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Quality Assessment of Different Water Sources of Mysuru City

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ABSTRACT

Water is an important component for all types of living systems. There are many types of water systems like surface water, ground water, stagnant water etc. The type of contaminants presents in water range from chemical to biological sources. The analysis of water is therefore of much significance as it is associated with many diseases. Water samples from surface, tap and ground was selected from different regions of Mysuru. The bacteriological parameters were studied. Aerobic plate count (APC) was done to know the bacterial load of the samples; this method is established on the thought that each organism will likely make a visible colony on a suitable agar containing nutrient medium. It is regarded as a generic test for the organisms of the sample that propel in aerobic condition at a temperature range of 25°C to 40°C. Surface water had 250 CFU/mL which is the maximum load while tap water and ground water had 120 CFU/mL and 108 CFU/mL respectively. From surface water *Staphylococci* was identified and studied while in tap water *Psedudomonas* was identified and studied.

Keywords: Water, Bacteriological parameters, *Staphylococci*, *Pseudomonas*, APC, CFU

INTRODUCTION

Microorganisms are significant inhabitants of almost all habitats and surfaces and thus emerged as one of the most important tools for various kinds of scientific explorations. Their existence is diverse and is regarded for both being useful and harmful. Similarly, water is also a potential habitat for microbial existence (1). Many different health related issues ranging from neurological disorders to gastrointestinal illnesses are seen from the contaminated water. It has been suggested that people suffering from AIDS are potent to diseases of water. Apparently, children, pregnant women or in general the immune compromised individuals suffer the most if there are contaminants in water beyond a desired range. Infants require greater care to keep them away from water borne illness (2). Unsafe drinking-water and poor sanitation and hygiene can present significant health risks by exposing populations to various microbial, chemical, and other hazards (3). Diarrhea occurs world-wide and causes 4% of all deaths and 5% of health effects leading to disability and is most commonly caused by gastrointestinal infections which kill around 2.2 million people globally each year with most cases being children in developing countries (4). The use of water in hygiene is an important preventive measure but contaminated water is also an important cause of diarrhea. There are two major sources of water, which are surface water and groundwater. Surface water is found in lakes, rivers and reservoirs (5). Groundwater lies under the surface of land, where it travels through and fills openings in the rocks. Surface water gets easily contaminated with pathogenic microorganisms and thus forms a common constituent of the water; this

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invasion of undesired and disease-causing organism is brought via sewage (6). When the pathogenic organisms are in large quantity, they become an asset for much discomfort. However, when in less quantity they do not become a danger to health and life of humans (7). The difference or variation in the amount of pathogenic microorganism is influenced by stream size, level of water, season, geographical area and the ability of watercourse to self-clean (8). The surface water has a repertoire of varied pathogenic microorganisms, which includes thermo tolerant coliform bacteria, coliforms, *Enterococcus faecalis*, and *Salmonella*. Many researchers have concluded that urban and agricultural pressures are majorly related with loading of *Salmonella* along with other enteric bacteria in the surface waters. Apparently, natural factors are also of high significance (9). The total load of bacteria present in groundwater ecosystems might differ with several orders of magnitude ranging from 10^2 and 10^6cells per cm^3 of ground water to 10^4 and 10^8cells per cm^3 of sediment (10). The ecosystem of aquatic life comprises of characteristic communities of microorganisms and non indigenous species. These are introduced into such environment; reduce rapidly and eventually disappear. The chief essentials or factors for monitoring the microbial constituents of the aquatic habitat would be important in analyzing the nature and behavior of plant, animal and human pathogens in natural water (11). Pathogens like bacteria, protozoan's and viruses can let their way into the water bodies by various means, like runoff from animal feedlots, sewer malfunction contaminated storm drains, leaking septic tanks, human faecal discharge to name a few (12). The water that gets contaminated via faecal discharge has the potency to constitute dangerous threats to health of swimmers and shell fish consumers. However, the economic loss incurred for shell fish harvesting and business is also a major threat (13).

Sources of contamination

Basically, the types of contamination can be broadly divided into 4 types

1. Biological contamination
2. Inorganic contamination
3. Radiological contamination
4. Organic contamination

The sources of contamination of water depends on various factors but the most common sources of are septic systems, improper hazardous waste, landfills, road salts and other chemicals, atmospheric contaminants etc. The storage tanks contain oils, gasoline, chemicals or other type of liquids (9,14). These tanks may leak and get into the water system and cause contamination. There are many improperly designed and constructed septic tanks which are used by homes and other buildings. Bacteria, virus and other contaminants leak and become a serious problem especially to ground water (10). Improper disposal of hazardous waste is a leading cause of water contamination especially in rural areas (2). Landfills generally have a protective layer at the bottom which meant to prevent contamination. Apparently, when it is cracked or damaged it cause large contamination in water systems (14).

