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Water quality status and Fisheries of Sewage fed tank in Bhadravathi Taluk of Karnataka, India

B.R. Kiran
Research and Teaching Assistant in Environ. Science, DDE, Kuvempu University, Jnana Sahyadri, Shankaraghatta–577 451, Karnataka, INDIA

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Abstract

Present study deals with the assessment of some physico-chemical , microbial parameters and fisheries activities of a sewage fed Jannapura tank for its suitability of human consumption and fish culture have been carried out during the period 2007-08. The aims of the present study were to determine the water quality, assess nature or humans impact on the physico-chemical and biological characteristics of the tank water with a view to effective utilization, better management, conservation and sustainable exploitation of the tank resources. E-coliforms were used as indicators of bacterial pollution while phosphate, nitrate, BOD and oxygen were used as indicators of possible nutrient enrichment in the tank. This water body lies in the heart of the Bhadravathi town (Karnataka) and continuously receiving sewage from the surrounding residential areas and producing bad odor. The presence of Escherichia coli (E.coli) bacteria in tank may indicate that the water has been contaminated from the domestic sewage. Nitrate, phosphate and BOD values were high depicting cultural eutrophication occurring from surface runoff of nitro-phosphate fertilizers from nearby lands into the tank and the present findings revealed that the water quality of the tank is productive and eutrophic. In addition, fish diversity, species cultured, fish marketing, advantage and disadvantages of sewage fed fisheries in the present water body are discussed in this article.

Keywords: Physico-chemical characteristics, *E-coli*, Jannapura tank, eutrophication**.**

Introduction

In early times, human settlements were always located near waterbodies viz., ponds, lakes, rivers etc. Even today, it is so in many places. But for the last few decades, due to the increase in population, urbanization and development in industrial and agricultural sectors, water bodies are increasingly getting polluted rendering the water unsuitable for human consumption and other uses. Besides human beings, aquatic flora and faunas are also affected (NCERT).

Water is an elixir of life. Majority of water available on the earth is saline in the nature, only small quantity exists as freshwater. Freshwater has become a scare commodity due to over exploitation and pollution[1,2]. Industrial, sewage and municipal wastes are being continuously added to water reservoirs, affect physico-chemical quality of water making them unfit for use of livestock and other organisms[3]. Excessive algal growth has been noticed in the water body due to high concentration of nutrients.

Water quality conditions in a water body are controlled by both natural processes and human influence. Natural factors such as the source of the water and the types of rock and soil in the pond watershed will influence some water quality characteristics. These factors are difficult to control and usually cause few problems. Instead, most serious water quality problems originate from land uses or other activities near or in the waterbody. The effects of these activities can usually be minimized through proper management and early detection of problems through testing[4].

Concerns about tank water quality are directly related to the uses of the waterbody. As with all management decisions, consider the primary uses of waterbody to determine which water quality parameters are of greatest concern. For example, a water body used to supply drinking water for animals should be tested for different parameters than a tank used excessively for fishing.

Sewage fed fisheries is unique technique of utilization of domestic sewage for fish culture long back in 1930s. The early inspiration of utilizing the sewage for fish culture emerged from the waste. Stabilization pond used as water source of vegetable fields. This technique is considered to be the largest operational system in the world to convert the waste in consumable product.

This practice is not only unhygienic but also harmful since the sedimented organic matter besides raising the bed level of tank being highly oxidisable in character may undergo decomposition and cause negative oxygen balance causes mortality of aquatic fauna. But sewage partly or fully decomposed contains a high percentage of nitrogen, phosphorus, Ca, K etc. These nutrients together with adequate alkalinity contribute largely to a high productivity in sewage water and for this reason fertilization of fishpond is sometimes carried out with raw sewage.

Water quality degradation by various sources becomes a important issue around the world. Usage of more land for agricultural purposes, soil salinization, increase in the use of agricultural fertilizers, common pesticide use and erosion have become problems threatening natural water source[5]. The aim of the present study is to observe water quality of Jannapura tank by physico-chemical and microbial procedures and to determine the changes in water quality parameters by seasons.

