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Professional Paper

ASSESSMENT OF QUALITY OF WATER FILTRATION UNITS IN RAWALPINDI AND COMPARATIVE ANALYSIS BETWEEN TAP WATER AND FILTRATION UNITS

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The study was conducted to investigate the physicochemical characteristics of different water samples from filtration plants and Tap water for quality assessment from different areas of Rawalpindi during May and June of 2013. Analysis showed that the samples from tap water contains microbial contamination and water samples from filtration units were free of microbial contamination and other analyzed parameters were within permissible limits as compared with Pakistan Standards Quality Control Authority, 2008. Thus study depicts that the working of the filtration plants is effective.
Key words: water, physicochemical characteristics, Rawalpindi.

Procjena kakvoće filtrirane vode u Rawalpindi i usporedna analiza vode iz slavine i filtrirane vode. U ovom radu provedeno je istraživanje fizikalno kemijskih obilježja različitih uzoraka vode iz postrojenja za filtriranje vode i vode iz slavine u svrhu procjene kakvoće vode na različitim područjima Rawalpindi regije tijekom svibnja i lipnja 2013. godine. Analize su pokazale da su u uzorcima vode iz slavine prisutna mikrobiološka onečišćenja dok su uzorci vode iz filtracijske jedinice bili bez mikrobilоškog onečišćenja, ostali analizirani parametri su u dopuštenim granicama u odnosu na Zakonom propisane Pakistanske standarde kontrole kvalitete.
Ključne riječi: riječi: voda, fizikalno kemijska obilježja, Rawalpindi.

INTRODUCTION

Water facilitates the human body by playing a vital role as an appetite suppressant. Water is free of fat, cholesterol and completely without calories. Many diseases such as asthma, allergies and hypertension etc can be caused by lack of water. Dehydration can cause increase in toxicity, joint and muscle soreness, decrease in digestive efficiencies [1]. The limited data is available on the utilization of drinking water by human body. World health organization study revealed that a person consumes 2 liter water/day having a weight of around 60 kg.

Water supply sources may include rain water, surface water and ground water .Water supplies may be drawn from a single source and also from multiple sources. International Water Management Institute in Sri Lanka was conducted in 2007 for the assessment of water management in agriculture. They observe the current availability of water for agriculture and depicted the water scarcity areas. Analysis shows that the world had sufficient water to provide food for its growing populations [2]. In Pakistan, there is limited provision of safe drinking water of international standard. Around 30% of population has access to safe drinking water and 70% of population has drinking water of impure quality. This can be analyzed through human use. There are very few laboratories that have the capability to completely analyze the drinking water in according to Pakistan and quality control standards. The United Nations Children Fund (UNICEF) report depicts that the diseases such as cholera, typhoid, dysentery, guinea worm infections are about 80 % of all the diseases and are responsible for 33% of deaths. In Pakistan the child death rate is around 12.5% and over 200,000 children die due to diarrheal diseases.

The project launched as National Water quality monitoring program conducted by the Pakistan council of research in water resources depicts about impure drinking water quality in major cities of Pakistan. Due to bacterial contamination, water that was not fit for human use includes 75% of Islamabad and 87% of Rawalpindi's. The report reveals the primary and secondary quality issues that cause serious potential threats for water resources in Pakistan. Due to the presence of physicochemical characteristics water has been tested that includes temperature, pH, Total Dissolved Salts, Total Suspended Salts, Total coliform test, Electrical conductivity, Chloride, Colour, Taste and Odour [3].

The heavy metals like arsenic, iron, fluoride are also present in drinking water. The most serious problem that has been reported throughout the country is the bacteriological contamination of drinking water. Water pollution results in ground water contamination from pesticide which causes reproductive damage in ecosystem, increase in the growth of algae when fertilizer, sewage and agricultural runoff consisting of organic material is discharged in water. WHO Guidelines (1999) are used for monitoring of water for cyanobacteria contamination.

