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Recycling of discharged wastewater for drinking purpose: a case study in Guna water treatment plant, Ethiopia

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ABSTRACT

The bottling water factory requires a massive amount of freshwater with due consideration of generating a significant amount of wastewater in the processes. Guna Spring Water Bottling Factory shows by surplus water discharged to the river as wastewater. The aim of this research is to assess the quality of discharged water and compare with World Health Organization drinking water standards and Ethiopian bottled drinking water specification to recycle for drinking purposes. The discharged wastewater quality assessment was conducted by chemical, physical, biological and bacteriological analysis. Atomic adsorption spectroscopy, flame photometer, photometer and UV-visible spectrometer were used for characterization. The water quality parameter was determined in all unit process (softener, sand filter, activated carbon and ultrafilter). Bacteriological analysis (total coliform, fecal coliform and *Escherichia coli* type1) were conducted. Effect of discharge flow rate (2, 4, and 6 m^3/h) and discharge time (5, 10, and 15 min) on water quality have been performed. The physical and chemical analyses resulted in the recommended range. Bacteriological analysis result has shown no exhibit organism. Hence, the discharged water from the different unit processes can be used as an alternative source of water for potable purposes.

Keywords: Drinking water; Wastewater; Potable water; World Health Organization standards; Water treatment

1. Introduction

Water is one of the most essential and non-substitutable ecological properties [1]. Sufficient, quality, secure and affordable delivery of drinking water is a basic need for human life [2]. However many people across the planet do not have access to safe and adequate water supply services which affects their life in various ways [3,4]. The water potential on earth has a decreasing trend owing to different factors which have associations with climate change (degradation of natural resources and natural disasters) [3]. Just to alleviate this emerging access and quality problems of potable water supply different bottling water factories were established in Ethiopia. However, the bottling water factory requires a vast amount of freshwater with due consideration of generating a significant amount of wastewater in the processes. In recently approximately 74% of Ethiopia population had a lack of safe drinking water [4,13]. The majority of the population around 89% lives in a rural area. Most information proposed that less than 12% have access to drinking water [5]. Only 19% of rural populations have access to safe drinking water supplies [6]. In most countries, there is no practice of reusing

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wastewater for potable purposes across all bottling water industries including the study area.

Guna Spring Water Bottling Factory (GSWBF) is one of the main water industries in Ethiopia exemplify by surfeit water release to the nearest river suppose as wastewater. So far no study has been conducted to evaluate the status of discharged wastewater and its impact on the environment. GSWBF has two spring water sources namely *Asequorey* and *Shemamatebite* which have a discharge capacity for both 96 m^3/d on average. These sources of raw water are located in Guna highland where human settlement is rare and not exposed to any waste. The factory discharges 5.76 m^3/d water from the treatment plant such as sand filter (SF), activated carbon filter (ACF) and softener (SOF) and 24.58 m^3/d water on ultrafilter (UF) as wastewater without evaluating the physicochemical properties. In general, about 37.03% of water discharged different unit operation considering as a wastewater daily during treatment washing SF, ACF, and SOF and production time UF, 31.25% only used as potable purpose as packed bottled drinking water and the remaining 31.72% used for other purposes like bottle washing, washing the floor, steam generator and washing general working area on a daily bases. Based on the data obtained from the factory, only 31.25% pure water which the factory uses and distributes to customers on a daily bases. This clearly shows that how much amount of money that the factory is losing on a daily bases due to the shortage of raw water and the bulk amount of water discharged as wastewater.

The water industry has a responsibility to protect water whenever possible. Because of the population increase and socio-economic growth have quickly enlarged water demand which mutually with renewable. However, finite water resource is resulting in a rising number of regions facing water shortage. The performance evaluation of the discharged wastewater characterized by physical, chemical and microbiological analysis should be conducted before released to the environment [7,8].

There are conservative techniques for the treatment of water from ground and surface water for drinking water such as chemical oxidation and reduction, electrochemical treatment, ion exchange, chemical precipitation, filtration, sand filter, rivers osmosis, membrane technology and evaporation [10,11]. Currently, there is also an environmentally eco-friendly and cost-effective absorption method from agricultural materials [12] used as the potential for low-cost adsorbent in wastewater treatment. The absolute treatment of wastewater is bringing by a chronological combination of different physical, chemical and biological unit processes.

The performance evaluation of the presented Guna treatment plant is vital to evaluate the existing effluent quality and also to meet the advanced treatment requirements. The evaluation also provides to recognize the treatment plant whether it is possible to hold higher hydraulic and organic loading. Performance judgment performs of presented treatment plant units is valuable in the production of supplementary data which also can be used in the enhancement in the design procedure to be followed for the propose of these units.

The objective of the study is to evaluate the potential usage of discharged wastewater from Guna spring water treatment for drinking water purposes and to fulfill the customer requirements based on the quantity and quality of water availability.

2. Materials and method

2.1. Study area

The study was performed in GSWBF found in Debre Tabor placed in North Gondar, Amhara National Regional State of Ethiopia. The woreda lies between 11°32″ to 12°35″ latitude and 37°25″ to 37°30″ longitude, with the altitude range of 1,900 to 4,035 m above sea level as shown in Fig. 1. The source of raw spring water is found at an altitude of 4,300 m above sea level. The factory is found at 136 km far away from Bahir Dar and 699 km North West of Addis Ababa. The mean maximum and minimum temperature of the place is 21°C from February to May and 9.6°C from June to January respectively [20]. According to the meteorological report, the mean annual rainfall is 1,570 mm. The factory has two spring water sources which are found 1.5 and 2 km far away from the factory respectively and the water coming to the factory by gravity without using a pump. The discharged capacities of the two sources are different in the summer and winter seasons but on average 4 m^3/h.

2.2. Study design

The study was carried out by taking different discharge wastewater samples from the Guna spring water treatment plant at selected points. The sample was determined by three basic water quality parameters such as physical, chemical and biological parameters were conducted. The sample was conducted as a factor of flow rate and discharged time within each unit operation and process.

2.3. Materials and chemicals

Media were used for bacteriological analysis such as nutrient agar used as a food to grow an aerobic plate count bacteria. MacConkey soup was used for the presumptive validating coliform test in means of probable number (MPN) dilution method as a food, Brilliant Green Bile Broth was used to prove total coliform there in the positive presumptive tests, electrical conductivity (EC) broth was used to verify fecal coliform present in the positive presumptive tests, Nutrient Broth used to build up *E. coli* type1 and Kovac's reagent was used to verify the presence or absence of *E. coli* type 1 in the positive presumptive test confirming coliform test.