Material and Methods

Jannapura tank is a perennial fresh water body located in Bhadravathi taluk of Shivamogga district, Karnataka. This waterbody is situated at 13°52′ N latitude and 75°40′ E longitude. The tank receives water from Bhadra reservoir left bank channel, rainwater and sewage from residential settlements. Small scale industries are located near the tank. The total area of the water body is about 20 hectares and depth is around 5-10 Mt. The water from this tank is used for irrigation and as well as for fish culture.

Water samples were collected monthly during morning hours of the day (between 8 AM to 10 AM) covering one year from February 2007 to January 2008. Some changeable and sensitive parameters like pH, dissolved oxygen, water temperature and free CO_2 were directly analyzed in the field itself. The unpreserved and preserved samples were transported to the laboratory keeping in icebox for analysis of remaining parameters. All necessary precautions were taken during sampling and transportation. *E.coli* analysis was carried out by membrane filter technique and coliform density was calculated as per MPN tables[6]. Fishes were identified as per standard literature[7,8].

Results and Discussion

Minimum, maximum and average values of physico-chemical, as well as microbiological parameters are depicted in figure-1. While, the average seasonal variations of the water quality parameters are shown in figure-2. It is evident that the maintenance of healthy conditions in aquatic ecosystem is dependent on the physico-chemical properties of water and biological diversity. The water temperature of the tank is an important parameter influencing the water quality. It varied according to the seasonal fluctuation of atmospheric temperature with maximum during summer season (30.60°C) and minimum during winters (15.05°C).

pH is a measure of the acid qualities of water; a pH of 7.0 means a neutral solution; water with a pH below 7 is normally harmful in that it may dissolve iron from pumping facilities and mains and produce a red water problem pH is one of the important factors that serve as an index of the pollution. The present waterbody showed an alkaline pH with the values ranging from 7.50 to 7.95. pH value of majority of lakes and reservoirs in India has been found between 6 to 9. The higher range of pH indicates higher productivity of water[9]. pH is lowered by acids: acid generating salts and free CO_2 ; HCO_3, OH^-, PO_4 and borates. Acceptable range of pH is 6.5-8.5.

The total dissolved solids test measures the total amount of dissolved minerals in water. The solids can be iron, chloride, sulphate, calcium or other minerals found on the earth surface. The dissolved minerals can produce an unpleasant taste or appearance and can contribute to scale deposits on pipe walls.

In the present study, TDS values varied between 345.20 and 418.70 mg/l. The peak value was observed in summer season. High solids in water cause inferior potable quality of water. However, total suspended solids ranged from 32.80 to 110.55 mg/l. Water body exhibited high value of solids which is caused by the addition of high quantity of sewage.

Chlorides in water body can be occurring naturally by deep aquifers or caused by pollution from water course, or industrial or domestic wastes. Chloride level above 250 mg/l can produce a distinct taste in drinking water. Where chloride content is known to be low, a noticeable increase in chloride levels may indicate pollution from sewage source. Chloride concentration varied between 160.50 and 186.78 mg/l. The limit of chloride is 250 mg/l with the upper limit of 1000 mg/l for drinking water[10]. In such condition the chloride concentration of the water body is under safe limit.

Dissolved oxygen (DO) in the water is necessary for respiration and thus is essential for aquatic life to exist. Much of the oxygen comes from the atmosphere and is dissolved in the water through diffusion and wave action. The remainder comes from plants through photosynthesis. It is removed by bacterial and other respiration. When the oxygen concentration falls below 3 ppm there is not enough oxygen for fish to survive or for the oxidation of dead plant material. In the current study, DO level fluctuated from a minimum of 2.2 mg/l to a maximum of 4.4 mg/l with an average of 3.2 mg/l. Eventually, the water body goes from an oligotrophic to an eutrophic state. Thus, it is important to keep track of the dissolved oxygen.

