



ANALYSIS OF BACTERIAL AND ALGAL INDICATORS IN THE OPEN WELL WATER COLLECTED FROM THE THANNYAM GRAMA PANCHAYAT, THRISSUR DISTRICT, KERALA, TO ASSESS WATER QUALITY

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ABSTRACT

The biological properties of water samples collected from six different open wells belonging to Thannyam Grama panchayat in Thrissur district have been analyzed to assess its quality and potability. Water sample collection and analysis were carried out during the pre-monsoon period of March-May 2016. Different bacteriological parameters such as total coliform count, faecal coliform count and *Escherichia coli* count and algal parameters such as presence or absence of algal indicators of water pollution, pollution index of algal genus, pollution index of algal species and pollution index score were determined for the selected well water samples. The results obtained have been compared with IS: 10500 specifications for drinking water to assess the quality and suitability. The investigation revealed gross pollution of studied open well water sources either due to excess levels of chemical parameters indicated by the detection of algal indicators of water pollution or due to fecal contamination based on the detection of bacterial indicators or due to both. The various factors such as improper waste disposal, dumping of solid wastes, leakages from septic tank and contamination due to fecal matters of animals and birds may be the reasons. The investigation concludes that all the open well water sources selected for the study are unfit for human consumption and requires immediate attention and urgent treatment before being used up for drinking and other domestic purposes.

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INTRODUCTION

Water is considered as the most valuable and priceless natural resource in the earth. Water can be obtained from a number of sources such as wells, ponds, rivers, lakes and oceans but clean, pure and safe water exists only briefly in nature which is also getting polluted by prevailing environmental factors and human activities. Among the various sources of water, ground water is said to be the safest water for drinking and domestic purposes as it is believed to be least affected by the external anthropogenic, environmentally disturbing activities. The process of percolation, which results in filtration and purification of water is the main reason that ground water is often used as a source of fresh water for human use (Kegley and Andrews, 1997). About 95% of rural population living in India depends on ground water for drinking and other domestic purposes. However during the past decade, widespread reports of ground water contamination have increased public concern about drinking water quality.

The tremendous organic loads imposed by unscientific disposal of wastes, improper sanitization measures, leach pit latrine system and other unhealthy land use practices have severely affected the ground water quality (APHA, 1985). In our country about 70% of the water is seriously polluted and 75% of illness and 80% of the child mortality is attributed to water pollution (Zoeteman, 1980). Better quality of water is described by its physical, chemical and biological characteristics. The physical and chemical parameters of a water body though provide indication about the water chemistry and quality, this does not alone reflect the clear picture of water quality. Since the biotic community in a natural water body system is the outcome of the integration and interaction of different physical, chemical and geological characteristics, the biological analysis is very important for the assessment and to confirm the water quality (Stevenson and Pan, 1999). In the light of the above information, the present investigation has tried to assess the quality of open well water collected from selected wells in the Thannyam Grama Panchayat which is situated in the Coastal belt of Thrissur district, to understand the reliability and suitability of these water sources.

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MATERIALS AND METHODS

Selection of Open wells

Six Open wells from different locations of Thanniyam Grama Panchayat in the Thrissur district were selected for the present study. During the selection procedure, the wells selected were situated more or less close to one or more different water polluting sources such as latrine, sewage pit, solid waste dumping, improper drainage systems etc. Details of well water samples collected are given in table 1.

Table 1 Details of open well water samples

Grama Panchayat	Sample code	Remarks
Thanniyam Grama Panchayat, Thrissur	WWS1	Open well water samples collected from six different locations in the Thanniyam Grama Panchayat during the pre-monsoon season (March - May 2016)
	WWS2	
	WWS3	
	WWS4	
	WWS5	
	WWS6	

Collection of Water Samples

Well water samples were collected during the pre-monsoon season and it was during the period of March-May 2016. To carry out analysis of algal indicators of organic water pollution, water samples are collected in high grade plastic bottles of one liter capacity and then preserved in 4 % formalin. Before collection, the plastic bottles are rinsed once with distilled water and then thrice with respective water sample. Water samples for different bacteriological parameters were collected in 250 ml pasteurized sterile bottles (at 121°C).

Analysis of Algal Indicators of Pollution

The methods described in the 'Standard Methods for the Examination of Water and Wastewater (1985)' as prescribed by American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF) were adopted. The identification of pollution indicator algae in the studied water samples was done with the help of standard books and monographs (Smith, 1950; Prescott, 1954; Ward and Whipple, 1959; Taylor *et al.*, 2007). Algal Genus Pollution Index and Algal Species Pollution Index were employed to study the water quality of selected open wells (Palmer, 1969). List of algal genus and species indicators of organic water pollution was prepared for water samples collected according to Palmer's list of indicators of algal genus and algal species of organic water pollution. Pollution index score was then assigned to each genus and species represented in each sample as per Palmer's pollution index score (1969). Then for rating of water samples as high or low organically polluted, the numerical values for pollution classification of water provided by Palmer was followed as shown below.