Treatment of contaminated water

Since the contamination of water is a serious interference with the normal healthy life of people, treatment measures of water are an important discussion. There are numerous ways of treating water to get rid of contamination (5). The treatment procedures like, precipitation, coagulation, distillation, adsorption, membrane water treatment, biologically active carbon filtration, disinfection etc. are carried

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out in order to bring the quality of water to drinking standards. Precipitation and coagulation include the softening of water, removal of various chemicals components like heavy metals, arsenic, phosphorus and fluorides. This is achieved by treating water with suitable chemicals and the contaminant is removed either by precipitation or coagulation (18). Chromatographic techniques are also important in separating undesired ions, and particles that constitute the contaminant. Membrane water treatment is an updated form of water treatment. Various kinds of membrane filters of different pore size are made available. The water is allowed to pass through these filters and that allows the restriction of contaminants on the membrane surface. Biologically active carbon filtration is the most widely used filtration technique. Some physical treatment procedures are also used in treating contaminated water. In this regard, use of ultraviolet radiations and ultrasound are most common (16).

The microbiology of water samples from surface water, ground water and tap water is studied. These three different samples of water are collected from different sources in Mysuru city.

The following research analysis includes physico-chemical analysis of water samples along with standard techniques like aerobic plate count and the MPN test to check the formidability, portability and the load of bacteria with a specific focus on coliforms. These tests reveal the quality of water and an insight on the pathogenic organisms is achieved following a study on their biochemical characteristics and antimicrobial sensitivity pattern. Bacterial genome analysis is also a part of our study.

MATERIALS AND METHODS

Sampling Sites

In the following study, three different water samples are collected from different localities of Mysuru city. The water is from various sources. Surface water, tap water and ground water are subjects of investigation here. Surface water is collected from Kukkarahalli Lake of Saraswathipuram which is in the heart of the city. The lake is popularly known for its diversity with respect to flora and fauna and tourist go for boating experiences in this lake. Tap water is collected from New Muslim Hostel which is located opposite to fire brigade station in Saraswathipuram. The water which was collected was used by the hostel borders for washing hands and other utensils related to food and cooking. The ground water is collected from a hand pump at a slum in Hanumant Nagar. The water which was collected was used by the residents of the locality for domestic purposes while some also used it for drinking purposes.

Sampling

The sample must be collected in conditions which are sterile. However, sample bottles must be properly sterile while sample is being collected. It is most recommended that the time gap from sampling to analysis should be ensured to be very less. It should not exceed more than 6 hours, and 24 hours is said to be maximum. For storage of the sample, glass or polyethylene bottles can be used and stored in dark and at a very low temperature of around 4^{o}C. During the transportation of sample from its site to the laboratory, it should be noted that the sample must be soon placed in box which is lightproof and covered with ice packs to ensure fast cooling. In case of unavailability of ice, the transportation time must not exceed 2 hours. It is mandatory that the samples are kept for rapid cooling in dark, upon the failure of maintaining these conditions, the sample must be discarded. Then the sample was analyzed at the laboratory (19).

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Bacteriological Parameters

These parameters are an important subject of study. This helps to analyze the number of bacteria that are present and if needed, the type of bacteria and their characteristic properties can be explored. It is important to note that these parameters are significant in classifying the water standards and an insight is obtained whether or not the water has pathogenic organisms (3).

Aerobic Plate Count

To indicate the bacterial load or population in a sample Aerobic Plate Count (APC) method is done. This method is also referred as aerobic colony count, standard plate count or total plate count. This method is established on the thought that each organism will likely make a visible colony on a suitable agar containing nutrient medium (Table 1). It is regarded as a generic test for the organisms of the sample that propel in aerobic condition at a temperature range of 25^{o}C to 40^{o}C (3). The different types of bacteria cannot be identified by APC. The method involves the following steps:

1. 1ml of the sample is taken and serially diluted in saline till 10^{-6} dilution.
2. 1ml from 10^{-2}, 10^{-4} and 10^{-6} is poured in Petri plates and Nutrient agar is poured. Gently shaken and kept for solidification.
3. After solidification, the plates are kept for incubation at 37^{o}C for 48 hours.

