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Original Research Paper

Influence of Seasons on the Physico-chemical Water Quality Parameters of Halkurke Tank and Honnavalli (Hirekere) Tank Waters

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ABSTRACT

Considering the impacts of agricultural runoff, domestic sewage and other anthropogenic activities on the quality of surface water, a physico-chemical study regarding water quality assessment of Halkurke tank and Honnavalli tank water samples belonging to Tiptur Tahsil was carried out for one year to know the seasonal variation and to assess water quality. In the present study, physico-chemical parameters such as temperature, pH, EC, TDS, TH, alkalinity, carbonate, bicarbonate, chloride, sulphate, phosphate, sodium, potassium, calcium, magnesium and boron were estimated. To check the suitability of water for irrigation SAR, % Na, RSC and RSBC parameters were evaluated. The results revealed that the physico-chemical parameters were within the range prescribed by BIS for drinking purposes, but they were on the higher side. The values of pH were on mild alkaline side due to higher alkalinity. Higher values of SAR (5.68 and 4.19), EC (704 and 732.25µmhos/cm), RSC (4.3 and 2.81 meq/L) and Na% (72.38 and 62.71) pose salinity and permeability problems to soils and put the said water samples under medium quality for irrigation purposes. Since these tanks are the only sources to recharge the underground water of the area, groundwater quality of these regions will also be gradually affected.

INTRODUCTION

The physico-chemical characteristics of water samples are important for understanding the aquatic environment. Wetlands are often referred as "biological supermarkets" as they support food chain and bio-diversity (Mitsch & Gosselink 1993, Prasad & Patil 2008). Good quality of water is described by its physical, chemical and microbial characteristics. Physico-chemical parameters play a vital role for providing information about the water bodies. Individual variations of water bodies caused by anthropogenic influences or variations in bottom structure and chemistry are other important features that bring drastic changes in the medium and cause deleterious effects on biota in general and fish in particular (Romana Akhtar & Jyoti 2007), and cause environmental degradation. Rapid industrialization, unscientific waste disposal and carelessness towards environment are causing environmental degradation (Desai 1995).

Clean water is one of the nature's greatest gifts to mankind and tanks are water reservoirs and used for drinking, fish culture, agriculture, animal bathing and other related uses. Therefore, the study on water quality of Halkurke tank and Honnavalli tank and influence of seasons on the water qualities have been considered here.

THE STUDY AREA

Tiptur taluk of Tumkur district falls into semi arid region and tanks are forming the important water resources of the area. The Government of Karnataka has declared Tiptur taluk as drought hit area in 2011. The two tanks selected for pursuing the water quality parameters are belonging to Tiptur taluk and Tumkur district which are coming under the southern part of Karnataka. Tiptur has a longitude of 76°28'41" E and latitude 13°15'30" N.

The records of minor irrigation department Tiptur division are indicating that Halkurke tank has an achkat area of 132.8 ha with a water spread area of 25 ha, and Honnavalli (Hirekere) has an achkat of 118.22 ha with a water spread area of 51.91 ha. Both the tanks are in Krishna basin.

MATERIALS AND METHODS

Water samples of Halkurke tank and Honnavalli tank were collected on monthly basis for chemical analyses over a period of one year from December 2010 to November 2011. Polythene containers of 2 L capacity, which were pre-treated with dilute nitric acid, dried and rinsed with the sample water, were used for collecting water samples. Water temperature was recorded on the spot using $1/10^{th}$ mercury thermometer. The samples were taken to the laboratory where pH and EC were measured using digital pH meter and conductivity meter respectively and analysed for TDS, TH, total alkalinity, CO_3^-, HCO_3^-, Cl^-, SO_4^{2-}, Na^+, K^+, Ca^{++}, Mg^{++} and B contents following the procedures given in APHA (1995) and Trivedy & Goel (1986).

Table 1: Rainfall details of the study area.

