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Comprehensive study of various parameters of drinking water in Gwalior (M.P.)

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ABSTRACT

Drinking water is most essential for livelihoods and for other consumptions. This paper presents a comprehensive analysis of the drinking water in Gwalior city of Madhya Pradesh (India). Due to over population, increase in drinking water consumption has arisen. In order to ascertain water quality for human consumption, major and minor parameters were evaluated in the drinking water supplied to the city and its surrounding areas. The data were analyzed and the objective of the study was derived from the data analysis. This attempt will helpful to decrease the drinking water and its attribute problems in the study area and it lead to a sustainable example for future generations and also be a good fore step for the research field too. Standard methods were used for determining of chemical and physical characteristics of the water samples. The concentrations of investigated parameters in the drinking water samples from Gwalior region were within the permissible limits of the Bureau of Indian Standards for Drinking Water.

Keywords: parameters for water quality, drinking water, standard methods, BIS, Gwalior, etc.

INTRODUCTION

Drinking water is indispensable for human existence. Water sustains all life on earth. One of the basic elements of the natural environment, water is a consumable item for humans and animals, a primary component for industry and a vector for domestic and industrial pollution. The Gwalior suffers a severe drinking water supply crisis, particularly in the dry seasons of every year. The drinking water supplies in the cities are intermittent. Nearly all of the surface sources and ground water sources have been exploited. The growing imbalance between supply and demand has led to chronic shortages and competition that have resulted in pollution and environmental degradation. Apart from quantitative shortages, the quality of drinking water in the Gwalior is becoming a serious public health issue for the past few years. The quality of water for drinking has deteriorated because of the inadequacy of treatment plants, direct discharge of untreated sewage into rivers and inefficient management of the piped water distribution system. Diseases caused by contaminated water are among the ten most prevalent water borne diseases in Gwalior. Diarrhea, which is caused by poor sanitation, hygiene and water quality, is one of the most prevalent water borne disease in Gwalior. [1, 2]

The most common and widespread health risk associated with drinking water is contamination; either directly or indirectly, by human or animal excreta, particularly faeces. If such contamination is recent, and if those responsible for it include carriers of communicable enteric disease, some of the pathogenic microorganisms that cause these diseases may be present in the water. Drinking the water, or using it in food preparation, may then result in new cases of infection. The pathogenic agents involved include bacteria, viruses, and protozoa, which may cause diseases that vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhea, dysentery, hepatitis, or typhoid fever, most of them are widely distributed throughout the world. Faecal contamination of drinking water is only one of several faeco-oral mechanisms by which they can be transmitted from one person to another or, in some cases, from animals to people. Other pathogens cause infection when water containing them is used for bathing of for recreation involving water contact, rather than by the oral route. Some may also cause infection by inhalation. [3, 4, 5]

Chemical and physical properties of water [6, 7]

- Water is a liquid at standard temperature and pressure. It is tasteless and odorless. The intrinsic color of water and ice is a very slight blue hue, although both appear colorless in small quantities. Water vapor is essentially invisible as a gas.
- Water is transparent in the visible electromagnetic spectrum. Thus aquatic plants can live in water because sunlight can reach them. Ultra-violet and infrared light is strongly absorbed.
- Since the water molecule is not linear and the oxygen atom has a higher electronegativity than hydrogen atoms, it carries a slight negative charge, whereas the hydrogen atoms are slightly positive. As a result, water is a polar molecule with an electrical dipole moment. Water also can form an unusually large number of intermolecular hydrogen bonds (four) for a molecule of its size. These factors lead to strong attractive forces between molecules of water, giving rise to water's high surface tension and capillary forces. The capillary action refers to the tendency of water to move up a narrow tube against the force of gravity. This property is relied upon by all vascular plants, such as trees.
- Water is a good solvent and is often referred to as the universal solvent. Substances that dissolve in water, e.g., salts, sugars, acids, alkalis, and some gases – especially oxygen, carbon dioxide (carbonation) are known as hydrophilic (water-loving) substances, while those that do not mix well with water (e.g., fats and oils), are known as hydrophobic (water-fearing) substances.
- All the major components in cells (proteins, DNA and polysaccharides) are also dissolved in water.
- Pure water has a low electrical conductivity, but this increases significantly with the dissolution of a small amount of ionic material such as sodium chloride.
- The boiling point of water (and all other liquids) is dependent on the barometric pressure. For example, on the top of Mt. Everest water boils at 68 °C (154 °F), compared to 100 °C (212 °F) at sea level. Conversely, water deep in the ocean near geothermal vents can reach temperatures of hundreds of degrees and remain liquid.
- The maximum density of water occurs at 3.98 °C (39.16 °F). It has the anomalous property of becoming less dense, not more, when it is cooled down to its solid form, ice. It expands to occupy 9% greater volume in this solid state, which accounts for the fact of ice floating on liquid water.

