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ASSESSMENT OF TOTAL ORGANIC CARBON (TOC) IN DRINKING WATER AS A PRECURSOR INDICATOR OF CHLORINATION BY-PRODUCTS, SUCH AS TRIHALOMETHANES (THMs), IN THE CITY OF TIRANA

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ABSTRACT

High-quality drinking water is essential for public health. The city of Tirana is supplied with drinking water from two main sources: the Bovilla Reservoir and the Selita Spring, as well as several other secondary sources. The Bovilla Reservoir has a fully operational treatment plant and produces approximately 2400 L/s of drinking water, covering about 60% of the city's needs. Meanwhile, the water from the Selita Spring is treated only with chlorine. This study aims to assess the Total Organic Carbon (TOC) content in these water sources, considering TOC as a precursor for the formation of trihalomethanes (THMs), and to evaluate the efficiency of the Bovilla treatment plant in reducing TOC levels. The removal of natural organic matter prior to disinfection is essential to minimize the formation of undesirable chlorinated organic compounds. The study involved the analysis of samples collected from both the supply sources and the distribution network, with a total of 189 samples gathered over a 9-month period, at a monthly sampling frequency. The parameters analyzed include: TOC, pH, free chlorine, conductivity, and turbidity, according to the relevant ISO standards. TOC was measured using the SHIMADZU instrument. Results: The highest TOC value was recorded in the Bovilla reservoir water in September (3.6 mg/L). Elevated TOC levels were also recorded during winter: 2.38 mg/L at the treatment plant outlet and 2.53 mg/L in the distribution network. The average TOC removal efficiency of the Bovilla treatment plant was estimated at 19.10%, reducing the average TOC content to 2.07 mg/L in the water entering the distribution network. This value approaches the EPA-recommended limit (TOC <2 mg/L), where at this level of organic content, the risk of THM formation does not exceed the permitted limit according to the EU directive (100 µg/L). The water from the Selita Spring showed lower TOC values (<2 mg/L) both at the source and in the network and is considered safer in terms of THM formation potential.

Keywords: Drinking water, TOC (Total Organic Carbon), THM (Trihalomethanes), water treatment, disinfection, water quality, distribution network.

INTRODUCTION

High-quality and safe drinking water is essential for public health and well-being. In order to be considered safe and clean, drinking water must be free from microorganisms and any substances that, at certain concentrations, can be harmful to human health. According to WHO and EU principles, to increase the safety and quality of drinking water, its parameters must be regularly analyzed (1). Based on these principles, this study aims to evaluate the parameter of Total Organic Carbon (TOC). As a result, the number of physicochemical indicators analyzed in water intended for human consumption in our country will be expanded. As water flows through rock formations and soil, it absorbs both inorganic and organic matter. The organic matter found in surface and groundwater is primarily natural organic matter (NOM), which originates from living or decaying vegetation, dead biomass of plants and animals, and soil erosion. This organic material is measured as Total Organic Carbon. It exists in particulate, dissolved, and colloidal forms and is highly resistant to biodegradation but reactive with oxidants such as chlorine, leading to the formation of disinfection by-products (DBPs). One of the main strategies for reducing DBP concentrations involves modifying water treatment processes to minimize THM (trihalomethane) formation during chlorination (3). This is achieved by controlling the water source and removing organic precursors—natural organic matter—before it comes into contact with chlorine. The extent to which this is feasible depends on the quality of the raw water and the technology of the treatment process. The removal of natural organic matter before the application of disinfectants reduces the amount of undesirable chlorinated organic compounds (2,3). As discussed above, this highlights the importance of measuring TOC levels. The evaluation of this parameter using a high-performance method, not previously applied, is essential for improving the quality and safety of drinking water by keeping disinfection by-products (carcinogenic compounds) at a minimal level. This forms the core argument of this study. The study holds particular importance because water treatment plants in our country typically use hypochlorite for disinfection. The disinfection process follows the reaction:

$$\mathbf{HOCl \leftrightarrow OCl^{-} + H^{+}}$$

(Hypochlorous acid ↔ Hypochlorite ion)