Rain gauge station	Winter (Dec-Jan)	Summer (Mar-Jun)	Monsoon (Jul-Oct)	Total (in mm)
Halkurke	35.2	101.2	230.2	366.6
Honnavalli	23.4	69.0	119.0	211.4

The rainfall (mm) was recorded in Halkurke rain gauge station and Honnavalli rain gauge stations from April 2011 to November 2011 and presented in Table 1 (Source: Agriculture Office, Tiptur).

Halkurke area received 27.6% of the annual rainfall in summer season, 62.8% in the monsoon season and 9.5% in winter season, whereas Honnavalli area received 32.7% of the annual rain fall in summer season, 56.4% in the monsoon season and 11% in winter season of annual rainfall during the study period.

RESULTS AND DISCUSSION

Water quality parameters of Halkurke tank and Honnavalli tank influenced by the seasonal variations are presented respectively in Table 2 and Table 3. Seasonwise average values of each water quality parameter have been considered for the discussion.

Halkurke tank water samples of winter and summer seasons have shown 23.4°C and 28.05°C respectively as minimum and maximum temperatures. Honnavalli tank water samples of the same season has shown the corresponding temperatures 23.47°C in winter and 28.45°C in summer. A rise in temperature of the water leads to the speeding up of the chemical reactions in water, reduces the solubility of gases and amplifies the tastes and odours. At elevated temperatures metabolic activity of the organisms increases, requiring more oxygen but at the same time the solubility of oxygen decreases, thus accentuating the stress (Trivedy & Goel 1986).

Halkurke tank water sample has pH values varying from 7.71 (summer) to 8.14 (monsoon). Alkaline pH of Halkurke tank (8.14) in monsoon season indicates higher alkalinity of its water. The alkaline range of pH indicates mixing of sewage and other effluents as these lead to pollution (Mishra & Saxena 1991). Nearly half of the domestic sewage of Halkurke village is released directly in to the tank and also this tank is the main source of water for washing clothes. Increase in photosynthetic activities of phytoplankton will reduce the free CO_2 content resulting in increased pH values (Gupta & Gupta 2006). pH of Honnavalli tank water varied from 7.27 (monsoon) to 7.65 (Summer) which is slightly alkaline. Desirable pH of 6.5-8.5 is bio-tolerable for drinking water (BIS standard).

Alkalinity of Halkurke tank water varied from 204 mg/L in winter to 349.75 mg/L in monsoon, whereas Honnavalli tank water alkalinity fluctuated from 271.5 mg/L in winter to 298.75 mg/L in summer. When alkalinity is high, bicarbonate system prevails and pH is usually on the alkaline side (Pandey & Soni 1993). The observations made here are supporting through bicarbonate. HCO_3 contents of the samples were 331g/L in summer and 261.25 mg/L in monsoon season respectively. It could be attributed to the leaching and seepage of pollutants into the lakes. Similar observation was reported by Johnson & Kauser (2004). As per BIS Standard, desirable value for drinking water is 200 mg/L (permissible limit is 600mg/L in absence of an alternative source).

The electrical conductance (EC) of water depends upon the concentration of ions and nutritional status of water. EC values of Halkurke tank water varied from 567µS/cm in winter to 704 µS/cm in monsoon, whereas EC values of Honnavalli tank water samples varied from 641.5 µS/cm in winter to 732.25 µS/cm in monsoon. The values of EC indicate the higher concentration of TDS and ionized salts present (Aramani et al. 2009). High values of conductance during monsoon might be due to voluminous runoff carrying diverse types of electrolytes from the surrounding areas (Taheruzzaman & Kushari 1995). The values of TDS of Halkurke tank water ranged from 367mg/L (winter) to 452.5 mg/L (monsoon), and TDS values of Honnavalli tank water sample varied from 410.5mg/L (winter) to 472.5mg/L (monsoon). According to BIS standard TDS of 500 mg/L is desirable and in absence of an alternative source 2000mg/L is permissible for drinking water. Total hardness (TH) fluctuated from 79mg/L (summer) to 87mg/L (winter) in Halkurke tank and 117.4mg/L (monsoon) to 138.75mg/L (winter) in Honnavalli tank. BIS standard acceptable range for TH is 300mg/L for drinking purpose.

