Mapana – Journal of Sciences
2024, Vol. 23, No. 1, 189-197
ISSN 0975-3303 | https://doi.org/10.12723/mjs.68.10

Physico-Chemical Assessment of Drinking Water of Coastal Area of Vizhinjam During Pre and Post Monsoon Seasons

S. Fasna Das*, Jisha George*, S. Aswathy*, G. Rathika Nath†, K. Rajesh*

Abstract

The construction of a Sea port at Vizhinjam in Trivandrum has evoked talks regarding possible environmental repercussions in the region. The present study is an attempt at analyzing the physico-chemical assessment of drinking water quality of different stations near the construction site of Vizhinjam port. It was evaluated during pre and post monsoon seasons. Temperature, pH, TDS, EC, DO, total alkalinity,T-H, Ca-H, Mg-H and Cl_2 levels were analyzed. The study shows variation of temperature between 25 °C and 27 °C. pH varied between 6.7 and 7.4. The present study has its significance for public hygiene in public interest. Most parameters which were studied were found to be within approved BIS levels showing drinkability.

Keywords: water quality parameters, temperature, total alkalinity, total hardness, public hygiene

Introduction

Water is one of the most essential commodity that makes our life sustainable and its quality is usually described by its physical and chemical characteristics. Consumption of water has an inevitable role in the existence of life. Water is also considered to be one of the most important aesthetic landscape elements[1] which provides health and

* Dept. of Chemistry, University College, Trivandrum, Kerala, India; rajesh_k_k@yahoo.com

† Dept. Of Chemistry, KSM DB College, Sasthamcotta, Kerala, India;

well-being to humans [2].Thus it is a fact that basis for any corporate development is the existence of water.

Wide usage of chemical fertilizers and pesticides in agriculture and rapid industrialization leads to pollution and depletion of aquatic biota and deterioration of water quality. Consumption of contaminated water generate human population with water borne diseases. That is why regular checkup of water quality at regular interval of time is considered as an inevitable criteria for the development of a healthy society [3–7]. The standard of living will increase if individuals have access to clean drinking water, proper sanitation, and personal, household, and communal cleanliness. From the micro level of households to the macro perspective of national economies, better management of water resources can save many lives by reducing the transmission of vector-borne diseases, making water bodies safe for recreational and other users. This can also have a significant positive impact on the economy, both directly and indirectly. The present study aim to check water quality parameters that helps to identify the physic chemical characteristic deviation of water samples collected from different locations near by the under construction Vizhinjam seaport.

During post monsoon seasons there is a chance of increase in the salinity of waterbodies due to dredging that may cause health problems like hypertension, kidney diseases and bone weakening. So, it is necessary to check the water quality parameters especially the salinity of waterbodies near the dredging area.

Material and Methods

Sample collection and Analysis: Collected hundred water samples for each pre– monsoon (March 2016) and post–monsoon (October2016) seasons from Vizhinjam port area viz, Nedumom , Balaramapuram , Nellimoodu , Pulluvila , Poovar , Vellayani and Punnammoodu. For the analysis, 20 samples were collected from each sitesand 5 water samples were collected from 5 ponds. Samples were collected by grab sampling method. The water sample collection and analysis has been done as per the standard methods prescribed in Bureau of Indian Standards (BIS) [9] and APHA [10]. Some of the parameters like pH, temp, and TDS of the samples were done onsite with the help

of digital p^H meter, thermometer and TDS meter. For further analysis, samples were collected in polyethylene bottles having capacity of 1L and stored in the laboratory at 4 ℃. Conductivity was measured using conductivity meter. Dissolved Oxyen (DO) was determined by the Winkler's method. Total hardness and calcium were determined by complexometric titration with standard EDTA. Magnesium was determined by the calculation method. Chloride was estimated using argentometric titration by standard $AgNO_3$ solution.

Result and Discussion

Hundred water samples for each season were analysed for all the parameters. Ten samples from each site Vizhinjam (VZM), Pulluvila (PUL), Balaramapuram (BLP), Nellimood (NEL) and Nedumam (NED) were chosen for the average values. Every measurements, with the exception of pH (units) and electrical conductivity (EC), is represented in mg/L. The electrical conductivity (EC) is expressed in µS/cm at 25 ℃.

