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Study of the content of fluorides in atmospheric air in Bokhtar region and Tursunzade city of Tajikistan

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ABSTRACT

Background: The emission and presence of air pollutants such as fluorides have over burdenized the public healthcare issues. The current study aimed to determine the content of fluorides in atmospheric air in Bokhtar region and Tursunzade city of Tajikistan. **Methods:** Based on the direction of wind, two zones were selected in the current study: experimental and control. In the first (experimental) zone, those areas were selected where the western, northern and northeastern directions of wind were significant. Dzhura Rakhmonov was assigned to the control zone with the shortest time for the eastward winds. In general, 72 samples of atmospheric air were taken in 12 settlements of the city of Tursunzade and 90 samples of atmospheric air in the Bokhtar region of the Khatlon province. To determine fluorine in air, a potentiometric method with an ion-selective electrode was used, which makes it possible to measure the potential concentrations of fluorides in atmospheric air. **Results:** Compounds of gaseous (hydrogen fluoride) and solid fluorine (salts of hydrofluoric acid), which are the main emission from various sources, were found in the atmospheric air of the populated areas of the city of Tursunzade, where the aluminum plant industry is located. The maximum amount of hydrogen fluoride in the experimental zone (Jamoat and Navobod) with a western wind direction was found in the autumn, which exceeded the MPC. However, the amount of solid fluorides in the western direction of the wind ranged from 0.01 to 1.0 mg / m3, which did not exceed the MPC value and was not significant. In control zone (Dzhura Rakhmonov) the said pollutants hydrogen fluoride and solid fluorine were not significant in autumn within accordance to MPC limit. The results of the study of atmospheric air in 15 administrative cities and districts of the Bokhtar region showed a complete absence of solid fluorides in all samples of atmospheric air. **Conclusion:** Compounds of gaseous fluorine and salts of hydrofluoric acid were found in the atmospheric air of populated areas of the city of Tursunzade, and no significant amounts in the Bokhtar region according to MPC and control. The maximum amount of fluorine compounds was found in the experimental zone (Jamoat Navobod) of the city of Tursunzade.

Keywords: fluorine, atmosphere air, concentration, Bokhtar region, Tursunzade, Tajikistan.

INTRODUCTION

Air pollution refers to the presence of chemicals and particulate particles in atmosphere which is harmful to human health and other living organisms. Fluorine is an essential trace element necessary for the normal development of the human body [1]. However, with excessive content in environmental objects, it can cause toxic effects on various organs and systems of a general population [2]. According to the World Health Organization (WHO), millions of people are exposed to excessive amounts of fluoride either by drinking contaminated water from natural sources or by exposure to toxic concentrations in air [3]. As a result, those individuals suffer from various health problems ranging from mild forms of dental fluorosis to skeletal deforming and lungs cancers. The WHO estimates that permanent tooth decay is the most common of all conditions: 2.4 billion people worldwide suffer from permanent tooth decay and 486 million children suffer from primary teeth decay in early ages. Although it is difficult to judge the global prevalence of dental enamel and skeletal fluorosis, there are estimates according to which, over a number of years, an excessively high concentration of fluoride in drinking water has led to tens of millions of cases of dental enamel and skeletal fluorosis worldwide [4].

Due to technological advancement, unfavorable socio-economic and environmental changes are taking place all over the world, including in the Republic of Tajikistan, the rational and balanced nutrition is of great importance in the formation and maintenance of public health, especially of children [5]. It has been repeatedly proven that it contributes to the prevention of diseases, increasing the body's resistance to the effects of adverse environmental factors and well-being [6].

In the scientific reports, there is a lot of information mentioning about the effect of chemically low-quality water or air pollution on the toxicity and morbidity of organs of the gastrointestinal tract, urinary, cardiovascular, respiratory and endocrine systems in humans [7-9]. In Tajikistan the population of most districts of the southern region uses water with high and low mineralization, which affects the health state of the general population [10]. They are also exposed to air pollution in terms of high industrial zone. However, most of the epidemiological studies from Tajik state, mainly address the problems of the intestinal infections transmitted by water [11]. Large-scale works related to the influence of the chemical composition of drinking water or air on the health of the population in the republic have not been carried out; there are only few reports related to diseases of urolithiasis and dental caries.