The water treatment processes includes the conventional filtration process that is made up of filter media .Filter media can be of silica, sand, anthracite coal and finely woven fabric. Filters are used to retain the impurities and allow the clean water to be collected at the other side of the filter. Variety of chemicals like pesticides, herbicides and bacteria can be removed through activated carbon filters. Physiochemical methods used for water treatment includes filtration and disinfection that require coagulation of unwanted material. Chlorine is still widely accepted method of disinfection used at water treatment facilities. The oldest and cheapest known traditional method used for water purification includes boiling and pasteurization but it is not proper when heavy metal ions and other toxic chemicals are present in water and for that purpose membrane filtration method is used for the removal of impurities from water. Source protection, treatment process modification, alternative disinfectant, activated carbon, membrane filtration process and control in drinking water distribution system are the controlling techniques for DBP and waterborne pathogens [4].

To deal with new challenges, Amendments to the secondary drinking water act in 1996 requires the establishment of new rules to balance the risk between pathogens and DBPS. To improve the control of microbial contamination, the Interim Enhanced Surface water treatment rule (1998) was established and to strengthens the control of microbial contaminants the Long Term 1 Enhanced Surface Water Treatment Rule was finalized in January 2002.To reduce the potential of cancer, reproductive and development health risks from Disinfectant Byproducts in drinking water and to improve the public health by reducing water born outbreaks the Stage 2 Disinfectant Byproduct rule was established based upon Stage 1 Disinfectant Byproduct rule. The two drinking water standards include national primary and secondary drinking water regulations. The main objectives of the study includes:

- Determination of physicochemical characteristics of collected water samples.
- Determine of contamination level in water samples.
- To examine that whether the filtration plants are working efficiently.
- Relative study of pipe water and filtration plants.

The study is important because water pollution has been widely accepted as a contributor to health problems in humans and marine animal ecosystems due to industrialization, overpopulation and some other related factors resulting in huge impact on our lives. Microbial contamination causes 100 times greater health issues then chemical contamination of water. The developing countries where access to safe drinking water is getting inadequate, water born diseases provide a major share to the human poor health. So, in order to supply an sufficient amount of clean water to the community different methods are being used for water treatment and treated water is predictable to meet drinking water quality standards and suggested as safe for drinking.

MATERIALS AND METHODS

Sampling

Total twelve water samples, including 6 from Filtration Units and 6 Tap Water samples were collected from different adjoining areas of Rawalpindi including Askari VII and XIV, Airport Housing Society, Bahria, Westridge, Chaklala scheme 3 in pre sterilized plastic bottles during May and June. After collection, samples have been brought into EPA lab for further analysis of physiochemical parameters and codes were given to samples.

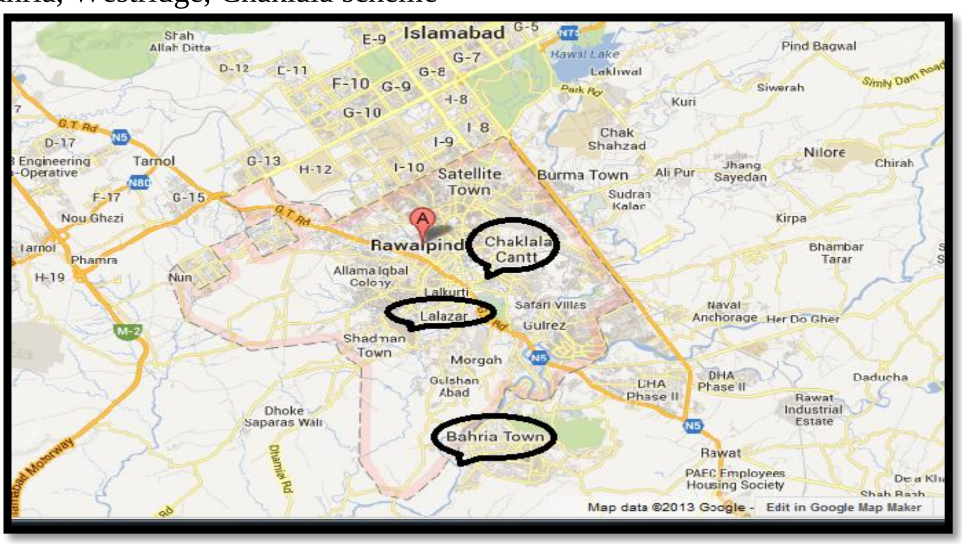

Figure 1. Map of Sampling Stations
Slika 1. Položaj mjesta uzorkovanja

Methodology

Physicochemical analysis of water samples have been done that includes temperature, pH, Electrical Conductivity, Total dissolved salts, Total Suspended Salts, Total Coliform Bacteria, Chloride, Taste, Color, Odor according to standardized methods of APHA-AWWA-WEF , 2005. The Techniques are named in Table 1 and results are shown in Tables 2 - 4.

