Quality of Drinking Waters and its Impact on Human Beings at Chapra (Saran), Bihar

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Abstract

The present study deals with the comparative quality of drinking waters of different sources at Chapra (Saran) – Bihar, which is located on the South bank of river Sarayu at 86^{0}02'N Latitude and 24-15 E Longitude. The municipal supply water gets severely contaminated by waste water through rusted and damaged pipelines and the groundwater through seepage from septic tanks, drains and deep sewerage system. The contaminants from these sources have deteriorated the quality of drinking water leading to spread of various water-born diseases due to increase in the value of turbidity, nitrate – nitrogen, total bacterial density and MPN coliform. The higher concentration of nitrate chloride and the presence of *E. coli, Staphylococcus aureus, Proteus vulgaris, Pseudomonas aeruginosa* and *Salmonella typhi* indicated the faecal contamination.

Key words : Drinking water, Human beings, Contamination, Seepage, Nitrate nitrogen.

Introduction

The drinking water supplied to a community is considered to be pure, wholesome and safe. People of Chapra town are mainly feed by municipal water processed from river Sarayu representing surface water hand pumps, borings representing underground water and wells representing subsurface water. Sewage and domestic waste water is discharged per day in the river Sarayu just before municipal water works which has increased the concentration of coliform bacteria in the river Sarayu (Bilgrami and Datta Munsi 1988). During major part of the year, specially during the rainy season, people get unprocessed water for drinking as well as domestic purposes. The municipal supply pipelines are leaking at numerous places in the town and at places these are mixed up with the drains. Water of other sources like hand pumps, wells and borings also get contaminated due to human interferences, presence of deep sewerage, drains and septic tanks (Aboo et al., 1988; Ebers and Bischofsberger, 1987) around the source. As a result, the physico-chemical and bacteriological properties of drinking water of different sources have deteriorated substantially.

Though the studies on the quality of drinking water were carried out by many workers (Panicker *et al.*1966; Prasad and lyer, 1980; Dhage *et al*, 1981; Simhachalam, 1982, Garud, 1983, Kumar, 1983; Trivedy *et al.* 1984; Saha and Pandit, 1985; Pitchai and Govindan 1986; Saha *et al.* 1986, 1987, 1988, 1990, 1991), our knowledge in this field is still fragmentary. As far as this part of the country is concerned. Very little work has been done.

Materials and Methods

Altogether four sites, i.e., Waterworks (municipal water), Variety (hand pump water), Mauna Muhalla (well water) and Mauna Muhalla (boring water) were selected which are located amidst the thickly populated areas. The samples were collected from July 2016 to June 2017 between 08:00 A.M. to 11:00 A.M.. The guidelines of World Health Organization were followed for the frequency of sampling.

The water temperature was recorded with the help of mercury thermometer graduated up to 110^0C pH was determined by pH meter. Dissolved oxygen was estimated by Winkler's modified method. Free carbon dioxide and bicarbonate alkalinity were determined by the method of Welch (1948). Silicate was determined by Jhingran et. al., (1969). Chloride and nitrate-nitrogen were estimated by the method suggested by National Environment Engineering Research Institute (NEERI) (1979) and the rest of the parameters were determined following standard methods of APHA (2005).

Results And Discussion

The yearly average water temperature was minimum (27.0^0C) in well water and maximum (29.3^0C) in boring water (Table 1). The value of turbidity was minimum (8 NTU) in hand pump water while maximum value (41 NTU) was recorded in the municipal water. The turbidity values have crossed the permissible limits of World Health Organization at all the sources. Increased turbidity is aesthetically objectionable for drinking water.

