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CHEMICAL ANALYSIS OF WATER POLUUTANTS IN AGRA –UTTAR PRADESH

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Abstract

Water is the most precious natural resource in the world since without it life can not exist. It is possible to survive without food for many days, but living without water even for a single day may have fatal consequences. The diverse uses of water are for the purposes of drinking, cooking, washing, bathing, gardening, irrigation, industry and a lot of other uses. The quality of the water is of vital concern for man since it is directly linked to human health. Drinking water quality is a matter of much concern as it is directly related to public health. A water sample having high turbidity, color, objectionable taste and odor is normally rejected for drinking purpose.. It also should be free from pathogenic microorganisms and chemical substances that are hazardous to human health. Water pollutants, their classification and adverse effects on human health and welfare as well as on aquatic organisms, along with pollution of groundwater and other fresh water systems are enlightened. The quality of water from the ring wells at AGRA was found to be unfit from portability consideration with respect to the concentrations of iron. Lead, was observed to be present in about 50% of the ring wells at higher concentration levels compared to the WHO's limit. The quality of ring well water was not found to be degraded with respect to the concentrations of copper, zinc and chromium. But the quality of ring well water was not found to be fit for drinking by their nickel contents.The hardness values of the supply water were recorded at similar ranges to that of tube well and ring well water. The concentrations of anions viz. chloride, sulphate, nitrate and fluoride, and that of the cations of sodium and potassium were found to be quite low relative to the guideline values for drinking water.

Keywords: *Pollutants, Chemical Contamination, Toxic Chemicals, Drinking water.*

Relevance of Study: Chemical contamination of drinking water, either naturally or by anthropogenic sources, is a matter of serious concern as the toxic chemicals do not show acute health effects unless they enter into the body in appreciable amounts, but they behave

as cumulative poisons showing the adverse health effects after a long period of exposure. The unbridled increase in the use of hundreds of new and structurally complex synthetic compounds in the fields of industry and agriculture has added many potentially toxic chemical substances in the aquatic environment such as asbestos, cyanides, nitrites, nitrates, fluorides, lead, nickel, cadmium, mercury, selenium, beryllium, barium, silver etc. of the inorganic constituents and pesticides, polynuclear aromatic hydrocarbons, halogenated hydrocarbons, phenols etc. amongst the organic chemicals. These materials are mutagenic, teratogenic as well as carcinogenic. Some

quality parameters such as colour, dissolved oxygen, pH, taste, odour, temperature , dissolved solids, turbidity, which influence or reflect the water chemistry, as well as some chemical constituents such as zinc, copper, iron, manganese, sulphate, hydrogen sulphide etc., although non-toxic, interfere with the aesthetic and organoleptic quality of water. Of the potentially harmful substances some appear to have a threshold effect in that, provided the concentrations lies below some critical level, no harm is caused Other contaminants appear not to have such level, so that any intake is potentially harmful, which is particularly true for carcinogens. It is, therefore, of utmost importance to determine the quality of drinking water with respect to all of its constituents and to take proper remedial measures, if required, to ensure the quality criteria formulated by various regulating bodies.

Aims and objectives

The objectives formulated for the study of drinking water quality in the district of Goalpara (Assam) are-

1. To determine the quality of water from various drinking water sources with respect to the physico-chemical characteristics and environmentally important metallic constituents.
2. To identify the possible sources of the parameters which are found at appreciable concentration levels.
3. To correlate, if possible, the principal contaminants with the water borne ailments and health hazards in the district,
4. To determine the ion equivalents and ion-balance along with statistical correlations among various parameters.

DISCUSSION & RESULTS

The surface of the earth measures 50,000 million hectares in area, 20% of this area is land and the remaining 80% is all covered by water. Thus, water is the most abundant as well as vital resource on the earth . The world's total water resources are estimated at 1.37 x I0K million ha-m. Of this, about 97 2% is saltwater mainly in seas and oceans and not suitable for drinking , irrigation and industrial uses. Only 2.8% is available as freshwater at any time on the planet of earth. Out of this 2.8%, about 2.2% is available as surface water and 0.6% as groundwater. Again, of the 2.2% surfacewater, 2.15% is locked in the icecaps and glaciers and only of the order of 0.01% (1.36 x 104 M ha-m) is available in lakes and reservoirs, and 0.0001% in streams ; the remaining being in other forms - 0.001% as vapour in the atmosphere, 0.002% as soil moisture in the top 0,6 m. Out of 0.6% groundwater, only about 0.3% (41.1 x 104 M ha-m) can be economically extracted with present drilling technologies, the remaining being unavailable as it is located below a depth of 800m The earth receives nearly 500,000 Kin' of precipitation in every year. Of this, only 110, OOOKm3 falls on land and 65% of it is lost by evaporation and transpiration. A part of the remaining 35% fills in rivers, lakes, ponds, wetlands and reservoirs and the rest enters the ground and is stored in the aquifers (World Resources, 2017-18)

