3.1 INTRODUCTION

Microorganisms are widely distributed in nature and are found in most natural waters. Microbial pollution in natural waters has always been determined by the enumeration of indicator microorganisms. Coliform bacilli and Escherichia coli are generally considered to be indicators of the bacteriological quality of water. Water contamination with pathogens and pollutants create many health problems for the people consuming the water. As such, water quality in relation to human health is an important fact of limnology. The waterborne infections are most common cause of mortality in the underdeveloped and developing countries.

Total coliform bacteria are a group of easily cultured organisms used to indicate water quality. Total coliform bacteria consist of environmental and fecal types. Coliforms are easy to isolate, present in larger numbers and usually survive longer in an aquatic environment than viruses, parasites and more serious types of bacteria. Most of the total coliforms are not considered pathogens under normal conditions.

Fecal coliform bacteria are found in the feces of humans and other warm-blooded animals. These bacteria can enter lakes directly or from agricultural and storm runoff carrying wastes from birds and mammals, and from human sewage discharged into the water. Fecal coliform by themselves are not dangerous (pathogenic). Pathogenic organisms include bacteria, viruses, and parasites that cause diseases and illnesses. Fecal coliform bacteria naturally occur in the human digestive tract, and aid in the digestion of food. In infected individuals, pathogenic organisms are found along with fecal coliform bacteria.

In recent years the pollution of water has become the most significant environmental problems in the world. Water is one of the essential natural resources for existence and development of life on earth. With the contamination of water, the aquatic life is also disturbed thus disrupting the whole aquatic system. Enormous anthropogenic
activities make all these water resources unfit for consumption. The accumulation of sewage and other waste in Lake, it is not able to recycle them and hence their self-regulatory capability is lost. The decomposition of these wastes by aerobic microbes decreases due to higher level of pollution. Usually the microbiological quality of water is assessed by checking non-pathogenic bacteria of fecal origin. E.coli and Enterococcus sps members are traditionally used as hygienic indicator bacteria (Annie Rompre et al., 2002). Pollution of the water bodies is increasing due to rapid population growth, industrial proliferation, urbanization, increasing living standards wide ranges of human activities.

Several researchers have pointed out that wastewater treated or untreated is a primary contributor of bacteria to the aquatic ecosystem (Smith, 1970). Water contaminated by bacteria is capable of transferring resistance are of great concern. Since there is the potential for transfer of antibiotic resistance to a pathogenic species (Goyal, et al., 1979). Because of the high incidence of antibiotic resistance among both coliforms and faecal coliforms bacteria they can longer be considered solely as harmless indicators of pollution (Grabow et al., 1976). Hence bacteriology of water continues to be an important component in defining the quality of public health.

3.2 MATERIALS AND METHODS

Samples of water for bacterial analysis were collected at monthly frequency during January 2010 to December 2012. The samples are collected in sterilized borosilicate glass stoppered bottles, the stopper and neck of the bottle should be covered to protect against dust and handling contacts and wrapping paper, pressed over stopper and neck sealed by secure hood. The samples are stored at a temperature between 6–10°C in refrigerator.

Laboratory Analysis

Membrane filter technique was used for counting coliform numbers (quantity) in water bodies. This technique involves filtering a known volume of water through a special sterile filter. These filters are made of nitrocellulose acetate and poly carbonate with a 150μm thick and have 0.45μm diameters pores. When the water samples are filtered bacteria in the sample are trapped on the surface of the filter. The filter is then carefully removed placed in a sterile petriplates containing the solidified media and incubated for 20 – 24 hours at 37°C and 44.5°C for Total coliform and Fecal coliform respectively.

The enumeration of total coliform and fecal coliform population was made by membrane filter technique with the following high media;

M-Endo media

The medium comprised of the following (g/L): Tryptose 10.0; Thiopeptone, 5.0; casitone, 5.0; yeast extract, 1.5; lactose, 12.5; sodium chloride, 5.0; dipotassium dihydrogen, 4.37; potassium dihydrogen phosphate, 1.375; sodium lauryl sulfate, 0.05; sodium dosolycholate, 0.10; sodium sulfite, 2.10; basic fuchsin, 1.05; Agar 15.0 and water 1000ml.