Table 1. Used techniques for physicochemical analysis of water samples
Tablica 1. Uporabljene tehnike za provedbu fizikalno kemijskih analiza uzoraka vode

Parameter	**Technique**
Temperature	Electric Thermometer
Odor	--
Taste	--
pH	pH meter
Color	Colorimeter
EC	Conductivity meter
TDS	Gravimetric technique
TSS	Gravimetric technique
Chloride	Titration method
Total Coliform Bacteria	Membrane filter technique

RESULTS AND DISCUSSION

Table 2. Physiochemical Characteristics of tap water and filtration Unit's samples During May
Table 2. Fizikalno kemijska obilježja vode iz slavine i uzoraka filtrirane vode tijekom svibnja

Sample #	Locality	Temperature (°C)	pH	E C (µS)	TDS mg/l	TSS mg/l	Chloride mg/l	Total Coliform	Taste	Odour	Color
1	WT	29.6⁰C	6.46	180.8	600	400	55.0605	20 /100ml	Taste Less	Odour Less	Color Less
2	WF	32.5⁰C	6.72	175.6	200	100	25.0275	0/100ml	Taste Less	Odour Less	Color Less
3	ST	27.5⁰C	6.35	179.9	200	200	175.192	80/100ml	Taste Less	Odour Less	Color Less
4	SF	26.5⁰C	6.45	177.6	900	100	50.1055	0/100ml	Taste Less	Odour Less	Color Less
5	BT	28.8⁰C	6.57	162.5	200	100	50.0255	50/100ml	Taste Less	Odour Less	Color Less
6	BF	34.7⁰C	6.52	162.0	200	300	25.0275	0/100ml	Taste Less	Odour Less	Color Less
7	A_7T	36.5⁰C	6.42	187.9	400	200	125.137	30/100ml	Taste Less	Odour Less	Color Less
8	A_7F	33.5⁰C	6.44	168.7	100	300	75.0825	0/100ml	Taste Less	Odour Less	Color Less
9	$A_{14}T$	29.5⁰C	6.90	158.8	300	100	175.082	40/100ml	Taste Less	Odour Less	Color Less
10	$A_{14}F$	34.4⁰C	6.89	188.6	100	100	75.136	0/100ml	Taste Less	Odour Less	Color Less
11	A_HT	31.4⁰C	6.41	177.4	300	600	150.027	20/100ml	Taste Less	Odour Less	Color Less
12	A_HF	30.0⁰C	6.32	176.5	100	400	75.1925	0/100ml	Taste Less	Odour Less	Color less

Table 3. Physicochemical Characteristics of Tap water and Filtration Units samples During June

Tablica 3. Fizikalno kemijska obilježja vode iz slavine i uzoraka filtrirane vode tijekom lipnja

Sample #	Locality	Temperature (^{o} C)	pH	E C (µS)	TDS mg/l	TSS mg/l	Chloride (mg/l)	Total Coliform	Taste	Odour	Color
1	WT	29.6^{0}C	6.46	180.8	800	600	155.0605	30 /100ml	Taste Less	Odour Less	Color Less
2	WF	32.5^{0}C	6.72	175.6	400	200	50.0275	0/100ml	Taste Less	Odour Less	Color Less
3	ST	27.5^{0}C	6.35	179.9	300	200	175.055	80/100ml	Taste Less	Odour Less	Color Less
4	SF	26.5^{0}C	6.45	177.6	900	400	180.1925	0/100ml	Taste Less	Odour Less	Color Less
5	BT	28.8^{0}C	6.57	162.5	400	300	150.0255	70/100ml	Taste Less	Odour Less	Color Less
6	BF	34.7^{0}C	6.52	162.0	500	700	125.0275	0/100ml	Taste Less	Odour Less	Color Less
7	A_7T	36.5^{0}C	6.42	187.9	200	500	175.0825	50/100ml	Taste Less	Odour Less	Color Less
8	A_7F	33.5^{0}C	6.44	168.7	300	600	150.1375	0/100ml	Taste Less	Odour Less	Color Less
9	A_{14}T	29.5^{0}C	6.90	158.8	600	300	150.0825	60/100ml	Taste Less	Odour Less	Color Less
10	A_{14}F	34.4^{0}C	6.89	188.6	200	300	150.0345	0/100ml	Taste Less	Odour Less	Color Less
11	A_HT	31.4^{0}C	6.41	177.4	500	800	175.0275	40/100ml	Taste Less	Odour Less	Color Less
12	A_HF	30.0^{0}C	6.32	176.5	300	500	125.1825	0/100ml	Taste Less	Odour Less	Color less