Based on the current health issues and the impact of air population, it is the need of the day to conduct epidemiological study related to trace element of fluorine compounds in air. It will help the Tajikistan government to develop and set a criteria for preventive measures. This work is of particular relevance and importance not only for the development of the public health system but in general for the health of the population of the entire Republic.

MATERIALS AND METHODS

METHODOLOGY

This study was carried out in 15 cities and districts of the Bokhtar region and in 12 settlements in the city of Tursunzade of the Republic of Tajikistan to study the content of fluoride in air during spring and autumn. The current source of atmospheric air pollution with fluorine compounds as a contaminant is due to State Unitary Enterprise known as "Tajik Aluminum Company", located in the densely populated area of the Gissar valley, Tursunzade, Republic of Tajikistan.

The main fluoride emissions from the source into air depend principally on the direction of the winds. In year, about 80% of the direction of winds in RRS (districts of republican subordination) is usually towards west, while 20% of year time it is usually towards north and northeast. Based on the direction of wind data was divided into two zones: experimental and control. In the first (experimental) zone, those areas were located where the west, north and northeast directions of wind were marked. While, village Dzhura Rakhmonov was assigned to the control zone with the direction of the wind towards the east. In general, 72 samples of atmospheric air were taken in 12 settlements of the city of Tursunzade (Table 1).

Table 1. Air sampling sites in settlements of the city of Tursunzade

Locality/town	Sampling location	Zones	Sampling season
Navobod	Obshoron	Experimental	Spring Autumn
	Shodiyona		
	Zakhmatkash		
Seshanbe	I. Bozorov		
T.Tuychiev	Dusti		
	Sarkor		
I.Somoni	Chinor		
	ZHPVTAK		
Pahtaobod	Anjibar		
J.Rahmonov	S. Sherozi	Control	
	Zarkamar		
	O. Numonova		

Despite the absence of fluorine-emitting enterprises in the Bokhtar region, a study of 90 samples of atmospheric air was carried out to determine the concentration of fluorides in the administrative cities and districts of the Bokhtar region of the Khatlon province (Table 2).

Table 2. Air sampling locations in target cities and districts of the Bokhtar region of the Khatlon province

City / district	Village/locality	Sampling season
Kubodiyon	District center (markaz)	Spring Autumn
Nurek	Nurek city center	
Pyanj	Center of Panj District	
A. Jami	A. Chomi district	
Kushonyon	h / w Bustonkala (village Bustonkala)	
Bokhtar	Khatlon street	
Jaihun	h / w dusti (r.Dusti)	
Levakant	Levakant city	
Vakhsh	h / w Vakhsh	
Javan	the town of Yavan	
J. Balkhi	the town of J. Balkhi	
Shakhritus	Shahritus district	
Dusti	Dusti district	
N.Khusrav	town of Bakhor	
Khuroson	h / d Hiloli (Mehnat)	

The study of atmospheric air samples from populated areas was collected in three different times of two seasons (spring and autumn). In total, 162 samples of atmospheric air were taken in cities and districts of the Bokhtar region and the city of Tursunzade.To determine fluorine in air, a potentiometric method with an ion-selective electrode was used [12]. Through this method the potential concentrations of fluorides in atmospheric air can be easily measured. This study was carried out in accordance with the provisions of the guidelines for the control of air pollution, hygienic standards of the list of MPCs for pollutants in the ambient air of populated territory of the Republic of Tajikistan.

Statistical analysis

Statistical analysis of the collected samples were carried out using the statistical package for social sciences SPSS (version 21.0). The data were summarized using tables and graphs. Absolute numbers of data are presented as means (M) and their standard errors (± m). Paired comparisons of dependent variables were performed using the Wilcoxon T-test. Comparison analysis of independent variables was performed using the Kruskal-Wallis ANOVA method.