M-FC media

The medium comprised of the following (g/L): Tryptone 10.0; Proteose peptone No.3 5.0; Yeast extract 3.0; Sodium chloride 5.0; Lactose 12.5; Bile salt No.3 1.5; Aniline blue 0.1g; Agar 15.0 and water 1000ml.
3.3 RESULTS

Bacteria that produce a red colony with metallic (golden) sheen within 24 hours incubation at 37°C on the Endo-type media are considered members of the coliform group (total coliform). The sheen may be cover either the entire colony or may appear only in a central area or on the periphery.

The results of monthly variation of total coliforms and fecal coliforms analysis of seven different lakes like, Shoolkere, Valageranahalli, Mallathalli, Nalligudda, Sompura, Hemegepura and Doddavoderahalli were presented in Fig: (50 to 63).

**Total Coliforms**

The Shoolkere lake during 2010, the highest total coliforms were observed (188/100 ml) in April and lowest were observed (43/100 ml) in December. In the year 2011, the highest total coliforms were observed (232/100 ml) in May and lowest were observed (32/100 ml) in October. In 2012, highest total coliforms were observed (366/100 ml) in March and lowest total coliforms were observed (66/100 ml) in September (Fig. 50).

The Valageranahalli lake during 2010, the highest total coliforms were observed (178/100 ml) in March and lowest were observed (48/100 ml) in November. In the year 2011, the highest total coliforms were observed (162/100 ml) in May and lowest were observed (28/100 ml) in November. In 2012, highest total coliforms were observed (165/100 ml) in April and lowest total coliforms were observed (58/100 ml) in December (Fig. 51.).

The Mallathalli lake during 2010, the highest total coliforms were observed (145/100 ml) in May and lowest were observed (65/100 ml) in December. In the year 2011, the highest total coliforms were observed (132/100 ml) in April and lowest were observed (52/100 ml) in December. In 2012, highest total coliforms were observed (135/100 ml) in April and lowest total coliforms were observed (41/100 ml) in December (Fig. 52)
Fig. 50: Monthly Variation of Total Coliform in Shoolkere Lake during Jan 2010 to Dec 2012.

Fig. 51: Monthly Variation of Total Coliform in Valageranahalli Lake during Jan 2010 to Dec 2012
Fig. 52: Monthly Variation of Total Coliform in Mallathalli Lake during Jan 2010 to Dec 2012.

Fig. 53: Monthly Variation of Total Coliform in Nalligudda Lake during Jan 2010 to Dec 2012.
Fig. 54: Monthly Variation of Total Coliform in Sompuara Lake during Jan 2010 to Dec 2012.

Fig. 55: Monthly Variation of Total Coliform in Hemegpura Lake during Jan 2010 to Dec 2012.
Fig. 56: Monthly Variation of Total Coliform in Doddavoderahalli Lake during Jan 2010 to Dec 2012.
The Nalligudda lake during 2010, the highest total coliforms were observed (225/100 ml) in May and lowest were observed (92/100 ml) in December. In the year 2011, the highest total coliforms were observed (188/100 ml) in May and lowest were observed (76/100 ml) in November. In 2012, highest total coliforms were observed (164/100 ml) in May and lowest total coliforms were observed (62/100 ml) in December (Fig. 53).

The Sompura lake during 2010, the highest total coliforms were observed (178/100 ml) in April and lowest were observed (45/100 ml) in December. In the year 2011, the highest total coliforms were observed (135/100 ml) in May and lowest were observed (31/100 ml) in November. In 2012, highest total coliforms were observed (152/100 ml) in May and lowest total coliforms were observed (32/100 ml) in December (Fig. 54).