Chemicals were used for physicochemical test analysis such as Nitraver5, nitrate reagent powder pillow for computing nitrate level in the sample, Phosver3 (ascorbic acid) reagent was used to determine the phosphate concentration, DPD1 tablets were exploited to evaluate the chlorine residual, silica oil was used to hide or remove the scratches on the vial during FCR and $Al_2(SO_4)_3$ was used as a coagulant during turbidity measurement, hardness tablets also were used to determine the total hardness, calcium hypochlorite was utilized as a disinfectant and sodium thiosulfate was used to neutralize for bacteriological analysis.

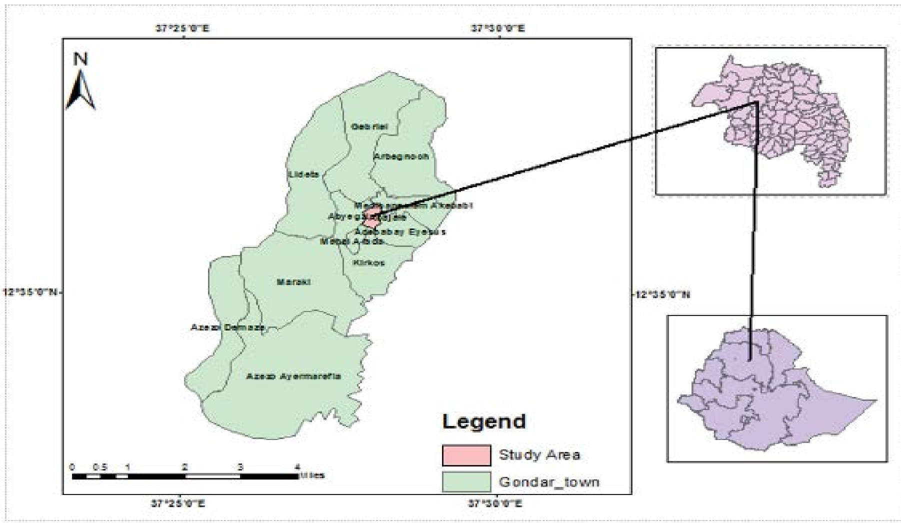

Fig. 1. Study site location.

2.4. Experimental design and descriptions

2.4.1. Media preparation

35 g of MacConkey was dissolved in 1,000 mL distilled water in Erlenmeyer flask, subsequently mixed fine using hot plate by shivering and swivel it until entirely dissolved and next monitor a clear color on conical flask over the molten solution. After that, sterilized the sample in an autoclave at 21°C for 15 min to take out the contamination and store the molten solution at 50°C in the oven.

2.4.2. Bacteriological sampling

The bacteriological test was conducted by using a sterile bottle of glass in 100 mL volume. Samples were preserved and sealed under a very low temperature of –4°C for the duration of storage before analysis has been done. The time between sampling storage for analysis should not exceed 6 h. The bacteriological analysis was conducted in the study of the factory and not exceeds 2 h after the sample was collected [15].

2.4.3. Physical and chemical sampling

For chemical and physical characterization, samples were stored in a fresh polyethylene bottle at a low temperature in the sampling icebox. Sample gathering and analysis were taken in six consecutive months from first July up to the end of December. From selected sampling points, 1,000 mL samples were collected in each unit process within the specific design flow rate and washing time. Following, samples were stored in the refrigerator for 48 h until the analysis was conducted but a test of color, odor, temperature, pH, and turbidity were determined instantly by colorimeter (Labsol, S-910) olfactometers (TO9 olfactometer, GmbH, Germany), handheld digital thermometer (TP101, China), pH meter (Esico-101, India), turbidity meter (Eutech-TN100, India) respectively. Whereas other physiochemical parameters tests were done in water and environmental engineering laboratory after store the sample in the refrigerator. Experiments were replicated three times to obtained accuracy results.

2.5. Method of analysis

Bacteriological analysis was carried out for display organism that is the total coliform, fecal coliform and *E. coli* type1 by MPN method [17]. Magnesium and calcium were determined by atomic absorption spectrometry (AAS) (novAA 400P, Germany). AAS is used for determining the chemical element that existed within the sample. Sulfate, chloride, iron, FCR, fluoride, and total alkalinity were analyzed by a photometer (ELICO-CL378, India). Phosphate and nitrate levels were determined through ultraviolet-visible (UV/Vis) spectrophotometer (PerkinElmer-LAMBDA 365) analysis. Potassium and sodium content was verified by (PerkinElmer-LAMBDA 365, India) flame spectrophotometer (DRAWELL-FP 640, China) analysis at the highest discharge intensity of 766.5 and 589 nm wavelength respectively.

3. Results and discussions

The present study mainly focused on the performance evaluation of wastewater discharged from GSWBF treatment plant of unit process and operation by conducting physical, chemical, and bacteriological analysis based on Ethiopian bottled drinking water specification [14] and World Health Organization (WHO) [16] drinking water standards. The evaluation was taken place on backwash and surface wash at different flow rate with different washing time from the selected unit process and operation.

3.1. Physical and chemical analysis

3.1.1. pH

The pH of all tested samples was found to be within the acceptable range of WHO guidelines [16] for drinking

(6.5–8.5) and Ethiopian bottled drinking water specification [18] (6.0–8.5). Fig. 2 has shown the measured pH ranges from 7.0–7.36 at the backwash in a sand filter, 6.85–7.12 at the surface wash in a sand filter, 6.9–7.2 at backwash in ACF, 6.83–7.04 at the surface wash in ACF, 6.86–7.12 at backwash in the softener, 6.78–7.05 at the surface wash in the softener, 7.06–7.50 at ultrafilter, 6.48–7.24 in the raw water and 7.20 in the reused water. The average pH values for all unit processes measured range from 6.89 to 7.28. The total average is 7.085. In general, the water tends to be alkaline. All samples have a pH of more than 6.0 but less than 8.0 and there was spatial variation in the factory product water measured. In general, the mean of the pH for the whole sampling points have no significant effects. Therefore, this water is safe to drinking since all the results were obtained acceptable range.