Hypochlorous acid (a strong oxidizing agent) reacts with natural organic matter to form disinfection by-products, including trihalomethanes, haloacetic acids, haloacetonitriles, haloketones, etc. The formation of disinfection by-products is influenced by water quality parameters (e.g., TOC, bromide, pH, temperature, ammonia, carbonate alkalinity) and treatment conditions (such as disinfectant dose and contact time) (2). Assessing TOC levels in both untreated (raw) and treated water will help determine the efficiency of the treatment process at the plant, as expressed by the reduction in TOC levels, thereby optimizing this process. Various studies have shown that when TOC levels exceed 4.0 mg/L, THM concentrations may surpass 100 µg/L (the EU limit) if the water resides in the distribution network for 2–3 days and depending on the level of free chlorine. However, THM formation can still occur at lower TOC levels, particularly when TOC is between 2 mg/L and 4 mg/L. Therefore, if TOC levels are greater than 4.0 mg/L, corrective treatment may be required. If the levels range between 2 mg/L and 4 mg/L, a more detailed assessment should be conducted to determine whether these TOC levels are leading to THM formation according to EPA. The recommended TOC concentration for treated water prior to primary disinfection with chlorine should generally not exceed 2.0 mg/L (2). Studies conducted in various countries, such as in Sanliurfa, Turkey, refer to a TOC value of 4 mg/L as a standard reference level (4). An evaluation of this parameter has also been carried out in a study in Tetovo, North Macedonia (5). Some countries, such as Hungary and Slovakia, consider this parameter as a key indicator (6). Our study will focus on assessing the TOC parameter, and in cases where high TOC values are observed, corrective actions will be recommended. The main objective of this study is to evaluate TOC in water intended for human consumption as a key indicator of the potential for chlorine by-product formation (THMs), thereby contributing to the improvement of the quality and safety of drinking water. By assessing this indicator, we establish a data baseline on the presence of natural organic matter in water sources and manage the organic load (TOC) by reducing its concentration prior to chlorination. As a result, the formation of trihalomethanes compounds that may pose health risks to consumers is minimized, thus increasing the safety and quality of drinking water.

MATERIALS AND METHODS

This study includes the analysis of the water supply system of the city of Tirana over the period from September 2024 to May 2025, focusing on water sources such as the Bovilla reservoir, the Selita Spring, and their respective distribution networks. Tirana was selected as the study area due to its urban importance, the presence of a water treatment plant, the nature of its water sources (primarily surface water from the Bovilla reservoir, gravity-fed mountain springs like Selita, and mechanically pumped groundwater sources), its proximity to the analytical laboratory, and the relationship between the supplied water volume and population density.

The Bovilla reservoir is the main source of drinking water for the city of Tirana, covering up to 60% of its needs. It is located on the Tërkuzë River and includes a catchment area of approximately 98 km². The reservoir's maximum storage capacity is 84 million cubic meters, with an average depth of around 18 meters and a maximum design depth of up to 53 meters. The hydraulic residence time of water in the reservoir is about 1.5 years, while its operational lifespan is estimated to be approximately 2.4 years (7). The normal water level is 318 meters above sea level. Climatic conditions significantly affect both the quality and quantity of the reservoir water. The average annual air temperature is 12.9°C, ranging from 7.6°C in the coldest months to 18.2°C in the warmest. The average annual precipitation ranges between 1200 and 1300 mm; however, in certain years, much higher levels have been recorded, reaching up to 2027 mm (8). Specifically, according to data from the Dajti meteorological station, precipitation levels were 2027 mm in 2006, 1742 mm in 2007, and 1154 mm in 2008 (8). The area surrounding the reservoir is characterized by hilly terrain and significant erosion, with about 10–20% of the vegetation cover degraded. In certain zones, this percentage reaches as high as 35–40%, which directly contributes to increased sedimentation and deteriorating water quality (9). For this reason, the water drawn from Bovilla undergoes a full treatment process at a dedicated treatment plant before being distributed for consumption. Currently, the treatment plant processes approximately 2400 L/s. The treatment process consists of several sequential stages. Initially, rapid mixing (known as the "flash mixer") is performed, during which chemicals such as polyaluminum chloride (used as a coagulant), sodium hypochlorite (used for oxidation), and hydrochloric acid (used for pH adjustment) are dosed.

When the water exhibits unpleasant taste or odor especially during the summer season powdered activated carbon (PAC) is added. The water then moves through the flocculation stage, followed by filtration. Finally, the filtered water undergoes a final disinfection step to ensure microbial safety before being distributed (8).