The Hemegepura lake during 2010, the highest total coliforms were observed (234/100 ml) in May and lowest were observed (87/100 ml) in February. In the year 2011, the highest total coliforms were observed (160/100 ml) in May and lowest were observed (63/100 ml) in November. In 2012, highest total coliforms were observed (236/100 ml) in May and lowest total coliforms were observed (88/100 ml) in September (Fig. 55).

The Doddavoderahalli lake during 2010, the highest total coliforms were observed (350/100 ml) in May and lowest were observed (98/100 ml) in October. In the year 2011, the highest total coliforms were observed (188/100 ml) in April and lowest were observed (91/100 ml) in November. In 2012, highest total coliforms were observed (201/100 ml) in March and lowest total coliforms were observed (81/100 ml) in January (Fig. 56).
Fecal coliforms

Colonies produced by fecal coliform bacteria on M-FC medium are various shades of blue and nonfecal coliforms colonies are gray to cream-coloured at 44.5°C for 24 hours.

The Shoolkere lake during 2010, the highest faecal coliforms were observed (271/100 ml) in August and lowest were observed (118/100 ml) in April. In the year 2011, the highest faecal coliforms were observed (275/100 ml) in October and lowest were observed (131/100 ml) in May. In 2012, highest faecal coliforms were observed (201/100 ml) in June and lowest faecal coliforms were observed (78/100 ml) in March (Fig. 57).

The Valageranahalli lake during 2010, the highest faecal coliforms were observed (288/100 ml) in July and lowest were observed (98/100 ml) in January. In the year 2011, the highest faecal coliforms were observed (175/100 ml) in September and lowest were observed (76/100 ml) in February. In 2012, highest faecal coliforms were observed (226/100 ml) in July and lowest faecal coliforms were observed (61/100 ml) in November (Fig. 58).

The Mallathalli lake during 2010, the highest faecal coliforms were observed (332/100 ml) in June and lowest were observed (78/100 ml) in November. In the year 2011, the highest faecal coliforms were observed (298/100 ml) in September and lowest were observed (109/100 ml) in December. In 2012, highest faecal coliforms were observed (312/100 ml) in August and lowest faecal coliforms were observed (81/100 ml) in December (Fig. 59).
Fig. 57: Monthly Variation of Fecal Coliform in Shoolkere Lake during Jan 2010 to Dec 2012.

Fig. 58: Monthly Variation of Fecal Coliform in Valageranahalli Lake during Jan 2010 to Dec 2012.
Fig. 59: Monthly Variation of Fecal Coliform in Mallathalli Lake during Jan 2010 to Dec 2012.

Fig. 60: Monthly Variation of Fecal Coliform in Nalligudda Lake during Jan 2010 to Dec 2012.
Fig. 61 : Monthly Variation of Fecal Coliform in Sompura Lake during Jan 2010 to Dec 2012.

Fig. 62 : Monthly Variation of Fecal Coliform in Hemegepura Lake during Jan 2010 to Dec 2012.
Fig. 63: Monthly Variation of Fecal Coliform in Doddavoderahalli Lake during Jan 2010 to Dec 2012.
The Nalligudda lake during 2010, the highest faecal coliforms were observed (191/100 ml) in August and lowest were observed (67/100 ml) in January. In the year 2011, the highest faecal coliforms were observed (250/100 ml) in September and lowest were observed (70/100 ml) in January. In 2012, highest faecal coliforms were observed (198/100 ml) in June and lowest faecal coliforms were observed (64/100 ml) in October (Fig. 60).

The Sompura lake during 2010, the highest faecal coliforms were observed (172/100 ml) in July and lowest were observed (56/100 ml) in October. In the year 2011, the highest faecal coliforms were observed (288/100 ml) in August and lowest were observed (61/100 ml) in November. In 2012, highest faecal coliforms were observed (265/100 ml) in June and lowest faecal coliforms were observed (82/100 ml) in November (Fig. 61).

