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Characterization of Physico-chemical and Microbiological Parameters of Tanker Water Samples in a Rural Area in Bangalore during post Covid pandemic

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KEYWORDS

tanker water, rural area, drinkable quality, Bangalore

ABSTRACT:

Introduction: The tanker water samples supplied in a rural area of Bangalore was studied between the period of September 2021 to February 2023. The study area is water stressed and is heavily dependent on water supplied by tankers throughout the year. It is claimed that the water supplied by the tankers are of drinkable quality.

Objectives: Prior studies of water quality supplied by the tankers in this area have not been conducted. Hence, the water quality was tested to understand the quality of water supplied by the tankers in the area.

Methods: The physicochemical parameters like pH, TDS, Electrical Conductivity and Total Hardness were measured and seasonal variation among the parameters was attempted to be identified. Water samples were collected from 04 tanker water, 01 source sample, and 01 purified water sample from Reverse Osmosis filter served as the control.

Results: The results obtained during the 18 months duration prove that the tanker water samples are not fit for direct consumption as the TDS, Electrical conductivity and total hardness far exceed the prescribed limits. Microbial contamination by *E.coli*, total and fecal coliform bacterial contamination was also found for some of the samples.

Conclusions: A marked difference was observed for these parameters between the tanker water and purified water samples. Hence the water should be treated by either boiling or filtering before consumption.

1. Introduction

During the first quarter of the year 2020, many urban and rural pockets of Bengaluru, Karnataka experienced severe Covid-19 infection and demarcated them as containment zones. The imposed restrictions perturbed the societal life at the containment zone. Kudlu village (12.8910° N, 77.6400° E) at Bengaluru Rural District experienced a severe normalcy disruption. Although this area has a mixed population, most people are economically poor, which is still under development. The water crisis is prevalent throughout the year in this semi-urban zone, and the residents are dependent on water supplied through tankers whose quality requires a comprehensive study. Very few residential blocks bear boreholes and depend on groundwater. Economically weaker sections receive water supply through tankers once in two weeks. During the lockdown period, the water supply to this containment zone was once in 25 days. Long queues with poor social distancing to collect water resulted in the gradual increase in cases with Covid -19 infection.

The gradual unlock down is now reeling back the normalcy at this containment zone with vigilant monitoring. However, this zone's water supply continues through tankers, and the frequency to the slum pockets has improved. The apartments do receive water once in three days through tankers. Approximately about 50-75 tankers transport water to this zone.

There exists no data on the quality of the water supplied through tankers at this containment zone. Frequent complaints of diarrhoea, gastrointestinal disorders are heard through personal anecdotes. Further, no studies on the prevalence of waterborne infection/diseases are available in this area. We also fear the residents,

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including the apartment dwellers and the economically weaker sections, are less aware of the quality of water they receive for their regular consumption. Hence, if people consume poor quality contaminated water, they become victims of waterborne infections. It can also predispose them to other infections, including the pandemic surge.

Although no direct correlation exists between CoVid -19 infection through water, waterborne diseases such as diarrhoea bear a corroboration of the pandemic infection.

Hence, careful discrimination is a must.

Access to safe and clean drinking water has been declared a human right by the United Nations General Assembly. Anthropogenic activities like industrial effluents, agricultural runoff, and poor disposal of waste are some of the causes of drinking water quality deterioration. [1]

The city Bangalore has been affected by water crisis since many decades. It has been predicted to be the next city after Cape Town to run out of drinking water in future. [2]

Electrical conductivity and Total Dissolved Solids are correlated parameters which are used to measure the salinity level of water. The measure of liquid capacity to carry out an electric charge is called as Electrical conductivity. The presence of inorganic salts and organic matter is the measurement for TDS. [4]

The parameters pH and hardness are also important parameters to determine the quality of water. [5]

Due to rapid industrialization and rise in population in the Silicon Valley of India, ground water depletion is happening. Due to this, the city of Bengaluru is heavily dependent on commercial tankers which supply water. The sources of this water are from lakes of the outskirts of the city or illegally dug borewells. Very few studies have been conducted to study the quality of water supplied by these tankers. Some studies have been conducted for the drinking water and lakes in different parts of the city.