RESULTS

The results of the study of atmospheric air in the settlements of the city of Tursunzade, located in the experimental and control zones with a western wind direction, are shown in Table 3. The maximum amount of hydrogen fluoride in the experimental zone (Jamoat Navobod) with a western wind direction was found in the autumn period, with a maximum permissible concentration of fluorine (0.08 mg / m3). At the same time, the amount of solid fluorides in the west wind direction ranged from 0.01 to 1.0 mg / m3 which is below the MPC value. Maximum content of fluorine in Navobod Jamoat was seen in the autumn however, it was not exceeding the MPC. In the control zone (Dzhura Rakhmonov jamoat), the concentration of hydrogen fluoride in autumn, was not exceeding the MPC values (Table 3).

Table 3. Fluorine content in atmospheric air samples (sampling with a westerly wind)

Village/locality (sampling location)	Zones	Fluoride content in mg/m^3		P value
		F – gaseous (MPC* 0,05)	F – solid (MPC 1,0)	
Autumn sampling				
Navobod	Experimental	0,08±0,003	1,0±0,06	<0,001
Seshanbe		0,06±0,002	0,6±0,03	
T.Tuychiev		0,04±0,001	0,7±0,04	
I.Somoni		Not detected	Not detected	
Pahtaobod		Not detected	Not detected	
J.Rahmonov	Control	0,003±0,001	Not detected	
Spring sampling				
Navobod	Experimental	0,04±0,006	0,6±0,03	<0,001
Seshanbe		0,03±0,004	0,4±0,02	
T.Tuychiev		0,04±0,001	0,5±0,01	
I.Somoni		Not detected	Not detected	
Pahtaobod		Not detected	Not detected	
J.Rahmonov	Control	Not detected	Not detected	

* maximum permissible concentration in air

Table.4 shows the fluorine content in the atmospheric air samples having north and northeast direction of the wind. When the wind changed from west to north and north-east direction from the aluminum smelter, hydrogen fluoride and solid fluorides were mainly determined in autumn in the corresponding experimental zones: Jamoat T. Tuychiev, Pakhtaobod, and along with I. Somoni street of the city of Tursunzade exceeding the MPC indicators. However, in the experimental zone (jamoat T. Tuychiev) in the autumn season, trace amounts of hydrogen fluoride were found, which did not exceed the MPC value (table 4).

Table 4. Fluorine content in atmospheric air samples (sampling in the north and north-east wind direction)

Village/locality (sampling location)	Zones	Fluoride content in mg/m³		P value
		F – gaseous (MPC* 0,05)	F – solid (MPC 1,0)	
Autumn sampling				
Navobod	Experimental	Not detected	Not detected	<0.001
Seshanbe		Not detected	Not detected	
T.Tuychiev		0,06±0,003	1,2±0,06	
I.Somoni		0,05±0,002	1,1±0,04	
Pahtaobod		0,05±0,002	1,0±0,04	
J.Rahmonov	Control	Not detected	Not detected	
Spring sampling				
Navobod	Experimental	Not detected	Not detected	<0.001
Seshanbe		Not detected	Not detected	
T.Tuychiev		0,04±0,002	0,5±0,03	
I.Somoni		0,05±0,003	0,7±0,04	
Pahtaobod		0,05±0,001	0,6±0,01	
J.Rahmonov	Control	Not detected	Not detected	

Table.5 demonstrates the Average annual fluorine content in atmospheric air depending on wind direction (mg / m3). The content of hydrogen fluoride and solid fluorides in different periods of the year ranged from 0.0001 to 0.08 mg / m3 and 0.001 to 0.2 mg / m3, respectively. The highest concentration of these substances was recorded in the summer-autumn period when precipitation was less frequent in the Republic and their permissible levels were mainly revealed in the atmospheric air. However, with long-term preservation of the latter, it can lead to a situation with environmental pollution exceeding the maximum permissible concentration.

As illustrated in Table 5, the results of the study of atmospheric air in settlements located in the experimental and control zones with the western, northern and northeastern wind directions from the aluminum smelter, the average annual content of hydrogen fluoride and solid fluorides in both spring and autumn periods varied from 0.0001 to 0.08 mg / m3 and from 0.001 to 0.2 mg / m3, respectively, slightly exceeding the MPC values.