Table 4. Pakistan Standards Quality Control Authority, 2008 (Kahlown, M.A., Tahir, M.A. and Sheikh, A.A.)

Tablica 4. Zakonom propisani pakistanski standardi kontrole kvalitete, 2008 (Kahlown, M.A., Tahir, M.A. and Sheikh, A.A.)

Physicochemical Parameters	**Quality Standards**
Odour	Not Acceptable
Taste	Not Acceptable
pH	6.5-8.5
Color	≤15TCU
EC	<290µS
TDS	<1000
TSS	<1000
Chloride	<250
Total Coliform Bacteria	0 per 100 ml

PHISYCOCHEMICAL PARAMETERS

Taste and Odour

For taste and odour analysis 12 different samples were analyzed and all water samples were tasteless and odorless. Tastes and odors in water supplies can generally be attributed to two different causative elements: the actions of human beings upon the aquatic environment and natural forces within the environment occasionally affecting each other. Actinomycetes and algae are two important groups of organisms that produce taste and odour related toxins in drinking water. As far as the human cause of taste and odours in drinking water is concerned, probably the most common cause of consumer complaints is chlorination in the water treatment plant. When low dosages of chlorine are added to water that contains phenols, chlorophenol compounds are formed and impart an unpleasant taste to the water. However, due to variety of other chlorinated organic compounds the medicinal odors frequently run into treated waters, contaminated by industrial wastes.

pH

When the concentration of carbon dioxide increases the pH of water automatically decreases (WHO, 2007). The normal range of pH of the water is between 6.5 - 8.5. Irritation to skin, eyes and mucous membranes can be caused by extreme pH. Water with pH values 10 - 12 has reported to cause hair fibers to swell. The pH of water should preferably be less than 8 for proper chlorination. If the pH of water before water distribution in pipes is not maintained, it can result in corrosion of pipes and contamination of drinking water and cause bad taste, odor and color (Haleem, 1996). As shown in Figure 1, it was observed that the pH of all drinking water samples were within the recommended range (6.5-8.5) advocated by World Health Organization (WHO) guideline standards for drinking water [5].

