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ASSESSMENT OF PHYSICO-CHEMICAL QUALITY OF MUNICIPAL WATER SAMPLES OF MAKRONIA SUB-URBAN AREA OF BUNDEL KHAND REGION, INDIA

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Abstract: Municipal water is one of the major resources of the drinking water in Makronia sub-urban area. In the present study samples collected from different localities in and around Makronia sub-urban area were analyzed for their physico- chemical characteristics were carried out during different months of the pre monsoon, monsoon and post monsoon seasons in sep. 2007 to sep. 2011. Results show that all the samples are under Indian standard limit for drinking purpose. The statistical analysis of the collected samples yielded the range of the variation, mean, standard deviation and co-efficient of variation. On the basis of analyses parameters, the results indicated the, satisfactory water quality of the water supplied by Municipal Corporation.

Key words: Physico - chemical characteristics, Municipal water

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INTRODUCTION

Water is the elixir for life. Adequate supply of potable safe water is absolutely essential and is the basic need for all human being on the earth. The quality of water may be described according to their physico-chemical characteristics. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential. However it is very difficult and laborious task for regular monitoring of all the parameters even if adequate manpower and laboratory facilities are available. Therefore, an attempt based on statistical correlation, has been used to develop mathematical relationship for comparison of physico-chemical parameters.

A number of investigations attempted before to check the water quality assessment with reference to drinking purpose have been carried out in Sagar city (Pathak & Limaye, 2008a; Pathak & Limaye, 2008b; Pathak & Limaye, 2008c; Pathak & Limaye, 2011a; Pathak & Limaye, 2011b; Pathak & Limaye, 2011c; Pathak & Limaye, 2011d; Pathak & Limaye, 2012a; Pathak & Limaye, 2012b; Pathak & Limaye, 2012c; Pathak & Limaye, 2012d; Pathak et al., 2011; Pathak et al., 2012).

MATERIALS AND METHODS

The present work aims to evaluate the municipal water suitability for drinking purpose. 05 sampling places were selected for this study and these are wide spread in the study area. Municipal water was collected from sep. 2007 to sep. 2011.

The water samples were collected in 500 ml polyethylene bottles. All the chemicals used were of AR grade. Analysis was carried out for various water quality parameters such as water temperature measured by using mercury-glass thermometer, Colour by Pt-Co scale method, pH, conductivity and Turbidity measured by using standard pH meter, conductivity meter and Turbidity tube respectively. Total solids (TS) by gravimetric method, total dissolved solids (TDS) by digital conductivity meter, chloride content by argentometric method; Total hardness was calculated by complexometric titration using EDTA titrimetric method, alkalinity by titrimetric method. Dissolved oxygen by Winkler method. Biological oxygen demand by standard methods, chemical oxygen demand (COD) was measured by Open reflux methods. Iron and fluoride by colorimetric analysis and rest all the parameters determined by as per Apha (APHA, 2005). The value of the physico-chemical parameters were compared with desirable/permissible limit of IS: 10500 drinking water specification (ISDW, 1991). The statistical analysis such as Pearson correlation matrix and curve estimation has been performed using by SPSS 11.0 Statistical Software (SPSS, 2011).

Table 1. Sampling locations and corresponding habitats

Station code-Sampling Locations	Collection Place	Sample Source
S1- I. Deen dayal Nagar	Residential Area	Municipal Water Supply
S2-Makronia chouraha	Residential Area	Municipal Water Supply
S3- Raja khedi	Residential Area	Municipal Water Supply
S4- Civil line	Residential Area	Municipal Water Supply
S5- Gopal ganj	Residential Area	Municipal Water Supply

Latitude 23°51'16"N, Longitude 78°47'04"E

RESULTS AND DISCUSSION

The analytical results of physical and chemical parameters of municipal water were compared with the standard guideline values as recommended by the IS:10500 for drinking and public health purposes. Most municipal water found in the Sagar city has pH value ranging from about 7.2 to 8.4 is found to be alkaline in nature.