The Selita–Shënmëri spring is a gravity-fed mountain source that delivers water without the need for pumping. Unlike Bovilla, the water from this source is not treated in a treatment plant but is only subjected to chlorination to ensure microbiological safety (10). This source continues to play an important role in meeting the city's water demand. Sampling in this study focused on the two main water supply sources for the city of Tirana: the Bovilla reservoir along with its corresponding treatment plant, the Selita–Shënmëri spring, and representative points from the water distribution network. Based on the configuration of the supply and distribution system, critical sampling points within the city of Tirana were selected, as presented in the table below:

Table 1. Sampling at Supply Sources and Their Distribution Network.

Codes	**Supply Sources**		
M1	Bovilla water, raw from the lake		
M2	Bovilla water before chlorination, after chemical treatment and filtration		
M3	Bovilla water after final chlorination (final output water from the plant)		
M6	Water from the Selita Spring before chlorination		
M7	Water from the Selita Spring after chlorination		
	Distribution Network		
Codes	Sampling Location / Water Type	Codes	Sampling Location / Water Type
M14	Lapraka water/ Bovilla	M22	Asim Vokshi water / Bovilla
M15	Qesaraka water / Bovilla	M23	5 Maji water / Bovilla
M16	Sarace water / Bovilla	M24	Ali.P. Gucia water / Bovilla
M17	Qemal Stafa water / Bovilla	M25	3 Dëshmorët water / Selita
M21	Irfan Tomini water / mix of Bovilla +Swimming Pool Well	M26	Student City water / Selita
M19	Federik Shiroka water / Bovilla	M27	50 Vjetori water / mix
M20	Niko Avrami water / Bovilla	M28	Arkitekt Sinani water / Bovilla
M21	Barrikada water / Bovilla	M29	Qamile Guranjaku water / Selita

Sampling was carried out once a month, in accordance with Albanian legislation on drinking water quality monitoring (11), following SSH ISO standards. The transportation, stabilization, and preservation of the samples were performed in compliance with the guidelines of the international standard ISO 5667-3. The parameters analyzed in the laboratory for untreated water (raw water) and water before the chlorination process were: pH, conductivity, total organic carbon (TOC), and turbidity. For treated water and water from the distribution network, the analyzed parameters were: free chlorine, pH, conductivity, TOC, and turbidity. These parameters are important for evaluating the efficiency of the water treatment process and are closely linked to the presence and removal of organic substances. Laboratory analyses were carried out in accordance with the relevant SSH, ISO, and EN standards. The determination of TOC was conducted using the SSH ISO 8245:1999 method; alkalinity was measured using the S SH EN ISO 9963 method; pH was determined using the S SH ISO 10523:2008 method; free chlorine by EN ISO 7392; conductivity by S SH EN 27888; and turbidity by S SH EN ISO 7027.
The instrument used for TOC analysis was the Total Organic Carbon Analyzer, Shimadzu type, which operates through high-temperature catalytic oxidation and measures the amount of carbon dioxide formed using a non-dispersive infrared (NDIR) detector. For the analysis of other indicators, the respective instruments were used, such as the HACH conductivity meter, HACH turbidimeter, HANA chlorimeter, DR 2000 spectrophotometer, and HACH pH meter. The statistical processing of the data was performed using SPSS software, version 20. The physicochemical parameters were analyzed for their distribution using the Shapiro–Wilk test, with a significance threshold of $p < 0.05$. To assess the relationships between parameters, the Spearman correlation coefficient was used, while to evaluate potential differences in organic pollution between the source points and those in the water distribution network, the Mann–Whitney test was applied.

RESULTS AND DISCUSSION

Based on studies conducted in other countries and the recommendations of the EPA for improving the quality of drinking water, it is necessary to evaluate additional indicators beyond TOC. For this reason, in the assessment of TOC in the drinking waters of the city of Tirana, several other parameters that affect water treatment were also measured. The respective values of these parameters are summarized in the table below, by season (Table 2).

Table 2. Results of parameters: free chlorine, pH, conductivity, and turbidity by seasons.