Taste and Odor –

Water can dissolve many different substances, giving it varying tastes and odors. Humans and other animals have developed senses which enable them to evaluate the potability of water by avoiding water that is too salty or putrid. The taste of spring water and mineral water, often advertised in marketing of consumer products, derives from the minerals dissolved in it. However, pure H_2O is tasteless and odorless. The advertised purity of spring and mineral water refers to absence of toxins, pollutants and microbes.

BIS 10500-1991- Standard for Drinking Water [8, 9, 10]

In this view of scarcity of water, testing of the available water is of paramount importance. To determine portability of water, bacteriological and hygienic chemical analysis is necessary. Microbiological examinations of water samples determine its portability and sanitary quality. Bureau of Indian standards have set the requirements for essential and desirable characteristics to be tested for ascertaining the suitability of water in IS 15001-1991. The BIS standard applies to the purity level acceptable for human beings to drink. Drinking water for human beings should contain some level of minerals (TDS), but these levels should not be excessive. BIS used the WHO standard as the basis and have been amended subsequently.

It says over exploitation of ground water which has the largest share of water supplied for human use has deteriorated to such an extent that the crucial parameters such as TDS, hardness, Chlorides, etc usually exceed the desirable levels substantially. Consequently, a higher permissible limit has been specified. Water used for drinking becomes unpalatable when the TDS level is above 500 mg/l, but lack of any better source enables people consuming such water to get used to its taste. For practically all industrial and some commercial uses, the purity levels required are very much higher and in most cases demand water with virtually no residual dissolved solids at all.

EXPERIMENTAL SECTION

Chemical Analysis of Water [11, 12]

The form in which water exists is greatly affected by presence of dissolved or suspended solid, liquid and gaseous substances, organic matter and micro-organisms. These characteristics of water are an important factor to man who uses the water for drinking or for technical purposes. Though portable water is being supplied by municipal bodies, there are certain areas in interiors where boring water, wells, water from natural reservoirs are used and consumed by human beings. The quality and amount of the various constituents actually form the basis for the definition of the quality of water, upon which the adequacy for various uses are determined. In this view testing of the available water is of paramount importance. To determine portability of water, bacteriological and hygienic chemical analysis is necessary. A microbiological examination of water samples determines its portability and sanitary quality.

Test for specific conditions -

Table 1 Recommended Tests in different conditions

Conditions or Nearby Activities	Recommended Test
Household plumbing contains lead	pH, alkalinity, hardness, lead, copper
Scaly residues, soaps don't lather	Hardness
Water softener to treat hardness	Manganese, iron (before purchase)
Stained plumbing fixtures, laundry	Iron, copper, manganese
Objectionable taste or smell	Hydrogen sulfide, corrosion, pH,
Water is cloudy, frothy or colored	Color, detergents
Corrosion of pipes, plumbing	Corrosion, pH, lead, copper, alkalinity
Rapid wear of water treatment equipment	pH, corrosion, alkalinity, hardness

Sample Collection – Water samples were collected from different places of Gwalior city. Eleven places were selected including main market (Bada), bus stand, railway station, etc. Three to five samples were taken randomly from each place, packed properly and sent for analysis.

