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RESEARCH PAPER

Ecological problems of water resources in Azerbaijan and their impact on human health

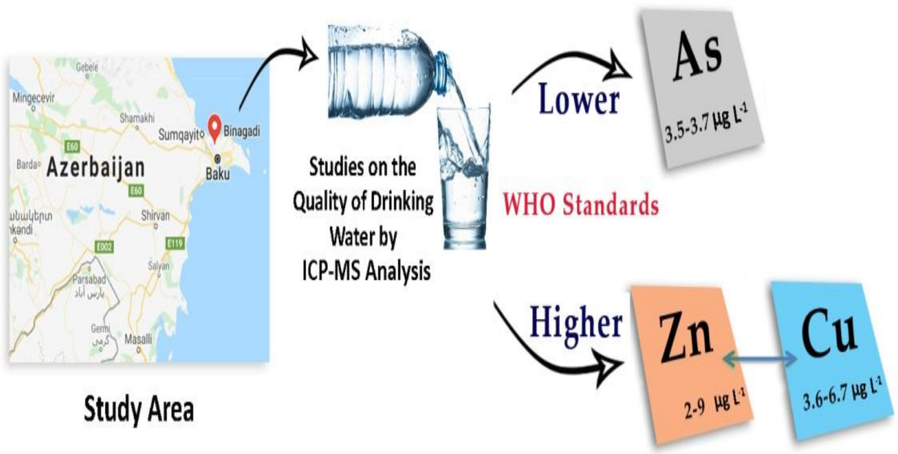
Fidan Yolchiyeva, Sevinc Hacjiyeva, A. Ali Huseyinli *, Aytac Hasanova

Department of Ecological Chemistry, Faculty of Ecology and Soil Science, Baku State University, Azerbaijan

Highlights

- The access to qualified drinking water for the population, is a key problem for the government of The Republic of Azerbaijan.
- The providing clean drinking water for population demands, is one the aims for social and economic parts of the republic.
- The measurement of As, Zn, and Cu in the water samples showed, 3.5-3.7, 2-9, and 3.6-6.7 µg/l respectively.
- The increased of Zn and Cu in drinking water, can be a major environmental concern for Republic of Azerbaijan.

Graphical Abstract



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Abstract

Access to safe drinking water for the population is of the most vital and important issues in Azerbaijan. Simultaneously, providing the population with clean drinking water is of great important direction of the social and economic development of the Republic. The present study represents the results of similar previous studies on the quality of drinking water in the Binagadi district. According to previous literatures, the principal elements of pollution in drinking water are Arsenic, zinc, and copper compounds. The concentration of As, Zn, and Cu has been estimated in Abseron Peninsula with drinking water. Water supplies were collected in 1 liter of polyethylene bottles, which were washed with deionized water before use. The concentrations of As, Zn, and Cu in the water samples showed that As: 3.5-3.7 µg/l; Cu: 3.6-6.7 µg/l; and Zn 2-9 µg/l, respectively. Also, the concentration of showed below but Zn and Cu were higher than the WHO standards permitted limits.

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* Corresponding author: ahuseyinli@yahoo.com (AA Huseyinli)

1. Introduction

Drinking water in the territory of Azerbaijan is unevenly distributed, with limited resources. At present, the country's surface water reserves are 27 m^3 meters, which in the dry years decreases to 20-21 m^3 meters. The surface water resources are rivers, lakes, water reservoirs, and glaciers. About 70-72% of freshwater resources in the studied area are formed outside of the country (Meunier and Beysens, 2016). Unequal distribution of water resources on seasonal and terrestrial waters, both local and transboundary pollution of rivers and lakes, installations built on water, and sediments in the river limit access by the population to safe drinking water (Shang et al., 2018). The outlined growth of industrial production in the Absheron Region entails an increase in the technogenic impact on all-natural environment components, including water. There is no single branch of industry and agriculture that would not be most closely associated with natural water use in a given quantity. Providing the population with water resources, corresponding sanitary and hygienic norms, and suitable water consumption is urgent for the Absheron Region. The problem of drinking water pollution in Azerbaijan is also a priority. The Kura Rivers are the main sources of drinking water in many cities and regions of the republic. The Monitoring Center for Pollution of the Environment and the Ministry of Ecology and Natural Resources of Azerbaijan Republic has published the results of monitoring the Kura River's degree of contamination. The Ministry of Ecology and Natural Resources of Azerbaijan regularly conducts water monitoring in the Kura Rivers. It always becomes clear that these rivers flow into Azerbaijan from Georgia and Armenia polluted. The Kura flows into Azerbaijan, polluted from the territory of Georgia. Only the city of Tbilisi dumps 1 million m^3 of polluted water a day in the Kura. On average, up to 700,000 tons of organic substances, 30,000 tons of nitrogen-phosphorus salts, 12,000 tons of various salts, and alkalis, 16,000 tons of surfactants are dumped annually in the Kura (Harrison et al., 2019; Meyer et al., 2019).

