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Comparison of Physico-Chemical and Biological Characteristics of Water of Three Different Sources, River Neelum, Spring Water and Filter Plant

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Abstract: Physico-chemical and biological characteristics of water from three different sources viz. spring water, water from river Neelum and domestically installed filter water, were studied during October 2009- January 2010. Temperature (^oC) 6.82 ± 0.67, 21.8 ± 0.83, 14.17 ± 0.49, pH 7.86 ± 0.5, 7.68 ± 0.16, 7.33 ± 0.25; Dissolved oxygen (mg/l) 14.78 ± 0.6, 13.9 ± 0.2, 8.34 ± 0.17; Alkalinity (mMol/L) 1.05 ± 0.02, 2.85 ± 0.03, 0.85 ± 0.01; Chlorides (ppm), 13.9 ± 0.3, 24.8 ± 1.04, 14.5 ± 0.4; Ca^{++} (ppm), 96.2 ± 2.45, 33.9 ± 1.05, 30.4±1.3, Mg^{++} (ppm), 37.6±1.07, 29.4±0.5, 28.5±0.5. ANOVA and LSD Values were calculated and significant differences were observed among the temperature, dissolved oxygen, chloride ion, calcium ion and magnesium ion of river water, spring water and filter water. Spring water had higher concentration of chemicals and significantly differed from others two and considered as hard water. In biological characteristics, the spring water was highly contaminated as 66 bacterial colonies were counted in it which was followed by river water (11 colonies) and least colonies (5) were counted in filter water. Spring water is not suitable or safe for drinking due to its hardness and contamination.

Keywords: pH, DO, Alkalinity, Chlorides, Calcium, Biological contamination

1. INTRODUCTION

Water in nature is rarely pure in the "distilled water" sense as it contains dissolved salts, buffers, nutrients, etc., with exact concentrations dependent on local conditions. Aquatic life have evolved over millions of years to the specific water conditions in their native habitats and may be unable to survive in significantly different environments. Water quality is a growing global concern. Polluted water and inadequate sanitation kill two children every minute worldwide (Prasanna and Ranjan, 2010). Water quality is the physical, chemical and biological characteristics of water in relationship to a set of standards. The primary uses considered for such characterization are parameters which relate to drinking water, safety of human contact, and for health of ecosystem. Interest in water analysis is due to the enormous importance of water to all categories of living things. It is necessary for the healthy development of man, animals and plants (Shareef *et al*., 2009). Drinking water quality is an issue of concern for human health in developing and developed countries worldwide. The risks arise from infectious agents, toxic chemicals and radiological hazards.

Rain falling through the atmosphere may pick up substantial amount of acid constituents, precipitate of mercury, other metals, nitrogen, phosphorus and many other potential pollutants, municipal and industrial waste, these impurities in water produce diseases or malfunctioning in human (Faith, 2010). Water quality is an index of health and well being of a society (Prasanna and Ranjan, 2010).

In Pakistan, mostly, fresh water is being contaminated by raw sewage irrigation, land disposal of industrial effluent and pesticides, and this contamination poses high risk to human health (Ali *et al*., 2004). Fresh water environment are subjected to variation by the environmental factors such as temperature, dissolved oxygen, alkalinity, pH etc. These factors are responsible for distribution of organism in different fresh water; according to their adaptation which allows them to survive in that specific habitat. Each water quality factor interacts with and influences other parameters. Maintenance of phytoplankton populations at desired levels is important in any water body because algal bloom must be maintained to improve the oxygen levels. Dissolved oxygen levels depend primarily on the relative magnitudes of pH and photosynthetic oxygen generation and total plankton respiration (Ali *et al*., 2004).

Pure water is colorless, odorless and tasteless. Waters unique physical and chemical properties and its ubiquitous presence make it essential for life. On an average human being consumes about 2 liters of water every day (Naresh *et al*., 2013). Drinking water must have an acceptable taste and have an appropriate temperature and free of harmful microorganisms. To get neat and clean water for drinking purpose, people try to

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get water either from springs present nearby, use ultraviolet water purification lamps that produce the UV-C or germicidal UV radiation of much greater intensity than sunlight. Ultraviolet purification system combined with various form of filtration are capable of killing (99.9%) the microorganism such as bacteria, viruses, algae, yeast. UV water treatment does not introduce any chemical to the water. It produces no byproducts, it doesn't alter the taste, pH and others product of water (Shareef *et al*., 2009).

The basic objective of this study was to compare the physical, chemical and biological characteristics of drinking water of different source taken from river Neelum, spring water near Chella Campus and water from domestically installed UV filter plant from Muzaffarabad Azad Jammu and Kashmir and to check whether these water sources are safe for drinking or not.

2. MATERIALS AND METHODS

Collection and Analysis of water samples:

Water samples were collected weekly from October, 2009 to January, 2010 (total 16 samples) from three different sources (River Neelum, spring water and filter plant). Sampling was carried out between 9.00 am and 1.30 pm. Three liters of each water were collected from selected sites in plastic bottles. Water color, temperature, pH and dissolved oxygen were measured directly from the collected water using a digital pH meter (LCD-11- type), digital thermometers INS (-50 to + 1200^{o}C) and Oxymeter (WalkLab: 0 to 20 ppm/mg/l) respectively, and color and taste of water were checked at the time of sampling. While all other parameters like total Alkalinity, Chloride, Calcium and Magnesium ions were calculated by titration method with EDTA, silver nitrate and hydrochloric acid followed by Harper and Wolf, (2009) and Prasanna and Ranjan (2010).