Essential characteristics of the drinking water are: Colour, Odor, Turbidity, pH value, Total hardness, Iron, Chlorides

Desirable characteristics of the drinking water are: Total dissolved solids, Calcium, Copper, Magnesium, Manganese, Zinc, Sulphate, Nitrate, Fluoride, Alkalinity, Pesticides, etc.

Table 2 Desirable Range of Different Parameters

Type of Test	Range
pH test	6.5 and 9.0
Turbidity test (visual comparison method)	0.0 NTU, 5NTU , 10NTU, & 25NTU
Chloride (Titration method)	10-200 mg/L (ppm) and 50-1000 mg/L (ppm) as chloride
Total hardness (Titration method)	25-600 mg/L (ppm) as CaCo3
Fluoride (Visual color comparison method)	0.0-2 mg/L (ppm) as fluoride
Nitrate (Visual color comparison method)	0.0-2.0 mg/L (ppm) as Nitrate-N
Iron (Visual color comparison method)	0.0-2.0 mg/L (ppm) as iron
Residual(free chlorine) (Titration method)	0.0-3.0 mg/L (ppm) as free chlorine

Instrument Used

1. Octo Aqua Test Kit [WT023-Multi Parameter Water Testing Kit] [13]

Himedia laboratories provide ready water testing kits- Microbial as well as chemical for the speed and accuracy in detection of drinking water potability. Test & B-sure range of microbial testing kits adding the easy detection of microbes in potable water. WT023 offered by Himedia is a multiparameter water testing kit determining levels of fluoride, nitrate, iron, residual (free) chlorine, chloride and total hardness iron besides measuring turbidity and pH.

Fig.1 Water Testing Kit

2. For pH testing - pH meter

3. For turbidity test- 5 bottles: Empty bottles marked sample bottle, for test. Standards of 0 NTU, 10 NTU, & 25 NTU for turbidity comparison.

4. For chloride test- 4 reagents bottles: Marked reagent CHL-A, CHL-B, CHL-C (2 bottles)

5. For total hardness test- 4 reagent bottles: Marked reagent TH-A, TH-B, TH-C (2 bottles)

6. For fluoride test-2 reagent bottles: Marked reagent FL-A, FL-B.

7. For Nitrate test- 3 reagent bottles: Marked reagents N-A, N-B, and reagent N-C.

8. For iron test-2 reagent bottles: Marked reagents-A, and reagent Fe-B.

9. For residual (free) chlorine test-4 reagent bottles: Marked reagent RCL-A, RCL-B, &RCL-C (2 bottles)

10. Miscellaneous - Colour comparator chart for fluoride, Nitrate & iron test, Hand gloves, 5 ml syringe, marked glass test jar, spoons, etc.

Parameter 1- pH: - [14, 15, 16, 17, 18]

pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect the pH of water. The overall pH range of natural water is generally between 6 and 8. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of water. pH lower than 4 will produce sour taste and higher value above 8.5 bitter taste. Higher values of pH hasten the scale formation in water heating apparatus and reduce the germicidal potential of chlorine. pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as Zn, Pb, Cd, Cu etc.

Safe pH range- 6.5 and 9.0.

Fig.2 pH meter

Procedure to Determine pH: - A pH meter is an electronic instrument measuring the pH (acidity or alkalinity) of a liquid (though special probes are sometimes used to measure the pH of semi-solid substances). A typical pH meter consists of a special measuring probe (a glass electrode) connected to an electronic meter that measures and displays the pH reading.