Water sample having total pollution index score of
 0-10= Lack of organic pollution
 10-15= Moderate pollution
 15-20= Probable high organic pollution
 20 or more = Confirms high organic pollution.

Bacteriological Parameters

The different bacteriological parameters analyzed for the well water samples includes total coliforms (TC) count, faecal coliforms (FC) count and *Escherichia coli* (EC) count. The

analysis of different parameters were carried out using Membrane Filtration Method (ISO 1990). 10 ml of the well water sample directly or after dilution is introduced aseptically into a sterile filtration assembly containing a sterile membrane filter of 0.2 or 0.45mm pore size. The sample is then drawn through the membrane filter by applying a vacuum for holding indicator organisms on or within the membrane filter. Transfer this membrane filter to a suitable selective culture medium in a petri dish. The petri dish is then subjected to a period of resuscitation for the acclimatisation of indicator organisms to the new conditions. This is followed by the incubation of petri dishes at suitable temperature and period of time to allow the replication of indicator organisms. The colonies formed are then identified and counted. The results are expressed in numbers of CFU per 100 ml of original sample.

RESULT AND DISCUSSION

Understanding of the problem of water pollution and quality of water requires appropriate monitoring tools which are helpful to detect and characterize the cause and source of imbalance in the physical, chemical and biological property. As the biological communities respond to stresses over time, the bio assessments of water bodies allow us to get the information on the changing physical and chemical quality of water and therefore useful for managing complex water quality problems. The biological community particularly microorganisms present in water play an important role as indicators of water quality (WHO, 1971).

Analysis of Algal Indicators of water Pollution

Analysis of algal genera and species as biological indicators of organic water pollution has been analyzed in the present study. The details obtained from the analysis of algal genera and species as per Palmer's pollution index (1969) in the studied open wells of Thanniyam Grama Panchayath are depicted in table 2&3.

The results show 9 algal genera and 8 algal species belonging to the list of Palmer's algal pollution indicators (1969) were detected in different water samples. The data recorded in table 2&3 reveals that 3 algal genera (*Phacus spp.*, *Pandorina spp.* and *Gomphonema spp.*) and 2 species (*Pandorina morum* and *Gomphonema parvalum*) listed in Palmer's pollution index were detected in water sample WWS1. Similarly 7 genera (*Phacus spp.*, *Navicula spp.*, *Scenedesmus spp.*, *Microcystis spp.*, *Gomphonema spp.*, *Synedra spp.* and *Oscillatoria spp.*) and 5 species (*Scenedesmus quadricauda*, *Gomphonema parvalum*, *Synedra ulna*, *Oscillatoria chlorine* and *Oscillatoria limosa*); 2 genera (*Pandorina spp.* and *Gomphonema spp.*) and 2 species (*Pandorina morum* and *Gomphonema parvalum*); 7 genera (*Phacus spp.*, *Microcystis spp.*, *Pandorina spp.*, *Gomphonema spp.*, *Synedra spp.*, *Oscillatoria spp.* and *Chlorella spp.*) and 5 species (*Pandorina morum*, *Gomphonema parvalum*, *Synedra ulna*, *Oscillatoria tenuis* and *Chlorella vulgaris*); 3 genera (*Phacus spp.*, *Microcystis spp.* and *Pandorina spp.*) and 1 species (*Pandorina morum*) and 5 genera (*Phacus spp.*, *Microcystis spp.*, *Gomphonema spp.*, *Synedra spp.*, *Oscillatoria spp.*) and 4 species (*Oscillatoria chlorine*, *Pandorina morum*, *Synedra ulna*, *Oscillatoria tenuis*) were detected and identified in water samples WWS2, WWS3, WWS4, WWS5 and WWS6 respectively.