Table(1)

Analysis of water quality parameters during pre-monsoon season.

Sl. No.	Sampling points	PH	Temp (^{0}C)	Tds	EC	DO	Total alkalinity	CO_3^{2-}	HCO_3^-	Total Hardness	$Ca^{2=}$	Mg^{2+}	Cl^-	Salinity
1.	Vzm 1	7.1	28.9	.1	262	5.24	22.84	0	26.84	75	2.46	7.86	205.03	135
2.	Vzm 2	7.2	27.8	.1	109	6.27	25.96	0	25.96	73	3.34	9.87	203.07	64
3.	Vzm 6	7.4	29.7	.3	170	5.49	21.56	0	24.56	68	4.46	8.56	203.26	93
4.	Vzm 8	7.3	28.5	.1	55	5.24	30.67	0	34.67	64	1.89	4.28	194.28	34
5.	Vzm 10	7.4	27.8	.4	320	5.82	18.84	0	22.84	70	3.56	9.84	192.02	167
6.	Vzm 11	7.5	29.7	.1	375	5.49	15.67	0	19.67	73	4.26	8.47	190.01	190
7.	Vzm 13	7.3	28.6	.5	425	6.47	16.84	0	20.84	64	2.18	7.47	200.26	267
8.	Vzm 14	7.6	27.4	.2	145	6.27	17.36	0	21.36	65	3.47	8.36	202.05	78
9.	Vzm 15	7.5	29.4	.4	240	5.49	30.67	0	34.67	68	4.48	9.56	201.06	123
10.	Vzm 16	7.4	28.6	0	30	5.82	20.36	0	24.36	70	1.69	4.65	203.26	23
11.	Pul 1	7.1	29.8	0	290	5.24	20.24	0	24.24	73	2.48	7.87	200.26	147
12.	Pul 2	7.3	28.6	.3	40	5.49	19.64	0	23.64	70	3.31	8.96	202.06	28
13.	Pul 6	7.5	27.4	.1	200	5.49	18.84	0	22.84	63	4.68	9.78	196.34	105
14.	Pul 8	7.3	28.5	.2	380	5.24	14.44	0	18.44	65	2.21	7.68	192.05	193
15.	Pul 10	7.4	29.7	.2	240	5.49	17.96	0	21.96	70	3.26	8.64	190.04	123
16.	Pul 11	7.6	27.8	.4	60	5.84	16.67	0	20.67	73	1.69	4.37	203.08	38
17.	Pul 13	7.5	28.5	1.2	240	5.24	18.84	0	22.84	70	4.28	8.26	201.03	128
18.	Pul 14	7.5	29.7	.3	74	5.5	20.26	0	24.26	73	1.89	4.65	203.34	47
19.	Pul 15	7.3	29.8	.1	240	5.24	20.36	0	24.36	74	2.48	7.34	198.67	187