Most of the municipal water samples are within the maximum permissible limit for drinking as per the IS:10500 standard. The value below 500 mg/l of TDS, indicating low content of soluble salts in municipal water which can be used for drinking without any risk. Site wise estimated values of 26 water quality parameters for 05 municipal water samples are presented in above table 2.

Results indicated that municipal water sources of S2 (ammonia), S4 (BOD) sampling places is slightly contaminated with respected to given parameters during few analysis period, for remedial action, it may be suggested that the Municipal water quality of study area can be checked regularly. It may be concluded that sampling places S4 more BOD due to anthropogenic activities like lack of maintenance of pipelines leakage and contact with sewage.

Some prominent correlations exist between water qualities parameters and from correlation values presented in table 3 and significance in table 4, it is revealed that:

- strongly positive relationship between turbidity and BOD indicated that increased in turbidity values increased BOD;

- strongly positive relationship between turbidity and o-Phosphate indicated that turbidity in water is mainly due to o-Phosphate;

- strongly positive relationship between residual chlorine and DO indicated that addition of hypochlorous acid or bleaching powder in municipal water treatment increased in value of DO with residual chlorine;

- TDS has strongly positive relationship with Chloride indicated that dissolved solids mainly contained chloride ions. Strongly negative relationship between chloride and permanent

hardness indicated in water sample present of chloride in lower amount and there is possibility of other ions like nitrate or sulphate in sample;

- strongly positive relationship between Perm. Hardness and Ca hardness or Ca Content indicated that calcium is predominant ions in water sample;

- multiple regression analysis method was used to evaluate relationship between DO and among other water properties (entire study). Identification of variables such as Colour, BOD, COD, Conductivity, TSS, pH, Residual chlorine, o-phosphate, Ammonia, Fluoride and Iron have significant and separate effects on the DO.

Table 2. Statistical evaluation for different Parameters in the municipal water Samples of in and around Makronia sub-urban area

Descriptive Statistics

	Range	Minimum	Maximum	Sum	Mean		Std.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TEMPRATURE	3.10	22.70	25.80	490.90	24.5450	.1811	.81012	.656	-.472	.512	.194	.992
COLOUR	13.00	9.00	22.00	285.00	14.2500	.7673	3.43166	11.776	.320	.512	-.418	.992
pH	1.44	6.82	8.26	154.80	7.7400	.1105	.49419	.244	-.805	.512	-.837	.992
TURBIDITY	14.00	7.00	21.00	219.00	10.9500	.6548	2.92853	8.576	2.094	.512	7.049	.992
DO	4.39	3.05	7.44	115.26	5.7630	.2832	1.26670	1.605	-.820	.512	-.076	.992
BOD	8.18	2.64	10.82	108.14	5.4070	.3714	1.66088	2.759	1.594	.512	5.512	.992
COD	5.84	8.48	14.32	196.63	9.8315	.3079	1.37693	1.896	2.090	.512	5.322	.992
CONDUCTIVITY	.31	.52	.83	13.86	.6929	.0214	.09556	.009	-.410	.512	-1.052	.992
ALKALINITY	154.00	126.00	280.00	3888.00	194.4000	7.9095	35.37231	1251.200	.479	.512	.747	.992
TS	240.30	325.52	565.82	8733.53	436.6765	14.3478	64.16531	4117.187	-.119	.512	-.577	.992
TSS	54.89	4.36	59.25	273.76	13.6880	2.4969	11.16639	124.688	3.896	.512	16.549	.992
TDS	187.72	318.85	506.57	8459.77	422.9885	13.0342	58.29064	3397.799	-.412	.512	-1.056	.992
CHLORIDE	105.09	23.52	128.61	824.56	41.2280	5.0225	22.46109	504.501	3.467	.512	13.216	.992
RESICHLORINE	.33	.03	.36	2.71	.1355	.0151	.06732	.005	1.857	.512	6.075	.992
PHOSPHATE	3.08	.83	3.91	35.38	1.7689	.1695	.75814	.575	1.161	.512	2.001	.992
NITRATE	4.97	1.05	6.02	36.51	1.8255	.2540	1.13587	1.290	2.984	.512	10.172	.992
AMMONIA	.24	.11	.35	4.16	.2080	.0153	.06826	.005	.398	.512	-1.001	.992
TH	94.98	163.80	258.78	4266.93	213.3465	5.0467	22.56960	509.387	.155	.512	.659	.992
TEMP. HARD.	85.51	116.61	202.12	3377.39	168.8695	4.1913	18.74389	351.333	-.918	.512	2.149	.992
PERM. HARD.	53.99	28.12	82.11	889.54	44.4770	2.8218	12.61969	159.257	1.457	.512	3.380	.992
Ca HARDNESS	172.12	52.50	224.62	2586.99	129.3495	11.6608	52.14867	2719.484	-.348	.512	-1.040	.992
Mg HARDNESS	132.22	21.92	154.14	1679.94	83.9970	10.0393	44.89722	2015.760	.487	.512	-1.255	.992
FLUORIDE	1.13	.26	1.39	17.56	.8780	.0783	.35027	.123	-.277	.512	-1.124	.992
IRON	1.30	.17	1.47	8.87	.4435	.0657	.29394	.086	2.676	.512	8.099	.992
Ca CONTENT	47.94	42.08	90.02	1239.97	61.9985	2.1489	9.61015	92.355	.811	.512	3.629	.992
Mg CONTENT	22.74	5.32	28.06	284.90	14.2450	1.0692	4.78165	22.864	.877	.512	3.345	.992