To provide the population with clean drinking water, the most rational option was the purification of surface water sources flowing on the distance about 1000 meters from the settlements. The installed cleaning facilities in the villages are designed for 20-30 liters of drinking water per capita daily. In each village, the purified water is delivered to the population by a water supply network located at a distance of 150,200 meters from each other. During this period, when constructing waterworks' purification facilities, a water supply network with a length of 1,381 km and more than 3,198 distribution points of water was built. One of the main directions of work on protecting water resources in Azerbaijan is introducing new production processes, where the treated wastewater is not discarded, but repeatedly used in technological processes. Great attention is paid to improving the efficiency of industrial sewage treatment.

As a result, it can be said that protecting water resources from depletion and contamination and their rational use for the national economy's needs is one of the most important environmental problems in Azerbaijan (Agathokleous, 2018). At present, to validate hygienic standards for the quality of drinking water, comprehensive studies are carried out. Water can have a positive and negative impact on people's health. First of all, this is due to the quality of the water used: its organoleptic properties, determined by color, taste, and smell, as well as chemical and bacterial composition (Mortada et al., 2015). In nature, water is never found in the form of a chemically pure compound. Processing a universal solvent's properties, it constantly carries a large number of different elements and compounds. The ratio of these compounds is determined by the conditions for the formation of water by aquifers' composition. There reported several reasons for outbreaks of intestinal infections caused by water. Amongst are bacterial contamination of water in sanitary protection zones of drinking water pipes; emergency condition of headwork's of water pipes; violation of the regime of water treatment and disinfection of drinking water pipes; unsatisfactory sanitary-technical condition of water supply and sewerage networks and inspection wells leading to accidents, sewage sludge consumption for drinking and technological purposes of technical water pipelines, etc.

Unlike groundwater, surface waters do not have natural lithological protection and are the most vulnerable component of the natural environment (Behmel et al., 2016).

The present study area is the Binagadi district in the northwestern Absheron peninsula stretched in 169.38 km^2. The population density is 1496 people per km^2. According to the 2014 statistics, the population of Binagadi is 254,500 people. There are 4 micro districts (6, 7, 8, and 9 micro districts) and 6 settlements in the administrative area of the district Rasulzade, Bilajari, Binagadi, Khojasan, Sulu-hill, and 28 May settlements. In the Bakuadinskom district, 95 industrialized enterprises are listed on the following list: 5 in industrial production, 85 in processing, 2 in electrical and gas industries, 3 in the water supply, and processing of industrialized offshore.

Binagadi district is equipped with three sources as Oghuz-Gabala, Kur, and Jeyranbatan water pipelines. The construction of new settlements and micro districts in the Absheron peninsula, where about 40% of ate country's population and 70% of the industry's capacity have been built, the growth of settlements and villages has increased the demand drinking water in the peninsula. Solving the problem with the solution of a water vapor Baku and Absheron peninsula can be considered part of the construction of the water pipeline, where 75% of Baku residents will be provided with drinking water (Mellors et al., 2005).

There are 79 operating wells in the Oghuz underground water reservoir. The distance between wells is 1000 m. During the drilling of wells, a 530 mm safety belt was lowered to the underground. This belt prevents the water from entering the upper layers. In this way, the plant and animal kingdom impacts are minimized (Sun et al., 2017; Zhao et al., 2018). Substances contributing to the quality of water are pollutants. This changes the physical and chemical properties of water, the reduction of oxygen in the water, the emergence of microorganisms, the formation of sediment and floating substances in the water. Major contamination sources are industry and utility wastewater, radioactive waste, mineral fertilizers (Makotchenko et al., 2017).