Table 1: Composition of Nutrient agar

Ingredients	Quantity per 100 ml
Peptone	0.5 g
Yeast extract	0.2 g
NaCl	0.5 g
Agar	1.5 g
Ph	7

RESULT

Aerobic Plate Count

Surface water: The colony characters of an identified colony are studied and following results were interpreted (Figure 1a, 1b and 1c). Colony diameter was greater than 1mm, suggesting that the colony is fairly large. It was circular in shape, Smooth. Elevation was observed to be Convex. Transparency was opaque. The colony was easily emulsifiable. Production of golden yellow pigment which was not diffusible into the medium was observed. The results of aerobic plate count (Table 2) suggest that one mL of surface water sample has approximately 250 CFU/mL of viable colonies of bacteria.

Table 2: Results of Total plate count for surface water

S. No.	Dilution factor	Number of colonies	CFU/mL
1	10^{-2}	480	480 x 10^{2}
2	10^{-4}	298	298 x 10^{4}
3	10^{-6}	133	133 x 10^{6}

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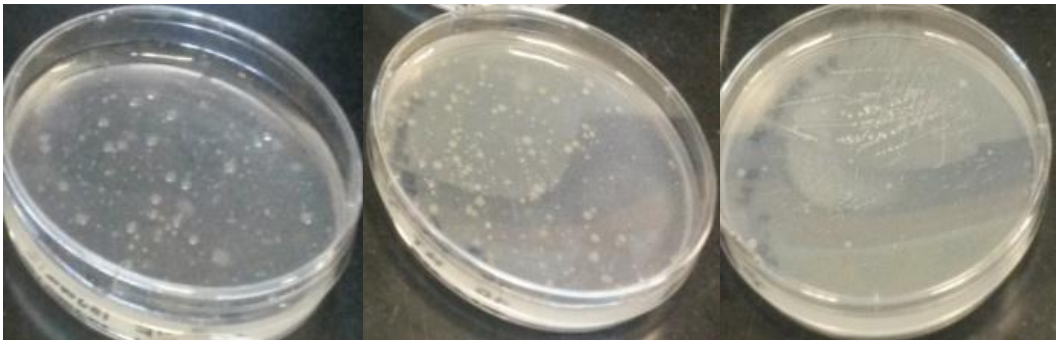

Figure 1(a): 10^{-2} **Figure 1(b): 10^{-4}** **Figure 1(c): 10^{-6}**

Figure 1: Result plates of Aerobic plate count for 10^{-2}, 10^{-4} and 10^{-6} in surface water

Tap water: The colony characters of an identified colony are studied and following results were interpreted (Figure 2a, 2b and 2c). The colony appeared greenish in colour. It was large, flat and irregular. The transparency was observed to be opaque. The colony had a fruity odour. The results of aerobic plate count (Table 3) suggest that one mL of tap water sample has approximately 120 CFU/mL of viable colonies of bacteria.

Table 3: Results of Total plate count for tap water

S. No.	Dilution factor	Number of colonies	CFU/mL
1	10^{-2}	255	255×10^{2}
2	10^{-4}	159	159×10^{4}
3	10^{-6}	73	73×10^{6}

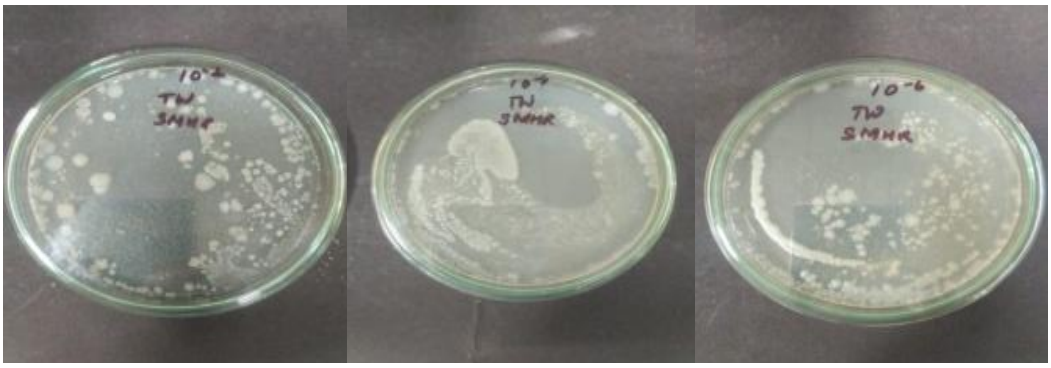

Figure 2(a): 10^{-2} **Figure 2(b): 10^{-4}** **Figure 2(c): 10^{-6}**

Figure 2: Result plates of Aerobic plate count for 10^{-2}, 10^{-4} and 10^{-6} in tap water

Ground water: The colony characters of an identified colony are studied and following results were interpreted (Figure 3a, 3b and 3c). Colony diameter was greater than 1mm, suggesting that the colony is fairly large. It was circular in shape and smooth. Elevation was observed to be Convex. Transparency was

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opaque. The colony was easily emulsifiable. The results of aerobic plate count (Table 4) suggest that one mL of ground water sample has approximately 108 CFU/mL of viable colonies of bacteria.