CONCLUSION AND RECOMMENDATIONS

The major conclusions derived from this study, carried out in the Sagar city are as follows. The physical and chemical parameters of the Sagar results shows that all the samples are under recommended limit for drinking purposes.

On the basis of detailed chemical analysis, it may be suggested that the regular monitoring must needed for municipal water supply of study area, quality can be checked effectively from the results of the present study, it may be said that, the overall municipal water quality of Makronia sub-urban area is chemically fit for domestic as well as drinking purpose.

	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-18	P-19	P-20	P-21	P-22	P-23	P-24	P-25	P-26
P-1	1	0.261	-0.307	-0.147	0.261	-0.02	-0.049	-0.019	0.164	-0.025	-0.024	-0.02	-0.097	0.006	-0.224	-0.058	0.122	-0.34	-0.389	-0.092	-0.213	-0.391	0.196	-0.129	-0.213	-0.391
P-2	0.261	1	0.37	0.62	0.412	0.691	0.763	0.002	0.638	0.123	0.593	0.002	0.581	0.759	0.479	0.753	0.104	0.207	0.641	-0.278	0.287	-0.007	0.514	0.691	0.288	-0.007
P-3	-0.307	0.37	1	0.475	0.049	0.462	0.497	0.332	0.371	0.408	0.387	0.332	0.383	0.432	0.455	0.44	0.146	0.183	0.517	-0.205	0.119	0.204	0.179	0.533	0.118	0.204
P-4	-0.147	0.62	0.475	1	-0.097	0.632	0.592	-0.278	0.315	-0.174	0.501	-0.28	0.652	0.751	0.524	0.677	-0.016	0.513	0.67	0.07	0.386	0.49	0.218	0.641	0.386	0.49
P-5	0.261	0.412	0.049	-0.097	1	0.402	0.359	0.217	0.588	0.293	0.372	0.219	0.407	0.261	0.216	0.178	-0.077	-0.262	0.176	-0.464	-0.002	-0.555	0.722	0.148	-0.002	-0.554
P-6	-0.02	0.691	0.462	0.632	0.402	1	0.686	-0.163	0.65	-0.015	0.712	-0.162	0.744	0.756	0.565	0.638	-0.164	0.249	0.532	-0.138	0.263	0.12	0.435	0.609	0.263	0.12
P-7	-0.049	0.763	0.497	0.592	0.359	0.686	1	0.019	0.661	0.174	0.76	0.018	0.684	0.785	0.634	0.693	0.205	0.512	0.731	0.018	0.503	0.305	0.468	0.742	0.503	0.305
P-8	-0.019	0.002	0.332	-0.278	0.217	-0.163	0.019	1	-0.143	0.979	-0.057	1	-0.039	-0.16	0.008	-0.196	0.316	-0.238	-0.053	-0.246	-0.123	-0.315	0.035	0.061	-0.123	-0.315
P-9	0.164	0.638	0.371	0.315	0.588	0.65	0.661	-0.143	1	0.021	0.788	-0.142	0.482	0.54	0.36	0.548	-0.113	-0.031	0.363	-0.338	0.062	-0.162	0.668	0.37	0.062	-0.162
P-10	-0.025	0.123	0.408	-0.174	0.293	-0.015	0.174	0.979	0.021	1	0.149	0.979	0.091	-0.014	0.126	-0.082	0.297	-0.19	0.055	-0.276	-0.074	-0.289	0.169	0.175	-0.074	-0.289
P-11	-0.024	0.593	0.387	0.501	0.372	0.712	0.76	-0.057	0.788	0.149	1	-0.057	0.633	0.706	0.578	0.548	-0.072	0.231	0.526	-0.154	0.238	0.12	0.65	0.562	0.238	0.12