Table 2 Pollution Index of Genera identified in selected open wells of Thanniyam Grama Panchayat during the pre-monsoon season, as per Palmer pollution index

Algal Genera	Palmer's Pollution Index (PI)	ODW1	ODW2	ODW3	ODW4	ODW5	ODW6
Phacus spp.	2	2	2	-	2	2	2
Navicula spp.	3	-	3	-	-	-	-
Scenedesmus spp.	4	-	4	-	-	-	-
Microcystis spp.	1	-	1	-	1	1	1
Pandorina spp.	1	1	-	1	1	1	-
Gomphonema spp.	1	1	1	1	1	-	1
Synedra spp.	2	-	2	-	2	-	2
Oscillatoria spp.	4	-	4	-	4	-	4
Chlorella spp.	3	-	-	-	3	-	-
Total Score for Algal genera		4	17	2	14	4	10

Table 3 Pollution Index of algal species identified in selected open wells of Thanniyam Grama Panchayat during the pre-monsoon season, as per Palmer pollution index

Algal Species	Palmer's Pollution Index (PI)	ODW1	ODW2	ODW3	ODW4	ODW5	ODW6
Scenedesmusquadricauda	4	-	4	-	-	-	-
Oscillatoria chlorine	2	-	2	-	-	-	2
Pandorinamorum	3	1	-	1	1	1	-
Gomphonemaparvalum	1	1	1	1	1	-	1
Synedra ulna	3	-	2	-	3	-	3
Oscillatoriatenuis	4	-	-	-	4	-	4
Oscillatorialimosa	4	-	4	-	-	-	-
Chlorella vulgaris	2	-	-	-	2	-	-
Total Score		2	13	2	11	1	10

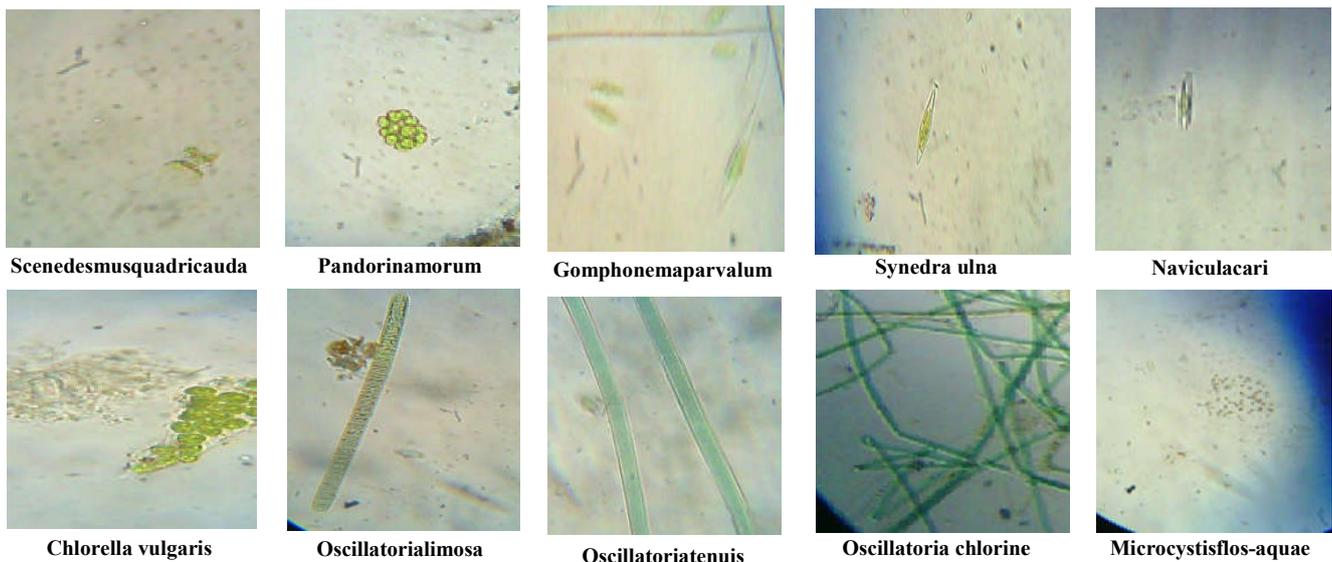


Plate 1 Photographs of Algal Indicators detected in the Well water samples

Considering Palmer's pollution index scoring system in the present investigation, the total score for Algal Genus Pollution Index of water sample WWS1, WWS2, WWS3, WWS4, WWS5 and WWS6 are 4, 17, 2, 14, 4 and 10 respectively. The pollution index score of water sample collected from WWS2 indicates probable high organic pollution while WWS4 and WWS6 indicate moderate level of organic pollution whereas pollution index score recorded in WWS1, WWS3 and WWS5 indicates no organic pollution. The total score obtained for Algal Species Pollution Index of water samples WWS1, WWS2, WWS3, WWS4, WWS5 and WWS6 are 2, 13, 2, 11, 1 and 10 respectively. The scores reveal WWS2, WWS4 and WWS6 fall under the category of moderate organic pollution while scores of water samples ODW1, ODW3 and ODW5 indicate no organic pollution. The high or moderate algal pollution index score recorded in the analyzed well water

samples (WWS2, WWS4 and WWS6) may be attributed to presence of high or moderate content of organic pollutants in the water. This in turn may be due to poor filtration quality of soil in the areas of those wells where improper sewage disposal, washing and cleaning practices are common.