It should be noted that in the control settlement (Jamoat Dzhura Rakhmonov), in addition to hydrogen fluoride (below the MPC values) with a west wind direction from the aluminum plant is in the range of 0.003 ± 0.001 mg / m3, which did not exceed the MPC values , which is also typical for some settlements in the experimental zone (village T. Tuychiev, Navobod and Seshanbe) (Table 5).

Table 5. Average annual fluorine content in atmospheric air depending on wind direction (mg / m3)

Village/locality (sampling location)	Zones	Fluoride content in mg/m³		P value
		F – gaseous (MPC* 0,05)	F – solid (MPC 1,0)	
West wind direction				
Navobod	Experimental	0,08±0,003	0,09±0,003	<0.001
Seshanbe		0,05±0,001	0,06±0,001	
T.Tuychiev		Not detected	Not detected	
I.Somoni		0,006±0,0001	Not detected	
Pahtaobod		0,006±0,0001	Not detected	
J.Rahmonov	Control	0,003±0,001	Not detected	
North and north-east wind direction				

Navobod	Experimental	Not detected	Not detected	<0.001
Seshanbe		Not detected	Not detected	
T.Tuychiev		0,05±0,003	0,08±0,002	
I.Somoni		0,07±0,005	0,2±0,004	
Pahtaobod		0,05±0,001	0,1±0,006	
J.Rahmonov	Control	Not detected	Not detected	

The results of the study of atmospheric air in 15 administrative cities and districts of the Bokhtar region illustrated in table 6, show both in the spring and autumn periods, there was a complete absence of solid fluorides in all selected samples of atmospheric air. However, trace amounts of hydrogen fluoride have been detected. As can be seen in table 6, in the districts of Kubodiyon, Kushoniyon, Yavan, N. Khusrav and the city of Levakant, insignificant trace amounts from 0.0001 to 0.002 mg / m3 of hydrogen fluoride were found.

Table 6. Average annual fluorine content in atmospheric air sampled in cities and districts of the Bokhtar region

City / district	Village/locality	Fluoride content in mg/m^3	
		F – gaseous (MPC* 0,05)	F – solid (MPC 1,0)
Kubodiyon	District center (markaz)	0,001±0,0001	Not detected
Nurek	Nurek city center	Not detected	Not detected
Pyanj	Center of Panj District	Not detected	Not detected
A. Jami	A. Chomi district	Not detected	Not detected
Kushonyon	h / w Bustonkala (village Bustonkala)	0,001±0,0001	Not detected
Bokhtar	Khatlon street	Not detected	Not detected
Jaihun	h / w dusti (r.Dusti)	Not detected	Not detected
Levakant	Levakant city	0,001±0,000	Not detected
Vakhsh	h / w Vakhsh	Not detected	Not detected
Javan	the town of Yavan	0,002±0,001	Not detected
J. Balkhi	the town of J. Balkhi	Not detected	Not detected
Shakhritus	Shahritus district	Not detected	Not detected
Dusti	Dusti district	Not detected	Not detected
N.Khusrav	town of Bakhor	0,002±0,001	Not detected
Khuroson	h / d Hiloli (Mehnat)	Not detected	Not detected

DISCUSSION

The results of the current study report about the content of fluorine in the atmospheric air of various settlements of the city of Tajikistan, where the aluminum plant is located. Compounds of gaseous (hydrogen fluoride) and solid fluorine were evaluated, which are the main emissions of the enterprise in Tajikistan.

It's worth mentioning that the Republic of Tajikistan belongs to the regions where there is a deficiency of fluoride compounds. Taking into account the absence of fluorine-containing industrial enterprises in the Khatlon province, the current study was aimed to study the presence of fluorine in atmospheric air.