The present investigation revealed that the free CO_2 is deviated in the range of 13 to 28 mg/l. High values were observed in summer (26 mg/l), where as lower values in monsoon season (15 mg/l). Total hardness is a measure of calcium and magnesium concentration in water and is controlled by the source of the tank water. Water body in limestone areas will generally have harder water than those in areas underlain by sandstone or shale. Total hardness varied between 240 and 352 mg/l. In potable water Ca^{++} and Mg^{++} range between 75 and 200 mg/l and 50 and 100 mg/l respectively[11]. In the present study, the water can be classified as hard category which is below the prescribed limit of 200-600 mg/l.

Peak level of BOD values were observed during the study period varied from 28.5 to 37.65 mg/l. As per the recommendations of BIS, BOD limits for bathing and drinking

purposes are 2 mg/l and 3 mg/l respectively. The COD values fluctuated between 51.6 and 60.50 mg/l, which are likely due to the addition of sewage bringing inorganic matter[12].

Considering phosphate, the most vital nutrient effecting productivity of natural water resources. The phosphate level in the present study fluctuated from 0.22 to 0.95 mg/l. Phosphate level increased during summer season with 0.80 mg/l and decreased in winter season to 0.28 mg/l. The peak phosphate in Jannapura water body environs could possibly result from agricultural runoff reaching surface waters by rain drainage or irrigation return reaching the water body.