The pH value was alkaline during major part of the investigation at all the sources. The yearly average value was lower in municipal water. The concentration of dissolved oxygen varied between 8.1 ppm to 12.6 ppm in municipal water, 2.4ppm to 9.3 ppm in the hand pump water, 2.6 ppm to 10.7 ppm in well water and 1.4 ppm to 6.1 ppm in the boring water. The average value of dissolved oxygen was maximum (10.1 ppm,) in municipal water and minimum (3.2 ppm) in boring water. As compared to surface water, the average values of dissolved oxygen were significantly lower in underground and sub surface water. The higher values in municipal water may be due to direct contact of ambient oxygen during the filtration process and in the distribution system. The yearly average value of free CO_2 was minimum (2.6 ppm) in municipal water and maximum (13.7 ppm) in hand pump water. The lower value of free CO_2 in municipal water may be due to its consumption in carbon assimilation and its conversion into carbonic acid and ultimately into stable bicarbonate. The values of bicarbonate alkalinity varied from 52.7 ppm to 130.4 ppm in municipal water from 117.6 ppm to 298.7 ppm in hand pump water, 157.1 ppm to 375.4 ppm in well water and from 88.2 ppm to 220.5 ppm in boring water. The concentration of free CO_2 and bicarbonate alkalinity were usually higher in underground sources than in the surface water. The finding was in conformity with the observations of Saha and Pandit (1985) and Saha and Kumar (1990).

Chloride served as a basis for determining pollution of ground water through sewage before the development of bacteriological procedures (Sawyer, 1960). The early average value of chloride was maximum (99.8 ppm) in hand pump water which was followed by the yearly average value in well water (65.7 ppm), boring water (18.5 ppm) and municipal water (8.3 ppm). The higher concentration of chloride in hand pump water revealed faecal contamination which may cause indigestion (WHO, 1984). The values of total hardness ranged from 15.8 ppm to 131.4 ppm, 188.9 ppm to 350.1 ppm, 162.3 ppm to 226.6 ppm and 71.2 ppm to 227.8 ppm in municipal water, hand pump water, well water and boring water respectively. Like total hardness, the yearly average value of calcium hardness was maximum (132 ppm) in hand pump water while the minimum value (70ppm) was recorded in municipal water. The maximum value of total hardness and calcium hardness recorded in hand pump water may be due to higher concentration of calcium and magnesium ions as compared to other sources. The yearly average value of silicate was maximum in boring water (46.4ppm) and the minimum value (16.3ppm) was obtained in municipal water. The higher concentration in boring water may be due to higher soluble reactive form of silica. The minimum value observed in municipal water may be due to its lower concentration and its utilization by the diatoms in the settling tanks. The nitrate-nitrogen concentration was much higher in ground water and well water a compared to the surface water. The NO_3N values ranged between 7.8ppm to 41.4ppm in hand pump water which was followed by well water (7.1ppm to 41.2ppm), boring water (5.4ppm to 27.5ppm) and municipal water (0.4ppm to 3.8ppm). The NO_3N values have crossed the recommended permissible limit prescribed by World Health Organization (WHO). Th higher concentration of NO_3N in underground water may be the possible cause of methemoglobinemia (cyanosis) in young babies (Kudesia, 1980). It may be due to percolation through drains and septic tanks (Ebers and Bischofsberger, 1987).

The value of sodium was maximum (48.9ppm) in hand pump water and minimum (2.5ppm) in municipal water. There was a sharp difference in the concentration of sodium in underground and surface water sources throughout the investigation period. The yearly average value of calcium and magnesium was also maximum in hand pump water and a wide range of variation was observed in all the sources. Higher values of calcium and magnesium may be the cause for increased hardness in hand pump water. Significant lower values of calcium in municipal water may cause rickets and defects in teeth (Kudesia, 1980).