Water pollution can generally be defined as the presence of materials in water which interfere unreasonably with one or more beneficial uses of it (Lamb, 2015). AH natural waters contain a variety of contaminants arising from erosion, leaching, and weathering processes. The foreign constituents may be catagorised as given below(Chandra, R., 2016):

(i) Water is an universal solvent. Therefore, a large number of minerals , which remain as positive and negative ions, get dissolved in water. Toxic metal ions like those of copper, cadmium, mercury and lead are important positive ions. Many oxygen containing organic compounds such as alcohols, sugars, and acids also go into water solution. The organic and inorganic, which are normally considered insoluble, can remain dissolved in trace amounts that may be significant to impose undesirable properties to water.

(ii) Some particles, whose settling rates are extremely low, may remain in water as suspended solids.

(iii) Living organisms metabolized nutrient matters in water producing waste products that remain in water as contaminants

(iv) Some insoluble materials, particularly metals , react with water to form soluble products.
(v) A large number of pathogenic microorganisms remain indefinitely in water, which are contaminants and whose ceaseless motion prevents settling
(vi) Some dissolved substances react with other insoluble substances bringing them into solution. Many minerals arc converted to soluble forms by acids in water3).
(vii) Water may carry a large number of floating matters, e g. oil spill, which are water contaminants.

Ground water pollution

As water percolates through soil and rocks, their filtering action is normally sufficient to remove suspended impurities from contaminated infiltration flows. However , excessive suspended solids can accumulate in the pores and thus eventually block the aquifers , preventing further recharge. Soluble impurities may be removed by the ion-exchange properties of some soils and rocks (Garg D.K., 2015). Nevertheless , groundwater pollution is a reality in most part of the world . The benefits of the precious groundwater reservoirs are being reduced by both inorganic and organic contaminants from different sources. Some of the common causes of groundwater pollution are -

1. from the water soluble products that are placed on land surface and streams ,
2. from the substances that are deposited or stored in the ground .
3. from the disposal, storage and extraction of materials. (Jain P.K. 2016)

The peculiarity about groundwater pollution is that many of the purifying processes like dilution, biochemical degradation etc., which are important in surface water, are absent in ground water.

Water pollutants

A pollutant may be defined as a chemical (a nutrient, radioactive substance, an organic compound) or a geochemical substance (soil particles); a physical parameter like heat or microorganism which is put to an ecosystem or environment with actual or potential , adverse or harmful, unpleasant and inconvenient effects (Trivedi., 2017), They behave in different ways when added to water . Non-conservative pollutants, which include principally organics, some inorganic and many microorganisms, are degraded by natural self - purification processes, so that their concentrations reduce with time. The degradation rate of a non-conservative pollutant is a function of particular pollutant, the quality of receiving water

, temperature, and other environmental factors . But the existing natural processes cannot affect many inorganic pollutants. These are conservative pollutants and their concentrations in the aquatic environment may be reduced by dilution. These pollutants often unaffected by normal water and wastewater treatment processes. Therefore, their presence in a particular water body may impose limitations on its uses (D.K. Saini , 1998). Some of the important adverse effects of water pollutants are (i) loss of aesthetic and recreational value' of water, (ii) spread of diseases, (iii) deterioration of taste, (iv) undesirable effects on aquatic life , (v) loss of aquatic production such as fish and prawn, (vi) corrosion of structures, (vii) adverse effects on industrial use of water especially in food, paper and textile industries, (viii) deterioration of agricultural fields due to irrigation by polluted water, (ix) accumulation of toxic substances in aquatic, ecosystem and ultimately in man, (x) adverse effect on availability of safe, clear water and (xi) long term physiological and social impacts (Trivedy *et al.* 1987).