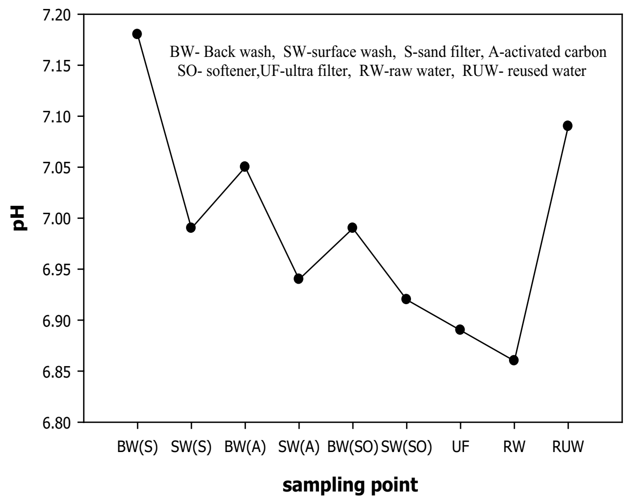

Fig. 2. Mean pH value with different sample points.

3.1.2. Turbidity

The measured turbidity value was various at the backwash and surface wash time. In different flow rate, different turbidity value was measured within different washing time. Therefore, the flow rate and washing time affect turbidity value. As the flow rate increases the discharged colloidal particles or turbidity also increase whereas the washing time increases. Subsequently, the removal particle was decreasing as shown in Fig. 3. The turbidity value on the ultrafilter unit process was zero at different flow rates with different discharged times. However, from other unit processes (sand filter, ACF and softener filter or ion-exchanger) different value was measured at different flow rate with different washing time. According to Ethiopian bottled drinking water specification (ES 597,2001), [18] and WHO drinking water standard the turbidity of drinking water maximum permissible level is <5 NTU whereas the obtained result from the experiment near to the standard value. In surface wash time all result indicates within the standard of drinking water range [7].

3.1.3. Hardness

The hardness of analyzed water samples varied from 2 to 48 mg/L as $CaCO_3$. The highest value of total hardness was observed at the reuse water sample as shown in Fig. 4b, whereas the lowest value was observed from each treatment unit process discharged wastewater at different flow rates and washing time including ultrafilter. Fig. 4a shows hardness various raw water from season to season and it confirmed a relatively significant gap between them. Therefore, the natural spring surface water may be soft in nature or the mineral composition varies from season to season. In the study factory, the water was very soft in nature. Also, take the comparative sampling points the factory product water hardness was measured from 10–40 mg/L as $CaCO_3$ at different production dates. The raw water before entering the reservoir tanks was measured at different seasons various between 20 to 38 mg/L as $CaCO_3$. The discharged wastewater collected in the collection tank was varying in the range of 22 to 54 mg/L. The hardness value of discharged wastewater to the nearest river in the study factory was obtained 20–58 mg/L as $CaCO_3$. Hence, this range of hardness is not harmful but it shows the similarity of raw water, discharged wastewater from different unit operations, reuse water and the normal factory packed water [8]. All the results clearly show that the discharged wastewater is found within the soft water range.

3.1.4. Electrical conductivity

Pure water is not a fine conductor of electric current slightly a good insulator. Raise in ions concentration enhances the EC of water. Usually, the amounts of dissolved ion solids in water would determine the EC. According to WHO standards and Ethiopian bottled drinking water specification [18], EC value should not be exceeded 400 μS/cm. In study factory, EC value in the sand filter at back and surface wash time was 109–147 μS/cm and 100–128 μS/cm, in ACF at back and surface wash time was 105–152 μS/cm and 120–126 μS/cm, in softener filter at back and surface wash time was 106–129.5 μS/cm and 110–126 μS/cm respectively and in the ultrafilter, 108.6–156 μS/cm was found as shown in Fig. 5. These results obviously indicate that water in study areas was not noticeably ionized and has a minor level of ionic concentration activity due to the absence of excessive dissolve solid ions accumulated in each unit process. Thus, it is not a well conductor of electric current.

3.1.5. Total dissolved solids

Water has the capability to dissolve a wide range of inorganic, organic minerals and salts such as calcium, sodium, potassium, bicarbonates, magnesium chlorides, and sulfates. There is no agreement that has been developed on positive or negative effects of water that exceeds the WHO standard limit of 1,000 ppm. Total dissolved solids (TDS) in potable water is initiated from sewage to urban industrial wastewater. Therefore, a TDS test has been measured as a sign to determine the general quality of the water. The acceptable range of TDS is 1,000 mg/L. In the present study, the range of TDS of analyzed water samples varied between 50 to 80 mg/L as shown in Fig. 6. The highest