The total bacterial density was maximum in municipal water (21.632 x 10/L). The yearly average value was also maximum in municipal water (5.407 x 10/L) which was followed by the value in well water (4.628 x 10/L), boring water (2.675 x 10/L) and hand pump water (2.488 x 10/L). The maximum value found in municipal water was possibly due to the higher concentration of the microbial population adding to the river through sewage and domestic waste water. The total bacterial density and microbial population did not deplete even after filtration. The higher bacterial density in this source also revealed the inadequate use of alum during coagulation and chlorine during disinfection process. The other possible way of contamination was through the rusted, damaged pipelines located parallel and closely to the drains. The outbreak of several water-borne diseases in different parts of Chapra (Saran) may be attributed to this contamination. Other than supply water, the average value of total bacterial density was also significantly higher in well water. This may possible be due to seepage from septic tanks and drains. The present finding is in conformity with the observations of Aboo et al. (1968). Sastry et al. (1969), Ebers and Bischofsberger (1987). Saha and Pandey (1987) and Saha and Kumar (1990).

The MPN coliform value varied from 53/100mL to 4,656/100ml in municipal water, from 41/100mL to 4544/100 mL in hand pump water, from 1,205/100mL to 12,810/mL in well water and 58/100 mL to 7,225/100mL in boring water. The MPN coliform was maximum in well water. The yearly average value was also maximum in well water (6050/100mL). Even the minimum value of MPN coliform found in hand pump water (41/100mL) exceeded the prescribed permissible limits of WHO. The values of MPN coliform were relatively higher during late summer months and early monsoon period. The spread of water-borne diseases in different parts during this period supported the findings. As per records of Sadar Hospital Chapra and private clinics of Chapra there is distinct enhancement in the number of patients suffering from food poisoning, gastroenteritis,

typhoid and cholera in the different parts of the Chapra during late summer and early monsoon months.

Apart from the enhanced concentration of different physico-chemical and biological conditions many species of bacteria were isolated from different drinking water sources (Table 2). *Escherichia coli* hand *Proteus vugaris* were isolated from all the sources *Pseudomonas aeruginosa, Salmonella typhi* and *Staphylococcus aureus* were observed in municipal, and pump and well water, while *Clostridium welchii* was isolated from municipal water only. The presence of pathogenic and non-pathogenic bacterial species in these sources gave an indication of faecal contamination in a true sense.

Present study revealed that the drinking water of different sources at Chapra is not satisfactory for the purpose of human consumption and other domestic uses. Water of these sources are highly unhygienic and pose great risk of water-borne diseases.

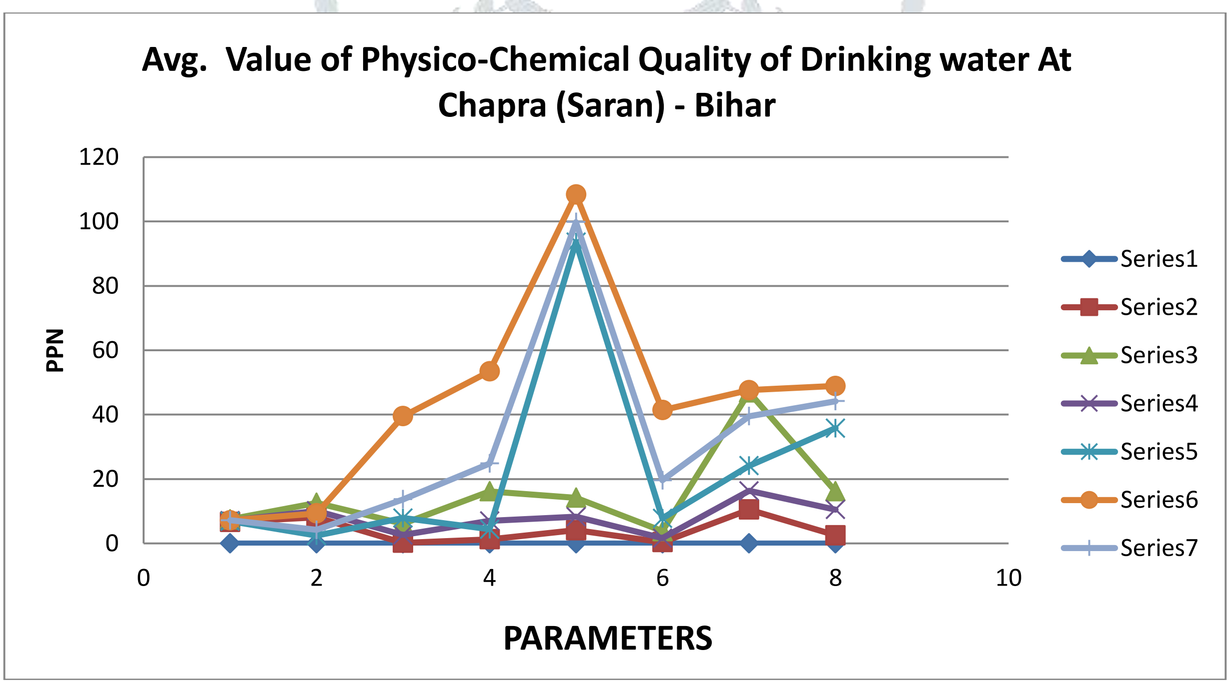
TABLE -1 : Minimum, Maximum and yearly average value of the physico-chemical and bacteriological quality of different drinking water sources at Chapra (Saran), Bihar- India during July 2016 to June 2017