One of the most dangerous environmental pollutions is the pollution of the environment with heavy metals. Toxic metals are imported into the environment by industry, organic waste, fuel, electricity. Heavy metals such as Fe, Mn, Cu, Cr, Cd, Hg, Pb, As, and others are very toxic. They can accumulate in the body and may result in chronic damage (Hwang et al., 2016; Oyebamiji et al., 2018). There are over 50 elements considered heavy metal, 17 of which are more toxic. Their toxicity level was determined by the type of metal, its biological role, and the effects of the organism. By means of natural and anthropogenic ways, these metals are released into the environment. Iron, cadmium, copper, zinc, chromium, etc. are the most common types of human poisoning. They are required in small doses in the body but are very toxic in large doses (Giakisikli and Anthemidis, 2017; Turner and Taylor, 2018). Oguz-Gabala-Baku water pipeline consists of 12 m glass fiber material. However, 55 km long steel pipes were used in high-pressure areas. The Oguz-Gabala-Baku water pipeline's length is 262.5 km, its diameter is 2000 mm, and its submersible capacity is 5 m^3 per second and is drawn from glass fiberglass (GRP) pipes. 78 wells, 20 observation wells were drilled in the Oguz region to supply the pipeline with water. The wells' productivity is about 130 liters per second, with a productivity of 70 liters per second. This study's goal was to measure three heavy metals (As, Zn, and Cu) in the Abseron Peninsula with drinking water.

2. Materials and Methods

In this study, the concentration of the zinc, copper, and Arsenic in the drinking water were determined by ICP-MS. This method is desiwaterd to determine metals and metalloids in surface, ground, and drinking waters via inductively coupled plasma-mass spectrometry (Giersz et al., 2018).

In this method, analysts introduce sample material to an argon-based, high-temperature radio-frequency plasma, usually via pneumatic nebulization. As energy transfers from the plasma elements dissolve, atomizes, ionizes, and is extracted from the plasma through a differential vacuum interface, separated based on their mass-to-charge (m/z) ratio by a mass spectrometer. This method has been demonstrated to be suitable for aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, strontium, and zinc (Table 1).

Nitric acid, deionized water, stock, standards, and other required solutions were used in the process. The internal standard is made of germanium, indium, lithium, scandium, and thorium elements. Tuning solution was made by soluble nitric acid in 2% of berily, cadmium, cobalt, copper, germanium, indium, rhodium, scandium, terbium, thallium, barium, cerium, magnesium, and lead elements.

Table 1. Recommended Analyst Masses and Internal Standards.

Element	Analytical Mass	Recommended Internal Standards	İnterference Calculation
Copper	63	Sc	C63
Zinc	66	Ge	C66
Arsenic	75	Ge	C75-3.127 (C77-0.815*C82)

A prepurified grade of argon is used in the analysis unless it can be demonstrated that other grades can be used successfully. Prepurified argon is usually necessary because technical argon often contains significant impurities (Hua et al., 2017). Statistical analysis is performed using one-way ANOVA, followed by Dunnett's multiple comparisons test where appropriate. Differences were considered significant when $P \leq 0.05$.

3. Results and Discussion

Results demonstrated that Oguz-Gabala-Baku coil research was carried out on the basis of Al, Cr, Fe, Co, Ni, As, Cd, Ba, Pb, Zn, and Cu (Carreras and Pignata, 2007). The concentration of heavy metals in drinking water is compared with the European Directive on drinking water 98/83/EC and the World Health Organization recommendations to provide quality drinking water. From previous literature on water sources, it was found that the main elements of pollution in drinking water are Arsenic, copper, and zinc compounds. The obtained result showed that all the well water and bore whole water samples investigated contain high concentrations of these heavy metals. Based on a five standard calibration from 0 to 100 µg/l (Perwitasaria et al., 2018). The Arsenic concentration obtains 3.5-3.7 µg/l in 3 studied stations ($P < 0.05$).