Sulphate ion concentration in the water sample of Halkurke was minimum (19.97 mg/L) in winter and maximum (26.85 mg/L) in summer season, whereas sulphate concentration of Honnavalli tank water was minimum (13.07 mg/L) in winter and maximum (28.1mg/L) in summer. The high sulphate concentration indicates pollution of water. In summer, the evaporation of water and rise in temperature could result in rise in sulphate level (Desai 1995). It may be due to pollution caused by domestic sewage and effluents.

Table 2: Water quality parameters of Halkurke tank during December 2010 to November 2011.

Parameters	Winter season					Summer season					Monsoon season				
	Dec.10	Nov.11	Jan.11	Feb.11	Mean	Mar.11	Apr.11	May 11	Jun.11	Mean	Jul.11	Aug.11	Sep.11	Oct.11	Mean
Temperature (°C)	24.1	22.8	23.7	23	23.4	27	28.7	29.5	27	28.05	26	28.2	26.2	30	27.6
pH	7.94	8.08	8.3	7.67	8	7.78	7.59	7.63	7.83	7.71	7.91	8.08	8.31	8.25	8.14
EC (µmhos/cm)	549	668	490	561	567	540	730	734	678	670.5	692	710	718	696	704
TDS (mg/L)	351	427	331	359	367	345.8	467	470	445	432	448	458	459	445	452.5
TH (mg/L)	89	69	100	90	87	84	66	86	80	79	85	91.6	76	90	85.65
T.alkalinity (mg/L)	171	225	210	210	204	220	228	240	240	232	422	437	300	240	349.75
Carbonate (mg/L)	20	20	10	20	17.5	0	0	0	30	7.5	18	15	20	22	18.75
Bicarbonate (mg/L)	151	205	200	190	186.5	220	228	240	210	224.5	404	422	280	218	331
Chloride (mg/L)	46.1	37	42.5	53.2	44.7	53.2	59.3	63.8	56.7	58.25	39	29.8	32	39	34.95
Sulphate (mg/L)	19.8	30	20	10.1	19.97	20	27.4	30	30	26.85	15	21.5	30	32	24.62
Phosphate (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (mg/L)	4.34	114	90	130	84.58	109.5	41	56.6	126	83.27	128	131	118	108	121.25
Potassium (mg/L)	0.16	9	8.1	9.3	6.64	8.85	7.4	9.6	9.15	8.75	10.3	11.2	12.75	9.45	10.92
Calcium (mg/L)	21.64	10.8	20	16	17.11	14.8	11.4	14.8	14	13.75	16	17.4	11.2	29.6	18.55
Magnesium (mg/L)	8.5	10.2	12.15	12.2	10.76	11.4	9.1	11.9	10.9	10.82	11	11.7	11.66	3.9	9.56

Table 3: Water quality parameters of Honnavalli tank determined from December 2010 to November 2011.

