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Physico-chemical analysis of drinking water samples collected from Shimlapuri in Ludhiana city

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Abstract
Ludhiana city is Manchester of India. It is famous for the manufacturing of cycles, sewing machines, woollen auto spare parts and many other tools. It is facing severe danger because all the industrial waste is getting mixed with ground water. An attempt was made to analyse the various physico-chemical parameters (pH, TDS, Hardness, carbonate, bicarbonate, nitrate, sodium, boron, calcium, alkalinity etc.) of the different ground water samples (hand pump, submersible and Municipal committee) collected from the Shimlapuri of Ludhiana city. The results were compared with the standard recommendations of Bureau of Indian standard, Indian council of Medical Research and WHO.

Keywords: physico-chemical, ground water, PH, TDS, hardness, alkalinity

Introduction
Water is essential to sustain life. Drinking water is an important constituent for all types of living beings. Groundwater is one of the most valuable natural resources due to rapid increase of population, rapid industrialisation, unplanned urbanisation and too much use of fertilisers and pesticides in agriculture [1]. Groundwater is a valuable dynamic and replenishes able natural resource in present day and limited in extent. In many developing countries agricultural chemical use has been low in comparison to levels in industrial countries [2]. Concerns over ground water pollution from agriculture chemicals were raised as a major issue in the study area more than ten years ago [3]. Water is an integral part of the environment and its ability is indispensable to the efficient functioning of the biosphere. Drinking water comes from surface and ground water. Large scale water supply system tends to relay on surface water resources and smaller water system tends to use ground water which has become highly contaminated by the addition of undesirable substances making it unfit and toxic for various purposes especially for drinking. Many incidents of consumption of contaminated water have been reported in Punjab. The water in quality guidelines provide a Limit Value for each parameter for drinking water. It is necessary that the quality of drinking water should be checked at regular time interval. Punam *et al*. revealed that physio-chemical parameters studied for the drinking water samples showed considerable agreement with the standard guidelines for drinking water set by national and international agencies [4], whereas Bansal *et al*. reported that in Aligarh the concentration of heavy metals was higher in domestic than in irrigation wells and decreases with increased depth of the well [5]. Perceived poor water quality influences the use of water, thus creating potentials of health risks through the development of unsafe alternative sources [6].

Water which is used by human for drinking purpose must be free from living and non-living organisms, toxic elements and chemical substances in concentration large enough to affect health. The addition of various kinds of pollutants through sewage, industrial effluents, agricultural runoff, etc., into the water main stream brings about a series of changes in the physicochemical characteristics of the water, which have been the subject of several investigations [7]. Also human activities are a major factor that determines the quality of surface waters directly and indirectly by atmospheric pollution, effluent discharges and agricultural practice [8]. Hence, water, which infiltrates through the soil and accumulates in underground aquifers and this water have had lengthy exposure to calcium carbonate and sulphate are typically hard and alkaline [9].

Most of the chemicals found in drinking water sources may be the cause of adverse human health effects, affect the acceptability of water and lower the effectiveness of water treatment.

The severity of this health effect depends upon the chemical; and its concentration, as well as the length of exposure. There are only a few chemicals that can lead to health problems after a single exposure, except through massive accidental contamination of a drinking water supply [10]. The main problems associated with chemical components of drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure, especially in the developing countries can be traced to lack of safe and wholesome water supply [11]. On the other hand, some chemicals in drinking water could be beneficial for health depending on its concentration, and total amount ingested. And yet, there is some evidence that if the concentration of sodium exceeds from the recommended amount, it may cause to increase blood pressure [12]. Though recent findings suggest that high sodium intake could result in high blood pressure (hypertension) that causes cardiovascular disease, stroke, and coronary heart disease, and mortality. Reducing salt intake lowers blood pressure and also reduces the incidence of cardiovascular diseases [13, 14]. So, Shimlapuri needs to have safe and adequate water supply at all levels to protect public health in both intra and inter generations.

Apart from this, it is important to recognise that nitrate and other nutrient pollution in ground water is often related to agricultural practices other than the use of the chemical fertilisers [2]. In the present research paper, the major water quality parameters analyzed are pH, Odour, Colour, Taste, Temperature, Total Dissolved Solids (TDS), concentration of Metals, Total Hardness, Alkalinity, Chlorides, Fluorides, Nitrates, Carbonates, Bicarbonates and Sulphates. pH represents the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health, however a lower value below 4 will produce sour taste, higher value above 8.5 gives an alkaline taste [15] TDS is the term used to describe the inorganic salts and trace amount of organic matter present in the water. The Calcium, Magnesium and Sodium are essential minerals for various metabolic functions in the body. Epidemiologic and clinical studies suggest that magnesium may reduce the frequency of sudden death that sodium contributes to the occurrence of hypertension and that calcium may help prevent osteoporosis [16]. The water samples (47 samples) were collected preferably from ground water sources keeping in mind the depth of ground water i.e. Hand pump (80-100 feet deep, 30 samples), Submersible (100-250 feet deep, 12 samples) and Tap water (Municipal Committee, more than 250 feet deep, 5 samples) from Shimlapuri of Ludhiana city.