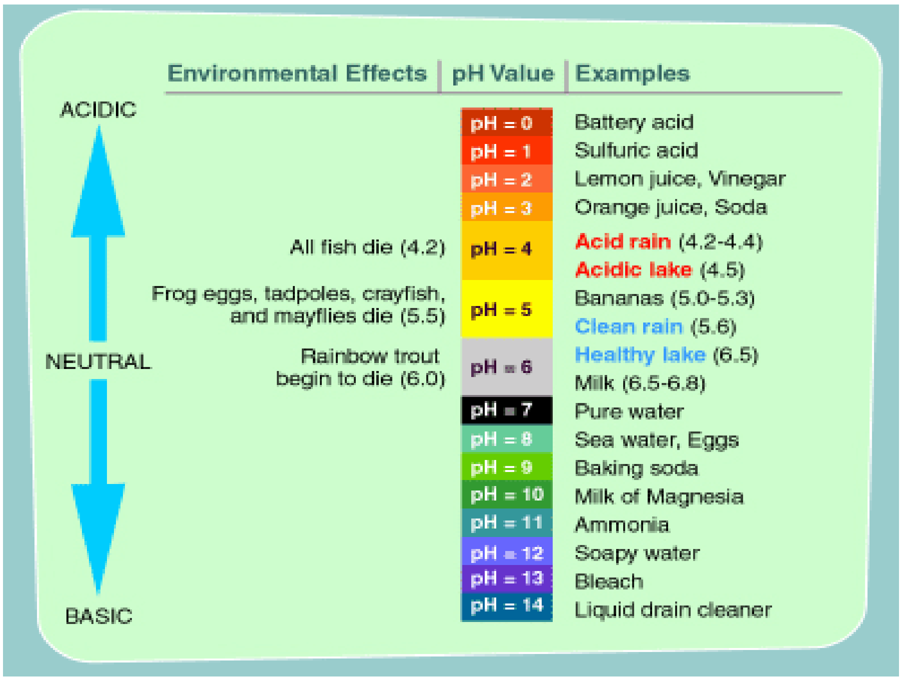

Fig.3 Effect of pH on Environment

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Parameter 2 - Turbidity:-

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality. Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand (the settable solids), very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid.

Fig.4 Turbidity at Different Levels

Causes-Turbidity in open water may be caused by growth of phytoplankton. Human activities that disturb land, such as construction, can lead to high sediment levels entering water bodies during rain storms due to storm water runoff. Areas prone to high bank erosion rates as well as urbanized areas also contribute large amounts of turbidity to nearby waters, through storm water pollution from paved surfaces such as roads, bridges and parking lots. Certain industries such as quarrying, mining and coal recovery can generate very high levels of turbidity from colloidal rock particles. In drinking water, the higher the turbidity level, the higher the risk that people may develop diseases. This is especially problematic for immune-compromised people, because contaminants like viruses or bacteria can become attached to the suspended solid. The suspended solids interfere with water disinfection with chlorine because the particles act as shields for the virus and bacteria. Similarly, suspended solids can protect bacteria from ultraviolet (UV) sterilization of water.

Allowed turbidity in water- The WHO (World Health Organization), establishes that the turbidity of drinking water shouldn't be more than 5 NTU, and should ideally be below 1 NTU.

Procedure of test-

1. Fill the water sample to be tested in the empty test bottles marked as test sample bottles.
2. Compare the turbidity (haziness) with the (shake the bottle well before use) standards of 0 NTU, 5 NTU, 10 NTU & 25 NTU provided for comparison.
3. Interpret the results in terms of NTU.
4. Safe turbidity range- 5 NTU to 25 NTU

Parameter 3-Chloride:-

Chlorination is the process of adding the element chlorine to water as a method of water purification to make it fit for human consumption as drinking water. Water which has been treated with chlorine is effective in preventing the spread of waterborne disease. Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the chloride concentrations is variable and dependent on the chemical composition. There is no known evidence that chlorides constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/l in supplies intended for public use. In many areas of the world where water supplies are scarce, sources containing as much as 2000 mg/l are used for domestic purposes without the development of adverse effect, once the human system becomes adapted to the water. High chloride content may harm metallic pipes and structures as well as growing plants.

Shock chlorination is a process used in many swimming pools, water wells, springs, and other water sources to reduce the bacterial and algal residue in the water. Shock chlorination is performed by mixing a large amount of sodium hypochlorite, which can be in the form of a powder or a liquid such as chlorine bleach, into the water. Water that is being shock chlorinated should not be swum in or drunk until the sodium hypochlorite count in the water goes down to three ppm or less.

