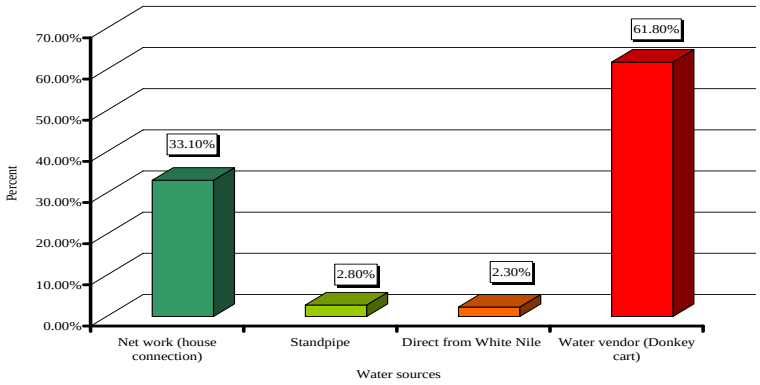


**Figure 2: Drinking water sources, Kusti town-Sudan.**

**Table 3: Relationship between water sources and the means used for conveying water from the source to the in house storage container, Kusti town-Sudan.**

| Water sources | Type of means | | | | | Total |
|---|---|---|---|---|---|---|
| | Closed plastic jercan | Open plastic jercan | Bucket | Plastic pipe | Others | |
| Network | 27 | 43 | 66 | 66 | 8 | 174 |
| Standpipe | 1 | 5 | 0 | 0 | 0 | 6 |
| Direct from Nile | 1 | 10 | 0 | 0 | 0 | 12 |
| Water vendors | 41 | 274 | 1 | 1 | 0 | 325 |
| Others | 4 | 3 | 1 | 1 | 0 | 9 |
| Total | 74 | 335 | 41 | 68 | 8 | 526 |

P value 0.000.

**Table 4: Relationship between source of drinking water and quantities of water provided per households in liter per day, Kusti town-Sudan.**

| Source of drinking water | Quantity of water provided in liters/day per household | | | Total |
|---|---|---|---|---|
| | 1- 306 | 307- 612 | > 613 | |
| Network | 94 | 18 | 62 | 174 |
| Standpipe | 5 | 0 | 10 | 15 |
| Direct from Nile | 1 | 0 | 11 | 12 |
| Water vendors | 28 | 3 | 294 | 325 |
| Total | 128 | 21 | 377 | 526 |

P value 0.000.

**Table 5: Relationship between water source and color acceptability, Kusti town- Sudan.**

| Water sources | Color | | Total |
|---|---|---|---|
| | Acceptable | Not acceptable | |
| Network | 47 | 127 | 174 |
| Standpipe | 5 | 1 | 6 |
| Direct from Nile | 0 | 12 | 12 |
| Water vendors | 90 | 235 | 325 |
| Others | 5 | 4 | 9 |
| Total | 147 | 379 | 526 |

P value = 0.002.

**Table 6: Relationship between water sources and taste acceptability, Kusti town- Sudan.**

| Water sources | Taste | | Total |
|---|---|---|---|
| | Acceptable | Not acceptable | |
| Network | 95 | 79 | 174 |
| Standpipe | 5 | 1 | 6 |
| Direct from Nile | 0 | 12 | 12 |
| Water vendors | 156 | 169 | 325 |
| Others | 8 | 1 | 9 |
| Total | 264 | 262 | 526 |

P value 0.000.

**Table 7: Relationship between water sources and odor acceptability, Kusti town- Sudan.**

| Water sources | Odor | | Total |
|---|---|---|---|
| | Acceptable | Not acceptable | |
| Network | 102 | 72 | 174 |
| Standpipe | 3 | 3 | 6 |
| Direct from Nile | 0 | 12 | 12 |
| Water vendors | 173 | 152 | 325 |
| Others | 9 | 0 | 9 |
| Total | 287 | 239 | 526 |

P value 0.000.

Table 1: Show the results of bacteriological analysis of 51 samples collected from water vendors during the three seasons (summer, rainy and winter), where 17 samples were analyzed for each season. All samples showed uncountable TC count in all seasons, the others bacteriological tests showed similar results as for CT, and TT with 100% positive in all seasons. But showed seasonal variation in EC which was determined as (15) 88.23%, (17)100% and (9) 58.82% in summer, rainy and winter seasons respectively. The means of samples contaminated by EC was 82.35% among all samples. Residual chlorine was not detected in samples examined in all seasons.

Figure 1: Shows comparison of the seasonal variation of *E.coli* (EC) in water samples collected from water vendors and household's compared with WHO guidelines and SSMO standards 2002, 2007; samples showed high growth of EC in the rainy season and average one in summer but low growth in winter season.

Figure 2: Shows household's drinking water sources among Kusti town population were 61.80% from water vendors (Donkey carts), 33.10% were connected to the local network and 2.3% brought their water from the White Nile direct.

**Plate 1: Water after been raised to overhead tank at the end of network, transport to consumers by water vendors (donkey carts), Kusti town-Sudan.**

**Plate 2: End of net work stand post collection point for water vendors, Kusti town-Sudan.**

**Plate 3: Water vendors (Donkey carts) congested at small treatment plant (NGOs) outlet from over head tank, during summer and winter seasons, Kusti town-Sudan.**

**Plate 4: Hose for filling water vendors' barrel, lying on the ground (Contaminated water), Kusti town-Sudan.**

**Plate 5: Untreated water intake at a point downstream (Matrat), Kusti town-Sudan.**

## DISCUSSION

The study revealed that 61.80% of the study area population depends on water vendors for their water supply. Majority of the water vendors obtain their water from untreated water source, direct from the Nile or even from irrigation projects (Matrat) surrounding Kusti town. Furthermore, 64.30% of the population transported water from distances more than 1000 meters. This may introduce a variety of contaminants for such water during transportation. This may also affects the people who use it, and impair their health and increase the water borne diseases prevalence which have been confirmed by this study. In this study the majorities of the study population were using unprotected sources and some protected ones, but not regularly disinfected and maintained. Observation showed that the unprotected water sources mostly found in towns are near to residents, residents obtain water from it through water vendors (donkey carts) which represent 61.80% **(WHO, 1971)**, This implies that the risk of contamination is very high. Study done in Pakistan villages by **(Jensen et al., 2003)** showed a higher level of *E.coli* was detected in unchlorinated standpipe water than chlorinated ones. In contrast, a study conducted in Chikwawa by **(Jabu and Grimason, 2005)** showed that the samples were uncontaminated with either coliforms or *E.col* because of appropriate protection of water sources.

Poor households often pay vendors several times the unit price paid by connected non-poor households, and they use only a fraction of the amount of water used by connected non-poor households. In many countries, water scarcity is one of the principal causes of poverty and malnutrition. At the beginning of a new millennium, the problem of water quality deterioration is also becoming important. Nowadays 300 millions of Africans are likely to live a water shortage situation. Recurrent and localized drought, increasing food insecurity and diseases with hydrologic origin or transmission cause millions of deaths every year **(Diana, 2000)**.

## CONCLUSION

Water vendors provide water to 61.80% of the study area population from the White Nile direct or from untreated water (Matrat) or from the end of network outlet and transport such water in containers of bad conditions for distances more than 1000 meter.

### Recommendations

1. Health authorities should regulate and improve the transportations means of water from treatment point to consumption areas (water vendors).
2. Secure ample supply of chemicals necessary for water treatment.
3. Prohibit water vendors from direct supply of raw untreated water to public.

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