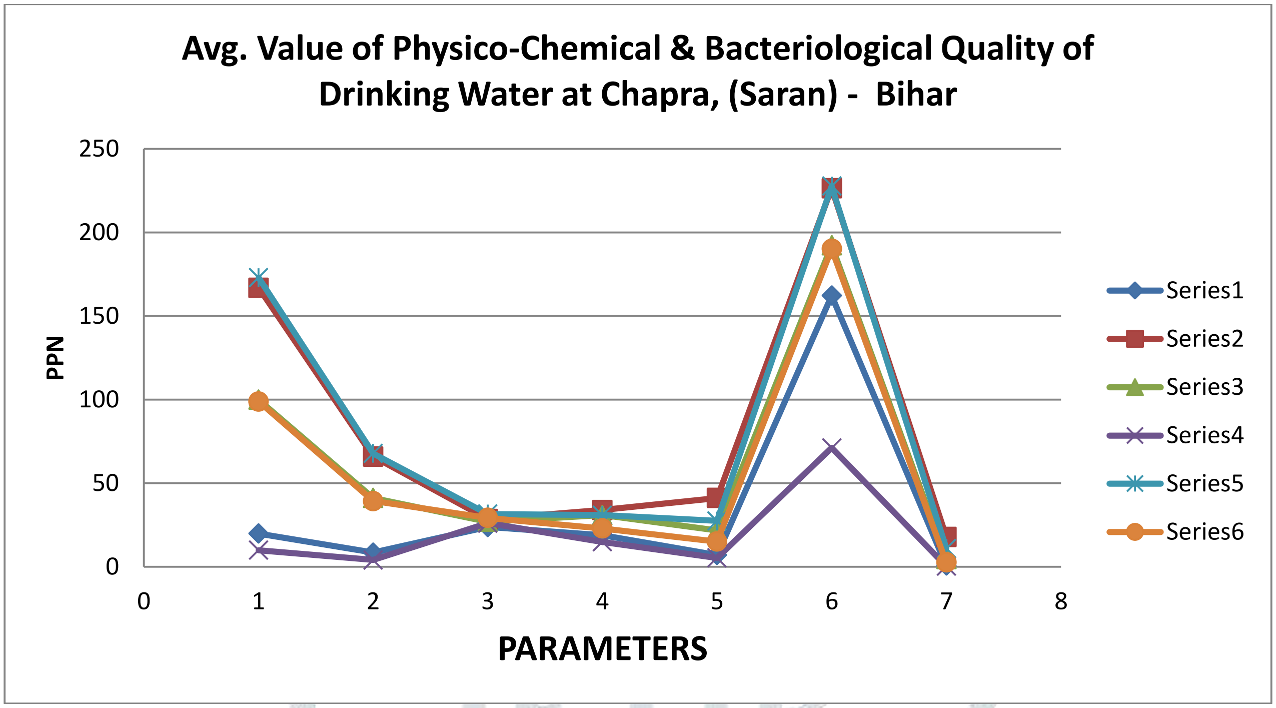
Sources	Municipal Water			Handpump Water (100ft. deep)		
Parameters	Min.	Max.	Yearly Avg.	Min.	Max.	Yearly Avg.
Water temp.(0^0C)	20.5	32.7	27.6	26.1	30.3	28.2
Turbidity (NTU)	22	41	29	8	33	28
pH	6.7	7.5	7.1	6.9	7.2	7.2
Dissolved Oxygen (ppm)	8.1	12.6	10.1	2.4	9.3	4.2
Free CO_2 (ppm)	0.2	6.1	2.6	7.9	39.5	13.7
H CO_3 alk (ppm)	52.7	130.4	101.4	117.6	298.7	176.5
Choloride (ppm)	4.1	14.2	8.3	93.6	108.4	99.8
Total Hardness (ppm)	15.8	131.4	98.8	188.9	350.1	235.3
Calcium hardness (ppm)	7	91	70	34	121	132
Silicate (ppm)	10.5	46.9	16.3	24.1	47.6	39.5
NO_3 $^-$N (ppm)	0.4	3.8	1.6	7.8	41.4	19.6
Na^+ (ppm)	2.5	16.2	10.5	35.8	48.9	44.2
Ca^{++}(ppm)	3.3	38.6	27.5	17.5	87.8	53.5
Mg^{++} (ppm)	1.3	16.2	7	4.4	53.4	24.8
Total bacterial density	$0.827x10^7$	$21.632x10^7$	$5.407x10^7$	$0.262x10^7$	$20.182x10^{-7}$	$2.488x10^7$
MPN Coliform/100mL	53	4656	2608	41	4544	958