	Free Chlorine (mg/L)			pH (units)			Conductivity (µS/cm)			Turbidity (NTU)		
	Aut	Win	Spr	Aut	Win	Spr	Aut	Win	Spr	Aut	Win	Spr
Bovilla Water Spring M1	0.00	0.00	0.00	8.01	8.17	8.08	316.67	345.67	333.33	8.63	6.24	2.04
Bovilla Water Spring M2	0.00	0.05	0.01	7.68	7.97	7.65	320.00	323.33	332.33	0.39	0.25	0.18
Bovilla Water Spring M3	0.60	0.57	0.63	7.76	7.77	7.60	306.67	326.67	315.00	0.16	0.29	0.15
Selitë Water Spring M7	0.39	0.89	0.36	8.12	8.04	7.66	166.67	224.83	211.67	0.37	0.44	0.28
Bovillë distribution network	0.48	0.51	0.36	7.92	8.00	8.00	292.20	269.47	314.05	0.57	0.70	0.31
Selitë distribution network	0.46	0.38	0.32	7.94	8.10	8.08	246.67	166.67	200.00	0.58	0.24	0.37

Free Chlorine: The distribution of free chlorine was analyzed according to seasonal averages, from the supply sources to the distribution network, focusing on critical points. The critical point M1 (Bovilla lake water) represents untreated, non-chlorinated water, therefore the free chlorine values are 0 mg/L. In sample M2, which represents water treated at the Bovilla plant, chlorine is used for the oxidation of organic matter. As a result, free chlorine values are low because it is consumed during the treatment process. According to Albanian legislation, the allowed level of free chlorine in drinking water is 0.5 mg/L (11). In sample M3, at the outlet of the treatment plant, values exceeding the legal limit (0.5 mg/L) were recorded in all three seasons. Even higher chlorine levels were registered at the Selita supply source during the winter season, where the water had 0.89 mg/L of free chlorine. This occurs due to increased pollution in winter and the lack of other treatment processes besides disinfection with hypochlorite. High chlorine values are used to ensure sufficient residual free chlorine throughout the distribution network Excess chlorine levels were recorded in January at several critical points, both in the supply and distribution networks. In the distribution network, chlorine values were lower than the recommended norm, indicating poor maintenance of the system, including the use of storage tanks and lack of proper cleaning.

pH: The pH values, based on seasonal averages from the supply sources to the distribution network, remained within the allowable limits according to Albanian legislation (11). From the table below, a clear difference can be observed in pH values between point M1 (raw water from the Bovilla lake), where seasonal averages range between 8.01–8.17 units, and points M2 and M3, where the pH values are lower, ranging from 7.60–7.77 units. This pH reduction is performed intentionally to increase the efficiency of the water treatment process, especially for the removal of organic matter.

Turbidity: From the table 2, it is observed that the highest turbidity values were recorded at point M1 during autumn and winter, specifically in the months of November (17.4 NTU) and December (14.4 NTU). These increases coincide with periods of rainfall, when suspended organic matter in the lake water rises. After treatment at the Bovilla plant, turbidity decreases significantly, and at points M2 and M3 it remains within the permissible limit (<1 NTU), according to the Albanian standard for drinking water (11). At the source and in the Selitë distribution network, turbidity is below 1 NTU. This source has a stable flow and naturally better water quality.

Conductivity: From the table 2, a slight decrease in conductivity can be observed from point M1 to M3 during the water treatment process at the Bovilla plant. The water from the Selitë source has lower conductivity compared to that of Bovilla. Both water sources show conductivity values within the allowed limits according to the Albanian legislation for drinking water (11).

Total Organic Carbon (TOC): In this study, TOC is determined as Dissolved Organic Carbon (DOC), as the samples were filtered through a 0.45 µm pore filter. To remove inorganic carbon, phosphoric acid (H_3PO_4) was used, while synthetic air with a purity of 99.999% was used for the combustion process. The organic carbon was oxidized into carbon dioxide (CO_2), which was ultimately measured using a non-dispersive infrared detector (NDIR). The working parameters for TOC analysis were: air pressure 200 ± 2 kPa, combustion furnace temperature 680°C, gas flow rate 150 mL/min, injected volume 50 µL, measurement time 4 minutes, and repeatability (CV) ≤ 2%. The instrument was calibrated using a standard curve in the range of 0–10 mg/L C, with a stock solution of potassium hydrogen phthalate ($C_8H_5KO_4$), corresponding to the working range of the samples, with a correlation coefficient of r = 1 (r ≥ 0.995) (12). To ensure the quality of the analysis, reagent blanks, calibration with known standards, and duplicate sample analyses were carried out. The assessment of TOC in the supply sources of Bovilla and Selitë, as well as in their respective distribution networks, is presented in the graph below.