Requirement of Chlorination-

Chlorine, the most common disinfectant in the India, is effective in killing most pathogenic bacteria and viruses. Municipal potable water supplies are usually chlorinated to provide a residual concentration of 0.5 to 2.0 ppm. Chlorine is *not* effective in killing certain protozoans like cryptosporidium.

1-To minimize biofilm - Continuous presence of chlorine in an automated watering system will minimize biofilm.
2-To replace chlorine lost by dissipation in the municipal piping system - Oftentimes, chlorine in tap water has dissipated and is no longer present by the time it reaches the automated watering system. Low levels of chlorine are added back into the water in order to maintain low bacteria levels in the animal drinking water.
3-To combat chlorine-resistant microbes- To kill certain bacteria, such as pseudomonas aeruginosa, which are resistant to lower concentrations of chlorine, higher chlorine concentrations are needed. One pharmaceutical research facility determined through testing that they needed to chlorinate RO water to above 2 ppm to provide pseudomonas-free water.
4-To ensure adequate disinfection when pH is high - Free chlorine is most effective at a pH of 5 to 7, where HOCl is the predominant form. The effectiveness declines with increased pH. Higher chlorine concentrations may be required to ensure adequate disinfection when the pH of water is high.

Harmful effects of chlorine - Chlorine can react with naturally occurring organic compounds found in the water supply to produce compounds known as disinfection byproducts (DBPs). The most common DBPs are trihalomethanes (THMs) and halo acetic acids (HAAs). Due to the potential carcinogenicity of these compounds, drinking water regulations across the developed world require regular monitoring of the concentration of these compounds in the distribution systems of municipal water systems. The World Health Organization has stated that the "Risks to health from DBPs are extremely small in comparison with inadequate disinfection."There are also other concerns regarding chlorine, including its volatile nature which causes it to disappear too quickly from the water system, and aesthetic concerns such as taste and odors. There are two Types of chlorine used in disinfection-Liquid Chlorine and Dry Chlorine

Procedure for Test-
1. Fill the aqua check test jar with water sample upto the 10 ml mark.
2. Add one tiny spoonful of reagent CHL-A & 2 drops of reagent CHL-B.
3. Mix well.
4. Add drop by drop reagent CHL-C counting the number of drops while mixing, until the colour changes to bluish violet.

If the expected chloride of the test sample is more than 200 mg/l (ppm). Use 2.0 ml of sample for the test instead of 10 ml; perform the test as per previous method.

Safe Chlorine range-10 -200 mg/L (ppm) as chlorine & 50 -1000 mg/L (ppm) as Chloride

Parameter 4-Total Hardness:-
Hardness of water is caused by the presence of multivalent metallic cations and is largely due to calcium, Ca^{++}, and magnesium, Mg^{++} ions. Hardness is reported in terms of CaCO3. Hardness is the measure of capacity of water to react with soap, hard water requiring considerably more soap to produce lather. It is not caused by single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations.

Sources of hardness - Hardness in water is defined as concentration of multivalent cations. Multivalent cations are cations (metal ions) with a charge greater than 1+, mainly dications. These dications include Ca^{2+} and Mg^{2+}. These ions enter a water supply by leaching from minerals. Common calcium-containing minerals are calcite, ($CaCO_3$), and chalk (calcium sulphate, ($CaSO_4$). A common magnesium mineral is dolomite ($CaMg\ (CO_3)_2$), which also contains calcium. Rainwater and distilled water are soft, because they contain few ions. The following equilibrium reaction describes the formation of calcium carbonate scales:

$CaCO_3 + CO_2 + H_2O \leftrightharpoons Ca^{2+}, 2HCO3^-$

Thus, CO_2, which occurs in air, can solubilize calcium carbonate. Calcium and magnesium ions can be removed by water softeners.