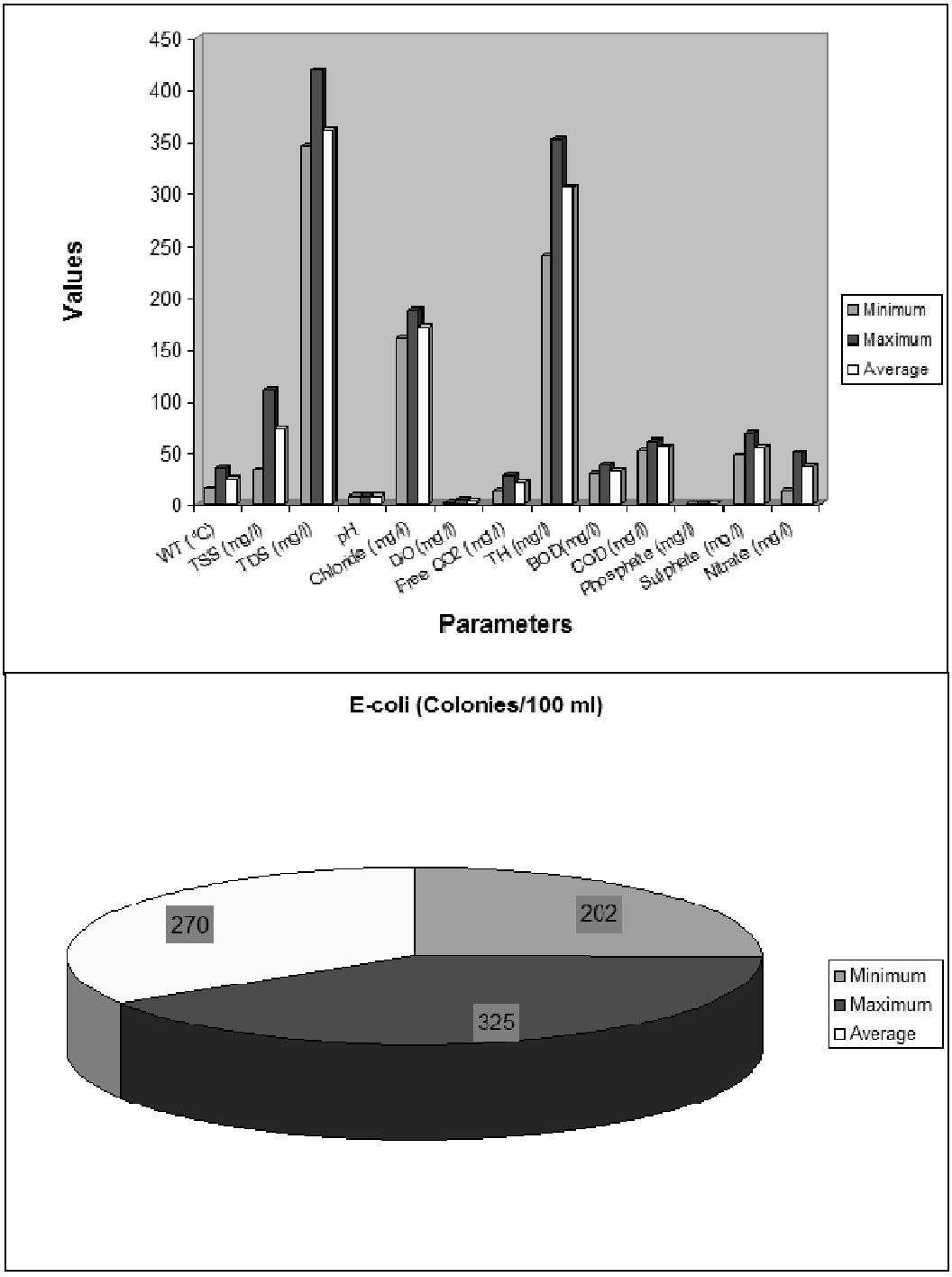

Figure-1
Minimum and maximum values of various physico-chemical and microbial properties of sewage fed tank at Bhadravathi taluk