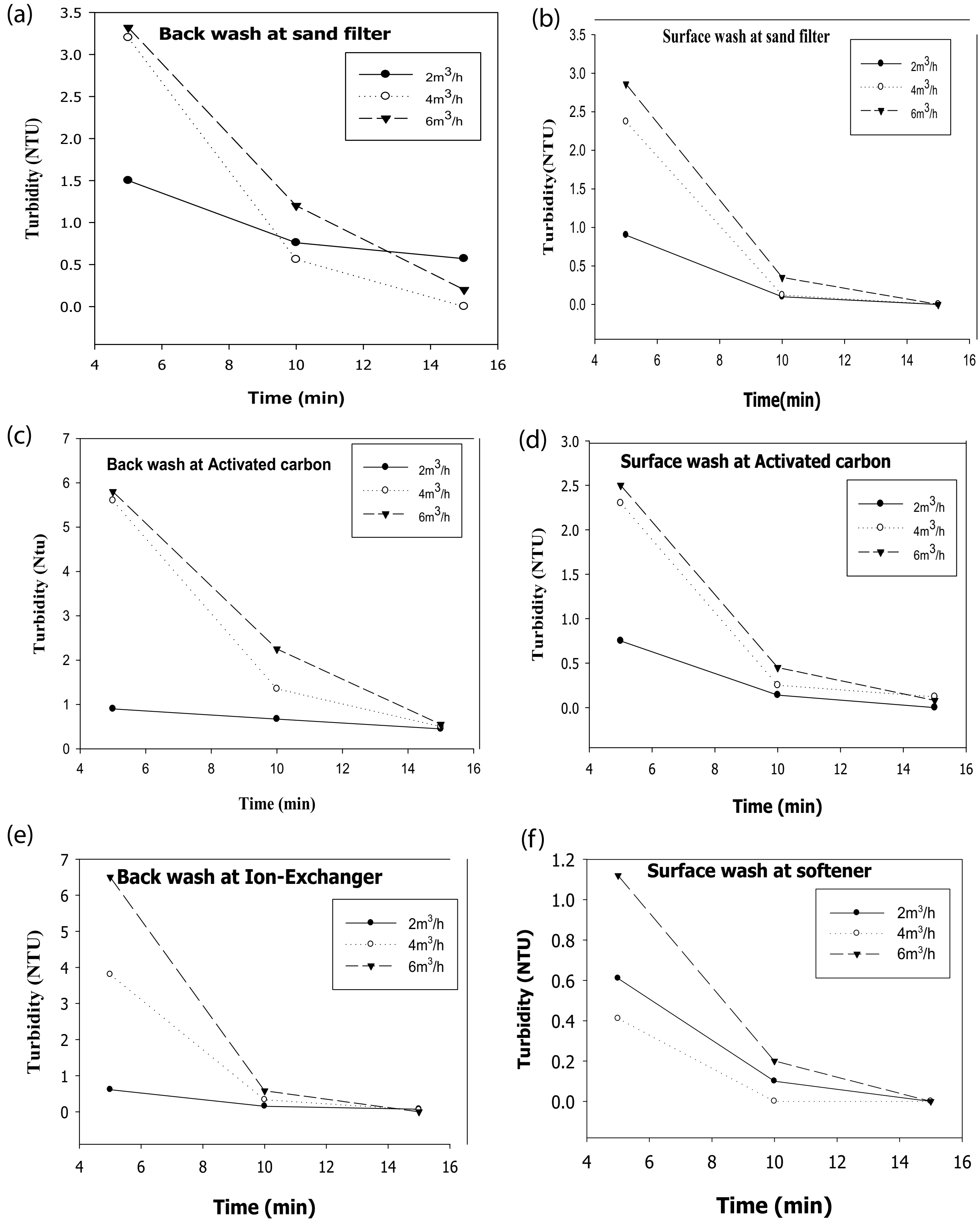

Fig. 3. Turbidity measure value at (a) sand filter BW and (b) SW, (c) activated carbon at BW and (d) SW, (e) ion-exchanger at BW and (f) SW.

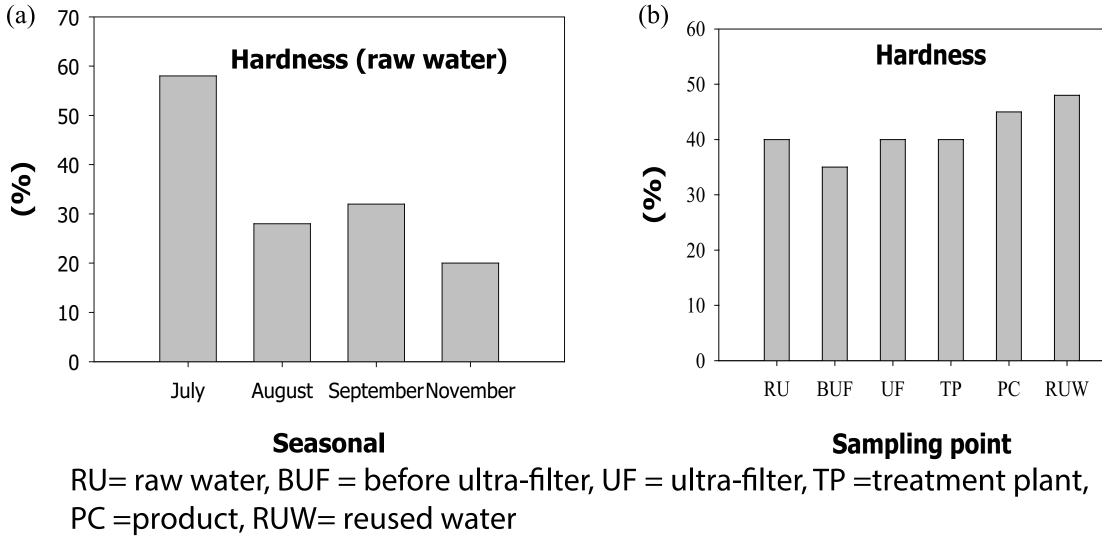

Fig. 4. The total hardness value of (a) RW at different seasonal and (b) different sampling points.

TDS value was observed at UF and this might be due to the high capacity of removing the dissolved materials and inorganic salts. However; all the values were within the standard limit of Ethiopian bottled drinking water specification and WHO (1,000 mg/L). Also, the study factory product water TDS value is from 50 to 65 mg/L almost similar to the experimental results. Thus, these ranges were tolerable and the concentration of TDS is not harmful and therefore, safe to drink in terms of TDS. Fig. 9a has shown the TDS value at a different flow rate within the different discharged times on the ultrafilter unit process. When the discharged flow rate increases from 10 to 30 m^3/h the removal of TDS on the membrane increase due to increasing the pressure. Separation has occurred in membrane ultrafilter through pressure difference. Due to the increase, the discharge flow rate of water at the up surface of the member acts as external pressure, enhances filtration. Thus, the result confirmed that the removal of TDS on this unit process does not depend on discharged time but only depends on the flow rate.

3.1.6. Nitrate

The nitrate level of all samples taken from the selected sampling points, raw water and collection tank was within the Ethiopian bottled drinking water specification and WHO permissible limit for drinking water (<50 mg/L). The measured value varies in a wide range between 1.12 and 13.6 mg/L. The highest is in the sand filter at 5 min washing time within 4 m^3/h flow rate and the lowest is in the ACF at 10 min washing time on 6 m^3/h flow rate. The nitrate-nitrogen content also varies from one unit operation into another (0.02–3.4 mg/L) but the recommended acceptable limit for drinking water is (<10 mg/L). Both nitrate and nitrate-nitrogen results were in the acceptable range based on Ethiopian bottled drinking water specification (ES 597, 2001), [18] and WHO drinking water standards. Fig. 7 has shown the nitrate content at flow rate 2, 4 and 6 m^3/h linearly decreases as the washing time increase from 5 to 15 min. The nitrate content at 5 min showed relatively high on both washing type. But after 10 min the nitrate concentration rapidly decreases. This may be due to the removal of accumulated nitrate content on this unit process. Therefore, washing after 10 min there is no significant effect on that bottled water quality by nitrate concentration even if all the results within the recommended range according to WHO and ES 597, 2001), [18].

3.1.7. Phosphate

As in the case of nitrate, phosphate also varies along with the treatment plant unit processes. In the present analysis phosphate values were found in a range of 0.01–0.72 mg/L. The maximum permissible limit according to WHO [19] has fixed it to be 0.1 mg/L. If the level becomes too high, plant growth can accelerate resulting in the dense growth of algae and plants in the water body. Phosphate concentration measured in ACF at 10 min washing time within 4 m^3/h is relatively or exceptionally high. Fig. 8 has shown the phosphate content at backwash and surface wash on different flow rate with different washing time decreases. However, after 10 min its reduction rate is different during both wash time. As shown decrease linearly the phosphate contents after 10 min washing times at ACF except at flow rate 4 m^3/h. The result shows after 10 min washing the discharged water for both back and surface wash low phosphate content was removed. Therefore, washing after 10 min at this unit process will not be necessary for the study factory in the future time. Figs. 8a and b show the phosphate content rapidly decreases after 10 min washing time at flow rate 2, 4 and 6 m^3/h except 6 m^3/h at backwash time.

