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Comparison of Brita and Profissimo water filters

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Abstract
This research was focused on testing two water filters - Brita and Profissimo, which were filtering two and five liters of water every day. The lifespan of used filters is four weeks, while they have been actively used for eight weeks in this study to check for their efficiency after exceeded usage. Along with this, the quality of tap water, which was filtered using these two types of filters, was also tested. The experiment of the whole study was divided into three main stages: microbiological analysis, biochemical analysis, and UV-VIS spectrophotometric analysis of filtered water. The measurements were done every five days. The aim was to compare the performances of Brita and Profissimo filters after the completion of the required experiments. Based on the results that are obtained from all the analyses mentioned previously, we can conclude that Brita 2l filter was the most efficient, while Profissimo 5l filter appeared to be the least effective filter. It is important to emphasize that the tap water in Sarajevo is generally clean and drinkable, so there is a possibility that when using more polluted water, greater deviations in the operation of filters can be observed. Overall, both water filters were usable even after two months of active usage and our measurements showed good water quality which lacks impurities and is safe for drinking.

Keywords: Water filters, water conductivity, total dissolved substances, water pathogens, HM hydrotester

1. Introduction

Water is considered one of the main sources of life on Earth. Water is among the six necessary nutrients (along with carbohydrates, protein, fat, vitamins, and minerals). It makes up approximately 60-70% of our body, and we can function only for three to five days lacking liquids. Water performs various significant functions throughout the body, including waste removal, temperature regulation, nutrition transfer, and digestion [1]. In Sarajevo, the primary and secondary water supply networks are approximately 1,064 km long. There are 47 supply zones, 36 wells, 55 reservoirs, 24 pumping stations with 70 pumping devices, and 11 hydroflex plants in the water supply system [2].

High levels of water pathogens make water unsafe for human consumption. The typical water pathogens include *Escherichia Coli, Legionella, Coliform* bacteria, *Pseudomonas aeruginosa, Salmonella*, Hepatitis A, *Cryptosporidium,* and *Giardia* [3]. Water pathogens enter the host when the host comes into contact with contaminated water. Contact includes drinking contaminated water or when the untreated water comes into

contact with the host's skin [4]. Some of the symptoms of infections caused by water microbiological pollutants are vomiting, dehydration, diarrhea, high fever, rash, cramping, abdominal pain, and even death. Being made up of hydrogen and oxygen, chemical elements, water is a substance that exists in three different states: liquid, solid, and gas. Among the most frequent and necessary chemicals, it has no taste and odor at room temperature and possesses the ability to dissolve various other compounds. In comparison to the majority of other solvents, water has a high melting point and boiling point, and a vaporization heat. Water is a polar solvent. Many biomolecules, which are typically charged or polar substances, dissolve easily in it [4]. Natural water contains several minerals, such as calcium, magnesium, potassium, phosphate, and carbonate. Water hardness is determined based on the total concentration of Ca2+ and Mg2+ in parts per million (ppm) or milligrams per liter (mg/l) [2], [3].

On the way from the natural source to our home tap, water picks up many unwanted substances that could be harmful to our health. Tap water often contains pollutants, pathogens, and scale, and may have an unpleasant taste and smell. One of the ways we can reduce the impurities in the water we drink is by using home filtration systems. There are several different types of water filters, the best known of which are mechanical filters that physically separate impurities from the water. Also, carbon filters have proven to be excellent at absorbing and removing contaminants, such as chlorine. For water softening and demineralization, water filtration technology with ion exchange is frequently used, in such a way that unwanted dissolved ions are exchanged for other ions with a similar charge [5].

Brita standard filters assimilate multiple processes to filter water. The water passes through a mesh screen that removes black flecks, which then passes through a part of the filter with an active carbon that helps remove chlorine and the unpleasant smell of the water. Meanwhile, an ion exchange resin captures copper, zinc, and other heavy metals. For optimal results, the filter is not recommended to be used for more than 4 weeks. The first liter of filtered water should not be used for drinking, due to the possible turbidity of the water [6].

Profissimo filters use two technologies for water purification, the first of which is ion exchange technology and activated carbon technology contributes to the filtering of organic impurities and substances that can affect the taste of water. It is recommended for only tap water to be used for this filter. The filter should be replaced with a new one after 4 weeks of use. The first two liters of filtered water are not recommended for drinking, due to the possible appearance of activated carbon particles or other substances in the water.