The Hemegepura lake during 2010, the highest faecal coliforms were observed (291/100 ml) in August and lowest were observed (81/100 ml) in December. In the year 2011, the highest faecal coliforms were observed (250/100 ml) in September and lowest were observed (58/100 ml) in November. In 2012, highest faecal coliforms were observed (261/100 ml) in July and lowest faecal coliforms were observed (66/100 ml) in December (Fig. 62).

The Doddavoderahalli lake during 2010, the highest faecal coliforms were observed (266/100 ml) in September and lowest were observed (51/100 ml) in November. In the year 2011, the highest faecal coliforms were observed (228/100 ml) in October and lowest were observed (70/100 ml) in January. In 2012, highest faecal coliforms were observed (221/100 ml) in August and lowest faecal coliforms were observed (43/100 ml) in November (Fig. 63).
3.4 DISCUSSION

Water is one of the most essential needs for the continued existence of all living organisms on earth. The day-to-day activities of all living organisms require water in some form. It is effectively and efficiently put into use by plants, animals, microorganisms and man. In the microbial world, no single microorganism has been discovered to be active at the extreme lack of water for the singular reason that man cannot exist without water. The most dangerous form of water pollution occurs when fecal contaminant like Escherichia coli enter the water supply. Contaminants ingested into water supply cause many diseases. The bacteriological quality of water is of paramount importance and monitoring must be given highest priority. This is so because studies have attributed several disease outbreaks to untreated or poorly treated water containing bacterial pathogens that have been isolated from surface water. The surface water sources, in general are not acceptable for consumption as they are often contaminated with different pollutants loaded by organic, inorganic and biological constituents. The contaminations in lentic water were found generally due to secondary contaminant like discharge of sewage, faecal matter, percolation of industrial waste water etc., Indicator organisms are commonly used to assess the microbiological quality of surface waters. Faecal coliforms are the most commonly used bacterial indicator for estimating faecal pollution.

The term “coliform organism” (total coliform) refers to any rod shaped nonspore forming, gram negative bacteria capable to ferment lactose at either 35 or 37°C with the production of acid, gas and aldehyde within 24 – 48 hours, whereas with same properties at a temperature of 44 or 44.5°C are described as “fecal (thermotolerant) coliform” organisms.

Studies reveal that fecal coliform analysis is a more definitive test for fecal pollution than the total coliforms. The word fecal coliform primarily defines E coli and occasionally Klebsiella. It is relatively harmless bacterial species and is almost always
present in water that contains enteric pathogens. Thus, because they are relatively easy to isolate and because they normally survive longer than the disease producing organisms, Fecal coliforms are a useful indicator of possible presence of enteric pathogens and viruses. In most cases water that is free from fecal coliforms is considered free of disease producing bacteria. Hence estimation of fecal coliforms is preferred over total coliforms.

During the present investigation the total coliform count in the studied lakes in general, greatly increased in summer months and decreased in monsoon and winter months. The total coliform count in the Shoolkere lake increased from 2010 to 2012, this increase corresponds to large catchment area fully exposed for the grazing of cattle and other human interferences. Sharma and Mall (1988) and Patralek (1992) opined that temperature also governs the bacterial population.

Bacteriological observation for fecal coliform in the studied lake revealed that higher bacterial population with the commencement of monsoon and relatively lower bacterial density during winter. Mallathalli lake recorded high fecal coliform count in June 2010. This is in conformity to observations of Singh (1985), Patralek (1992), Parihar *et al.*, (2003) and Mohan *et al.*, (2007). Higher bacterial population during monsoon months was obviously due to transport of organic matter from various sources through surface runoff from the catchment area in accordance with Singh (1985).

Infectious diseases caused by pathogenic bacteria, viruses and protozoan parasites are among the most common and widespread health risk of drinking water. People are introduced to these microorganisms through contaminated drinking water, water drops, aerosols and washing or bathing. Water contamination and spread of infectious diseases must be handled in this context and the present investigation throws light on facts about Bangalore Lakes.
3.5 REFERENCES