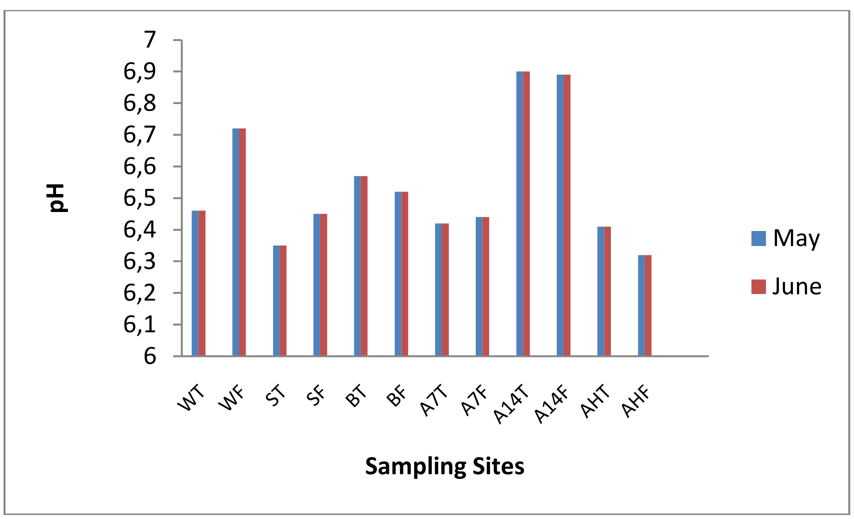

Figure 1. Effect of pH on drinking water sample
Slika 1. pH uzoraka pitke vode

Color

For color analysis 12 different samples were analyzed and all the samples were colorless. One of the most important and conveniently observed indicators of water quality is the color of water. Colorless water is the highest quality drinking water . Inorganic constituents such as dissolved iron, dissolved organic substances like humic or fulvic acids, organics from anthropogenic sources such as dyes, suspended particulate matter such as plant debris, phytoplankton and zooplankton are the potential inorganic, organic and bacteriological contributors of color to natural water. The acceptable value for color in water samples is ≤ 15 TCU/Hazen Units. Color parameter may not exceed 15 Hazen for most drinking water standards.

Electrical Conductivity

The EC data range must be less than 290 µS. The water temperature and electrical conductivity of water are directly proportional to one another and depends on each other. For an increase of 1 degree ^{O}C of water temperature the electrical conductivity of water increases by 2-3%. The good indicator of the total salinity is the electrical conductivity.

The normalized measure of the water's ability to conduct electric current is the electrical conductivity (EC). Dissolved salts such as sodium chloride and potassium chloride are the factors through which EC is mostly influenced. The abundance of dissolved salts due to poor irrigation management, minerals from rain water runoff, or other discharges are the sources of EC (Warrick, 2003). As shown in Figure 2, it was observed that the Conductivity of all drinking water samples was within the recommended range advocated by World Health Organization (WHO) guideline standards for drinking water [5].

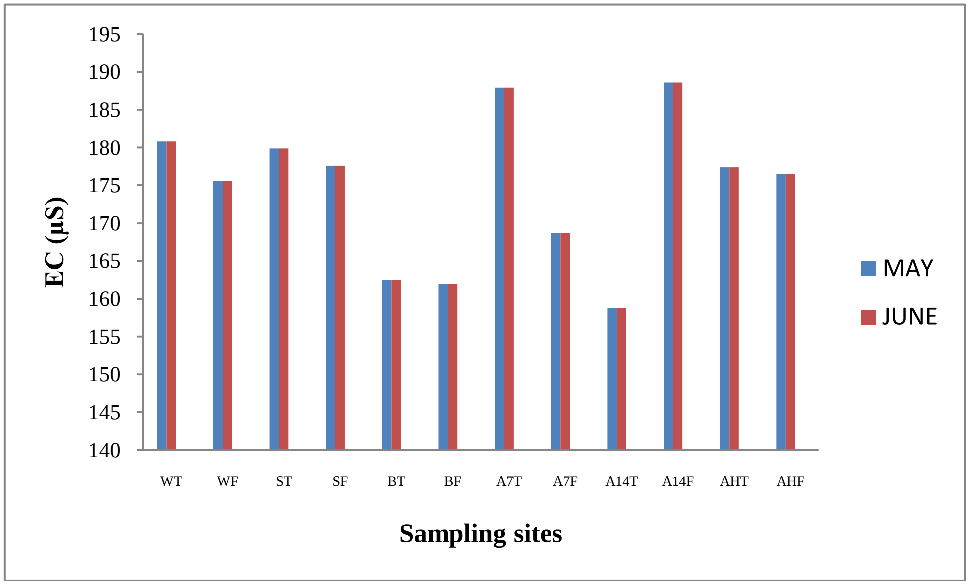

Figure 2. Effect of EC on drinking water samples
Slika 2. Električna vodljivost uzoraka pitke vode

TDS

TDS stands for total dissolved solids and the total concentration of dissolved substances and various kinds of mineral in water is represented by TDS. TDS consists of inorganic salts and a small amount of organic matter [6]. 12 drinking water samples were analyzed for TDS. The TDS value range less than 1000 and falls within permissible limit of drinking water quality.

Aesthetic problems for consumers (such as undesirable taste, salty bitter) are caused by high concentration of TDS in the drinking water. The nitrates, sodium, barium, copper sulfates, and fluoride are most problematic. A flat taste, which is undesirable to many people, is found in water that has been caused by a very low concentration of TDS. It has been observed that harmful effects to the human body are not caused by the consumption of water having low TDS. As shown in Figure 3, it was observed that the TDS Values of all drinking water samples were within the recommended range advocated by World Health Organization (WHO) guideline standards for drinking water [5].