Tanker water samples of Bengaluru were analysed for physicochemical and bacteriological characteristics in 2019. The hardness for most of the samples were higher than the permissible limits. Some of them had microbial contamination in them. The levels of calcium, chloride and nitrate were within acceptable limits. [6]

Drinking water quality was assessed from samples collected from west Bangalore namely Rajajinagar, Vijayanagar, Nagarbhavi and Rajarajeshwarinagar. The Biological Oxygen Demand, Chemical Oxygen Demand and TDS values were higher for most of the samples compared to that of the prescribed limits. [3]

Water samples collected from Northeast Bangalore had high levels of TDS and bacterial contamination. [7]

2. Objectives

Scientific literature ascertains water at Bengaluru is contaminated and recommends continuous monitoring. No specific monitoring studies of water are available to Kudlu. Thus, a study on the water quality at this containment zone appears to be imperative in generating baseline data.

Before studying the water quality, a preliminary survey on the water consumed for different purposes and suffering due to waterborne illness, water treatment such as filtering and boiling before drinking by the residents was essential. The results of the survey indicated that majority of the people residing in this area was poor, was not aware of the basic hygiene, and sanitation practices. Some of them even did not have toilet facility in their home. They also were consuming the supplied tanker water for drinking and domestic use. Further, there exists no seasonal data on the water quality at this zone. A seasonal collection of the water from the tankers, their comprehensive physicochemical analysis, analysis of select inorganic metal contaminants and screening for any waterborne disease-causing microorganism, can help us to comment on the quality of water supplied in the area.

3. Methods

Materials and Methods

Study Area Details

The study area is Kudlu village (12.8910° N, 77.6400° E) at Bengaluru Rural District (Figure 1).

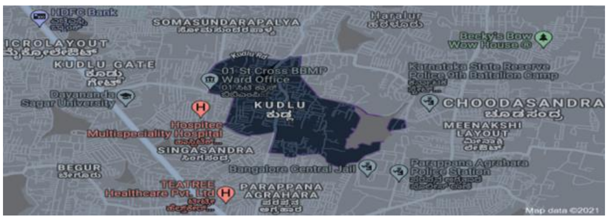

Figure 1. Map of Study Area

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Figure 2. Tankers supplying water in the area

The measure of acidity of a sample is measured by pH. [8[. The quality of drinking water can be assessed using TDS and total hardness. [9]

Water hardness is measured by the capacity of water to produce lather and react with soap. It is caused due to the presence of salts of calcium and magnesium. [11]

Electrical conductivity is the ability to conduct electricity or current. For water, it helps to estimate the quantity of TDS or ions. [10]

Faecal contamination of water is detected by the presence of E.coli. This causes diarrhoea in people consuming the contaminated water. [12]

The source for all this tanker water is a lake in Bengaluru (locally called as Gopal Reddy Talab). One sample from the source was also collected to understand the variation with the collected tanker water samples.

Water samples were collected from 04 tanker water and 01 sample from source and tested for physicochemical characteristics like pH, temperature, TDS, electrical conductivity and total hardness. 01 control sample is taken from purified RO water. One sample from the source (lake water) was also analysed. Samples 1, 2, 3 and 4 are tanker water samples and sample 5 is purified water used for control. Water samples have been collected and analysed during the period from September 2021 till February 2023.

The samples were collected once every 25 days and analysed for a total duration of 18 months to identify any variations in the physicochemical properties.

4. Results

The water samples have been collected for 18 months and physico chemical and microbiological parameters have been studied using a potable meter. The comparative values for the collected samples in pH (Table 1), TDS (Table 2), Electrical conductivity (Table 3), Temperature (Table 4) and Total hardness (Table 5) are represented in below tables. The graphical presentation for comparative variation between the samples in pH (Figure 3), TDS (Figure 4), Electrical conductivity (Figure 5), Temperature (Figure 6) and Total hardness (Figure 7) are presented below.

Total coliform and faecal coliform bacteria were found to be present (>161 cfu/mL) in all the tested tanker water samples during the studied period. However, these were found to be absent for all the purified water samples and the source water samples collected.

Table 1. Comparative Results obtained for pH.