The water pollutants can he categoiized into the following major types-

1. Oxygen demanding wastes,
2. Disease - causing agents,
3. Synthetic organic compounds,
4. Plant nutrients,
5. Inorganic chemicals and mineral substances,
6. Suspended solids,
7. Radioactive wastes,
8. Thermal discharges.

Drinking water quality

Waters vary widely in their characteristics and therefore it is not desirable to give specifications for what might be termed as “normal” samples. An way of appreciating the significance of water quality parameters is to consider the various standards and guidelines which are used to specify water quality for various uses. In the case of potable water it is accepted practice to use guidelines or standards which are based on an assessment of the importance of a particular parameter or a group of parameters. The water quality parameters can be grouped as (Tebbutt, 2018)- Organoleptic parameters . These parameters are readily observable but have little health significance. Typical examples of this group are colour,

suspended matter, taste and odour . Guidelines for these parameters are generally set on the basis of aesthetic considerations.

Natural physico-chemical parameters: This group includes normal quality parameters such as pH, conductivity, dissolved solids, alkalinity, hardness, dissolved oxygen, etc. Some of these have limited health significance, but generally the guidelines are intended to ensure chemically balanced water. 3. Undesirable substances in excessive amounts A wide variety of substances belong to this group, some of which may be directly harmful at high concentrations, some may produce undesirable tastes and odours, and others may not be directly harmful in themselves but indicators of pollution. Chloride, tluoride, iron, manganese, nitrate, phenol and total organic carbon are constituents of this group. Guideline levels of these substances are based either on consumer acceptability or their significance in relation to other factors.

Toxic substances: A considerable number of inorganics and organics such as arsenic, cyanides, lead, mercury, organophosphorus compounds, pesticides and trihalomethanes are included in this group. The severity of the toxic effects of a particular substance on consumers of water containing it depends on the dose received, the period –of consumption and other dietary and environmental factors . Since the main concern in drinking water is with the long-term effects of exposure to low levels of potentially toxic materials, it is not easy to set limits on a scientific basis.

Microbiological parameters: These are most important parameters in determining safety of drinking water, standards of which are based on the need to ensure the absence of bacteria, indicative of pollution by human wastes.

Thus the acceptibility of a water sample cannot be evaluated by mere senses such as the appearance, taste or the odour of the sample. No sample can be considered as safe if it is not subjected to rigorous tests The guideline values of the parameters for drinking water have been prescribed by the World Health Organization and other quality regulating bodies. The guidelines or standards have been set out ensuring aesthetically pleasant water without any significant risk to human health (WHO, 2014; 2015)

Problems related to drinking water quality

The natural aquatic ecosystem may be polluted by a large number of pollutants from various sources, a broad outline of which has already been given. Complex physiochemical

processes involving the pollutants and other constituents of water continuously alter the water quality When natural water flows over soil surface, soluble constituents of soil get dissolved in water and sediment particles entrained in it making water turbid. A long residence time of the surface run-off causes a large number of soil-water adsoiption and ion-exchange reactions affecting the quality of receiving water. Municipal wastewater, infiltrated with sewage water often cause bacterial pollution of the water sources. Wastewater from bathrooms, sinks, washbasins, etc. also contains high concentration of aerobic heterotropic microorganisms and colifrom bacteria. Water can serve as an efficient transmitter of human pathogenic microoganisms which are of sewage origin Domestic sewage carries from I to 100 enteric viruses per ml., of more than 60 types, all of which are considered to be pathogenic to man. Metals in aquatic ecosystem can exist in soluble (as free metal ions and as organic and inorganic complexes), colloidal dispersion and suspended particulates (either directly or as adsorbed species) states. In colloidal and particulate forms they may be accumulated in the bottom sediments. However, the metals may be re-released from the sediments depending upon the physiochemical conditions such as pH and oxidation potential, and also various biotic factors Surface water invariably contains lead, which is one of the most important metals of environmental concern Lead finds its pathway to surface water from road run-off and atmospheric washout processes. This metal originates in organic tetra alkyl compounds used as antiknock additives for gasoline. Besides lead, the presence of other heavy metals in road run-off assimilated water bodies has been reported.

Collection of the samples: Water samples were collected in polythene containers of 5 lit. capacity Before use, the containers were cleaned with chromic acid solution, rinsed several times with distilled water and then dried thoroughly. The containers were filled up to the mouths and packed tightly to prevent agitation during transportation and to minimize contact with air. The sources of water that were used for sample collection were ring wells, tube wells, municipal supply points, rivers and ponds of District Agra, UP. Sampling sources of the same location of a sampling station were used for sample collection. Samples from a pond were obtained by mixing water collected from various parts around its boundary.