Preparations of Culture Media

Nutrient agar (Oxoid CMO3), culture media was prepared by dissolving the recommended quantity of media into distilled water (Jha *et al*., 2008). In present study moist heat method (autoclaved at 121^{o}C and pressure 15 lb/in^{2}) was used to sterilize all materials, media and water collecting bottles before use.

Statistical analysis:

Data was analyzed by using Duncan's multiple range tests for ANOVA and to compare the different variables, least significant test (LSD) was applied. Standard Error of the Means was also calculated (Herv, 2010).

3. RESULTS AND DISCUSSION

1 Physico-chemical parameter:

Water's color and water

The weather and color of water did not show any change as weather remained clear and color of water also remained clear, due to less rain in these months (from October, 2009 to January, 2010). The color of the natural water result from the unabsorbed reflected light rays of the sun light. Apparent color is caused by suspended matters which interfere with light penetration (Simková *et al*., 2013).

Water Temperature (^{o}C)

The water temperature of the three different water sources had significant differences among them. The mean temperature of river water was (6.82^{o}C±0.67) which is lower than the other two water i.e. filter water (14.17^{o}C±0.49) and spring water (21.8^{o}C±0.83). According to LSD value (0.7235), a significant difference was observed in water temperatures among river water, spring water and filter water (Table 1and 2). All biological and chemical processes in an aquaculture operation are influenced by temperature. Aquatic life adjusts their body temperature and metabolic rate by water temperature. Temperature has a great effect on the availability of sulfur, phosphors, calcium and other elements. At temperatures above or below optimum, aquatic life is reduced. Mortalities may occur at extreme temperatures (Olivier, 2008).

pH

The mean values of pH during the different weeks of the three water samples i.e. spring, River Neelum and filter water were found to be 7.86±0.5; 7.68±0.16; 7.33±0.25, respectively. The pH of all the three water remained between 7.0 and 8.4 attributing neutral or slightly alkaline character. According to LSD values (0.313 at 0.05 levels), non significant differences in pH was observed among river water, filter water, and spring water (Table 1and 2). The present values of pH of all water sources were found according to the WHO (6.5–8.5) recommended values. The mean values of pH of three water samples were within WHO acceptable limit, making it marginal for irrigation and drinking purposes. Waters with pH values ranging from about 6.5 to 9.0 at day break are most suitable for fish production (Mallya *et al.*, 2007).

Dissolved Oxygen (DO)

The mean values of dissolved Oxygen during study period was higher in river water (14.78±0.6 mg/L) followed by spring water (13.9±0.2 mg/L) due to highest flow (lotic water characteristic) of water in river and spring (Rukeh, 2013). DO was significantly low in filtered water (8.34±0.17 mg/L). Dissolved oxygen showed maximum values in winter season. It may be due to temperature variations and maximum growth of aquatic plants in spring water. Dissolved oxygen showed inverse relationship with water temperature. According to LSD and ANOVA, there was a significant difference in absorbed DO (Table1 and 2). Surface

water contain large amount of DO, absorbed from the atmosphere as well as from photosynthetic activity at day time. Temperature affecting the solubility of dissolved oxygen, cold water have more oxygen than warm water. According to WHO permissible value of dissolved oxygen (8 mg/L), filter water was found to be suitable, although it was lower than rest of the others two. The presence of dissolved oxygen in H_2O is necessary to keep it fresh and sparkling but more quantity of oxygen causes corrosion of pipe materials and cause disease in fishes. For drinking purpose its permissible value is 4 to 12 mg/L (Mallya *et al*., 2007). The river water which has lowest temperature throughout study period had greater value of DO. (Ali *et al*., 2004) reported similar results. In the present study, dissolved oxygen ranged between the suitable limits of tolerance for fish growth.

Alkalinity (m Mol/ L)

During the study period the mean values of total alkalinity were estimated to be 1.05±0.02 m Mol/L, 2.85±0.03 m Mol/L, 0.85±0.01 m Mol/L of river, spring and filtered water respectively, and the average alkalinity values for different water samples were significantly different from each other (Table1 and 2). Alkalinity is a measurement of carbonate and bicarbonate ions dissolved in the water. Higher alkaline water has a higher pH and generally contains elevated level of dissolved solids. More than 20 m Mol/ L alkalinity is considered harmful for human being, fish and other aquatic fauna (Ali *et al*., 2004). The present result showed much lower concentration, reason for lower alkalinity is due to less pollution and large volume of water which dilute the effect of pollution. Total alkalinity of three different water sources was found to be lesser than WHO standard, hence these waters were potable.