Sample Collection

The present research was done by collecting drinking water samples from the Shimlapuri of Ludhiana city. The water samples were collected sufficiently (one litre) in polyethylene bottles, which were thoroughly rinsed out two to three times with the water before final collection of the water sample. All the sample bottles were carefully sealed with aluminium foil to prevent the cross contamination of the water sample. The water samples were then preserved in the lab. at 8^{o} c. The colour, taste, temperature, odour and T D S of water were noted immediately after the collection and the other parameters were analyzed in the laboratory.

Results and Discussion

Various physic-chemical parameters analyzed for the different water samples are tabulated in Table 1 and 2. As far as the physical parameters like colour, odour and taste are concerned, all water samples had agreeable taste and unobjectionable smell and taste. Only a few samples of hand pump carried some milky appearance with salty taste and chemical like smell. The temperature of samples of hand pump, submersible and tap water was 1^{o}, $2\text{-}3^{0}$ and $5\text{-}6^{0}$ F respectively. pH of all the water samples of all the treatments was lying between 6.4 – 8.3. This particular range was in agreement with the Indian and World Health Organization (WHO) recommendations. pH of the drinking water of municipal committee indicated that the water is healthy for human use. Total dissolved solids in the hand pump samples (2031 mg/L) was exceeding the standard limit (500 mg/L, WHO), however TDS of submersible (282 mg/L) and tap water (91mg/L) were in agreement with recommended

Table 1: Physico-chemical parameters (Mean values) of various water samples.

Physico-chemical Parameters	Samples of Hand Pump	Samples of Submersible	Samples of Tap Water	Standard Recommendation
Colour	Milky	Colourless	Colourless	5 Hazen Unit
Taste	Salty, Alkali	Agreeable	Agreeable	Agreeable
Odour	Chemical like	Unobjectionable	Unobjectionable	Unobjectionable
Temperature (in ^{0} F)	1	2-3	5-6	Not Specific
pH	8.26	7.03	6.4	6.5-8.5
Hardness(mg/L)	820	305	63	300
TDS (mg/L)	2031	282	91	500
Alkalinity (mg/L)	816	319	129	200

Value (500mg/L). Hardness, carbonate, bicarbonate and calcium contents of submersible and tap water samples are agreeable but that of hand pump are very high. Calcium is one of the principal cation associated with hardness of drinking water. The hardness of water can range from 75 mg/L (soft water) to more than 300 mg/L (hard water) as $CaCO_3$ the possible reason for the very high concentration of these ions in hand pump is rapid development of industry and fertilizers that can lead to leaching of minerals in the ground water tables. Mean alkalinity values (129 mg/L) of municipal committee water samples was not objectionable, whereas the water of hand pump (816 mg/L) and submersible (319mg/L) was highly alkaline. High alkalinity of these may be due to the presence of high concentration of carbonate and bicarbonates. Sulphate (70 mg/L) and Chloride (205 mg/L)

Table 2: Concentration (Mean Value) of metals and nonmetals in various water samples.

Water Quality Test	Samples of Hand Pump	Samples of Submersible	Samples of Tap Water	Standard Recommendation
Calcium (mg/L)	210.5	60.2	12.5	75
Carbonate(mg/L)	122	20	Absent	25

Bicarbonate(mg/L)	132	20.25	9.5	100
Sulphate (mg/L)	389	177.5	70	200
Chloride(mg/L)	1041	303.75	205	250
Fluoride (mg/L)	2.07	1.72	1.35	1.5- 1.9
Sodium (mg/L)	212.5	103.5	12.5	20
Boron (mg/L)	0.56	0.32	0.2	1.0
Nitrate (mg/L0	103	61	14.5	45

salts were also in the safe limits in tap water samples, but again these values were totally disagreed with standard recommended values for hand pump (389, 1041 mg/L respectively) and submersible (177.5, 303.75 mg/L respectively) water. Due to their excessive concentration in hand pump its taste is salty. Fluoride (1.5-1.9) and Boron (1 mg/L) were present within the range as suggested by Bureau of Indian Standard and WHO in all types of water. Nitrate (45 mg/L) and Sodium (20 mg/L) contents were also within the range suggested by WHO in tap water but samples of hand pump and submersible had high value (Table 2).

Conclusions

Physico-chemical analysis of 47 water samples was performed using appropriate techniques and the results were compared with the standard recommended values of Bureau of Indian standard and WHO and it had been concluded that the water of hand pump is not fit for the drinking purpose as only two parameters namely pH and Boron ion concentration were in the range of values given by Bureau of Indian standard and World Health Organization, all other parameters were significantly different. Whereas the water samples of submersible motors were comparatively in agreement with standard recommendations and can be used for domestic and commercial purpose. Ground water samples collected from taps (municipal Committee) shows perfect agreement with the standard recommendations of Bureau of Indian standard and hence can be used for drinking.

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