Water quality parameters selected for this study

The parameters selected for the present investigation are-

1. Physical parameters : Temperature, Colour, pll. Conductance, Hardness, Total Dissolved Solids (I DS), Total Suspended Solids (TSS), Total Solids (I S)
2. Major anions : Chloride, Sulphate, Bicarbonate, Nitrate, Phosphate, Fluoride.
3. Major cations : Sodium, Potassium, Calcium, Magnesium, Iron.
4. Trace metals : Copper, Zinc, Lead, Nickel, Chromium.

Hardness

Hardness of the water samples were determined by ED T A titrimetric method, using Eriochrome Black-T as an indicator. The expression for hardness is.

$$\textbf{Hardness (as mg/l,CaC03)} = \frac{\textbf{ml.of EDTA used X1000}}{\textbf{ml. of sample}}$$

Hardness is the property of water which prevents lather formation with soap and produces scale in hot water systems. It is caused by polyvalent metallic ions, particularly that of calcium and magnesium, along with some contributions of other metals such as iron, strontium and manganese, if present in appreciable amounts The principal sources of the two major cations viz. calcium and magnesium ions, responsible for causing hardness, are sedimentary rocks, seepage and run-off of soils. Groundwater is more hard than surface water because of higher solubilizing potential of groundwater over surface water towards soils or rocks containing minerals calcite, dolomite and gypsum. Industrial and industrially related sources of calcium and magnesium include the inorganic chemical industries and discharges from operating and abandoned mines.

Solids

To determine the total dissolved solids (TDS) in an water sample, 50 ml of the filtered sample was taken in a pre-weighted borosil beaker and evaporated to dryness in a water bath. The beaker with the residue was then kept in an oven at 105-105° C temperature until a constant weight was shown by the beaker The IDS was calculated as-

$$\textbf{TDS mg/l} = \frac{(W_2\text{-}W_1)\text{x}1000}{V}$$

Where, W_1 = Initial weight of the beaker.

W_2 = Final weight of the beaker.

V = Volume of the sample taken (in ml).

To determine the total solids (TS) in the samples, the same procedure as that of TDS was followed, but with unfiltered sample

Results

The quality of water from the ring wells at AGRA,UP was found to be unfit from portability consideration with respect to the concentrations of iron. Lead, was observed to be present in about 50% of the ring wells at higher concentration levels compared to the WHO's limit. The quality of ring well water was not found to be degraded with respect to the concentrations of copper, zinc and chromium. But the quality of ring well water was not found to be fit for drinking by their nickel contents.The hardness values of the supply water were recorded at similar ranges to that of tube well and ring well water. The concentrations of anions viz. chloride, sulphate, nitrate and fluoride, and that of the cations of sodium and potassium were found to be quite low relative to the guideline values for drinking water. But average phosphate loads of the supply water were found to be a matter of concern from potability point of view as they were observed to lie above the stipulated limit. The concentrations of iron were also recorded at higher levels compared to the guideline value of 0.3 mg/1. Regarding the trace metals viz. zinc, copper and chromium, their concentrations did not exceed the guideline limits. But lead and nickel contents of supply water were recorded at higher concentration levels compared to that which should be normally present in drinking water.

The concentrations of the anions, chloride and sulphate and that of the cations viz. sodium and potassium were not recognized to be responsible for degrading river water quality for drinking purpose. But, the concentrations of nitrate and phosphate in river water were observed to be sufficiently high to affect the pot-ability . The iron concentrations were also recorded at higher levels than the stipulated limit for drinking water. Regarding copper and zinc, the river water conforms to standards, but the concentrations of lead were recorded at higher levels than the guideline value. Not only the lead contents, but the concentrations of nickel and chromium were also found to be higher in the water of the river Yamuna.

This study shows that the drinking water scenario in the district Agra is not satisfactory, there are a number of co-related factors contributing substantially to the overall health situation. A few of these factors are unhygienic conditions, improper sanitation practices, absence of scientific drainage system, presence of stagnant water, improper water management etc. These, along with water quality, play major roles in spread, recurrence and fatal consequences of various diseases. Moreover, the microbiological status of the drinking water sources in the district Agra, is yet to be determined. Thorough study on these factors is a potent field for further work.

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