This project was focused on testing and comparing the two most popular water filters available on the market, intended for home usage - Brita and Profissimo. Both Brita and Profissimo water filters have specific properties for usage and filtering, as well as different commercial prices. We wanted to test the efficiency of two filters and whether they will be affected or changed over eight weeks of active usage. The filtered water was tested for 16 different parameters, which include pH, hardness, hydrogen sulfide, iron, copper, lead, manganese, total chlorine, mercury, nitrate, nitrite, sulfate, zinc, fluoride, sodium chloride, and total alkalinity. Based on the experiments that were required and results obtained in this project, we want to conclude whether there will be any changes between filters after approximately two months of usage. Thus, this project aimed to test the quality of the filtered tap water by checking the potential presence of microorganisms and to compare the final results between Brita and Profissimo water filters.

2. Research method

Water samples from the faucet were collected in sterile tubes to prevent further contamination. To avoid accumulated impurities, tap water was run for 5 – 10 seconds at first. In total five samples were needed; control, 2l Profissimo, 5l Profissimo, 2l Brita, and 5l Brita. Control water was collected three times for 500ml, separating ~1,5ml into an Eppendorf tube, which is needed for further analysis, and marking it with the letter C, as denotation for control. For filtration using 2l Profissimo, 5l Profissimo, 2l Brita and 5l Brita filter, a pitcher with an appropriate filter was used, where tap water was collected three times for 500ml. Approximately 1.5 ml of water was separated into an Eppendorf tube, marking it with 2P, 5P, 2B and 5B.

Solid nutrient mediums (LB agar plates) were used. For each measurement, 5 LB Agar plates were used. Each plate was marked with a date and the name of the water sample – C for Control, B2 for Brita 2l filter, B5 for Brita 5l filter, P2 for Proffisimo 2l filter, and P5 for Proffisimo 5l filter. Adding 150 µl of each water sample to corresponding plates and spreading it out with an inoculation loop will implant potential bacteria in the samples. After each inoculation, the inoculation loop was sterilized by heat, in order to prepare it for the next sample. When all samples were done, inoculated LB Agar plates were placed in an incubator at 37°C overnight. Colonies were counted the next day if there were any. They were marked in the table as colony-forming units or CFUs for short.

In this experiment, two types of biochemical analyzes of water quality were performed.

The first analysis of water was conducted by using the HM hydrotester, which measures the electrical conductivity of water (EC), total dissolved solids (TDS), and water temperature. Electrical conductivity is measured in microsiemens per centimeter (uS/cm) and the electrical conductivity of drinking water should not exceed 400 µS/cm [7]. Total dissolved solids (TDS) include any salts, minerals, metals, anions, or cations that are dissolved in water, such as calcium, bicarbonates, chlorides, sulfates, magnesium, potassium, etc. TDS is measured as a volume of water with the unit milligrams per liter (mg/l), also known as parts per million (ppm). The TDS level of water that is considered the most suitable and acceptable ranges between 50 and 150 ppm.

Water quality analysis by HM hydrotester was performed on a total of fifteen water samples of 500 ml:

1. Three samples consisted of unfiltered water, also known as the control.
2. The other three water samples consisted of water filtered with 2l Brita filter.
3. Three samples consisted of water that was filtered with a 5l Brita filter.
4. Three samples of water were filtered with a 2l Profissimo.
5. Three samples consisted of water filtered with a 5l Profissimo filter.

To measure TDS, EC, and water temperature, it is necessary to place the HM hydrotester in the water sample, which will read the required parameters within a few seconds. In order to obtain the most accurate results, the average of 3 values will be calculated for each sample and it will be considered as the final measurement result for that sample.

The second water quality analysis was performed by using Varify test strips, with which we measured changes in substances that are dissolved in water, along with the pH level. The substances that were measured include Iron, Lead, Copper, Nitrate, Nitrite, Flouride, Manganese, Zinc, Sulfate, Hardness, Total Alkalinity, Free Chlorine, Total Chlorine, Hydrogen Sulfide, and Sodium Chloride.

Water quality analysis by Varify test strips was performed on a total of five water samples of 500 ml:

1. A sample of unfiltered water, better known as the control.
2. A sample of water that was filtered with a 2lBrita filter.
3. A sample of water that was filtered with a 5l Brita filter.
4. A sample of water filtered with a 2l Profissimo filter.