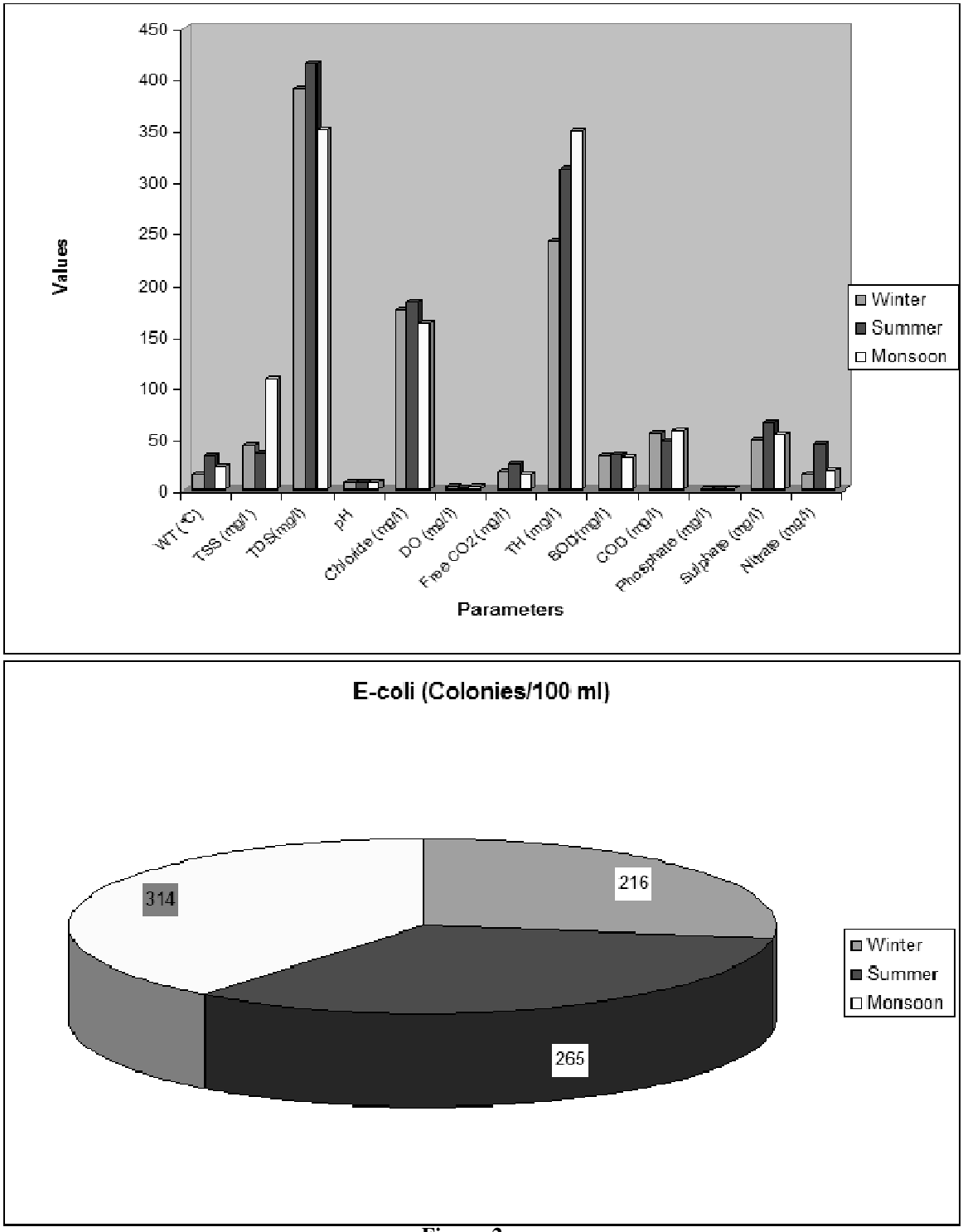

Figure-2
Average seasonal variations of physicochemical and microbial population of the sewage fed water body in Bhadravathi taluk of Karnataka

Sulphate concentration in the tank water deviated from a minimum of 46.5 mg/l to a maximum of 68.78 mg/l with an average of 54.79 mg/l respectively. Higher sulphate level was observed during summer season (65.64 mg/l). Sulphate in tank water is primarily related to the types of minerals found in the watershed and acid rain. Industries and utilities that burn coal release sulphur compound into the atmosphere that are carried into the water body by rainfall. Nitrate level fluctuated between

12.88 and 49.38 mg/l. Nitrate concentration exceeded the permissible limit prescribed by WHO[13] and Central pollution control Board standards (table-1).

Table-1
Permissible limit of physico-chemical characteristics of water

Parameter	Maximum permissible limit, CPCB (1995)	WHO (2004)
pH	6.5-8.5	7.0-8.5
Alkalinity (mg/l)	30	120
TDS (mg/l)	500	500
TSS (mg/l)	100	-
BOD (mg/l)	30	6.0
COD (mg/l)	250	-
Calcium (mg/l)	75	-
NO_3 (mg/l)	45	10
Chloride (mg/l)	200	-
Sulphate (mg/l)	200	-
EC (µmhos/cm)	1500	-
Total hardness (mg/l)	-	500

The high NO_3 concentration could be due to leaching and surface runoff of nitro-phosphate fertilizer from nearby farmlands into the tank as well as sewage from the residential areas and solid waste material dumped into the water body. This give rise to cultural eutrophication and this could have serious ecological implications such as algal blooms, hypoxia and even fish kill in the tank. Eutrophication could also lead to unpleasant taste and odour of the water when the algae die and decompose thus deteriorating the quality of water[14]. Nitrogen does not occur naturally in soil minerals but is a major component of all organic matter. Decomposing organic matter releases ammonia which is converted to NO_3 if oxygen is present[15]. This conversion occurs more rapidly at higher water temperatures[16]. All inorganic forms of nitrogen (NO_3^-, NO_2^- and NH_4^+) can be used by aquatic plants and algae. If these inorganic forms of nitrogen exceed 0.3 mg/l (as N) in spring, it means there is sufficient nitrogen to support summer algal blooms. Excessive amounts of nitrate can also be dangerous for drinking water. Dairy cows should not drink water with NO_3 concentrations in excess of 100 mg/l measured as nitrate-nitrogen.

E-coli form bacterial can cause waterborne diseases. These coliforms at high levels may occur in the waterbody that receive animal wastes or human wastes. These bacteria are generally only a concern if the water will be used for animal drinking water or for swimming. It is recommended that water bodies used for swimming contain less than 200 fecal coliform bacteria per 100 ml of water. Tank waters used for livestock watering should contain less than 10 fecal coliform bacteria per 100 ml for adult animals and zero fecal coliform bacteria for calves and other young livestock. In the current study, *E-coli* bacteria fluctuated between 202 and 325 coliforms /100 ml. The peak values were observed in monsoon season, which might be due to the flushing of faecal contaminated water from the surrounding drains and bank sides[17].