P-12	-0.02	0.002	0.332	-0.28	0.219	-0.162	0.018	1	-0.142	0.979	-0.057	1	-0.039	-0.16	0.008	-0.196	0.315	-0.239	-0.053	-0.247	-0.124	-0.316	0.036	0.06	-0.124	-0.316
P-13	-0.097	0.581	0.383	0.652	0.407	0.744	0.684	-0.039	0.482	0.091	0.633	-0.039	1	0.785	0.832	0.688	0.032	0.525	0.635	0.113	0.622	0.148	0.471	0.772	0.622	0.148
P-14	0.006	0.759	0.432	0.751	0.261	0.756	0.785	-0.16	0.54	-0.014	0.706	-0.16	0.785	1	0.75	0.744	0.063	0.46	0.709	-0.027	0.488	0.218	0.545	0.793	0.488	0.218
P-15	-0.224	0.479	0.455	0.524	0.216	0.565	0.634	0.008	0.36	0.126	0.578	0.008	0.832	0.75	1	0.756	0.109	0.618	0.73	0.148	0.639	0.319	0.423	0.781	0.639	0.319
P-16	-0.058	0.753	0.44	0.677	0.178	0.638	0.693	-0.196	0.548	-0.082	0.548	-0.196	0.688	0.744	0.756	1	0.215	0.552	0.705	0.088	0.582	0.268	0.478	0.684	0.582	0.268
P-17	0.122	0.104	0.146	-0.016	-0.077	-0.164	0.205	0.316	-0.113	0.297	-0.072	0.315	0.032	0.063	0.109	0.215	1	0.157	0.133	0.082	0.157	0.091	0.071	0.102	0.157	0.091
P-18	-0.34	0.207	0.183	0.513	-0.262	0.249	0.512	-0.238	-0.031	-0.19	0.231	-0.239	0.525	0.46	0.618	0.552	0.157	1	0.578	0.738	0.898	0.729	-0.101	0.56	0.898	0.728
P-19	-0.389	0.641	0.517	0.67	0.176	0.532	0.731	-0.053	0.363	0.055	0.526	-0.053	0.635	0.709	0.73	0.705	0.133	0.578	1	-0.124	0.477	0.486	0.287	0.769	0.477	0.486
P-20	-0.092	-0.278	-0.205	0.07	-0.464	-0.138	0.018	-0.246	-0.338	-0.276	-0.154	-0.247	0.113	-0.027	0.148	0.088	0.082	0.738	-0.124	1	0.697	0.484	-0.36	0.045	0.697	0.484
P-21	-0.213	0.287	0.119	0.386	-0.002	0.263	0.503	-0.123	0.062	-0.074	0.238	-0.124	0.622	0.488	0.639	0.582	0.157	0.898	0.477	0.697	1	0.353	0.121	0.62	1	0.353
P-22	-0.391	-0.007	0.204	0.49	-0.555	0.12	0.305	-0.315	-0.162	-0.289	0.12	-0.316	0.148	0.218	0.319	0.268	0.091	0.729	0.486	0.484	0.353	1	-0.404	0.226	0.353	1
P-23	0.196	0.514	0.179	0.218	0.722	0.435	0.468	0.035	0.668	0.169	0.65	0.036	0.471	0.545	0.423	0.478	0.071	-0.101	0.287	-0.36	0.121	-0.404	1	0.265	0.121	-0.404
P-24	-0.129	0.691	0.533	0.641	0.148	0.609	0.742	0.061	0.37	0.175	0.562	0.06	0.772	0.793	0.781	0.684	0.102	0.56	0.769	0.045	0.62	0.226	0.265	1	0.621	0.226
P-25	-0.213	0.288	0.118	0.386	-0.002	0.263	0.503	-0.123	0.062	-0.074	0.238	-0.124	0.622	0.488	0.639	0.582	0.157	0.898	0.477	0.697	1	0.353	0.121	0.621	1	0.353
P-26	-0.391	-0.007	0.204	0.49	-0.554	0.12	0.305	-0.315	-0.162	-0.289	0.12	-0.316	0.148	0.218	0.319	0.268	0.091	0.728	0.486	0.484	0.353	1	-0.404	0.226	0.353	1