5. A sample consisted of water filtered with a 5l Profissimo filter.

Varify measuring strips enable effective measurement of changes in substances in water in just a few seconds. To analyze a substance in a water sample, it is necessary to take one test strip and dip it into the water sample for two seconds. Then it is important to remove the strip from the water, gently shake off the rest of the water from the strip and compare the strip with the color chart provided on the box. However, it is important to quickly compare the color changes on the strips, because this is a time-sensitive test.

When water samples are placed in the UV-VIS spectrophotometer, the machine emits light at a given wavelength (in this experiment it is from 200 to 1000 nm) and at the same time measures the amount of light that is being absorbed by the water. Since water is the main solvent used to dissolve different molecules and substances, as well as samples of interest, the purity of the water is crucial in spectrophotometry analysis. The principle of UV-VIS spectrophotometry is based on the substance molecules in the water that can absorb UV-

VIS light of a specific wavelength and the correlation between the absorption spectrum and the concentration of the substance [8].

For the UV-VIS spectrophotometry in this experiment, a 96-well plate was used and 200ul of triplicates of each of the following samples were put into their corresponding wells:

1. Blank – distilled water (dH_2O)
2. Control – tap water
3. 2l Brita filtered water
4. 5l Brita filtered water
5. 2l Profissimo filtered water
6. 5l Profissimo filtered water

All samples above are kept in the Eppendorf tubes before placing 200ul of each one in the spectrophotometer. The absorbance is measured using a UV-VIS spectrophotometer with the appropriate protocol, i.e., full absorption range (from 200 to 1000nm), every 10nm. After the spectrophotometric measurement is finished, the results of every measurement are uploaded online in the appropriate Excel sheets and are tracked and analyzed for reporting the result of this experiment.

3. Results and discussion

Table 1. shows the results of the microbiological analysis that was done in order to detect the presence of bacteria found in tap water and filtered water samples. The presence of bacteria was not detected in the control water samples or in water filtered with Brita and Profissimo filters. Regarding the first measurement, only one colony was found in a 2l water sample filtered with a Brita filter, which can be explained as a contamination issue during the inoculation of the sample. On the other hand, the study limitation is that the control water sample, before using filters, has already been on the satisfying level of CFUs. Moreover, the results of the analysis performed by the KJKP "Vodovod I Kanalizacija" d.o.o. Sarajevo indicates that water in the public water system is safe to drink.

Table 1. Table shows results of microbiological analysis

Measurement	Water sample	Colony forming units
1st	Control	0
	2l Brita	1
	5l Brita	0
	2l Profissimo	0
	5l Profissimo	0
7t	Control	0
	2l Brita	0
	5l Brita	0
	2l Profissimo	0
	5l Profissimo	0
12th	Control	0
	2l Brita	0
	5l Brita	0
	2l Profissimo	0
	5l Profissimo	0

Figure 1. represents the changes in the performance of the filters used, over 13 measurements, normalized to the control water. As can be seen from the graph the TDS of all samples gradually increases. Water filtered using a Brita filter which filtered 2 liters of water per day had the lowest TDS values throughout the whole experiment. The analysis of the water filtered by the Profissimo filter that filtered 5 liters of water per day showed that it had averagely the highest total dissolved substances values at the end of the research. This is due to the decrease in the quality of water filtering. However, it is important to emphasize that all filters have worked

efficiently when we talk about the reduction of TDS even after a month of active use, which is when it is recommended to replace the filters.