TABLE -2 : Minimum, Maximum and yearly average value of the physico-chemical and bacteriological quality of different drinking water sources at Chapra (Saran), Bihar- India during July 2016 to June 2017

Sources	Well Water (65ft. Deep)			Boring Water (440ft. deep)		
Parameters	Min.	Max.	Yearly Avg.	Min.	Max.	Yearly Avg.
Water temp.(0^0C)	23.9	28.6	27.0	26.2	31.6	29.3
Turbidity (NTU)	19	34	31	15	31	23
pH	7.1	7.5	7.2	7.1	7.6	7.2
Dissolved Oxygen (ppm)	2.6	10.7	5.1	1.4	6.1	3.2
Free CO_2 (ppm)	4.5	34.2	11.2	4.6	21.2	9.2

HCO_3 alk (ppm)	157.1	375.4	282.5	88.2	220.5	160.8
Choloride (ppm)	58.6	77.8	65.7	11.2	28.9	18.5
Total Hardness (ppm)	162.3	226.5	192.3	71.2	227.8	190.2
Calcium hardness (ppm)	20	167	100	10	173	99
Silicate (ppm)	32.6	45.8	41.1	32.8	53.9	46.4
$NO_3{}^{-}N$ (ppm)	7.1	41.2	21.8	5.4	27.5	15.2
Na^{+} (ppm)	29.8	46.7	40.6	28.4	38.1	32.8
Ca^{++}(ppm)	8.6	66.0	41.2	4.2	67.8	39.4
Mg^{++} (ppm)	6.5	44.8	19.7	1.9	30.8	19.4
Total bacterial density	$0.846x10^7$	$17.962x10^7$	$4.618x10^7$	$0.389x10^7$	$11.011x10^7$	$2.675x10^7$
MPN Coliform/100mL	1205	12810	6050	58	7225	1641





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