Sl. No.	Sampling points	PH	Temp (^{0}C)	Tds	EC	DO	Total alkalinity	CO_3^{2-}	HCO_3^-	Total Hardness	$Ca^{2=}$	Mg^{2+}	Cl^-	Salinity
20.	Pul 16	7.2	28.7	.1	290	5.49	18.67	0	22.67	65	3.56	8.78	194.47	155
21.	NEL 1	7.5	28.4	.5	65	5.49	25.67	0	29.67	60	1.69	4.38	196.34	34
22.	NEL 2	7.8	28.8	.5	77	5.82	27.96	0	31.96	65	1.54	4.46	194.28	33
23.	NEL 6	7.6	28.9	.2	56	5.5	24.36	0	28.36	65	1.69	4.38	205.03	28
24.	NEL 8	7.8	28.9	.5	18	5.49	19.43	0	23.43	70	1.45	4.54	204.18	9
25.	NEL 10	7.4	28.5	.2	32	5.24	30.84	0	34.84	60	1.48	4.69	203.12	16
26.	NEL 11	7.5	28.6	.3	250	5.49	22.44	0	24.44	62	1.75	4.25	201.05	125
27.	NEL 13	7.1	28.6	.3	242	6.27	16.87	0	20.87	68	1.96	1.37	200.26	121
28.	NEL 14	7.4	28.5	.5	48	6.27	20.96	0	24.96	65	1.25	4.75	198.67	24
29.	NEL 15	7.6	28.6	.7	65	5.86	21.87	0	25.87	70	1.69	4.38	192.06	32
30.	NEL 16	7.5	27.8	.6	87	5.49	27.96	0	23.96	60	1.54	4.65	204.16	43
31.	BLP 1	7.7	28.7	.3	118	5.24	21.24	0	26.24	78	1.69	4.38	205.06	59
32.	BLP 2	7.4	28.2	.2	59	5.49	19.84	0	23.84	70	1.54	4.46	203.16	29
33.	BLP 6	7.4	28.9	.1	280	5.24	20.84	0	24.84	58	1.69	4.38	201.06	140
34.	BLP 8	5.8	28.9	.1	118	5.49	27.63	0	31.63	60	1.45	4.54	192.08	59
35.	BLP 10	7.5	28.5	.3	160	5.24	21.96	0	25.96	66	1.48	4.37	190.06	80
36.	BLP 11	7.8	29.5	1	250	5.5	18.44	0	22.44	69	1.75	1.37	204.12	125
37.	BLP 13	7.6	27.8	.5	325	6.27	20.84	0	24.84	60	1.96	4.65	203.34	164
38.	BLP 14	7.5	29.5	.1	380	5.24	27.64	0	31.64	61	1.25	4.65	201.08	47
39.	BLP 15	7.2	29.5	.4	125	5.5	23.96	0	27.96	63	1.69	4.46	198.67	63
40.	BLP 16	7.6	28.9	.4	156	5.49	21.84	0	25.84	66	1.54	4.25	194.47	78
41.	NED 1	7.4	27.7	118	.3	5.5	16.96	0	22.96	65	2.36	8.76	198.67	59
42.	NED 2	7.9	28.2	59	.2	5.49	20.26	0	26.84	63	3.48	7.48	196.43	29
43.	NED 6	7.1	28.4	225	.4	5.24	25.67	0	31.46	65	4.67	9.67	202.04	112
44.	NED 8	7.5	27.3	116	.2	5.49	17.84	0	23.56	75	5.68	10.46	204.16	58
45.	NED 10	7.6	27.8	90	.1	5.5	24.28	0	30.28	60	6.67	9.78	203.26	45
46.	NED 11	7.8	26.8	64	.3	5.84	19.25	0	25.67	63	2.46	8.26	201.05	32
47.	NED 13	7.4	30.2	122	.1	5.24	23.67	0	29.45	68	3.28	7.76	194.04	61
48.	NED 14	7.2	29 .8	84	.4	6.47	21.46	0	27.84	70	4.68	9.34	192.08	42
49.	NED 15	7.1	27.5	76	..2	5.49	23.67	0	29.34	73	5.74	10.47	205.07	38
50.	NED 16	7.3	26.8	56	.1	5.24	22.84	0	28.47	75	6.36	8.48	204.18	28
51.	Poovar pond	7.4	28.4	296	1.5	5.49	32.86	0	38.64	75	26.37	10.56	227.05	198
52.	Vizhinjam pond	7.3	29.7	98	.4	5.24	26.29	0	32.68	73	4.28	8.74	230.16	49
53.	Balarama puram pond	7.3	30.2	94	.7	5.5	28.24	0	32.84	74	32.64	10.36	225.26	47
54.	Vellayani lake	7.3	30.6	96	.5	5.49	26.64	0	32.96	74	4.74	7.67	226.28	48
55.	Punnam moodu lake	7.3	29.2	94	.5	5.24	28.24	0	34.76	74	10.64	8.68	228.26	47

Table(2)