Fisheries in Sewage fed tank: The sewage fed tank is usually large and can be as big as 20 ha in size. Although this sewage-fed tank is generally shallow and vary from 10 to 15ft in depth. The photosynthetic activity in the tank is the basis for biological purification of the sewage. *Cyprinus carpio* and Indian major carps stocking takes place once in a year depending on the intensity of operation.

Species cultured and Diversity: Although both Indian and exotic carps are grown, fish farmers have specific preference for the Indian carps, namely catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) with bulk of the stocking consisting of mrigal. Exotic fish like silver carp (*Hypophthalmichthys molitrix*), and common carp (*Cyprinus carpio*) are stocked as a small percentage. However, during 2003-04 the population of *Notopterus notopterus* was high but now a days the population of *Oreochromis mossambicus* is increased and they constitute 30-40% of the species stocked with different forms.

In addition to the above, other fish species found in Jannapura tank are *Labeo calbasu, Osteobrama cotio cunma, Cirrhinus fulungee, Puntius chola, Salmostoma untrahi, Rasbora daniconius, Amblypharyngodon melettinus, Garra kempi, Mystus cavasius, Clarias batrachus, Aplocheilus panchax, Ambassis kopsii, Channa striatus, C. marulius, C. punctatus, Mastacembalus armatus* and *Gambusia affinis.*

Fish marketing: Fish marketing is becoming more popular. Fish are harvested early in the morning and sold to the peoples at the tank site and remaining fishes were transported to the market site using plastic containers placed on bicycles, and tricycles. Based on the market demand, fishes weighing more than 300 g are generally harvested and sold. Some fishes are also sold to hotels that cater food to poor people. There are also persons for the transportation of fishes in fresh condition for marketing using bicycles/ auto and they earn about Rs. 50-60 per kilogram of fish.

Advantages of sewage fed fish culture: i. No manuring and supplementary feeding is required due to high content of nutrients in sewage. ii. Input cost is very low (only in fish seed) and production is very good.

Disadvantages of sewage fed fisheries: i. The sewage contains high load of organic (high BOD) and inorganic matters, toxic gases but its dissolved oxygen contents is very low. ii. As the raw sewage is used in fish ponds, there is a chance of infection and pollutions to enter into human body through fish. But this risk can be minimized if good managerial practice is followed viz., Use of treated sewages for fish culture instead of raw

sewage. Keeping the fish for 3-4 weeks in clean fresh water before consumption and marketing.

Conclusion

From the present findings, it is found that the water quality of Jannapura tank is not suitable for drinking, washing and bathing purposes. Environmental condition of the tank was not good due to the continuous dumping of waste materials as well as flowing of sewage from the residential settlements. From the observed values of dissolved oxygen, biochemical oxygen demand and chemical oxygen demand, it may safely be concluded that the bacteriological load in the water body is high and the water body has reached the eutrophic stage yet it is recommended that dumping of all kind of waste materials including sewage waste into the tank should be stopped immediately to allow the self purification process of a aquatic system to regain its original beauty. It will be better if the tank is given some purification treatment and renovation including providing fencing around the periphery of the waterbody. The government organizations are to plan for time to time monitoring of the water quality along with a check on the influents, standards with a view to reduce the external contribution into the pollution level of Jannapura tank. The water quality parameters obtained in this tank could be used as a baseline data and reference point when assessing further changes caused by nature or man in this tank, since there has not been published information of data on this important tank. Everything humans do, even mere existence, affects the quality of the water.

There is an urgent need to establish a proper disposal method for the raw sewage in Jannapura tank as this is seriously threatening public health. There is also need for the municipal authorities to consider applying for construction of wetlands to enhance the quality of their sewage effluents. These are fairly easy to construct. constructed wetlands can reduce the ecological implications as they can remove BOD, suspended solids, phosphorus and nitrogen to significant levels. Therefore, it is necessary implement practices and policies to preserve the quality of water, for water is one of the most valuable natural resources left in the world, and people depend on it greatly.

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