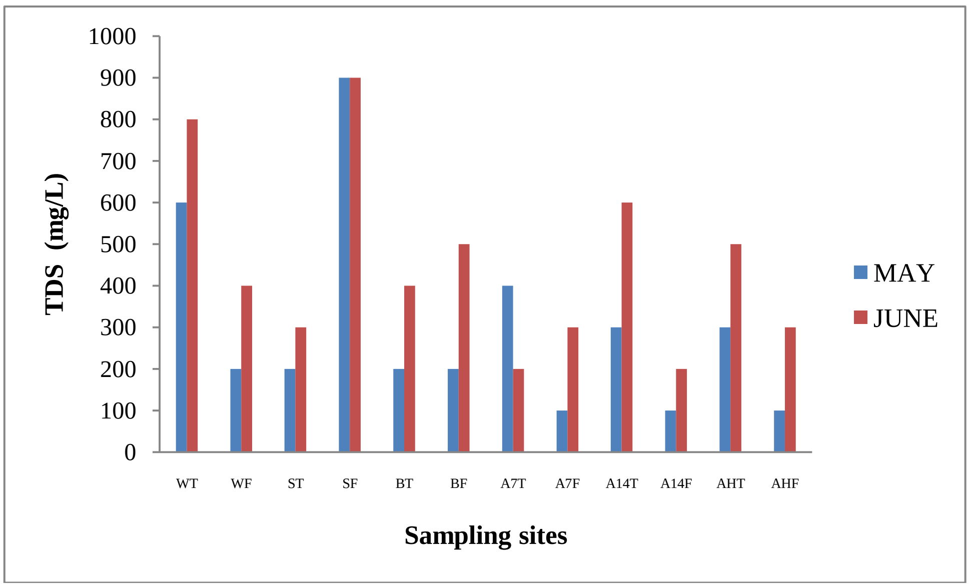

Figure 3. Effect of TDS on drinking water samples
Slika 3. Ukupna otopljena tvar uzoraka pitke vode

TSS

For TSS, 12 drinking water samples were analyzed. Solids in water that can be trapped by a filter are Total Suspended Solids. A wide variety of material such as silt, decaying plant and animal matter, industrial wastes, and sewage are included in TSS. Many problems for stream health and aquatic life can be caused by high concentration of suspended solids. Some of the solutes will precipitate and will affect the solubility of the suspended mater due to changes in pH.

Light can be blocked from reaching submerged vegetation by high TSS. The process of Photosynthesis will be slowed down as the amount of light passing through the water is reduced. Dissolved oxygen will be less released into the water by plants due to the reduced rates of photosynthesis. An increase in surface water temperature will be caused by high TSS because the suspended particles absorb heat from sunlight. As shown in Figure 4, it was observed that the TSS values of all drinking water samples were within the recommended range advocated by World Health Organization (WHO) guideline standards for drinking water [5].