Health considerations- The low and high value of Hardness has advantages and disadvantages. Absolutely soft water are tasteless. On the other hand, hardness upto 600 mg/L can be relished if got acclimatized to. Moderately hard water is preferred to soft water for irrigation purposes. Absolutely soft water are corrosive and dissolve the metals. More cases of cardiovascular diseases are reported in soft water areas. Hard water is useful to growth of children due to presence of calcium

Measurement-

Soft:	0–60 mg/L
Moderately hard:	61–120 mg/L
Hard:	121–180 mg/L
Very hard:	>181 mg/L

Procedure for Test-
1. Fill the aqua check test jar with water sample up to the 10 ml mark.
2. Add one spoonful of powder reagent TH-A with the tiny spoon provided.
3. Mix well to dissolve the powder completely.
4. Add 4-5 drops of reagent TH-B and mix well.

Observation-
Observe change in colour of solution.
Solution turn to Blue: SOFT
Solution turn to red: HARD

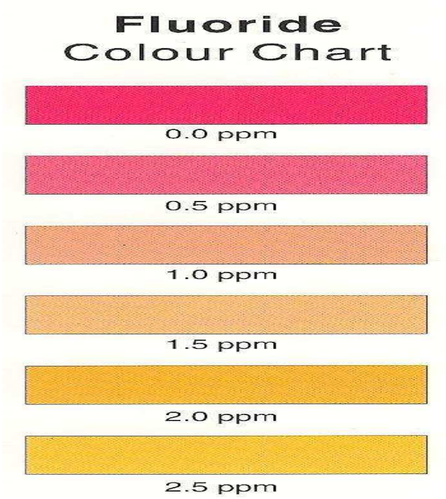
Checking level of hardness- Add drop by drop reagent TH-C, counting the number of drops while mixing, until the colour changes from red to blue. Now apply the formula given below.

Safe total hardness range-25 -600 mg/L (ppm) as $CaCo_3$

Parameter 5- Fluoride:-
Traces of fluorides are present in many waters. Higher concentrations are often associated with underground sources. In seawater, a total fluoride concentration of 1.3 mg/l has been reported. In groundwater, fluoride concentrations vary with the type of rock that the water flows through but do not usually exceed 10 mg/l. Presence of large amounts of fluoride is associated with dental and skeletal fluorosis (1.5 mg/l) and inadequate amounts with dental caries (< 1 mg/l).

Health considerations- When children are young and their teeth are still forming, fluoride makes tooth enamel harder and more resistant to decay. Although low levels of fluoride are beneficial, excessive amounts can be harmful. Excessive fluoride in drinking water may produce fluorosis (mottling of teeth), which increases as the optimum level of fluoride is exceeded. Dental fluorosis appears during tooth formation and is caused by excessive fluoride ingestion, which leads to enamel protein retention, hypomineralization of the dental enamel and dentin and disruption of crystal formation using acid.

Procedure for Test-
1. Fill the aqua check test jar with water sample upto the 10 ml mark.
2. Add 3 drops of reagent FL-A .mix the contents well.
3. Now add 8 drops of reagent FL-B. Mix the contents and allow to stand for 2-5 minutes.
4. Match the correct colour and read the mg/L (ppm) Fluoride from the colour chart.



Safe Flouride range- 0.0 -2.0 mg/L (ppm) as Flouride

Parameter 6-Nitrate Test:-

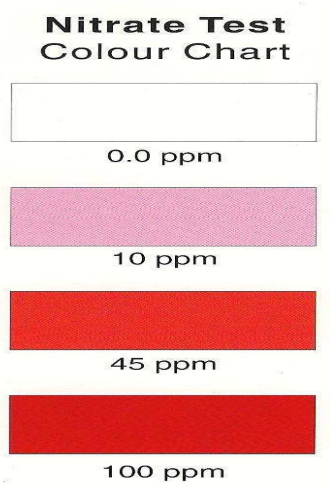
Drinking water high in nitrate is potentially harmful to human and animal health. Nitrate (NO3) is a naturally occurring form of nitrogen (N) which is very mobile in water. It is essential for plant growth and is often added to soil to improve productivity. Water moving down through soil after rainfall or irrigation carries dissolved nitrate with it to ground water. In this way, nitrate enters the water supplies of many homeowners who use wells or springs.