3.1.8. Alkalinity

Alkalinity is a measure of the substance in water which has an acid-neutralizing ability. An alkalinity test measures the level of bicarbonates, carbonates, and hydroxides in water and test results are generally expressed as ppm

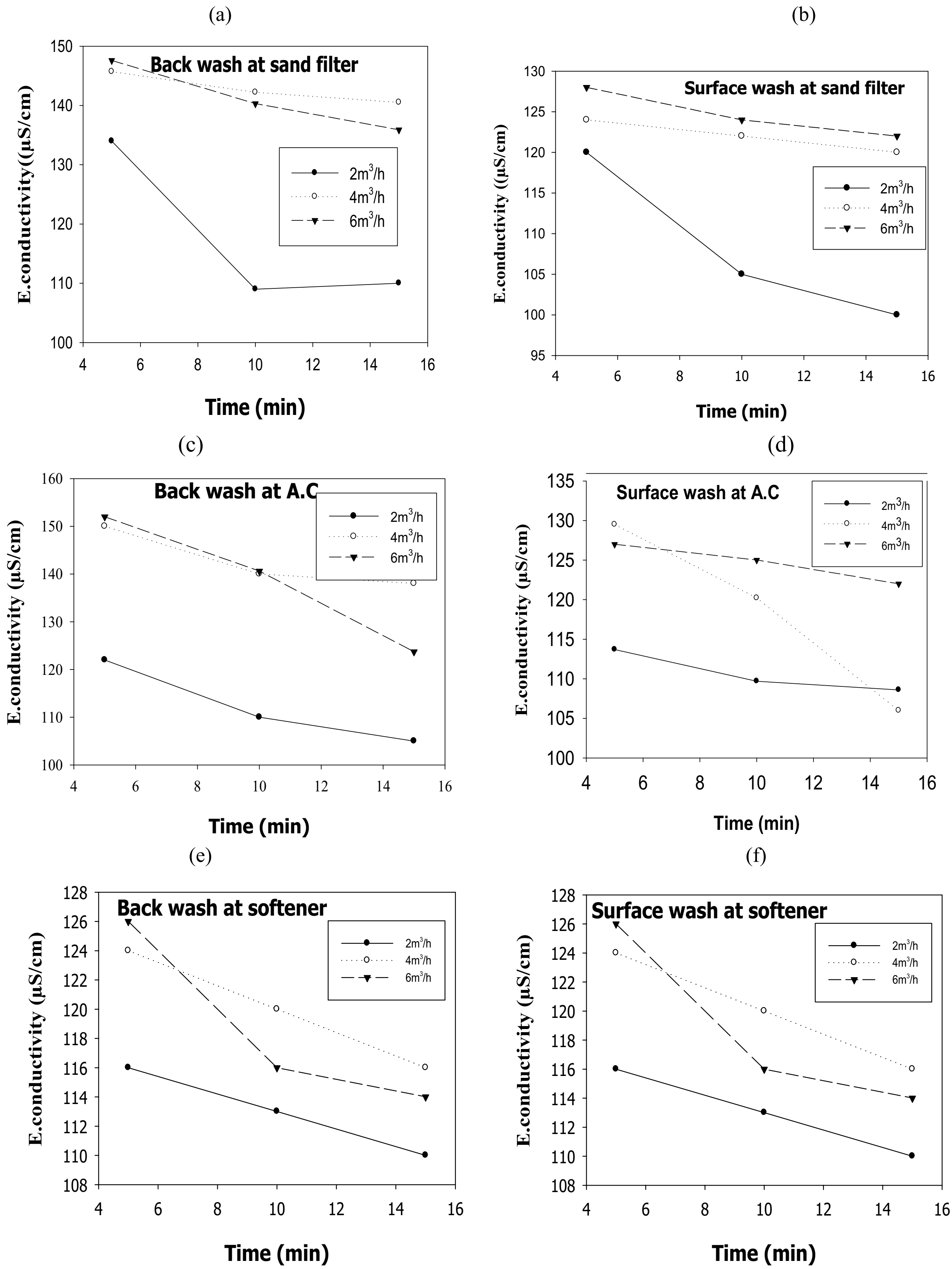

Fig. 5. Electric conductivity value at (a) sand filter BW and (b) SW, (c) activated carbon at BW and (d) SW, (e) ion-exchanger at BW and (f) SW.