Table 3. Matrix of Pearson Correlation for different Parameters in the municipal water Samples of in and around Makronia sub-urban area

	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-18	P-19	P-20	P-21	P-22	P-23	P-24	P-25	P-26
P-1	.	0.267	0.188	0.537	0.266	0.934	0.836	0.935	0.491	0.916	0.92	0.932	0.684	0.98	0.342	0.809	0.608	0.143	0.09	0.7	0.367	0.088	0.406	0.588	0.367	0.088
P-2	0.267	.	0.108	0.004	0.071	0.001	0	0.994	0.002	0.605	0.006	0.995	0.007	0	0.032	0	0.663	0.381	0.002	0.235	0.219	0.976	0.02	0.001	0.219	0.975
P-3	0.188	0.108	.	0.034	0.836	0.04	0.026	0.152	0.108	0.074	0.092	0.153	0.096	0.057	0.044	0.052	0.538	0.441	0.02	0.385	0.619	0.389	0.451	0.015	0.619	0.389
P-4	0.537	0.004	0.034	.	0.683	0.003	0.006	0.235	0.175	0.463	0.024	0.233	0.002	0	0.018	0.001	0.948	0.021	0.001	0.77	0.092	0.028	0.356	0.002	0.093	0.028
P-5	0.266	0.071	0.836	0.683	.	0.079	0.12	0.357	0.006	0.21	0.106	0.354	0.075	0.267	0.36	0.453	0.746	0.264	0.457	0.039	0.993	0.011	0	0.534	0.993	0.011
P-6	0.934	0.001	0.04	0.003	0.079	.	0.001	0.492	0.002	0.951	0	0.495	0	0	0.009	0.002	0.488	0.29	0.016	0.562	0.263	0.615	0.055	0.004	0.263	0.615
P-7	0.836	0	0.026	0.006	0.12	0.001	.	0.938	0.002	0.463	0	0.938	0.001	0	0.003	0.001	0.385	0.021	0	0.94	0.024	0.191	0.038	0	0.024	0.191
P-8	0.935	0.994	0.152	0.235	0.357	0.492	0.938	.	0.549	0	0.81	0	0.872	0.502	0.974	0.408	0.174	0.312	0.825	0.296	0.605	0.176	0.882	0.798	0.605	0.176
P-9	0.491	0.002	0.108	0.175	0.006	0.002	0.002	0.549	.	0.931	0	0.55	0.031	0.014	0.119	0.012	0.634	0.897	0.116	0.145	0.796	0.496	0.001	0.108	0.796	0.496
P-10	0.916	0.605	0.074	0.463	0.21	0.951	0.463	0	0.931	.	0.532	0	0.702	0.954	0.595	0.731	0.203	0.423	0.818	0.239	0.757	0.217	0.476	0.461	0.757	0.217
P-11	0.92	0.006	0.092	0.024	0.106	0	0	0.81	0	0.532	.	0.811	0.003	0.001	0.008	0.012	0.764	0.328	0.017	0.517	0.311	0.615	0.002	0.01	0.311	0.614
P-12	0.932	0.995	0.153	0.233	0.354	0.495	0.938	0	0.55	0	0.811	.	0.87	0.5	0.973	0.407	0.176	0.31	0.824	0.294	0.602	0.175	0.879	0.801	0.602	0.174
P-13	0.684	0.007	0.096	0.002	0.075	0	0.001	0.872	0.031	0.702	0.003	0.87	.	0	0	0.001	0.893	0.018	0.003	0.636	0.003	0.534	0.036	0	0.003	0.534