Samples	1	2	3	4	5	Source
Sep 21	8	8	8	8	6.8	8
Oct 21	8.4	8.6	8.2	8.4	7.2	6.76
Nov 21	6.1	6.31	6.53	6	6.01	8.11
Dec 21	6.9	6.89	6.38	6.91	6.89	8.21
Jan 22	7.6	6.58	6.55	6.44	7.4	8.32
Feb 22	6.33	7.1	6.76	6.38	6.56	8.34
Mar 22	6.58	6.68	6.66	6.89	6.59	7.2
Apr 22	7.07	6.34	6.86	5.79	6.23	6.8
May 22	5.86	5.98	6.23	6.18	6.55	7.5
Jun 22	7.8	6.82	6.96	6.86	6.85	7.7
Jul 22	6.48	6.81	7.06	7.06	6.87	7.8
Aug 22	7.08	7.08	7.08	7.08	6.9	6.79
Sep 22	6.55	6.35	7.31	7.3	7.3	7.2
Oct 22	7.13	6.59	7.68	7.68	7.63	6.87
Nov 22	7.64	7.52	7.35	7.78	7.09	8.12
Dec 22	7.6	6.54	6.59	7.7	7.2	8.23
Jan 23	6.7	6.79	6.83	6.57	7.6	8.13
Feb 23	7.15	6.79	6.86	6.88	7.76	8.16
Min	5.86	5.98	6.23	5.79	6.01	6.76
Max	8.4	8.6	8.2	8.4	7.76	8.34

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Mean	7.048235	6.876111	6.993889	6.994444	6.968333	7.68
Std. dev	0.687529	0.613389	0.523982	0.694976	0.465072	0.573459

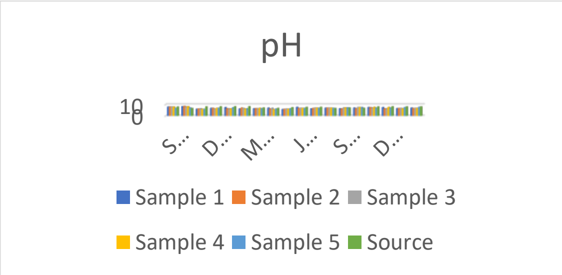

Figure 3. Graphical presentation for pH variation across samples

Table 2. Comparative Results obtained for TDS.

Samples	1	2	3	4	5	Source
Sep 21	555	520	475	548	54	277
Oct 21	548	536	486	524	69	233
Nov 21	687	613	540	580	81	412
Dec 21	460	591	538	587	67	421
Jan 22	707	670	584	584	64	431
Feb 22	642	610	506	518	99	442
Mar 22	609	436	508	518	158	283
Apr 22	423	550	575	476	170	275
May 22	414	451	412	402	150	268
Jun 22	431	399	404	424	150	286
Jul 22	281	352	405	372	140	285
Aug 22	319	319	319	319	128	214
Sep 22	280	28	305	330	99	244
Oct 22	235	668	136	319	130	253
Nov 22	284	362	286	334	124	410
Dec 22	465	598	567	278	124	423
Jan 23	243	301	295	310	123	432
Feb 23	260	312	384	307	125	443
Min	235	28	136	278	54	214
Max	707	670	584	587	170	443
Mean	435.7222	462	429.1667	429.4444	114.1667	335.1111
Std. dev	154.8091	160.9379	120.5005	108.4995	34.21054	84.17567

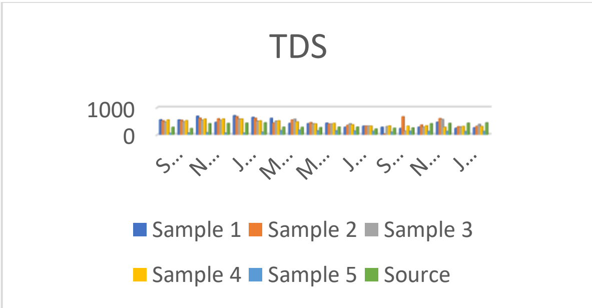

Figure 4. Graphical presentation for TDS variation across sample

Table 3. Comparative Results obtained for Electrical conductivity

Samples	1	2	3	4	5	Source
Sep 21	1178	1184	1176	1174	127	583
Oct 21	1100	1182	1170	1029	146	434
Nov 21	1438	1221	1074	1066	161	783
Dec 21	910	1189	1063	1178	134	754
Jan 22	1474	1352	584	584	124	767
Feb 22	1201	1217	1036	1158	201	763
Mar 22	1193	880	1014	1112	316	577
Apr 22	882	1082	1086	951	339	574
May 22	812	886	828	806	303	579
Jun 22	820	813	804	824	302	585
Jul 22	627	685	799	751	281	576
Aug 22	632	632	632	632	254	414