Chloride ions (Cl^{-1})

The mean values of chloride ions revealed that the chloride ions concentration was higher in spring water (24.8 ± 1.04 ppm), followed by river water (14.5 ± 0.4 ppm) and filtered water (13.9 ± 0.3 ppm). The difference was significant among these water sources but spring water is significantly different from other two (Table 1 and 2). Low chloride level (0.02 ppm) can be stress the fish (Kelly *et al*., 2012).

Calcium ions Concentration (Ca^{++})

The hardness of water depends mainly on the presence of dissolved calcium and magnesium salts (Naresh *et al*., 2013). The experimental mean vales for calcium ion revealed that it was persistently higher in spring water (96.2±2.45 ppm) than the river water (33.9±1.05 ppm) and filtered water (30.4±1.3 ppm). According to LSD at 0.05 levels, a significant difference was observed among spring water, filtered water and river water (Table1 and 2).

Hardness of water is mainly due to the amount of Ca^{++} ion. In the present study, calcium ion concentration of spring water exceeded the WHO recommended value (75 mg/L). So, spring water may be considered as hard water and its value is higher than that of WHO recommended value. The hardness of water derives largely from weathering of minerals, lime stone.

Magnesium Ion Concentration (Mg^{++})

The magnesium ion concentration was higher in spring water (37.6±1.07 ppm), followed by river water (29.4±0.5 and filtered water (28.5±0.5). According to the LSD value at 0.05 level, significant difference was observed in Mg^{++} values among spring, river, and filter water, while in river water and filter water no significant difference was observed **(Table 1 and 2).** The maximum permissible value set up by WHO for magnesium is 50 mg/L. The present values for Magnesium ions fall within the range of WHO value of magnesium ion. So, these three water sources were safe for drinking.

Ionic concentration of any water is dependent on melting of glaciers, weathering of rocks and anthropogenic impact. Total of anion (Cl^- and HCO_3^{-}) must balance the total cations of the water as (Semwal, and Jangwan, 2009). Weathering of the soil and rock minerals produces higher concentration of common ions in spring water.

Growth of Bacteria:

Among bacteriological examination, different water samples were collected in pre-sterilized bottles, and then spread on preformed agar plates and incubated overnight. The result after incubation showed that spring water was heavily contaminated as 66 colonies were counted from this source of water, While the river water allowed the less growth (11 colonies) than spring water, while the filtered water had the lowest number of bacterial colonies (5 colonies) **(Fig.1-3).** Spring water was highly contaminated because underground water was polluted and contaminated due to over population, open sewerage system and having favorable temperature (21^oC) as compared to river and filtered water. The results from data analysis show that river Neelum water sample, spring water are certainly unsafe for drinking purposes without any form of treatment, but safe for various other surface water usage purposes.

Table 1: Mean value (n=16) of different physic-chemical parameters of rivers, spring and filtered water during Oct, 2009-Jan, 2010

Parameters	River water	Spring water	Filtered water
Water temperature(°C)	6.82±0.67	21.8±0.83	14.17±0.49
pH	7.68±0.16	7.86±0.5	7.33±0.25
Dissolved Oxygen (mg/L)	14.78±0.6	13.9±0.2	8.34±0.17
Alkalinity (m Mol/ L)	1.05±0.02	2.85±0.03	0.85±0.01
Chloride ion (ppm)	13.9 ± 0.3	24.8 ± 1.04	14.5 ± 0.4
Calcium ion (ppm)	33.9±1.05	96.2±2.45	30.4±1.3
Magnesium ion (ppm)	29.4±0.5	37.6±1.07	28.5±0.5

Table 2: Comparison of mean of Physico-Chemical Parameters of River, Spring and Filter water during Oct, 2009- Jan, 2010.

Treatment	Temp (°C)	pH	DO(mg/L	Alkalinity	Cl^{-1}	Ca^{++}	Mg^{++}
River water	6.82c	7.68a	14.78a	1.05b	13.9b	33.9b	29.4b
Spring water	21.8a	7.86a	13.9b	2.85a	24.8a	96.2a	37.6a
Filtered water	14.17b	7.33a	8.34c	0.85c	14.5b	30.4b	28.5c

The column means followed the different letters, are statistically significant at P (<0.05)

Fig. 1-3: Showing number of Bacterial colonies growing on plates prepared by nutrient media and water sources.

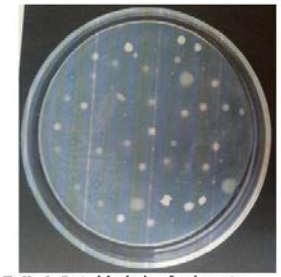

Fig No. 1: Bacterial colonies of spring water

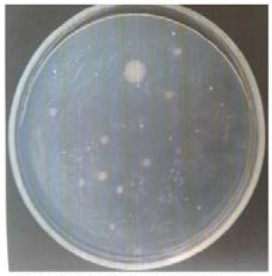

Fig No.2: Bacterial colonies of river water

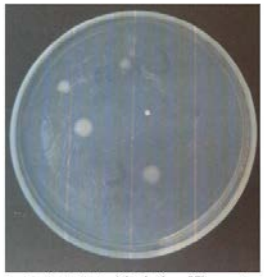

Fig No.3: Bacterial colonies of filter water

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