Effects of Arsenic as a toxic heavy metal even at very low levels of exposure on human health were investigated. Arsenic involved the nervous system, hematopoietic, and renal system. It also affects the blood and circulation system, damages the nervous system, and eventually leads to death. Emissions of copper non-ferrous metallurgy (98%), burning of leaded gasoline. High amounts of copper compounds can lead to death caused by liver and kidney failure and the nervous system. As a result of the studies, it was found that the concentration of copper ions is 3.6-6.7 µg/l ($P < 0.05$). Effects of copper deficiency can include anemia, low numbers of white blood cells, and defects in connective tissue leading to skeletal problems. High levels of copper exposure can destroy red blood cells, possibly resulting in anemia (Muryanto and Bayuseno, 2014).

Zinc, as a regularly natural substance, is found in many foodstuffs. Besides, certain amounts of zinc were found in drinking water, which may increase whenever stored in metal tanks. Industrial sources of toxic waste sites may cause zinc amounts in drinking to reach the levels that can cause health problems. Zinc is a trace element that is essential for human health. The shortage of zinc can disturb the sense of taste and smell, a decrease of appetite, slow wound healing, skin sores, and congenital disabilities, as well (Calvo et al., 2009).

Although the human system can control additional zinc concentrations, however, too much zinc doses can also cause influential health problems, including skin irritations, vomiting, stomach cramps, nausea, and anemia. Also, high amounts of zinc can adversely affect the pancreas and disturb protein metabolism and cause arteriosclerosis. On this basis, less than 3 µg/l of zinc concentration is recommended in drinking water. Concentrations in the drinking water samples were in the range of 2-9 µg/l ($P < 0.05$). Table 2 presents the concentrations of metals determined in water samples taken from the Oguz–Gabala-Baku water pipeline (Fig. 1).

4. Conclusions

According to the result, in all samples, the concentrations of Arsenic showed below from the permissible limit (non-significant change) and, at this time, cannot be a risk factor for human health. In all samples, the concentration of copper high from the permissible limit. The concentration of zinc in the second sample is below the allowable limit, but the other samples high the limit. Based on this result, it is determined that the ICP-MS method can be adequate to identify and quantify the metals of drinking waters at trace levels and is a fundamental way to assess toxicity control in many regions. Cupper changes showed a lower increase in sample 2 and higher in sample 3. The continuous monitoring of drinking water in this area and other areas to check the availability and control of heavy metals for human health.

Table 2. The concentrations of studied metals in water samples were taken from the Oguz-Gabala (Baku).

Sample	**Metal concentrations μg/l**		
	As	Cu	Zn
Sample 1	3.5	3.6	9*
Sample 2	3.6	4.6	2
Sample 3	3.7	6.7*	5.8*

*P< 0.05.

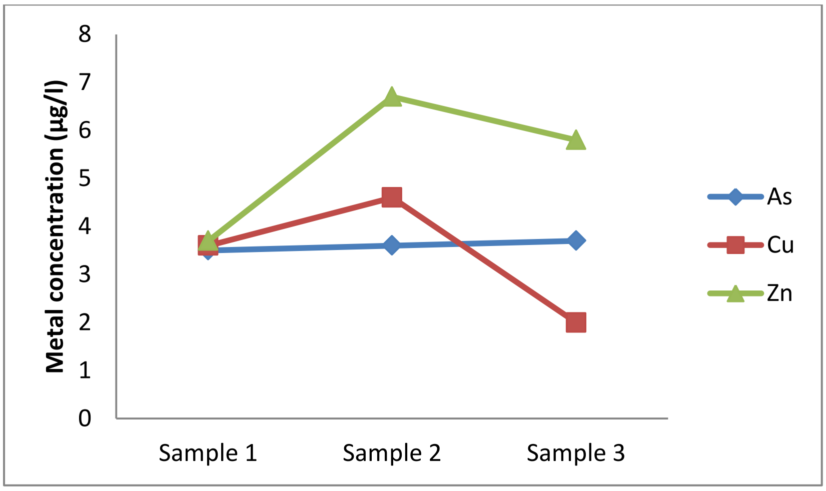

Fig. 1. The Comparison of heavy metal concentrations with 98/83/EC Directive and WHO (P< 0.05).

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