Analysis of water quality prameters during post-monsoon season

Sl. No.	Sampling points	PH	Temp (^{0}C)	Tds	EC	DO	Total alkalinity	CO_3^{2-}	HCO_3^-	Total Hard-ness	Ca^{2-}	Mg^{2+}	Cl^-	Sali-nity
1.	Vzm 1	7.2	28.7	.2	270	5.24	24.64	0	30.56	78	2.21	6.48	205.03	135
2.	Vzm 2	7.3	27.8	.3	128	6.27	30.86	0	35.87	75	2.46	7.46	203.07	64
3.	Vzm 6	7.5	28.5	.4	186	5.49	27.54	0	31.56	72	3.26	8.46	203.26	93
4.	Vzm 8	7.3	27.4	.2	67	5.24	32.67	0	36.67	70	2.34	4.67	194.28	34
5.	Vzm 10	7.5	27.5	.5	335	5.82	22.64	0	26.84	75	4.26	9.86	192.02	167
6.	Vzm 11	7.6	29.8	.3	380	5.49	20.36	0	25.37	78	2.35	7.26	190.01	190
7.	Vzm 13	7.4	28.7	.4	435	6.47	21.56	0	26.67	68	2.34	8.45	200.26	267
8.	Vzm 14	7.4	28.6	.3	156	6.27	20.48	0	24.48	70	3.21	9.27	202.05	78
9.	Vzm 15	7.3	27.8	.4	245	5.49	32.56	0	36.56	72	2.12	6.78	201.06	123
10.	Vzm 16	7.6	28.4	.1	45	5.82	24.75	0	30.56	73	2.46	4.75	203.26	23
11.	Pul 1	7.3	27.5	.3	295	5.24	25.43	0	29.47	75	4.26	10.25	200.26	147
12.	Pul 2	7.4	27.8	.2	55	5.49	23.67	0	28.56	72	3.34	9.34	202.06	28
13.	Pul 6	7.5	28.6	.3	210	5.49	22.56	0	28.75	68	2.56	7.68	196.34	105
14.	Pul 8	7.3	27.8	.1	385	5.24	18.64	0	22.67	70	3.36	8.64	192.05	193
15.	Pul 10	7.5	28.5	.2	245	5.49	20.67	0	25.67	73	2.28	4.37	190.04	123
16.	Pul 11	7.4	29.5	.3	75	5.84	18.56	0	23.47	75	2.34	6.74	203.08	38
17.	Pul 13	7.6	27.5	1.2	256	5.24	22.48	0	28.65	70	2.25	8.56	201.03	128
18.	Pul 14	7.5	28.6	.4	85	5.5	25.26	0	29.47	78	2.56	9.46	203.34	47
19.	Pul 15	7.4	29.4	.2	275	5.24	26.34	0	30.68	75	3.31	10.34	198.67	187
20.	Pul 16	7.3	27.4	.3	310	5.49	23.67	0	22.67	68	3.47	4.25	194.47	155
21.	NEL 1	7.6	27.8	.6	75	5.49	29.67	0	35.68	65	2.21	4.38	196.34	37
22.	NEL 2	7.7	27.4	.7	84	5.82	32.64	0	37.43	70	3.24	6.68	194.28	42
23.	NEL 6	7.5	28.5	.5	66	5.5	30.78	0	32.87	68	2.36	5.36	205.18	33
24.	NEL 8	7.6	29.8	.7	36	5.49	23.47	0	27.46	75	4.28	7.34	204.17	18
25.	NEL 10	7.5	27.6	.3	45	5.24	35.67	0	40.84	65	5.56	8.56	203.12	23
26.	NEL 11	7.6	28.6	.4	275	5.49	28.64	0	28.64	68	6.28	9.26	202.17	137
27.	NEL 13	7.3	28.4	.5	280	6.27	20.78	0	25.56	72	7.36	10.34	200.05	140
28.	NEL 14	7.6	29.8	.6	60	6.27	24.56	0	28.74	70	4.25	7.27	198.67	30
29.	NEL 15	7.5	27.5	.7	80	5.86	27.34	0	30.62	75	3.69	6.59	192.02	40
30.	NEL 16	7.4	28.6	.5	110	5.49	32.78	0	27.48	65	2.48	5.76	202.06	55
31.	BLP 1	7.5	27.8	.6	128	5.24	25.67	0	30.65	75	3.56	6.37	204.16	64
32.	BLP 2	7.3	28.2	.6	72	5.49	25.34	0	27.56	73	4.36	7.86	205.03	36
33.	BLP 6	7.5	28.7	.3	310	5.24	24.68	0	28.74	68	5.64	8.96	190.04	155
34.	BLP 8	7.4	27.8	.4	148	5.49	31.42	0	35.28	65	6.48	9.64	196.47	74
35.	BLP 10	7.6	29.8	.6	185	5.24	26.74	0	30.64	72	2.67	5.58	203.16	93
36.	BLP 11	7.7	28.7	.5	275	5.5	24.56	0	26.64	73	3.47	6.96	201.04	137
37.	BLP 13	7.5	28.6	.4	350	6.27	25.76	0	28.72	65	4.76	7.86	202.36	175
38.	BLP 14	7.7	29.5	.1	395	5.24	32.64	0	35.26	68	5.28	8.67	204.26	197
39.	BLP 15	7.4	29.3	.4	136	5.5	27.78	0	32.64	70	6.67	9.38	190.06	68
40.	BLP 16	7.7	28.7	.4	190	5.49	25.68	0	30.64	72	2.24	5.86	192.04	95
41.	NED 1	7.5	28.7	138	.4	5.5	20.84	0	28.67	70	2.26	6.26	205.04	69
42.	NED 2	7.8	27.8	80	.3	5.49	24.36	0	31.26	68	3.31	8.76	204..18	40