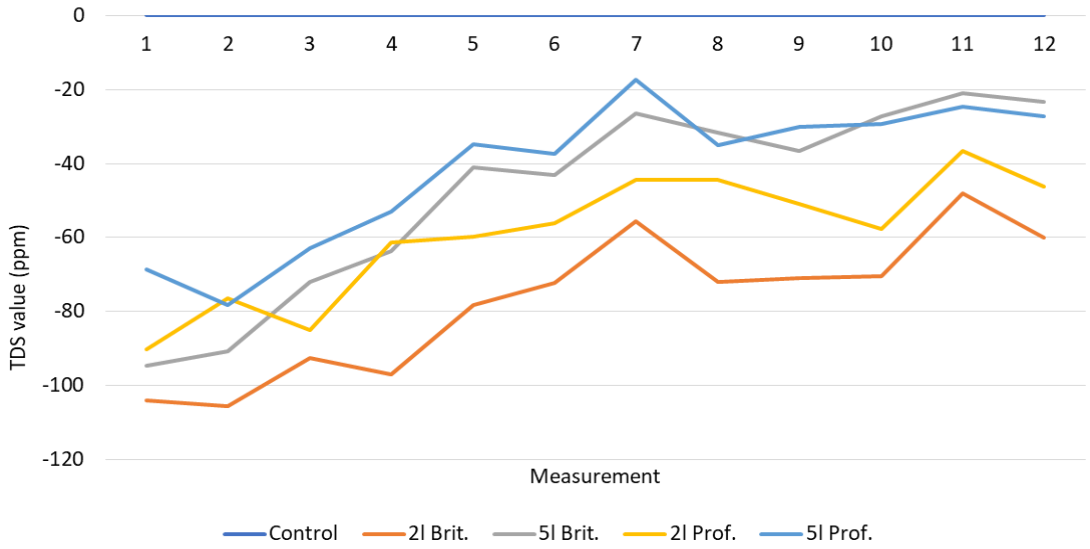

Figure 1. Graph results of total dissolved substances values normalized to control

Figure 2. shows the trend of electrical conductivity of filtered water using each filter over the course of 13 measurements normalized to the control samples. As can be seen from the graph, conductivity gradually increased over the given period. Water filtered with Brita 2l filter had the lowest value of conductivity throughout the experiment; while Profissimo 5l filtered water had the highest values of conductivity that continued to increase until the 13th measurement. The conductivity of water increases along with salinity and the number of contaminants present in water (dissolved compounds, charged chemicals, and minerals), which can be detrimental to the quality of water. This can be particularly seen in the example of the Brita 2l filter which performed the best as it initially had high values of conductivity to be eventually decreased to a very low value at the final measurement. The electrical conductivity of water filtered with Brita 5l also decreased, but still, it had a high value of conductivity at the final measurement compared to other filters.