Table 4: Results of Total plate count for ground water

S. No.	Dilution factor	Number of colonies	CFU/mL
1	10^{-2}	277	277×10^{2}
2	10^{-4}	190	190×10^{4}
3	10^{-6}	34	34×10^{6}

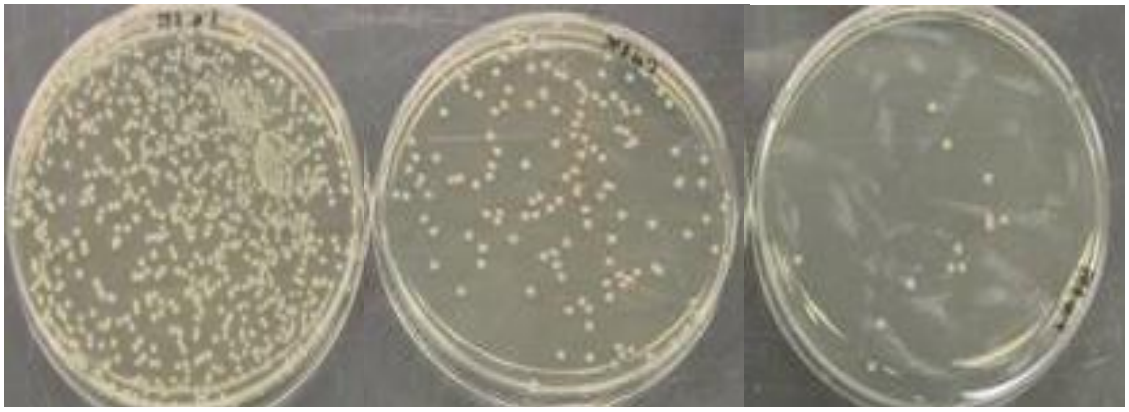

Figure 3(a): 10^{-2} **Figure 3(b): 10^{-4}** **Figure 3(c): 10^{-6}**

Figure 3: Result plates of Aerobic plate count for 10^{-2}, 10^{-4} and 10^{-6} in ground water

DISCUSSION

Aerobic plate count

The aerobic plate count result for surface water, tap water and ground water was reported to be 250 CFU/mL, 120 CFU/mL and 108 CFU/mL respectively. It is a measure of total bacterial load present in the water sample. The organisms that require moderate temperature to grow are referred as mesophiles. Aerobic plate count method when done on nutrient agar allows only the growth of these mesophylic bacteria. The surface water was reported to have maximum CFU/mL when compared with other two samples. This might be because of the exposure of water to diverse organisms from both aquatic animals and aquatic plants. The increased bacterial load can be regarded with human activities like boating, fishing etc. The tap water reported higher CFU/mL values than ground water. This is because of the improper hygiene maintained for the storage tanks connected to the tap. The tank last cleaned was 6 months before the date of sampling. The ground water load of bacteria was reported to be the least among all the three samples. A well grown colony from surface water was completely studied and was reported to be *Staphylococcus* (Figure 4a, 4b and 4c). Likewise, a colony from tap water was studied and reported as *Pseudomonas* (Figure 5a, 5b and 5c).

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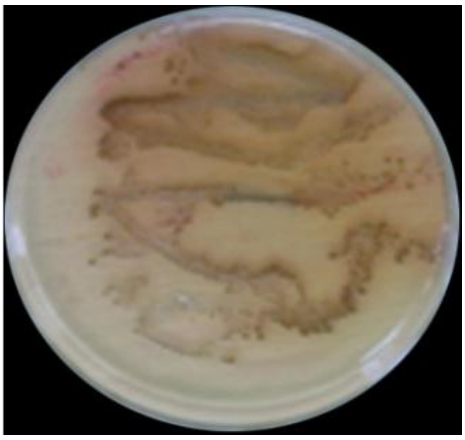