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Sep 22	500	60	605	660	264	456
Oct 22	484	339	270	638	259	435
Nov 22	565	719	577	657	249	769
Dec 22	972	1232	1158	535	245	777
Jan 23	558	583	585	587	248	786
Feb 23	577	610	738	611	250	745
Min	484	60	270	535	124	414
Max	1474	1352	1176	1178	339	786
Mean	884.6111	881.4444	844.3889	830.7222	233.5	630.9444
Std. dev	311.0082	345.8139	257.435	227.6422	66.57181	133.9127

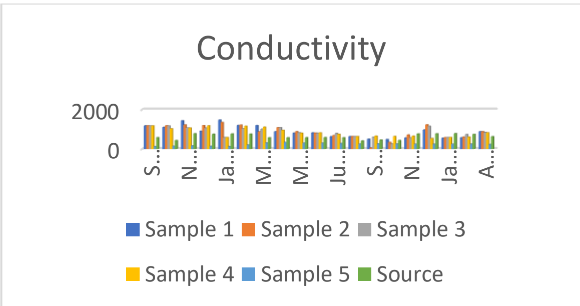

Figure 5. Graphical presentation for Electrical Conductivity variation across samples

Table 4. Comparative Results obtained for Temperature

Samples	**1**	**2**	**3**	**4**	**5**	**Source**
Sep 21	25.6	25.7	25.8	25.5	25.7	26.5
Oct 21	26.5	25.9	25.2	26	25.5	26.7
Nov 21	24.8	24.8	24.7	24.5	24.9	26.8
Dec 21	24.7	24.7	24.6	25.5	24.6	26.9
Jan 22	24.6	24.7	24.4	24.4	24.4	26.2
Feb 22	24.8	24.4	24.3	24.6	24.3	26.5
Mar 22	26.8	26.7	26.6	26.4	26.7	27.6
Apr 22	27.8	27.3	27.8	27.3	27.4	25.3
May 22	25.9	25.8	25.9	25.8	25.6	25.2
Jun 22	26.3	26.1	26.8	26.9	26.1	24.3
Jul 22	24.2	24.2	24.3	24.3	24.1	26.3
Aug 22	25.6	25.6	25.6	25.6	25.7	26.2
Sep 22	636	25.3	26.01	26.18	25.3	26.3
Oct 22	25	25.1	6.98	25.1	25	26.6
Nov 22	25.5	24.5	24.4	25.3	24.4	26.5
Dec 22	24.8	24.5	24.3	23.6	24.2	26.4
Jan 23	23.8	23.6	23.6	23.8	23.5	26.3
Feb 23	23.8	23.7	23.8	23.6	23.6	24.3
Min	23.8	23.6	6.98	23.6	23.5	24.3
Max	636	27.3	27.8	27.3	27.4	27.6
Mean	59.25	25.14444	24.17167	25.24333	25.05556	26.16111
Std. dev	139.8862	0.965644	4.312257	1.064753	1.014463	0.835423

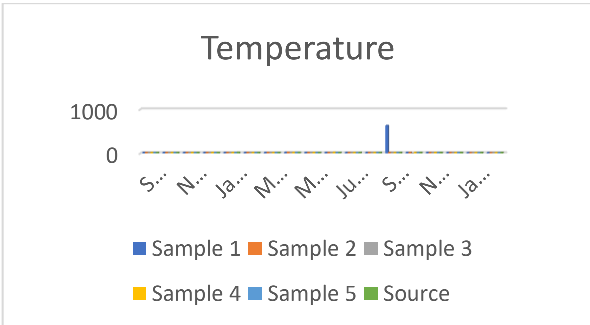

Figure 6. Graphical presentation for Temperature variation across samples

Table 5. Comparative Results obtained for Total Hardness

Samples	**1**	**2**	**3**	**4**	**5**	**Source**
Sep 21	1000	1000	1000	1000	0	500
Oct 21	500	1000	500	500	0	500
Nov 21	500	500	1000	50	0	100
Dec 21	500	500	500	500	0	100
Jan 22	500	500	500	500	50	100