Health consideration: - High nitrate levels in water can cause methemoglobinemia or blue baby syndrome, a condition found especially in infants less than six months. The stomach acid of an infant is not as strong as in older children and adults. This causes an increase in bacteria that can readily convert nitrate to nitrite (NO_2). Do not let infants drink water that exceeds 10 mg/l NO_3-N. This includes formula preparation. Nitrite is absorbed in the blood, and hemoglobin (the oxygen-carrying component of blood) is converted to methemoglobin. Methemoglobin does not carry oxygen efficiently. This results in a reduced oxygen supply to vital tissues such as the brain. Methemoglobin in infant blood cannot change back to hemoglobin, which normally occurs in adults. Severe methemoglobinemia can result in brain damage and death.

Pregnant women, adults with reduced stomach acidity, and people deficient in the enzyme that changes methemoglobin back to normal hemoglobin are all susceptible to nitrite-induced methemoglobinemia. The most obvious symptom of methemoglobinemia is a bluish color of the skin, particularly around the eyes and mouth. Other symptoms include headache, dizziness, weakness or difficulty in breathing. Take babies with the above symptoms to the hospital emergency room immediately. If recognized in time, methemoglobinemia is treated easily with an injection of methylene blue.

Procedure for Test-

1. Take 1.0 ml of water sample in aqua test jar provided.
2. Now add one spoonful of reagent N-A and 5 drops of reagent N-B .Add 1 spoonful of reagent N-C shake well. Wait for 5 minutes to allow maximum color development.
3. Dilute to 10 ml marked with DM water.
4. Nitrate= mg/L (ppm) value obtained by standard colour comparison.



Safe Nitrate range- 0.0 -100.0 mg/L (ppm) As Nitrate

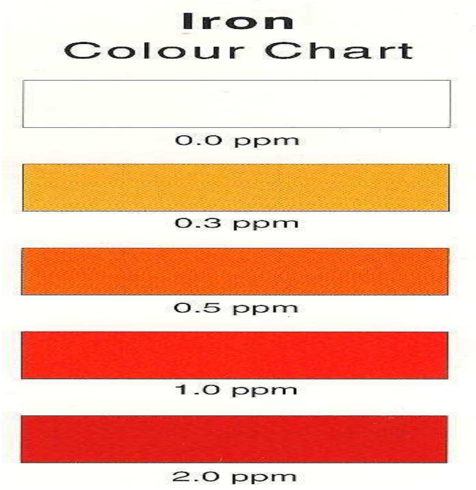
Parameter 7- Iron:-
Anaerobic ground waters may contain iron II at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. Taste is not usually noticeable at iron concentrations below 0.3 mg/l, although turbidity and colour may develop in piped systems at levels above 0.05 to 0.1 mg/l. Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, physiological status, sex and iron bio-availability and range from about 10 to 50 mg/day. Although iron has got little concern as a health hazard but is still considered as a nuisance in excessive quantities. Long time consumption of drinking water with a high concentration of iron can lead to liver diseases (hemosiderosis). Iron also promotes the growth of iron-bacteria. This gives a rusty appearance to the waters. Colonies of these bacteria may also form a slime which causes problems in water closets, pipes, pumps and distribution system. Iron is generally divided into two main categories:

1) **Soluble** or
"Clear water" iron, is the most common form and the one that creates the most complaints by water users. This type of iron is identified after you've poured a glass, of cold clear water. If allowed to stand for a few minutes, reddish brown particles will appear in the glass and eventually settle to the bottom.

2) **Insoluble**
When insoluble iron or "red water" iron is poured into a glass, it appears rusty or has a red or yellow color. Although not very common in Wisconsin's water wells, insoluble iron can create serious taste and appearance problems for the water user.

Health consideration: - Iron is not considered hazardous to health. In fact, iron is essential for good health because it transports oxygen in your blood. In the United States, most tap water probably supplies less than 5 percent of the dietary requirement for iron. High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items. Water with high concentration of the iron when used in preparation of tea and coffee, interacts with tanning giving a black inky appearance with a metallic taste. Coffee may even become unpalatable at concentration of iron more than 1 mg/L.