Parameters	Winter season					Summer season					Monsoon season				
	Dec.10	Nov.11	Jan.11	Feb.11	Mean	Mar.11	Apr.11	May 11	Jun.11	Mean	Jul.11	Aug.11	Sep.11	Oct.11	Mean
Temperature (°C)	24	22	22.9	25	23.47	27.9	30.5	29	26.4	28.45	25.8	25	25.3	24.8	25.22
pH	7.5	6.78	8.3	7.67	7.56	7.67	7.21	7.61	8.13	7.65	7.56	6.98	7.36	7.2	7.27
EC (µmhos/cm)	572	762	585	647	641.5	694	719	732	713	714.5	715	736	737	741	732.25
TDS (mg/L)	366	488	374	414	410.5	444	460	469	462	458.75	465	479	472	474	472.5
TH (mg/L)	148	119	155	133	138.75	140	138	127	135	135	117.8	129	112.8	110	117.4
T.alkalinity (mg/L)	226	300	280	280	271.5	310	265	310	310	298.75	306	296	255	320	294.25
Carbonate (mg/L)	26	0	30	0	14	40	30	40	40	37.5	20	14	0	19	13.25
Bicarbonate (mg/L)	200	300	250	280	257.5	270	235	270	270	261.25	286	282	255	301	281
Chloride (mg/L)	17.7	22	21.3	35.45	24.11	31.9	31.5	35.5	28.4	31.82	30	17	18	30.2	23.8
Sulfate (mg/L)	8.23	8.5	30	5.58	13.07	30	27.4	30	25	28.1	21	18	10	8	14.25
Phosphate (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (mg/L)	3.9	114	87	117.5	80.6	106.5	112.7	121.9	113.6	113.67	115	119	49.5	108	97.87
Potassium (mg/L)	0.12	6	5.7	5.9	4.43	5.5	4.2	6.1	5.85	5.41	7.3	9.1	10.65	6.45	8.37
Calcium (mg/L)	38.47	21.2	35.3	22.4	29.34	31.3	27.7	22.4	24	26.35	25.6	28.3	18.8	19.2	22.97
Magnesium (mg/L)	12.63	16	16.3	18.7	15.91	15	16.7	17.2	18.2	16.77	13.1	14.2	16	15	14.57

The high values of sulphate level of the two samples in summer are in accordance with the observations made by Desai (1995). Desirable level of sulphate ion as per BIS standard is 200mg/L for drinking water.

Phosphate ion concentrations present in the water samples of both the tanks were less than 0.01 mg/L. In presence of oxygen, phosphates co-precipitate with the complex insoluble oxides of iron and manganese. Aluminium and calcium are also known for co-precipitating phosphates with their insoluble salts in presence of oxygen. These might have caused phosphorus precipitation and settling it to sediments resulting in the overall decrease of phosphorus in water (Trivedy & Goel 1986).

Chloride ion concentration of water is another important parameter to be considered for knowing the quality of water since its higher concentration can impart undesirable taste to water and may cause corrosion in the distribution system (McConnell 1972). Chloride concentration of water samples is known to depend upon the characteristics of the sediments and the pollution load of the reservoir. The values of chloride are usually low in unpolluted waters (Desai 1995) and higher chloride values are indicating the deterioration of water quality. The desirable level of chloride ion is 250mg/L for drinking water (BIS standard). In the present study, chloride values varied from 34.95mg/L in monsoon to 58.25mg/L in summer in Halkurke tank water and 23.8 mg/L in monsoon to 31.82mg/L (summer) in Honnavalli tank. Increased concentration of chloride towards summer could be due to more evaporation of water caused by higher seasonal temperature.

Table 4: Irrigation characteristics of Tank water samples.

Halkurke	Season	EC (µmho/cm)	SAR	RSC (meq/L)	RSBC (meq/L)	% Na	B (mg/L)
	Winter	567	4	1.89	2.2	53.5	0.2
	Summer	670.5	4.02	2.33	2.99	62.6	0.22
	Monsoon	704	5.68	4.3	4.49	72.38	0.77
Honnavalli	Winter	641.5	3.02	2.02	2.88	47.35	0.11
	Summer	714.5	4.19	2.81	2.97	62.71	0.07
	Monsoon	732.25	4.03	2.69	3.46	59.38	<0.01

EC-Electrical conductivity, SAR-Sodium adsorption ratio, RSC-Residual sodium carbonate, RSBC-Residual sodium bicarbonate, B-Boron content.

Table 5: Limits of some important parameter indices for rating water quality and its suitability for irrigation .