Sl. No.	Sampling points	PH	Temp (^{0}C)	Tds	EC	DO	Total alkalinity	CO_3^{2-}	HCO_3^-	Total Hard-ness	$Ca^{2=}$	Mg^{2+}	Cl^-	Sali-nity
43.	NED 6	7.3	29.8	250	.5	5.24	30.84	0	37.84	70	4.46	10.46	203.16	125
44.	NED 8	7.5	28.6	155	.3	5.49	23.46	0	31.46	73	5.28	9.87	202.08	77
45.	NED 10	7.8	29.8	120	.3	5.5	28.26	0	35.76	65	6.21	10.84	194.02	60
46.	NED 11	7.6	28.4	74	.5	5.84	24.67	0	31.46	68	2.56	9.56	192.06	37
47.	NED 13	7.5	29.7	160	.3	5.24	29.87	0	35.87	72	3.47	8.64	203.18	80
48.	NED 14	7.4	28.6	84	.7	6.47	28.56	0	34.64	75	4.48	10.76	202.05	42
49.	NED 15	7.3	29.4	110	.5	5.49	26.34	0	34.78	75	5.67	9.46	196.08	55
50.	NED 16	7.6	28.8	70	.3	5.24	28.46	0	33.67	74	6.32	10.78	190.06	35
51.	Poovar pond	7.5	27.6	296	1.7	5.49	42.34	0	44.56	80	26.28	12.74	235.08	198
52.	Vizhinjam pond	7.6	28.7	98	.7	5.24	34.46	0	38.64	75	7.25	10.48	238.24	49
53.	Balarama-puram pond	7.5	29.8	94	.7	5.5	38.67	0	38.76	75	32.46	13.46	236,26	47
54.	Vellayani lake	7.6	28.4	96	.5	5.49	36.84	0	38.96	75	7.68	10.28	234.24	48
55.	Punna-mmoodu lake	7.5	29.6	94	.5	5.24	38.26	0	40.56	75	11.34	8.76	236.26	47

$_pH$

M.Sreenivasa Rao etal has reviewed about the importance of pH in potability of water[11]. In pre-monsoon and post-monsoon season the measured pH values of water samples varied between 7.4 to7.6.