Procedure for Test-
1. Take 5 ml of test water sample in aqua check test jar provided.
2. Add 1 spoonful of reagent Fe-A and 1 spoonful or reagent Fe-B.
3. Mix the contents thoroughly by swirling .Allow to stand for 5 min.
4. Dissolved Iron= mg/L (ppm) value obtained by standard colour comparison.



Safe Iron range-0.0 2.0 mg/l (ppm) as Iron

Parameter 8- Residual (Free) Chlorine:-
Chlorine is a relatively cheap and readily available chemical that, when dissolved in clear water in sufficient quantities, will destroy most disease causing organisms without being a danger to people. The chlorine, however, is used up as organisms are destroyed. If enough chlorine is added, there will be some left in the water after all the organisms have been destroyed, this is called free chlorine. Free chlorine will remain in the water until it is either lost to the outside world or used up destroying new contamination. Therefore, if we test water and find that there is still some free chlorine left, it proves that most dangerous organisms in the water have been removed and it is safe to drink. We call this measuring the chlorine residual. Measuring the chlorine residual in a water supply is a simple but important method of checking that the water that is being delivered is safe to drink

When and where to test water

- The most common place to use chlorine as a disinfectant is in a piped water supply. Regular chlorination of other water supplies is difficult and usually reserved for disinfection after repair and maintenance. The chlorine residual is usually tested at the following points:
- Just after the chlorine has been added to the water to check that the chlorination process is working.
- At the outlet of the consumer nearest to the chlorination point to check that residual chlorine levels are within acceptable levels (between 0.5 and 0.2 mg/l).
- At the furthest points in the network where residual chlorine levels are likely to be at there lowest. If chlorine levels are found to be below 0.2 mg/l it might be necessary to add more chlorine at an intermediate point in the network.

Procedure for Test-
1. Fill the aqua check test jar with water sample upto the 10 ml mark.
2. Add 4-5 drops of reagent RCL-A and shake well
3. Add two drops of reagent RCL-B. Mix well.

Checking level of Chlorine - Add drop by drop reagent RCL-C counting the number of drops while mixing, until the blue colour disappears. Now apply the formula given below;

Observation-
Observe change in colour of solution.
Solution turns blue: Free chlorine present
No blue colour : chlorine is absent

Safe residual Chlorine range-0.1 -3.0 mg/L as Chlorine

RESULTS AND CONCLUSION

All the collected samples were analyzed for following eight parameters.

PARAMETERS	BUS STAND				
	Sample I[st]	Sample II[nd]	Sample III[rd]	Sample IV[th]	Sample V[th]
1.pH	7.71	7.71	7.71	7.82	7.71
2. Turbidity	10 NTU	10 NTU	10NTU	25 NTU	10 NTU
3. Chloride	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm
4. Total hardness	325 mg/L	325 mg/L	350mg/L	350 mg/L	325 mg/L
5.Flouride	0.5 mg/L	0.5 mg/L	0.5 mg/L	0.5 mg/L	0.5 mg/L
6. Nitrate	45mg/L	45 mg/L	45mg/L	45 mg/L	45mg/L
7.Iron	0.3 mg/L	0.3 mg/L	0.3 mg/L	03 mg/L	0.3 mg/L
8.Residual (free) chlorine	Cl absent	Cl absent	Cl absent	Cl absent	Cl absent

In total, we analyzed 37 samples of water with 8 parameters identified by octo aqua test kit from different regions of Gwalior. Out of 37 sample of water, 27 samples of water have all analyzed parameters with in desirable limit & water can be used for drinking. However 10 samples of water have some parameters more than desirable limit but still within permissible limit. There are no any samples of water with parameters more than permissible level.

It is suggested that in public places like bus stand, railway station, etc regular monitoring is required because these are highly populated area and hence can affect the health of local public of Gwalior region. For domestic utility, primary treatment on water is an essential step to be taken. It can be an alternative to use other water resources in period of water shortage in the region. But treatment on discharge water is an essential aspect for the above purpose. The results obtained from the present investigation shall be useful in future management of water reservoir.

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