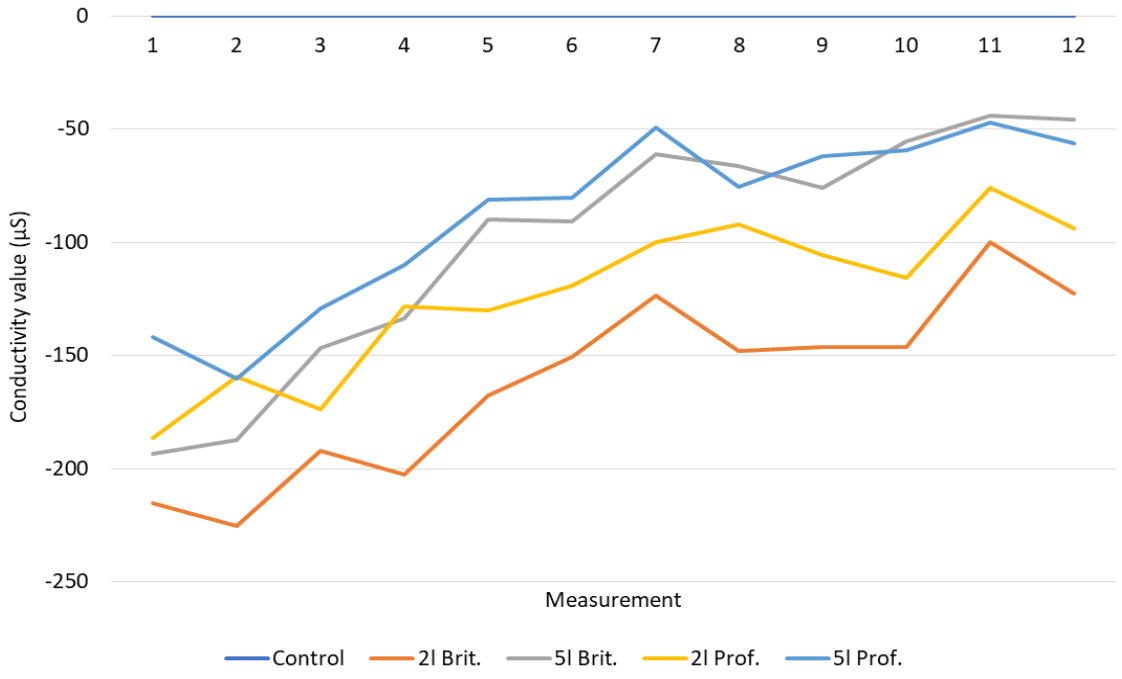

Figure 2. Graph results of conductivity values normalized to control

Table 2. represents the results of the 16 most important contaminant parameters that can be found in water. As it can be seen from the table, pH of all water samples ranges from 6 to 7, satisfying the recommended pH level of water. Water is considered soft to hard with a maximum parameter of 100ppm (1ppm=1mg/l), and in this case, the highest level of hardness was 100. The first measurements of water samples show the concentration of iron in control as 0.15ppm, while 0.3ppm is tolerated maxima. Regarding copper contaminants, 1ppm is the highest value, while more than 15ppm of lead is showing signs of higher contamination. Total chlorine and nitrate are acceptable with ppm of 3 and 10 and in this case, both values are satisfying. Nitrite and zinc, have values 0.75ppm and 5ppm and those should not be above the 1 and 5ppm limit, contrasting to sulfate in the first measurements of control, 2l and 5l water samples filtered with Brita filter range between 400ppm and 800ppm, where 200ppm is only tolerated. The values of fluoride and sodium chloride are below the recommended maximum of ppm, 4ppm and 250ppm precisely. The last parameter observed is total alkalinity which ranges between 40ppm and 180ppm, and has results among the allowed parameters. Results were observed according to the color chart of the Varify water test kits. Overall, most of the results were within the allowed parameters that prove that the quality of the control as well as the filtered water is satisfactory.

Table 2. Important contaminant parameters of water

	Measurement	pH	Hardness	Hydrogen Sulfide	Iron	Copper	Lead	Manganese	Total Chlorine	Mercury	Nitrate	Nitrite	Sulfate	Zinc	Fluoride	Sodium Chloride	Total Alkalinity
	Control	6.875	25	0	0.15	0	5	0	0.2	0	0	0.75	400	5	3	100	0
	2l Brit.	6	18.75	0.075	0	0	0	0	0.25	0	0	0	800	0	0	0	0
1	5l Brit.	4.5	0	0	0	0	0	0	0.05	0	0	0	800	0	0	0	0
	2l Prof.	6.5	0	0	0	0	0	0	0	0	10	1	0	0	0	0	0
	5l Prof.	6.5	30	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	100
	Control	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80
	2l Brit.	6	0	0	0	0	0	0	0.2625	0	0	0	1200	0	0	0	0
5	5l Brit.	6	0	0	0	0	3.25	0	0	0	0	0	0	0	0	0	20
	2l Prof.	6	0	0	0	0	0	0	0	0	0	0	100	0	0	0	40
	5l Prof.	6	0	0	0	0	3	0	0.2	0	0	0	0	0	0	0	0
	Control	6	18.75	0	0	0	0	0	0	0	0	0	0	0	0	0	60
	2l Brit.	6	18.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	5l Brit.	6.375	6.25	0	0	0	0	0	0	0	0	0	0	4.5	0	0	0
	2l Prof.	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5l Prof.	6	0	0	0	0	5	0	0.0625	0	0	0	0	0	0	0	0

Figure 3. and Figure 4. represent the graphs from the first and twelfth measurements. Among thirteen measurements, they have the most outstanding results. Every filtered water showed similar absorption rates and the control had slight deviations. Peaks that are captured between 200 nm and 350 nm are due to the properties of water. Figure 3 shows no unusual deviations from the parameters of clear water, the filters decreased the absorption rates of molecules in water or in other words, filtered the water properly. In Figure 4, a major peak can be seen within Brita 5l water sample, but their value is up to 0.04 which can be neglected. Therefore, we can say that there were several insignificant traces of different elements in each water sample. This proves that mentioned filters filtered the tap water effectively.