Temperature

Temperature plays a very important role in maintaining O_2/CO_2/ Carbonate/bicarbonate equilibrium and taste. The temperature of drinking water has an influence on its taste. The temperature of samples varied from 25 ℃ to 28℃

Electrical Conductivity

Palmajumder etal has reviewed about the importance of Electrical conductivity in drinkable water [12]. The range of EC values measured was between 491 and 667 µS/cm.

Total Alkalinity

Total alkalinity values for all samples varied from 18 to 32 mg/L.

Total Dissolved Solids (TDS)

The range of TDS values was 295 mg/L to 400 mg/L. Bad taste is a result of high total dissolved solids concentrations.

Dissolved Oxygen (DO)

The amount of pollution in water bodies is indicated the dissolved oxygen. The DO value of the water samples used in this investigation ranged from 4.46 to 7.36 mg/L. Inorganic material precipitation and dissolution in water are also aided by dissolved oxygen, or DO. To evaluate the quality of raw water and monitor stream contamination, one must be aware of DO levels.

Total Hardness (TH)

Water hardness is influenced by the concentration of Ca and Mg salts. [12]. One of the main characteristics of drinking water is thought to be total hardness. The concentrations of calcium and magnesium ions are used to characterize hardness. It ranged from 70 mg/L to 75 mg/L in this investigation..

Calcium (Ca^{2+})

Due to the increased need for soap and other cleaning supplies, water with a high calcium concentration should not be used for domestic tasks like washing, bathing, or drying clothes. Water naturally contains calcium. Because calcium is present in water as Ca ions, it is a factor in determining the hardness of the water. The amount of calcium ranged between 4 mg/L and 20 mg/L..

Magnesium (Mg^{2+})

Magnesium may be found in many different minerals; it is also frequently washed into water from rocks. Due to its numerous uses, magnesium may find its way into water in a variety of ways. Magnesium salts have a laxative effect at high concentrations, especially when they are present as $MgSO_4$ [12]. The water samples under investigation had magnesium concentrations ranging between 6 mg/L and 14 mg/L.

Chloride (Cl^-)

The discharge of home sewage is the primary cause of chlorides in the waterways. [13]. The dissolving of salt deposits, chemical industry effluent discharges, oil well operations, sewage discharges, irrigation drainages, etc. are some of the reasons why chloride is

found in natural waterways. Both surface water and ground water may become locally contaminated as a result of each of these sources. Chloride content was determined to be between 200 and 227 mg/L in the current investigation.

Conclusion

Assuring the quality of water is vital for both environmental well-being and public safety, influencing aspects ranging from human consumption to the sustainability of ecosystems. Water quality parameters are essential indicators used to assess the condition of water bodies and ensure their suitability for various purposes. These parameters serve as crucial tools in monitoring and managing water resources effectively. Detecting water quality necessitates evaluating diverse parameters to verify that water adheres to designated standards for its intended purpose. By regularly assessing the parameters like pH, temperature, EC, TDS, DO, total alkalinity, amount of carbonates and bicarbonates, total hardness, salinity, hardness of calcium and magnesium ions, chlorides etc. we can make decisions to protect water quality and can preserve ecosystems for future generations. The current study is important for maintaining public health and cleanliness. The majority of the parameters were discovered to be well within the BIS-recommended bounds. Therefore, it was determined that the water samples examined for this investigation were fit for human consumption. The current study's findings demonstrated that drinking water gathered from several Vizhinjam sea port locations was deemed to be safe for human consumption. Boiling water, using aqua guards, properly chlorinating, using an effective system for collecting and disposing of waste, treating sewage waste, recycling waste into useful products like fertilizers, and educating the public through the media about the causes and effects of water pollution are all advised..

Author Contribution Statement: Author Contribution Statement: Fasna Das S: Data curation, Writing- Original draft preparation, Reviewing and Editing;Rajesh K: Investigation, Supervision, Data curation; Rathika Nath G: Investigation, Supervision, Data curation; Jisha George: Conceptualization and Methodology; Aswathy S: Data curation and Validation.

Declaration of competing interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of funding/ financial support: The authors declare that no financial aid/ funding was received from any agency for study presented in this report.