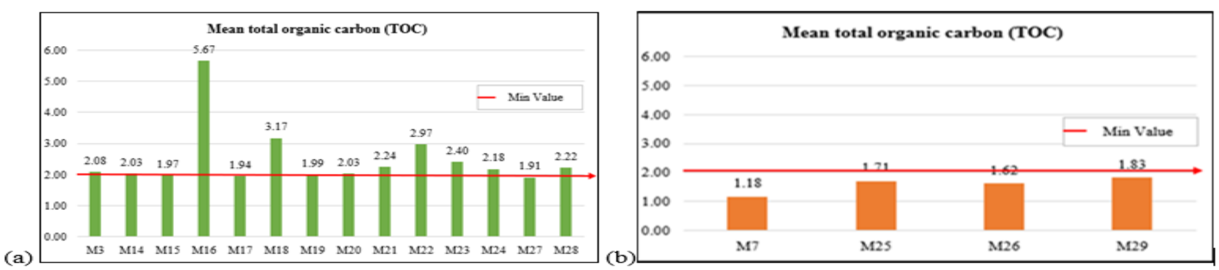


Figure 1. TOC values at the source and in the distribution network for both water supplies studied
(a) – Bovilla; (b) – Selitë

In the figure above, for the Bovilla source, an increase in TOC concentration is observed from the source towards the distribution network, particularly at point M16, where the average reaches 5.67 mg/L, due to one isolated high value. A similar increase is noted at point M18, as a result of the mixing of Bovilla water with well water. Meanwhile, the Selitë source and its corresponding distribution network show lower TOC values (<2 mg/L); however, a slight increase is observed at the critical point M29.The TOC results by month for both supply sources and their respective distribution networks during the study period are presented in the graph below.

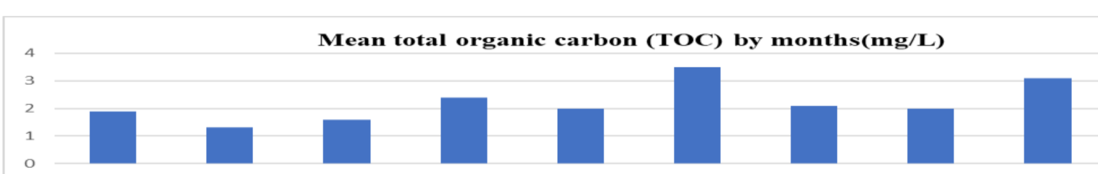


Figure 2. Monthly TOC values during the study.

The highest average TOC value is recorded in February, both at the supply source and in the distribution network. During the autumn and winter seasons, there is an increase in rainfall, which is reflected in the elevated TOC concentrations in this month (Figure 2).
To assess the efficiency of water treatment at the Bovilla plant, an evaluation of TOC content was carried out at the critical points (M1, M2, M3) and by month, for water from the plant's inlet to its final outlet. The results are presented in the figure below.