Category	EC (mS/cm)	RSC (meq/L)	SAR	Restriction to use
I	<0.7	<1.25	<3.0	None
II	0.7-3.0	1.25-2.5	3.0-9.0	Medium
III	>3.0	>2.5	>9.0	Severe

Most of the freshwaters derive their sodium, potassium, calcium, magnesium and other nutrients from soils and rocks which will vary with the geography of the place. Calcium forms the most abundant cation in freshwater. The presence of calcium in water results from passage through or over deposits of limestone, dolomite, gypsum and gypsiferous shale. The concentration of magnesium in water is comparatively less than calcium possibly due to its lesser occurrence than calcium (Garg 2003).

The value of calcium ranged from a low of 13.75 mg/L (summer) to a higher value of 18.55 mg/L (monsoon) in Halkurke tank. Its values varied from 22.97 mg/L (monsoon) to a high of 29.34mg/L (winter) in Honnavalli tank. Desirable levels of calcium and magnesium are 75mg/L and 30 mg/L respectively for drinking water (BIS standard). Magnesium values varied from a low of 9.56 mg/L (monsoon) to a high of 10.82 mg/L (summer) in Halkurke tank, and a low of 14.57 mg/L (monsoon) to a high of 16.77 mg/L (summer) in Honnavalli tank. Sodium values varied from 83.27mg/L (summer) to 121.25mg/L (monsoon) in Halkurke, and Honnavalli tank water from 80.6 mg/L (winter) to 113.67 mg/L (summer). Potassium values varied from 6.64 mg/L (winter) to 10.92 mg/L (monsoon) in Halkurke tank water, and from 4.43 mg/L (winter) to 8.37mg/L (monsoon) in Honnavalli tank.

The graphical representation of experimentally determined values of physico-chemical parameters of Halkurke tank, Fig.1(a) and Honnavalli tank, Fig.1(b) water samples influenced by seasonal variations during November 2010 to December 2011.

Waters from both the tanks are presently not used by the public for drinking but they are used for irrigation and livestock. Tank waters are helping in recharging the groundwater which is another source for domestic and agricultural use. Therefore, if the quality of the tank waters are not properly maintained at the desired levels, the polluted waters will percolate and recharge the groundwater which will result in the qualitative degradation of groundwater.

Irrigation characteristics of Tank water samples (Table 4): From the water quality data, the irrigational indices, i.e., SAR, % Na, RSC and RSBC were evaluated from the following equations. For calculations of these, concentrations were taken in meq/L.

$$SAR = Na^{+} \Big/ \sqrt{Ca^{++} + Mg^{++}} / 2 \quad \text{(Richard 1954)}$$

$$RSC = (CO_3^{-2} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+}) \text{ (Eaton 1950)}$$

$$RSBC = (HCO_3^{-} - Ca^{2+}) \text{ (Gupta \& Gupta 1987)}$$

$$Na\ \% = Na^{+} \times 100/(Ca^{+2} + Mg^{+2} + Na^{+} + K^{+})$$

(Manivasakam 1984-85)

According to Ayers & Westcott (1989), Eaton (1950) and Wilcox (1955) the rating of water for its suitability in irrigation is given in the following Table 5.

A low SAR value of <3 indicates little danger from sodium. Tank waters of the two tanks studied recorded SAR values in the range of 3.02 to 5.68 and fall under medium quality for irrigation as set by Ayers & Westcott (Table 5).

As per the Indian standards (BIS 1991), a maximum limit of 60% sodium is recommended for irrigation water. Halkurke tank recorded 53.5% Na in winter, 62.6 % Na in summer and 72.38% Na in monsoon season. Hence, the water is not suitable for irrigation during summer and monsoon seasons. Honnavlli tank water recorded 47.35% Na in winter,