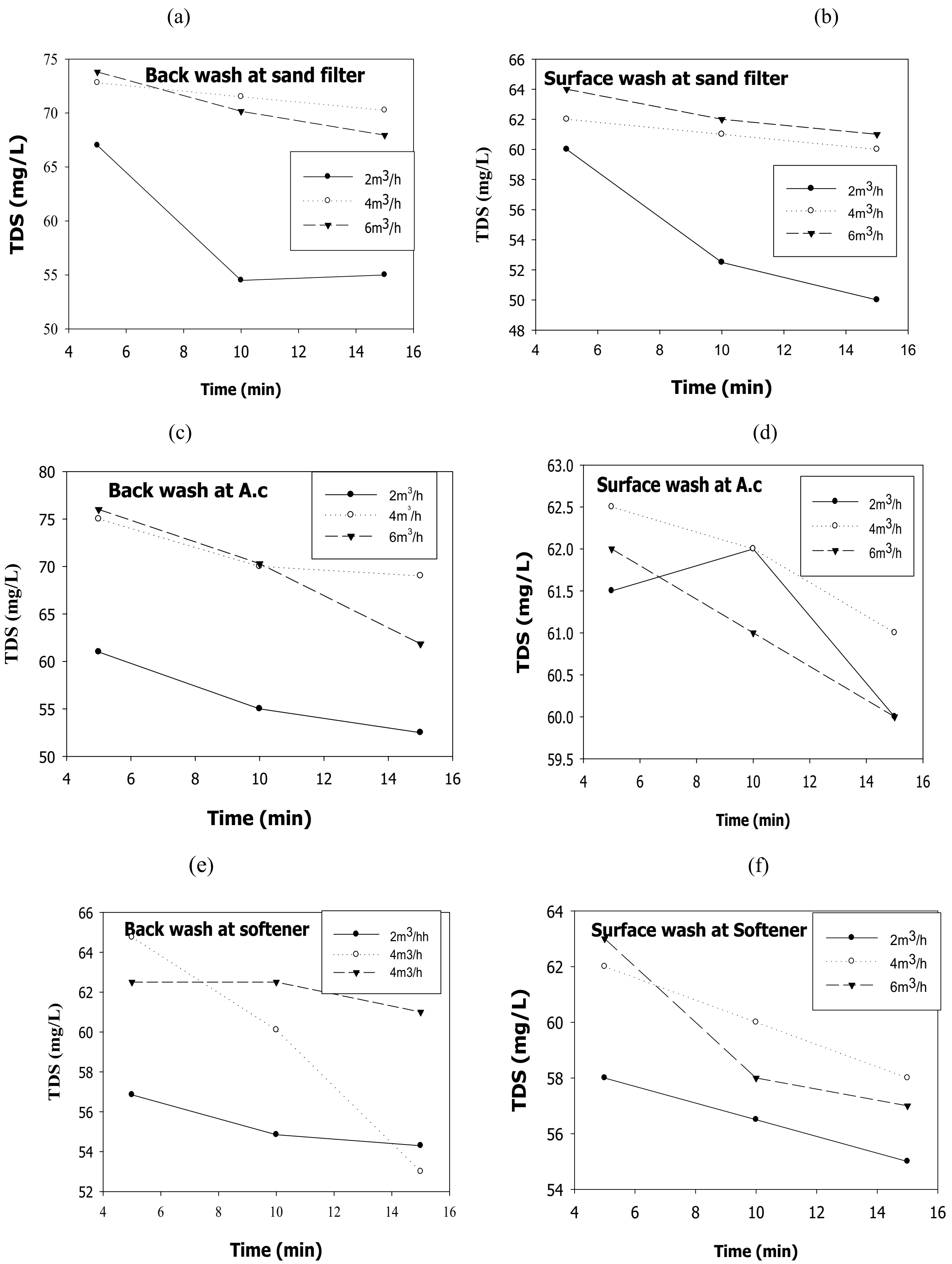

Fig. 6. TDS value at (a) sand filter BW and (b) SW, (c) activated carbon at BW and (d) SW, (e) ion-exchanger at BW and (f) SW.

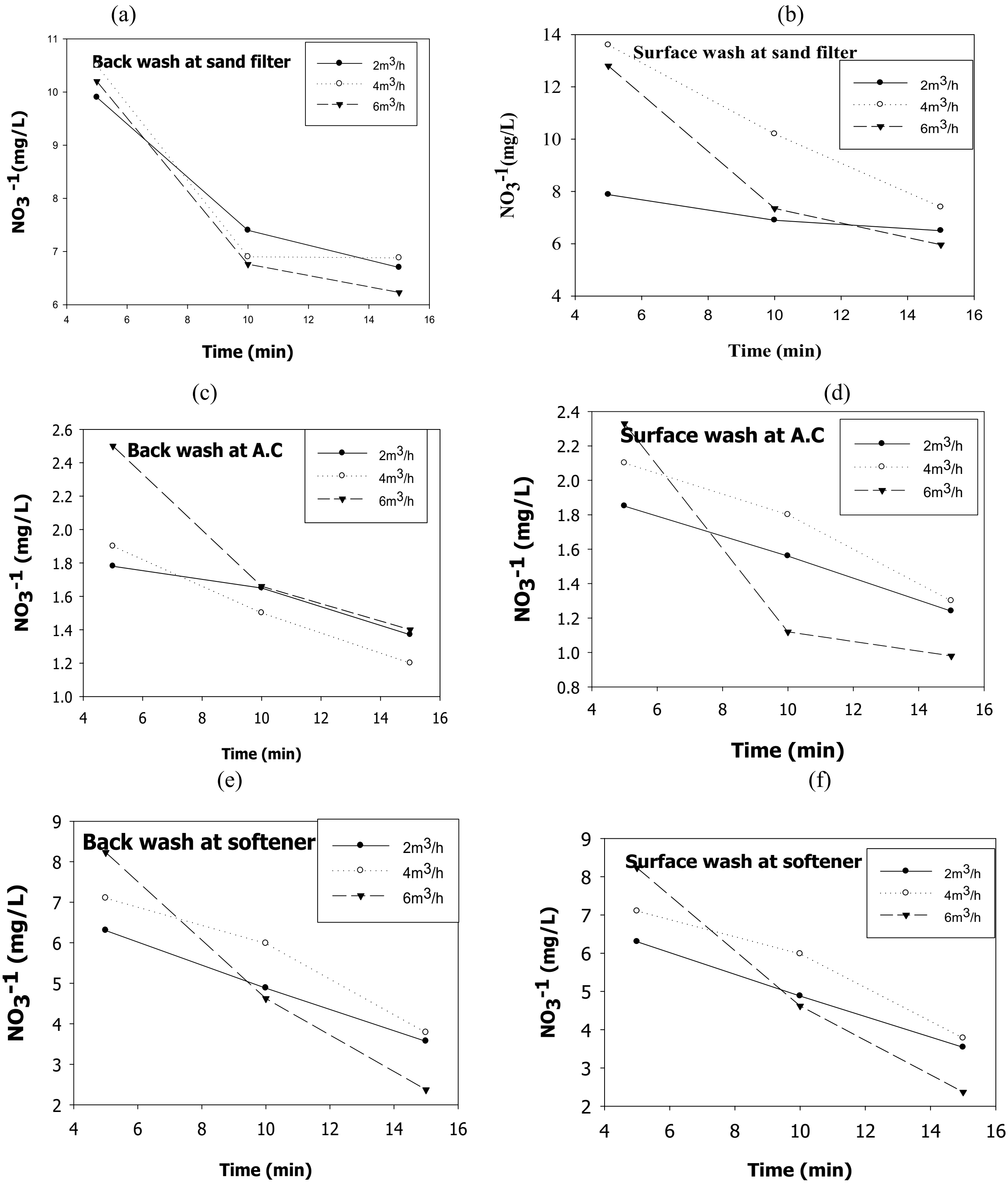

Fig. 7. Nitrate value at (a) sand filter BW and (b) SW, (c) activated carbon at BW and (d) SW, (e) ion-exchanger at BW and (f) SW.