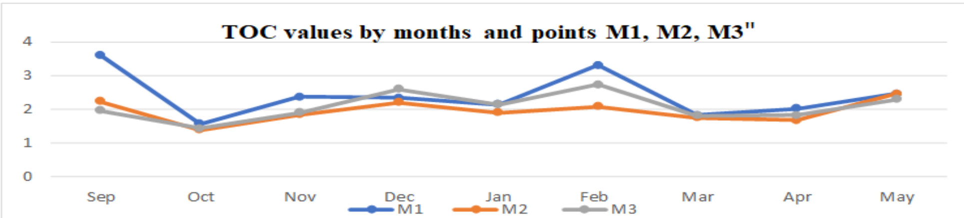


Figure 3. TOC values at the Bovilla plant by month and critical points

Figure 3 shows TOC removal efficiency by month after the filtration process. It is observed that during the treatment process of surface water from the lake (point M1), the TOC content decreases at point M2 (after oxidation and filtration) and further at point M3 (outlet towards the distribution network). The average TOC value at point M3 is 2.08 mg/L. By season, this value varies as follows: in autumn 1.765 mg/L, in winter 2.491 mg/L, and in spring 1.976 mg/L. From the comparative analysis of TOC values at the Bovilla plant, it is noted that in the months of February and December, TOC values at point M3 (outlet to the network) are slightly higher than at point M2 (after filtration). This can be explained by fluctuations in filtration performance and by the fact that the sample at M3 represents chlorinated water, which has been stored for about three days in the distribution reservoir. Below is presented the efficiency of TOC removal during the water treatment process.

Table 3. TOC Removal efficiency by month after the filtration process.

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Average
38.065	11.903	22.288	5.905	11.433	36.97	4.8087	17.267	0.2437	19.102

The highest efficiency of the TOC removal process was achieved in September, where the initial TOC value was 3.607 mg/L and after treatment it was reduced to 2.234 mg/L, reaching an efficiency of 38.06%. The lowest efficiency was recorded in May, with only 0.24%, which can be explained by the fact that activated carbon was not used during this month, although it plays an important role in removing organic compounds (TOC). Referring to the average value for all the months of the study, the overall TOC removal efficiency at the Bovilla water treatment plant is 19.102% (Table 3).
The measured TOC values at the Bovilla plant are comparable with similar studies, such as a study conducted in Turkey in 2019, which analyzed the Sanliurfa Drinking Water Treatment Plant (4). The parameters used for this comparison are given in the table below.

Table 4. TOC Parameters at the Bovilla Treatment Plant.

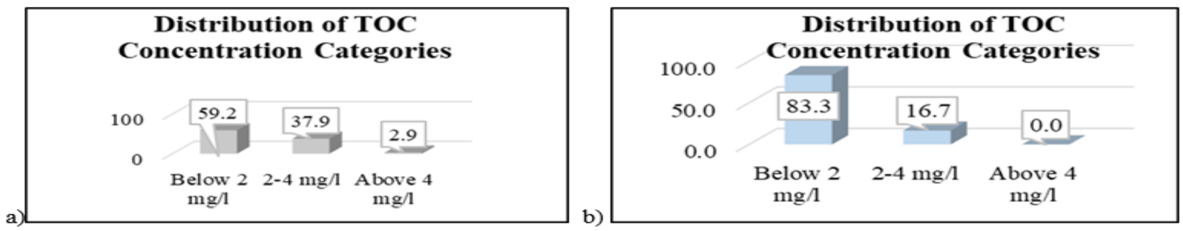
Parameter	Max TOC value in raw water	Average TOC in raw water	TOC Removal efficiency After filtration (%)	Average TOC after treatment (mg/L)
Bovilla Water	3.607	2.404	19.102	2.07

Compared to the study conducted in Sanliurfa, Turkey (4), the raw water in Bovilla shows lower TOC values, with an average of 2.40 mg/L compared to 4.11 mg/L in Sanliurfa. The maximum TOC value in Bovilla is 3.6 mg/L, whereas in Sanliurfa it is 4.63 mg/L. The average TOC removal efficiency after filtration is 19.1% in Bovilla and 24.8% in Sanliurfa. After treatment, the TOC value in Bovilla is 2.07 mg/L, lower than the 2.94 mg/L reported in Sanliurfa. This value is close to the critical threshold of 2 mg/L, above which the risk of trihalomethanes (THM) formation increases. Therefore, the treatment process in Bovilla is effective and well-controlled, minimizing the risk of THM formation in the distributed water. Comparing with data from a study conducted in Tetovo, North

Macedonia (5), the maximum TOC value in the surface waters of Bovilla lake was measured in September (3.6 mg/L), while in Tetovo, the maximum value was recorded in July (4.41 mg/L). It is important to note that the drinking water treatment in Tetovo city is limited to chlorine disinfection only, without any additional physical or chemical treatment processes. The data from both studies show comparable values, indicating similarities in the qualitative characteristics of surface waters in the two regions.

Additionally, the TOC assessment is based on EPA standards, which link this indicator to the formation of trihalomethanes (THM). According to these standards, for TOC values in the range 2 mg/L < TOC < 4 mg/L, there is a risk that THM concentrations may exceed the regulatory limit of 100 µg/L, while for TOC > 4 mg/L, corrective interventions are recommended (2).