Figure 4(a): *Staphylococcus* species on Baird Parker agar medium

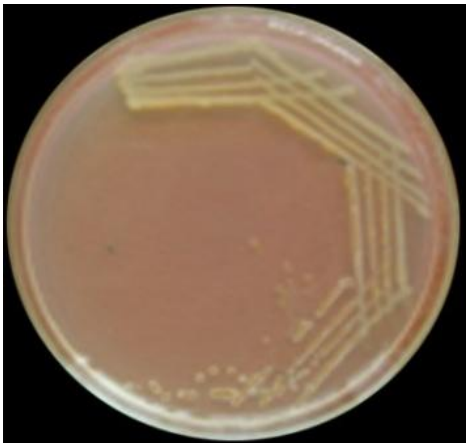

Figure 4(b): *Staphylococcus* species on NA medium

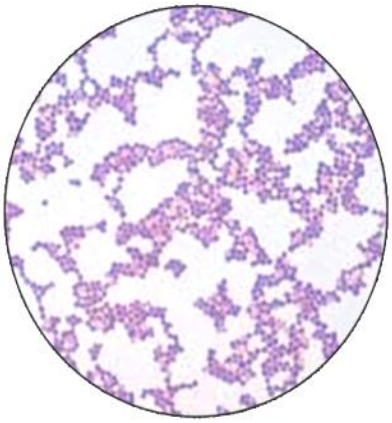

Figure 4(c): The 45X microscopic observation after grams staining showed that it is gram negative organism which is arranged in clusters and therefore regarded as staphylococcus

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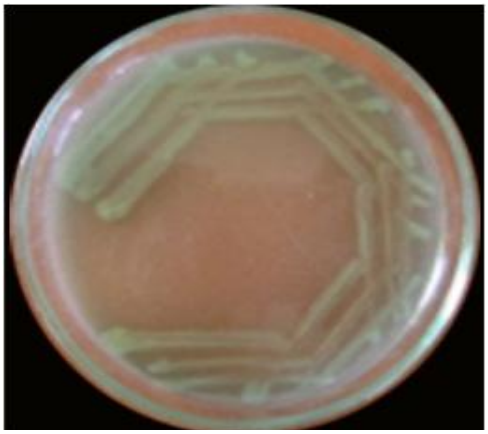

Figure 5(a): *Pseudomonas* species on NA medium oxidase test

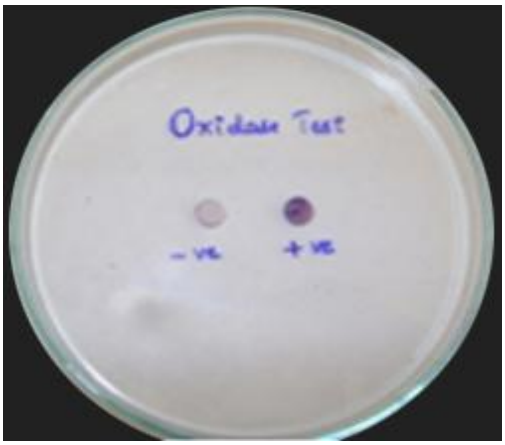

Figure 5(b): *Pseudomonas* species showing on NA medium oxidase test

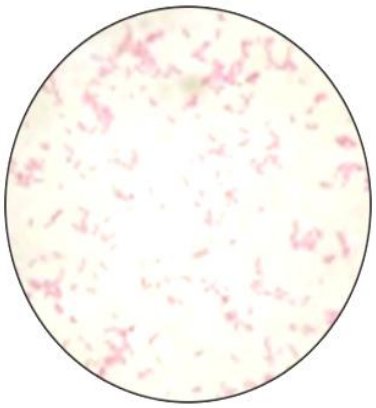

Figure 5(c): The 45X microscopic observation after grams staining showed that it is gram negative organism which has a rod-shaped structure, confirming as *Pseudomonas* species

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SUMMARY

Water from different sources in Mysuru city was collected to analyze for its bacteriological parameters. Samples were collected with adequate measures and taken to the laboratory. Bacterial parameters were studied for all the three samples by aerobic plate count. Surface water had 250 CFU/mL which was reported to be the maximum load while tap water and ground water had 120 CFU/mL and 108 CFU/mL respectively. From surface water a colony was studied and identified as *Staphylococci.* From tap water, an isolate was identified and characterized which revealed it to be *Pseudomonas.*

CONCLUSION

The research study revealed various domains for water quality. The bacterial load was found to be highest in surface water because of various kinds of human activities like fishing, boating, tourism etc. Along with these, the inhabiting flora and fauna of aquatic habitat also add on to the bacterial load. Ground water site was right next to the defecation site. *Staphylococcus* species and *Pseudomonas* species were isolated from surface water and tap water respectively. It can be concluded that there exists a strong relationship between water quality parameters, human activities, seasonal changes and urbanization. An extensive study is highly recommended.

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