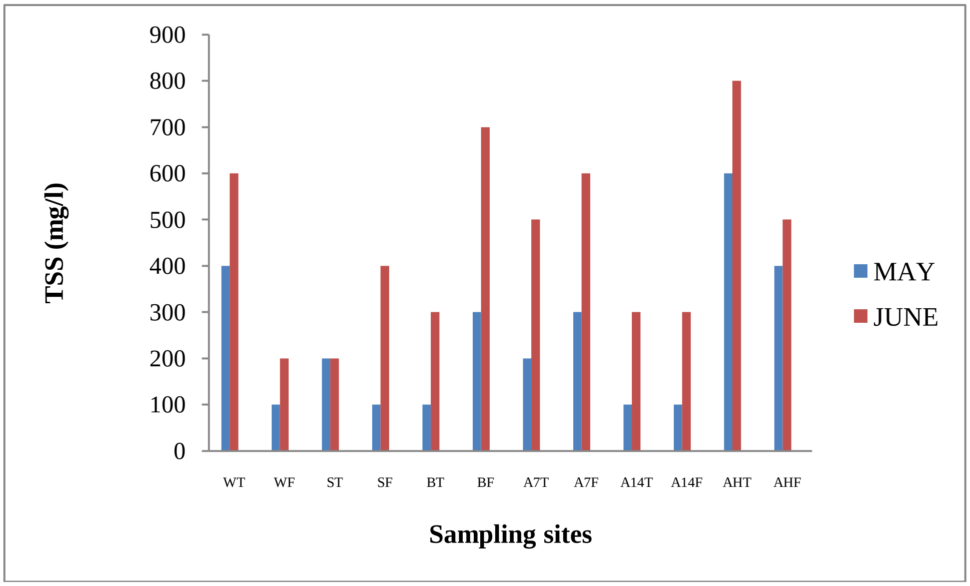

Figure 4. Effect of TSS on drinking water samples
Slika 4. Ukupna taložna tvar uzoraka pitke vode

Chloride

The "salt" content of the water is usually related to chlorides. 12 drinking water samples were analyzed with the help of titration method. Salty taste water will increase the corrosion of plumbing and home appliances and will have the high chloride concentration. The recommended concentration for chloride is 250 mg.

Increased chloride levels are present in water supplies having high concentration of TDS. Chloride contributes 50 percent of the TDS. High concentrations of chlorides are present in human and animal waste. Humans and animals are less affected by the presence of chlorides in drinking water. Salty taste is the most evident effect of high chlorides. Sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusion are the natural sources from where chloride comes in drinking water. As shown in Figure 5, it was observed that the chloride values of all drinking water samples were within the recommended range advocated by World Health Organization (WHO) guideline standards for drinking water [5].

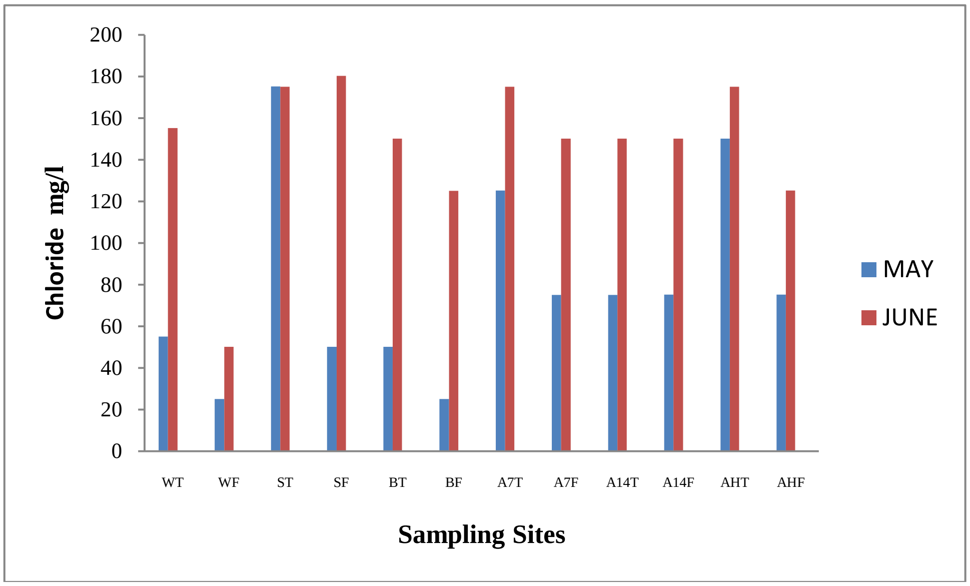

Figure 5. Effect of Chloride on drinking water samples
Slika 5. Sadržaj klorida u uzorcima pitke vode

Total Coliform Test

For total coliform test, 12 drinking water samples were analyzed. The collection of relatively harmless micro organisms that live in large numbers in the digestive systems and intestines of human beings and warm- and cold-blooded animals are total coliform bacteria. Humans and animals wastes contain microorganisms that aid in the digestion of food and disease causing bacteria and viruses. Source of the coliform bacteria includes soil and decaying vegetable. Water would certainly become a vector for that particular disease, if such waste would contaminate water source and there is a risk of exposure to water-borne disease. According to WHO, the E coli and faecal coliform bacteria must not be detectable in any 100 ml sample of all water intended for drinking. Analysis shows that all the tap water samples have coliform bacteria ranging from 20 colonies till 80 colonies to the maximum per 100 ml sample and water samples from filtration plants have no bacterial colonies. As shown in figure 6, the tap water samples are contaminated and are not fit for drinking and have microbial contamination whereas water samples from filtration plants are not contaminated and are fit for drinking as advocated by World Health Organization (WHO) guideline standards for drinking water [5].