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Feb 22	500	1000	1000	1000	0	100
Mar 22	1000	1000	1000	1000	50	500
Apr 22	1000	1000	1000	1000	50	500
May 22	50	500	50	50	0	500
Jun 22	1000	1000	100	100	50	500
Jul 22	500	500	500	500	50	500
Aug 22	500	500	500	500	0	500
Sep 22	40	500	500	0	50	500
Oct 22	250	1000	100	250	0	500
Nov 22	1000	500	1000	500	100	100
Dec 22	500	500	500	100	0	100
Jan 23	1000	500	100	100	0	100
Feb 23	500	500	1000	500	0	100
Min	40	500	50	0	0	100
Max	1000	1000	1000	1000	100	500
Mean	602.2222	694.4444	602.7778	452.7778	22.2222	322.2222
Std. dev	315.217	243.749	352.9527	346.1985	29.91758	198.7616

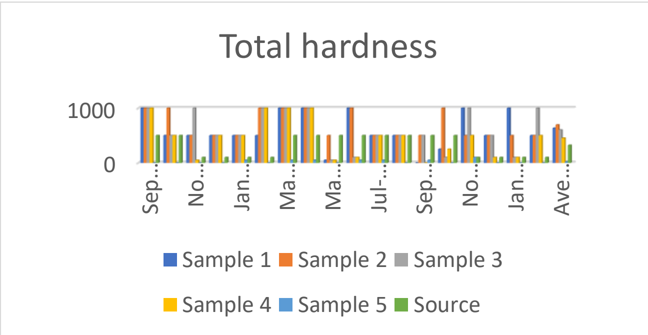

Figure 7. Graphical presentation for Total Hardness variation across samples

Table 6. Comparative Results obtained for *E.coli* (CFU/100 ml).

Samples	**1**	**2**	**3**	**4**	**5**	**Source**
Sep 21	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Oct 21	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Nov 21	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Dec 21	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Jan 22	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Feb 22	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Mar 22	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Apr 22	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
May 22	270	8	160	Not Detected	Not Detected	Not Detected
Jun 22	20	1	22	12	Not Detected	Not Detected
Jul 22	90	Not detected	Not Detected	140	3	Not Detected
Aug 22	42	17	18	27	1	Not Detected
Sep 22	22	Not detected	39	Not detected	1	Not Detected
Oct 22	64	Not detected	Not detected	5	0	Not Detected
Nov 22	Not Detected	5	Not detected	Not detected	3	Not Detected
Dec 22	Not Detected	Not Detected	Not Detected	Not Detected	0	Not Detected
Jan 23	Not Detected	Not Detected	Not Detected	Not Detected	0	Not Detected
Feb 23	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected

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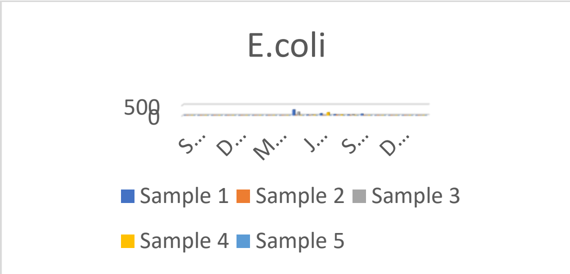

Figure 8. Graphical presentation for bacteria variation across samples

5. Discussion

The data obtained till date for 18 months presents that there is a marked variation in the parameters for pH, Electrical conductivity, temperature, total hardness and total dissolved solids between the samples obtained from tankers and that collected from water purifier.

The average hardness obtained for purified water (22.22) is far less compared to that obtained for the tanker water samples which ranged between 322 to 690. Hence the tanker water samples are very hard water.

The electrical conductivity for the purified water was 233.5 while the values obtained for tanker water samples ranged between 630 to 884 µs/cm. The total dissolved solids for the tanker water samples were more than 330 ppm whereas for the purified water was less than 115.

Contamination by the bacteria E. coli (range between 1 to 270) was also noted for six months during the time period of May to October 2022 months, possibly due to rainy season in the city. Contamination with total and fecal coliform bacteria was also found in all the tanker water samples tested. However, the source water was not found to be contaminated with this microorganism.

However, no significant variation was obtained for the temperature and pH between the tanker water samples, source water, and water obtained from purifier.

These results indicate that further analysis of the water samples should be carried out to find out the presence of heavy metals. Also, the water supplied by the commercialized tankers in this area of Bangalore is not suitable for direct consumption. Hence the water should be treated using water softeners, boiled and filtered before drinking.

Awareness camps should be conducted for the residents of the area to raise awareness about the hazards of water contamination, good hygiene and sanitation practices, and importance of treating water before consumption.

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