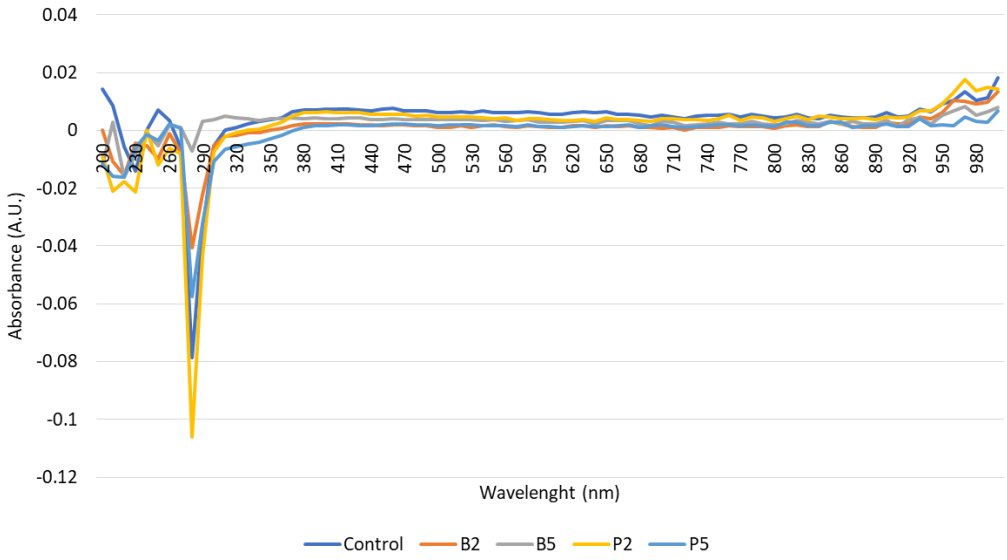

Figure 3. Graph results of UV-VIS spectrophotometry analysis after first measurement

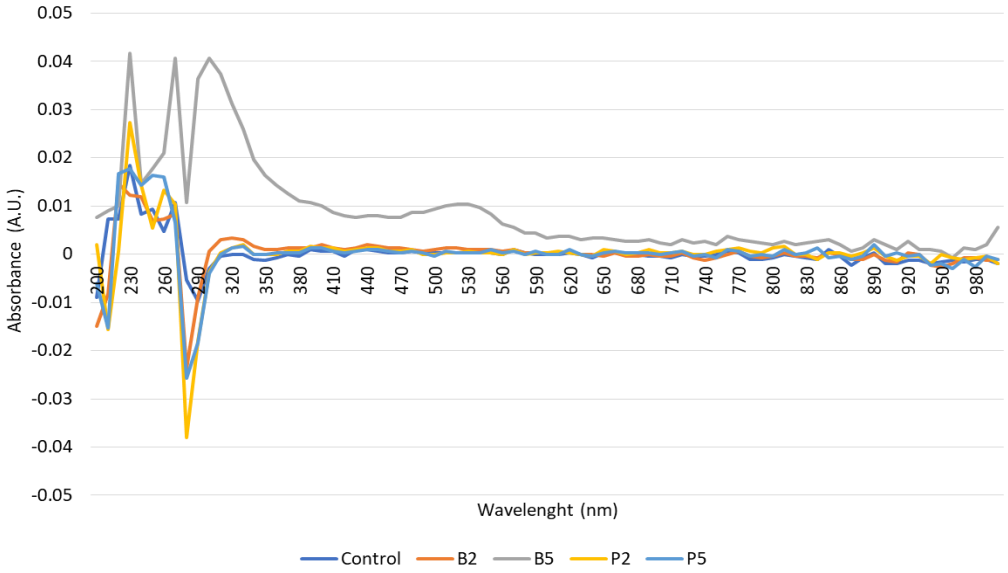

Figure 4. Graph results of UV-VIS spectrophotometry analysis after twelfth measurement

4. Conclusion

Water filters are used all around the world in order to improve quality and purify drinking water at home. Brita creates one of the best filters on the market; it claims to last up to four weeks. Profissimo is less popular, however, it provides an excellent and cheaper alternative for Brita filters which also claims to efficiently filter water for up to four weeks. In this graduation project, the efficiency of Brita and Profissimo filters was tested, and the differences in their performances, as well as the differences in the results given by the filters when filtering a larger and smaller amount of water for two months. It can be concluded that both Brita and Profissimo filters had good results within both months of testing with a slight decrease in performance in the second month of the experiment. Nevertheless, both filters are usable even after one month. The water was purified and drinkable after filtration even at the end of the second month. The experiment confirmed that the Brita filter had better performance than the Profissimo filter. More precisely, the Brita filter that filtered 2 liters of water per day showed the best performance, while the Profisimo 5l filter proved to be the least efficient. Lastly, it is important to mention that the tap water in Sarajevo is of good quality and drinkable, so there is a possibility that greater deviations in the operation of the filters would be observed if water containing more impurities was used.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

The contribution to the paper is as follows: Selma Kozarić, Adna Hrapović, Aiša Trebo, Ajla Tipura: study conception and design; Selma Kozarić, Adna Hrapović, Aiša Trebo, Ajla Tipura: data collection; Selma Kozarić, Adna Hrapović, Aiša Trebo, Ajla Tipura: analysis and interpretation of results; Selma Kozarić, Adna Hrapović, Aiša Trebo, Ajla Tipura: draft preparation. All authors approved the final version of the manuscript."

Ethical approval statement

Ethical approval is not applicable for this research.

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