P-14	0.98	0	0.057	0	0.267	0	0	0.502	0.014	0.954	0.001	0.5	0	.	0	0	0.79	0.041	0	0.91	0.029	0.356	0.013	0	0.029	0.356
P-15	0.342	0.032	0.044	0.018	0.36	0.009	0.003	0.974	0.119	0.595	0.008	0.973	0	0	.	0	0.646	0.004	0	0.535	0.002	0.17	0.063	0	0.002	0.17
P-16	0.809	0	0.052	0.001	0.453	0.002	0.001	0.408	0.012	0.731	0.012	0.407	0.001	0	0	.	0.364	0.012	0.001	0.711	0.007	0.253	0.033	0.001	0.007	0.253
P-17	0.608	0.663	0.538	0.948	0.746	0.488	0.385	0.174	0.634	0.203	0.764	0.176	0.893	0.79	0.646	0.364	.	0.507	0.576	0.733	0.51	0.703	0.766	0.67	0.509	0.703
P-18	0.143	0.381	0.441	0.021	0.264	0.29	0.021	0.312	0.897	0.423	0.328	0.31	0.018	0.041	0.004	0.012	0.507	.	0.008	0	0	0	0.672	0.01	0	0
P-19	0.09	0.002	0.02	0.001	0.457	0.016	0	0.825	0.116	0.818	0.017	0.824	0.003	0	0	0.001	0.576	0.008	.	0.601	0.033	0.03	0.219	0	0.033	0.03
P-20	0.7	0.235	0.385	0.77	0.039	0.562	0.94	0.296	0.145	0.239	0.517	0.294	0.636	0.91	0.535	0.711	0.733	0	0.601	.	0.001	0.031	0.119	0.85	0.001	0.031
P-21	0.367	0.219	0.619	0.092	0.993	0.263	0.024	0.605	0.796	0.757	0.311	0.602	0.003	0.029	0.002	0.007	0.51	0	0.033	0.001	.	0.127	0.61	0.004	0	0.127
P-22	0.088	0.976	0.389	0.028	0.011	0.615	0.191	0.176	0.496	0.217	0.615	0.175	0.534	0.356	0.17	0.253	0.703	0	0.03	0.031	0.127	.	0.077	0.338	0.127	0
P-23	0.406	0.02	0.451	0.356	0	0.055	0.038	0.882	0.001	0.476	0.002	0.879	0.036	0.013	0.063	0.033	0.766	0.672	0.219	0.119	0.61	0.077	.	0.26	0.61	0.077
P-24	0.588	0.001	0.015	0.002	0.534	0.004	0	0.798	0.108	0.461	0.01	0.801	0	0	0	0.001	0.67	0.01	0	0.85	0.004	0.338	0.26	.	0.004	0.339
P-25	0.367	0.219	0.619	0.093	0.993	0.263	0.024	0.605	0.796	0.757	0.311	0.602	0.003	0.029	0.002	0.007	0.509	0	0.033	0.001	0	0.127	0.61	0.004	.	0.127
P-26	0.088	0.975	0.389	0.028	0.011	0.615	0.191	0.176	0.496	0.217	0.614	0.174	0.534	0.356	0.17	0.253	0.703	0	0.03	0.031	0.127	0	0.077	0.339	0.127	.

Table 4. Matrix of Significance (2-Tailed) for different Parameters in the municipal water Samples of in and around Makronia sub-urban Area

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