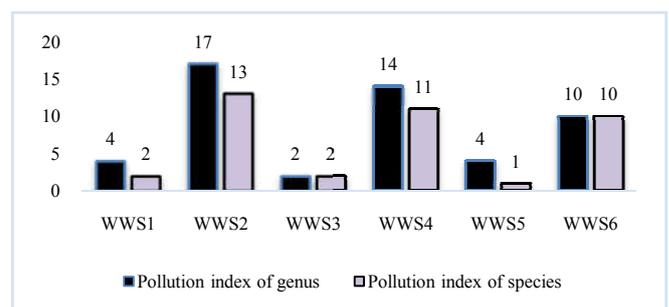


Figure 2 Algal index of Genera and Species in the Well water samples

Analysis of Bacterial Indicators of Water Pollution

One of the serious health risks in connection with open well water sources is the chance for direct or indirect bacterial contamination by human or animal excreta. Therefore it is necessary to regularly evaluate the potability of these water sources used for drinking and other domestic purposes, through the analysis of bacterial indicators. The data obtained from the bacteriological analysis of selected open well water samples in the present study is depicted in table 4.

Table 4 Bacteriological properties of selected open well water samples collected from Thannyam Grama Panchayat during the pre-monsoon season

Parameter (mg/l)	BIS IS 10500: 2012 guidelines	Water sample					
		WWS1	WWS2	WWS3	WWS4	WWS5	WWS6
TC/100ml	0/100ml	84±6	0.0±0	36±3	9±1	55±3	48±2
FC/100ml	0/100ml	38±3	0.0±0	12±2	0.0±0	21±1	18±2
EC/100ml	0/100ml	12±2	0.0±0	0.0±0	0.0±0	4±1	9±2

The data presented in the table 4 shows total coliform, faecal coliform and *Escherichia coli* count are recorded in well water samples WWS1, WWS5 and WWS6 while water sample WWS6 recorded both TC and FC count and no count for *E. coli* whereas water sample WWS4 recorded only TC count. Well water WWS2 is the only the water sample which did not record any bacterial indicator count. TC count in the analyzed water samples ranged from 9 CFU/100ml to 84 CFU/100ml. Fecal coliform count ranged from 12 CFU/100ml to 38 CFU/100ml while *E. coli* count is ranging from 4 CFU/100ml to 12 CFU/100ml. As per the guidelines of Canadian Drinking Water Quality and Bureau of Indian Standards for the drinking water, the total coliforms, faecal coliforms and *Escherichia coli* should not be detected per 100 ml of drinking water. The total coliform count recorded in well water sample WWS4 not necessarily indicate contamination of water by faecal matter, however the detection of faecal coliform and particularly *E. coli* in well water samples WWS1, WWS5, WWS6 and WWS3 is a clear indication of contamination by human sewage or animal droppings which contain serious disease causing organisms. Improper sewage discharges, leakages from septic tank and their leaching in to well water sources due to poor filtering action of soil in the area might be the reason for the contamination of water sources with faecal coliforms (Chitanand *et al.*, 2008).

by faecal matter which is confirmed through the detection of coliform bacteria or due to the detection of both algal as well as bacterial indicators of pollution. Detection of faecal coliform bacteria in water samples WWS1, WWS5, WWS6 and WWS3 and higher score for algal indicators of organic pollution in WWS2 strongly indicates potentially dangerous situation and anyone who consume water from these water sources without pretreatment pose severe health risk.

Hence it is suggested that water from these sources should be pretreated before consumption.

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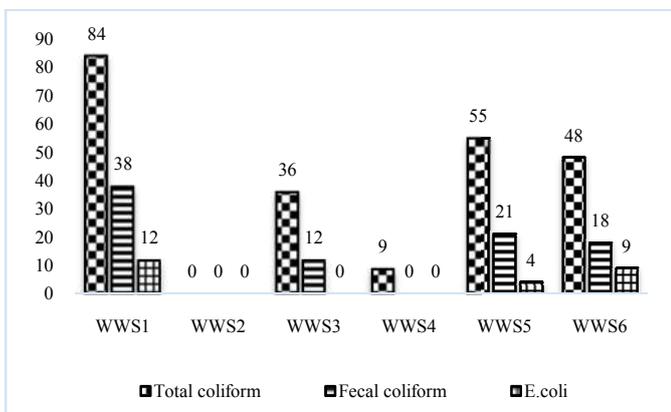


Figure 3 Bacteriological properties of Well water samples

CONCLUSION

The investigation revealed all the well water samples analyzed in the present study are polluted either due to excessive levels of organic matter as indicated by the detection of algal indicators of organic water pollution or due to contamination