Acknowledgement: None.

References

[1] R. Kaplan, S. Kaplan, The experience of nature: a psychological perspective, Exp. Nat. a Psychol. Perspect. (1989).

[2] A. Abraham, K. Sommerhalder, T. Abel, Landscape and well-being: A scoping study on the health-promoting impact of outdoor environments, Int. J. Public Health. 55 (2010) 59–69. https://doi.org/10.1007/s00038-009-0069-z.

[3] K. Loganathan, A.J. Ahamed, Multivariate statistical techniques for the evaluation of groundwater quality of Amaravathi River Basin: South India, Appl. Water Sci. 7 (2017) 4633–4649. https://doi.org/10.1007/s13201-017-0627-0.

[4] S.K. Chapagain, V.P. Pandey, S. Shrestha, T. Nakamura, F. Kazama, Assessment of deep groundwater quality in kathmandu valley using multivariate statistical techniques, Water. Air. Soil Pollut. 210 (2010) 277–288. https://doi.org/10.1007/s11270-009-0249-8.

[5] S. Venkatramanan, S.Y. Chung, T. Ramkumar, G. Gnanachandrasamy, S. Vasudevan, A multivariate statistical approaches on physicochemical characteristics of ground water in and around Nagapattinam district, Cauvery deltaic region of Tamil Nadu, India, Earth Sci. Res. J. 17 (2013) 97–103. http://www.scielo.org.co/scielo.php?pid=S1794-61902013000200003&script=sci_arttext&tlng=en (accessed February 21, 2023).

[6] S. Pundir, V. Kandari, P. Singh, R. Singh, M.A. Siddique, Assessment of groundwater quality of Dehradun Valley, Uttarakhand, India, for drinking purposes using multivariate statistical techniques, Environ. Dev. Sustain. (2022). https://doi.org/10.1007/s10668-022-02784-8.

[7] T. Sarkar, K.K. Bharadwaj, M. Salauddin, S. Pati, R. Chakraborty, Phytochemical Characterization, Antioxidant, Anti-inflammatory, Anti-diabetic properties, Molecular Docking, Pharmacokinetic Profiling, and Network Pharmacology Analysis of the Major Phytoconstituents of Raw and Differently Dried Mangifera indica (Himsaga, Appl. Biochem. Biotechnol. 194 (2022) 950–987. https://doi.org/10.1007/s12010-021-03669-8.

[8] A. Prüss-Üstün, R. Bos, F. Gore, J. Bartram, Safer Water, Better Health: Costs, benefits and sustainability of interventions to protect and promote health, 2008. https://apps.who.int/iris/bitstream/handle/10665/43840/?sequence=1 (accessed February 21, 2023).

[9] BIS, Bureau of Indian Standards, Indian Stand. 4 (1994) 1–29. https://www.services.bis.gov.in/tmp/WCFAD28118832_25012022_1.pdf (accessed February 21, 2023).

[10] W.E. Federation, Standard Methods for the Examination of Water and Wastewater Standard Methods for the Examination of Water and Wastewater, Public Health. 51 (1999) 940–940. https://doi.org/10.2105/AJPH.51.6.940-a.

[11] M. Srinivasa Rao, D. Manimanjari, M. Vanaja, C.A. Rama Rao, K. Srinivas, V.U.M. Rao, B. Venkateswarlu, Impact of elevated CO2 on tobacco caterpillar, spodoptera litura on peanut, arachis hypogea, J. Insect Sci. 12 (2012). https://doi.org/10.1673/031.012.10301.

[12] M. Palmajumder, S. Chaudhuri, V.K. Das, S.K. Nag, An appraisal of geohydrological status and assessment of groundwater quality of Indpur Block, Bankura District, West Bengal, India, Appl. Water Sci. 11 (2021). https://doi.org/10.1007/s13201-021-01389-2.

[13] V.T. Patil, P.R. Patil, Groundwater quality of open wells and tube wells around amalner town of jalgaon District, Maharashtra, India, E-Journal Chem. 8 (2011) 53–58. https://doi.org/10.1155/2011/676213.