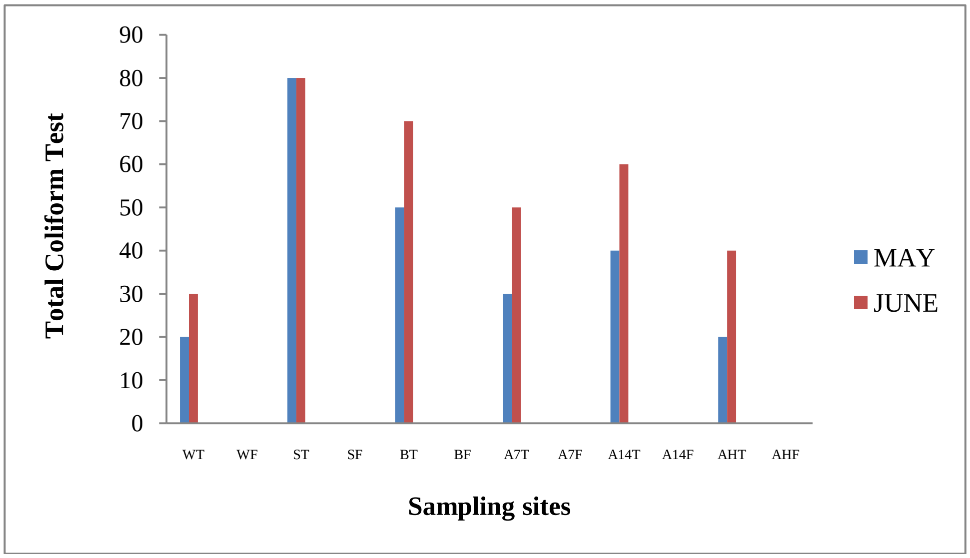

Figure 6. Effect of Total Coliform Test on drinking water samples
Slika 6. Ukupne koliformne bakterije u uzorcima pitke vode

CONCLUSION

Analysis of Physicochemical parameters that includes temperature, pH, Electrical Conductivity, Total Dissolved Solids, Total Suspended Solids, Chloride Content, Total Coliform Bacteria, Taste, Colour, and Odour in 12 different water samples have been done. It is concluded that:

- All the tap water samples and Filtration plant samples were tasteless, odorless, and colourless.
- Physiochemical parameters in all Tap water samples and Filtration plant samples except Total Coliform bacteria were within the permissible limits and this showed that the tap water has microbial contamination ranging from 20 till 80 colonies to the maximum in 100 ml sample. This showed that Tap water samples were unfit for drinking.
- Filtration plant samples analysis showed that they were free from microbial contaminations and working efficiently.

Hence it is recommended that, to control water contamination and to effectively implement quality standards for drinking water, preventive measures must be taken at all water treatment plants and water distribution systems. C For monitoring of water quality cost effective methodology should be intended. To improve existing water distribution infrastructure, extensive resources should be committed. For the maintenance of drinking water quality standards public awareness should be established.

REFERENCES

[1] Agarwal and Manish, Assessment of Pollution by Physicochemical Water Parameters Using Regression Analysis: A Case Study of Gagan River at Moradabad- India, Advances in Applied Science Research, 2(2011)2, 185 -189.

[2] J. A. Clark, C.A. Sabanatinos, Characterization of indicator bacteria in municipal raw water, drinking water and new main water supplies, *Journal of Microbial*.28(1982), 1002–1013.

[3] F. Donato, S. Monarca,S(2003)., Tumors, urolithiasis ,fetal malformations, deteriotions of the cognitive function in the aged and atopic eczema, Drinking water hardness and chronic degenerative Disease 111(2003), 57-70.

[4] T. Kingham, T. Hoggart , "Chlorination control in a large water treatment works," in IEEE Colloquium on Application of Advanced PLC Systems with Specific Experiences from Water Treatment, 1995.

[5] WHO World Health Organization, Total dissolved solids in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality, 1996.

[6] Health Canada, Guidelines for Canadian Drinking Water Quality: Chemical and Physical Parameters, 2007.