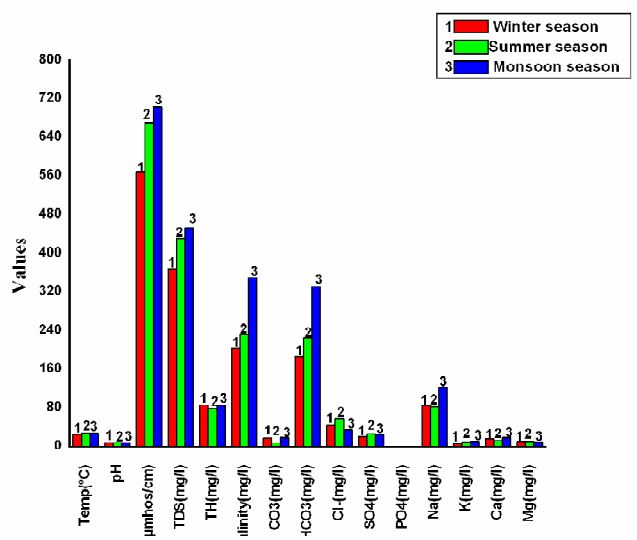

Fig. 1(a): Graphical representation of physico-chemical characteristics of Halkurke tank.

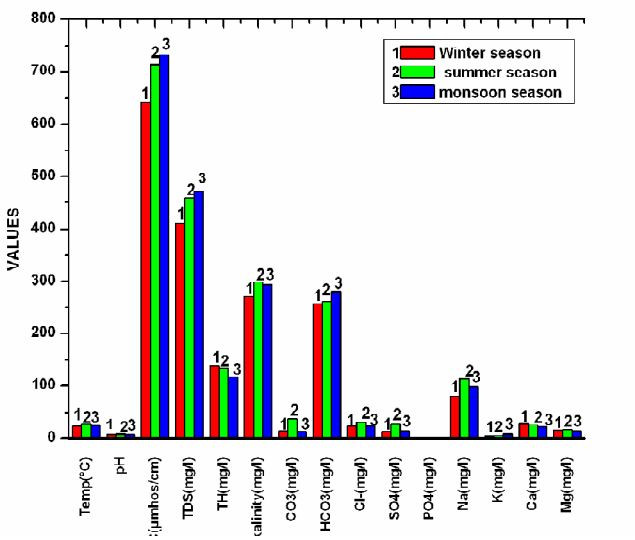

Fig. 1(b): Graphical representation of physico-chemical characteristics of Halkurke tank.

62.71% Na in summer and 59.38% Na in monsoon. The water is not suitable for summer irrigation.

The RSC values of Halkurke water varied from 1.89 meq/L (winter) to 4.3 meq/L (monsoon), whereas in Honnavalli tank, the RSC values varied from 2.02 meq/L (winter) to 2.81 meq/L (summer). The high values of RSC may be attributed to increase in carbonate and bicarbonate in the samples during the respective seasons. This index also puts the two water samples under medium to severe restriction to use for irrigation. Calcium and magnesium precipitate as carbonates and residual carbonates and bicarbonates are left in the soil as sodium carbonate. The water with high RSC value has high pH and land irrigated with such water becomes infertile owing to the deposition of sodium carbonate (Jain et al. 2011).

The value of boron content varied from <0.2mg/L (winter) to 0.77mg/L (monsoon) in Halkurke sample, and from <0.01mg/L (monsoon) to 0.11mg/L (winter). In this regard both the water samples are safe for all crops.

CONCLUSION

pH is on the alkaline side but within the permissible level. The alkaline range of pH indicates pollution and also reduced free CO_2 due to increased photosynthetic activity of phytoplankton. Total alkalinity is higher than the acceptable range. As far as drinking purpose is concerned all other parameters indicate that the samples are within the permissible level in absence of an alternate source. RSC values of both the samples exceed 2.5 meq/L in monsoon and also in summer indicating the samples are not suitable for irrigation during the said seasons. SAR values of the two samples were in medium quality range. Hence, it may be concluded that waters of the two tanks may pose salinity and permeability problems as revealed by EC, SAR, RSC and %Na values.

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