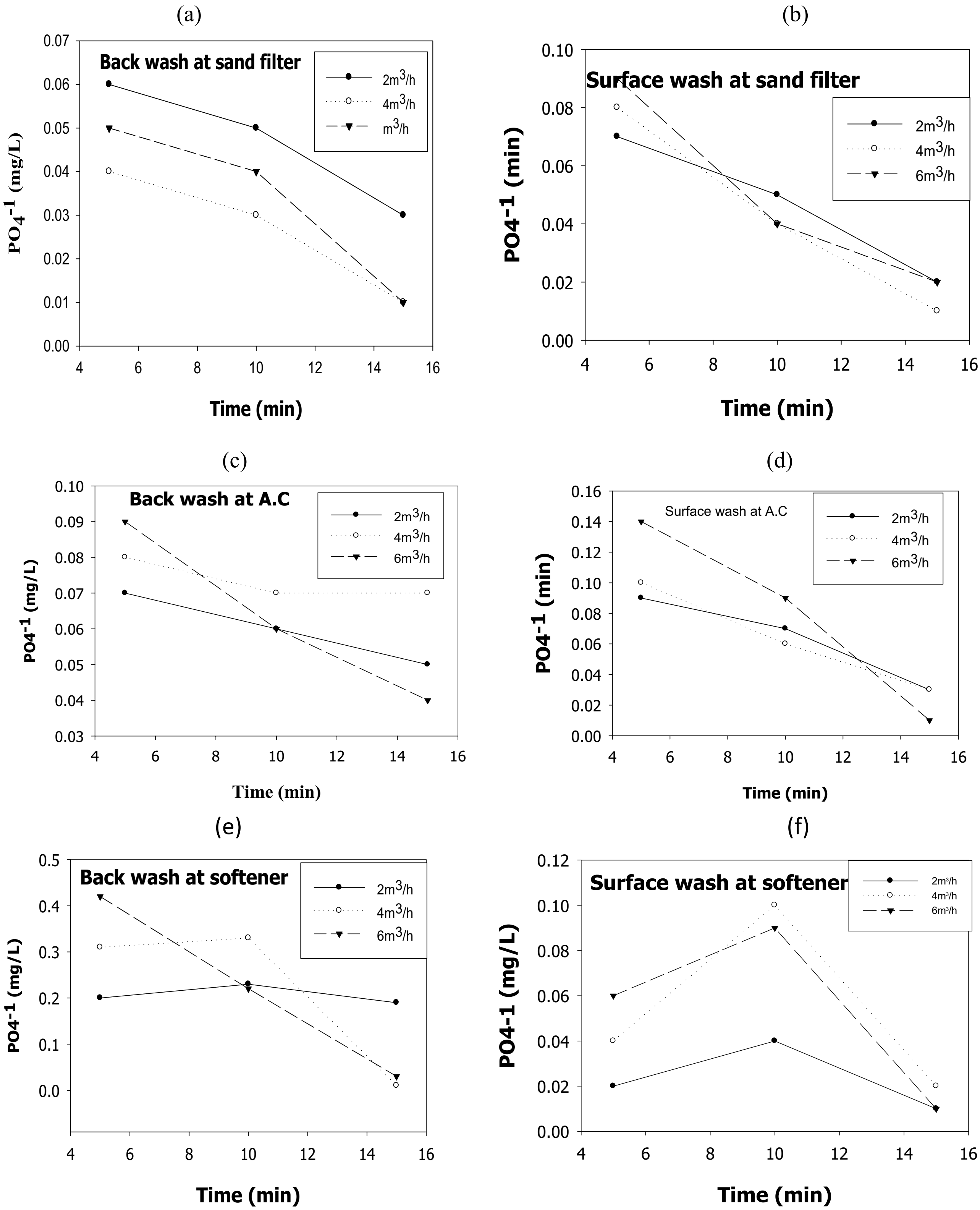

Fig. 8. Phosphate concentration value at (a) sand filter BW and (b) SW, (c) activated carbon at BW and (d) SW, (e) ion-exchanger at BW and (f) SW.

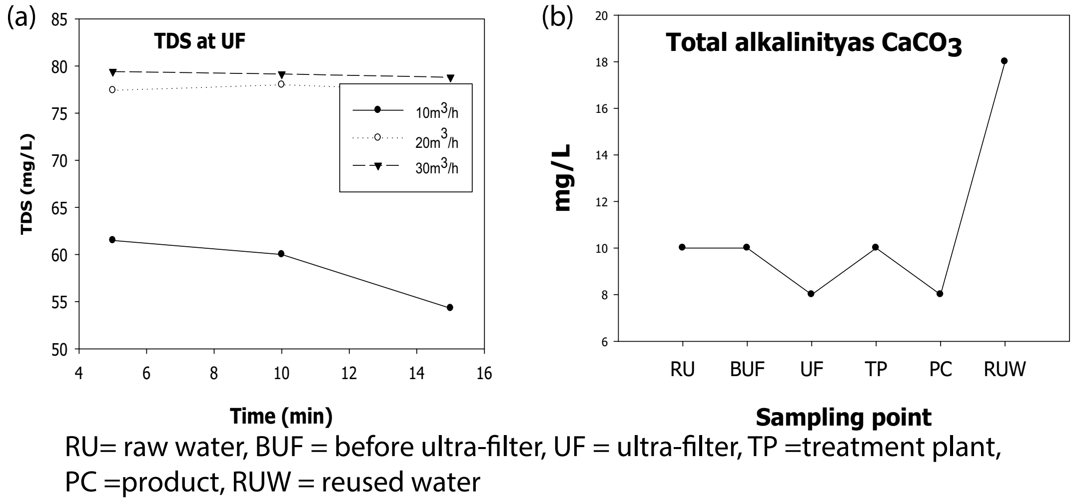

Fig. 9. TDS value at (a) UF and (b) total alkalinity at different sampling points.

of calcium carbonate ($CaCO_3$). In the current study from Fig. 9b shows that the total alkalinity ranged from 8 to 18 mg/L. Ethiopian bottled drinking water specification (ES 597, 2001), [18] has set the maximum value of alkalinity for drinking water to be 200 mg/L and according to WHO [16], it is to be 200 mg/L. Therefore, the discharged water that considering as wastewater by the study factory was safe to drink and no need farther treatment. In general, the discharged water at different unit operations or unit processes, the product water from the study factory, the raw water and the collected wastewater that come from the treatment plant different unit processes have almost the same value.