The percentage distribution of TOC values from the supply source to the water distribution network for both sources in the study, in relation to the risk of trihalomethane (THM) formation, is presented below:



Graph 4. Percentage distribution of TOC values by water supply sources: a) – Bovilla; b) – Selitë.

The graphs presented above show that the Bovilla source has a higher percentage of samples (37.9%) in the range 2 mg/L < TOC < 4 mg/L and 2.9% of TOC values above 4 mg/L compared to the Selitë source. As a result, there is a greater possibility of THM formation in the water distribution network from Bovilla.

From the statistical analysis of the TOC (Total Organic Carbon) parameter, no statistically significant correlations were found with any of the other measured physico-chemical parameters ($p > 0.05$ in all cases). This result suggests that organic pollution, evaluated through the concentration of total organic carbon, is independent of other water parameters and most likely originates from external sources such as anthropogenic discharges, agricultural activities, or biological waste. This statistical independence highlights the need to identify and analyze specific sources of organic pollution in the water supply system.

To assess possible changes in TOC content between the source points and the distribution network, the Mann–Whitney U test was applied, a non-parametric test suitable for data with a non-linear distribution. Prior to analysis, TOC data underwent logarithmic transformation to improve interpretability and statistical coherence. Comparisons were made between independent groups for water from the Bovilla and Selitë sources and their respective distribution networks. The data regarding this statistical processing is provided in the table below.

Table 5. Statistical analysis for evaluating TOC changes between the source and the distribution network.

Comparison	Z	Significance (2-tailed)	Interpretation
M3 vs M14–24, 27–28	–0.090	0.928	No statistically significant difference. TOC concentrations are similar between the supply source (M3) and the distribution network.
M3 vs M18	–0.354	0.724	No significant difference between the supply source (M3) and M18, which represents the mixing of Bovilla and well water.
M3 vs M27	–0.973	0.331	No significant difference between the supply source (M3) and M27, which represents mixing of Bovilla water with well water.
M7 vs M25, M26, M29	–2.687	0.007	There is a statistically significant difference between M7 as the supply source and the group M25, M26, and M29 of the distribution network.

Main findings of this study showed that no statistically significant differences were identified in TOC concentrations between the Bovillë supply source (M3) and its distribution network. However, a statistically significant difference was found between the Selitë source (M7) and the distribution network points M25, M26, and M29 (Mann–Whitney $U = 48.0$, $Z = –2.687$, $p = 0.007$). This result signals an increase in organic pollution within this network, which may be related to external factors such as unmanaged water deposits, secondary leaks, infrastructure degradation, or anthropogenic pollution along the network.

CONCLUSIONS

- In both supply sources of Tirana, the average TOC concentrations do not exceed the value of 4 mg/L, a threshold above which the formation of trihalomethanes (THMs) surpasses the permissible limit according to EU and Albanian standards (100 µg/L). Water from the Bovillë water treatment plant shows good performance in treating surface water (assessed for the first time), with an average TOC value of 2.07 mg/L, very close to the EPA's set limit. Despite this positive conclusion, a slight increase in TOC values is observed during the winter season, reaching 2.38 mg/L in the plant and 2.53 mg/L in the distribution network. February shows the highest average TOC level both at the supply source and in the distribution network.
- Meanwhile, water from the Selitë source has lower average TOC values, below 2 mg/L, both at the source and in the distribution network, making it safer in terms of THM formation potential. However, a statistically significant difference was observed between the Selitë source and points in the distribution network, suggesting the possibility of contamination along the network.

Recommendations. Based on the findings of this study, it is recommended to: Include TOC analysis as an indicator parameter in the Bovillë water treatment plant for better optimization of the surface water treatment process; Pay special attention to reforestation around the Bovillë lake area, as it is considered a necessary measure to reduce erosion and the introduction of organic matter into the water; Assess the concentrations of THMs during the winter season in the Bovillë distribution network, due to the increase in TOC during this period; Additionally, improve the maintenance of the Bovillë and Selitë distribution networks through cleaning of deposits and limiting uncontrolled interventions in the network, aiming to preserve water quality up to the consumer;

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