3.1.9. Other major ions concentration

Fig. 10 shows the major dissolved ion concentration at the different sampling points. The measured value of both calcium and magnesium of the different water samples were ranged from 2.69 to 2.88 mg/L and 1.44 to 1.56 mg/L respectively, but the recommended permissible limit for drinking water in Ethiopian bottled drinking water specification (ES, 597, 2001), [18] and WHO drinking water standard WHO [16] is 75 mg/L and 50 mg/L respectively. It clearly showed that the dissolved cation and anion concentration varies along with all sampling points and indicated that the concentration value has not caused significant health problems which is found in the standard range. The measured value of sodium in various water samples was found in the range of 0.85–1.2 mg/L and for potassium ion was obtained in a range of 5.96–7.35 mg/L. however, the maximum permissible level for drinking water in Ethiopian bottled drinking water specification (ES, 597, 2001), [18] and WHO drinking water standard WHO [16] is 200 mg/L for sodium and 50 mg/mL for potassium. Table 1 shows the comparison of an existence measured data with the Ethiopian bottled drinking water specification and WHO Maximum permissible level. As it shows clearly, all measured dissolved ions in different water samples are less than the standard specification which hence safe for potable purposes.

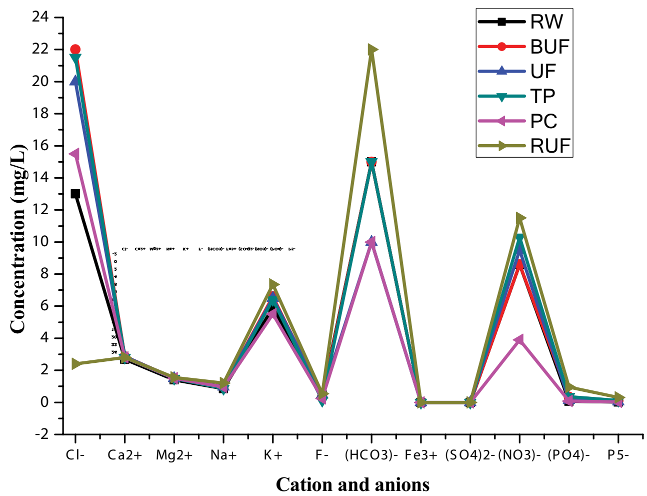

Fig. 10. Total dissolved ion concentration at the different sampling points.

3.2. Microbiological water quality

To know whether drinking water is free of disease-causing microorganisms, tests have been conducted in each sample. In the analysis total coli (TC), fecal coli (FC) and *E. coli* type1 were determined. Table 2 shows that in raw water there is the presence of TC and FC but *E. coli* type1 was absent. Total coliform, fecal coliform, and *E. coli* type1 count of the discharged water that considers waste comes from different unit operations shows more than the acceptable value of Ethiopian bottled drinking water specification (ES, 597, 2001), [19] and WHO guideline. The source of raw water had more than 1 MPN/100 mL which is beyond the guideline value of WHO. This might indicate inadequate sanitization, inadequate construction source water collection chamber due to agricultural fertilizer runoff. The raw water bacteriological analysis in August was 3 MPN/100 mL of TC and 1 MPN/100 mL of FC but *E. coli* type1 was absent whereas in September nil for all.

Table 1
Analyzed major ions dissolved in water and comparative with standard drinking water specification

Major ions dissolved in water	Measured at different unit process (mg/mL)	Ethiopian bottled drinking water permissible limit (mg/L)	WHO maximum limit (mg/L)
Bicarbonate	15–22	31	31
Calcium	2.69–2.88	75	75
Chloride	13–24	250	250
Fluoride	0.47–0.54	1.5	1.5
Iron	0	0.3	0.3
Magnesium	1.44–1.56	50	50
Nitrate	8.6–11.5	50	50
Phosphorus	0.02–0.31	0.1	0.1
Potassium	5.96–7.35	50	50
Sodium	0.85–1.2	200	200
Sulfate	0	250	250
Phosphate	0.01–0.95	0.085	0.09

Table 2
Microbiological analyzed water at the different unit process

Sampling points	TC (MPN/100 mL)	FC (MPN/100 mL)	*E. coli* type1	Ethiopian BDWS	WHO guidelines
RW	5	2	–	–	–
SF	0	0	–	–	–
ACF	0	0	–	–	–
SOF	0	0	–	–	–
UF	0	0	–	–	–
TP	0	0	–	–	–
RUF	0	0	–	–	–

– absent

Of all the samples tested in this study free chlorine residual (FCR) value, 2.43–4.25 mg/L on the sand filter during backwash time and 0.03–3.05 mg/L at surface wash but the rest showed between 0.0–0.23 mg/L. Free chlorine residual measured in this study showed a decreasing trend as it goes from sand filter to ultrafilter. The study factory used calcium hypochlorite as a disinfectant in the reservoir tanks in pre chlorination system. Exceptionally a high value of FCR was observed on sand filter unit operation whereas the unit process is very less recorded, it may be the FCR absorbed by ACF. In general, the discharged water that considering wastewater by the study factory the result shows safe water to drink based on the WHO drinking water standard and Ethiopian bottled drinking water specification (ES 597, 2001), [18] fulfill the bacteriological requirements. From Table 2, raw water result shows the total and fecal coliform bacteria above the permissible limit value but *E. coli* type1 was absent this indicated that easily treated or disinfected by chlorine and improving the sanitation time.

4. Conclusion

The study considers public issues related to discharged wastewater quality to reuse for potable purposes. It will give a brief understanding of the bottling factory on the consumption of treated wastewater as a freshwater source based on laboratory results. Physical water quality requirements (temperature, color, odor, taste, turbidity, EC, TDS, and pH) were within the recommended ranges by the Ethiopian bottled drinking water specification and WHO drinking water standards. Similarly, the chemical water quality requirements (alkalinity, nitrate, nitrate-nitrogen, hardness, sodium, potassium, fluoride, iron, etc.) were within the recommended ranges. On the other hand, the phosphate level was above the recommended range. From each selected flow rate and washing time at each unit process, the bacteriological analysis has shown the discharged water being free from coliform bacteria though the raw water showed total coliform and fecal coliform bacteria in the absence of *E. coli* type1. Regarding the washing time rate, there is no significant change in physical, chemical and bacteriological parameters. In general, the discharged water contains the deposited free residual chlorine which resulted in absence of pathogenic microorganism. Thus, it concludes that based on the three-basic water quality parameter results, the discharged water from the different unit process on a daily basis can be used as an alternative source of water for the potable purpose. Investigation of phosphate has shown values ranging between 0.01 to 0.95 mg/L. it is recommended to neglect the phosphate by using the chemical methods that can be approached for phosphate removal include the chemical precipitation method and electrocoagulation method. In addition, the physicochemical methods for removal of phosphate involve the usage of polymer hydrogels and the sorption process In general this shows that there is no need for advanced treatment. Therefore, the bottling water factory can produce in full production scale having the minimum freshwater requirement.

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