An elevated level of Fluorine in the environment is responsible for various health problems such as dental carries and bone deformities [13]. There are several areas in Tajikistan which are more susceptible to a high level of fluorine due to presence of state industries. The emission of fluorine to the atmospheric air from this source will significantly contribute to air pollution. As shown in the table.3, the city of Tursunzade (Jamoat Navobod), with a west wind direction, has a maximum amount of hydrogen fluoride (0.08 mg / m3) in the autumn period. While, the amount of solid fluorides in the west wind direction ranged from 0.01 to 1.0 mg / m3 which was below the MPC value. Trace amount of fluorine in Navobod Jamoat was seen in the autumn however, it was not exceeding the MPC value. In the control zone (Dzhura Rakhmonov village), the concentration of hydrogen fluoride in

autumn was not exceeding the MPC values (Table 3). Similar studies in line with our reports show that in an industrialized area the contents of fluorine are high in the air [14].

Taking into consideration the direction of wind and source of emission, the results of the current study shows that atmospheric air in settlements located in the experimental and control zones (jamoats Navobod and Seshanbe) (Jamoat Dzhura Rakhmonov) with a north and northeast wind direction shows the absence of fluorine in atmospheric air. It might be the direction of wind that contaminates the atmospheric air which is typical for some settlements in the experimental zone. These results are in line with previously published study where the direction of wind and presence of contamination source is responsible for air pollution [15]. In table.5 it has been revealed that the content of hydrogen fluoride and solid fluorides year long varies from 0.0001 to 0.08 mg / m3 to 0.001 to 0.2 mg / m3. The highest concentration gradient was found in the summer-autumn period. The results also shows that atmospheric air from experimental and control zones with the western, northern and northeastern wind directions from the aluminum industry have a varied annual content of fluorine in both spring and autumn periods (0.0001 to 0.08 mg / m3 and from 0.001 to 0.2 mg / m3), slightly exceeding the MPC values. Conversely, in the control settlement (Jamoat Dzhura Rakhmonov), the concentration of hydrogen fluoride with a west wind direction from the aluminum plant did not exceed the MPC values (0.003 ± 0.001 mg / m3).

The control zone in the city of Tursunzade (Jamoat J. Rakhmonov (including three villages,: S. Sherozi, Zarkamar and O. Numonova). basically, no fluorine compounds were found. This might be possibly due to air turbulence, due to which some of the plant's emissions may be directed to the east. Thus, the content of fluoride compounds (mainly hydrogen fluoride) in the atmospheric air of the settlements of the city of Tursunzade was below or slightly exceeding the MPC values. Nevertheless, hydrogen fluoride was found in Navobod jamoat in the autumn season with a west wind direction. With the north-east direction of the wind in the autumn season, in the center of the city of Tursunzade, trace amounts of fluoride compounds were found in the form of hydrogen fluoride.

CONCLUSION

Research revealed that compounds of gaseous fluorine and salts of hydrofluoric acid were the most detectable chemical elements in the atmospheric air of populated areas of the city of Tursunzade, and trace amounts in the Bokhtar region. The maximum amount of fluorine compounds was found in the experimental zone (Jamoat Navobod) of the city of Tursunzade.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that can adversely affect the current study.

AUTHOR CONTRIBUTION

EKN conceptualized the whole study, wrote the first draft of the manuscript, performed the statistical analysis and supervised the whole study. BII collected the data and helped in revising the manuscript. ASP helped in study design and conceptualization. ASM helped in editing the final version of the manuscript. All Authors have read and approved the final version of the manuscript.

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REFERENCES

1. *Martin, A. and C.M. Jones, Some medical considerations regarding atmospheric fluorides. HSMHA health reports, 1971. 86(8): p. 752.*
2. *Smith, F.A., H.C. Hodge, and B. Dinman, Airborne fluorides and man: Part II. Critical Reviews in Environmental Science and Technology, 1979. 9(1): p. 1-25.*
3. *Walna, B., et al., Fluoride pollution of atmospheric precipitation and its relationship with air circulation and weather patterns (Wielkopolski National Park, Poland). Environmental monitoring and assessment, 2013. 185(7): p. 5497-5514.*
4. *Dhar, V. and M. Bhatnagar, Physiology and toxicity of fluoride. Indian Journal of Dental Research, 2009. 20(3): p. 350.*

5. *Mariotti, F., et al., Potential pitfalls of health claims from a public health nutrition perspective. Nutrition reviews, 2010. 68(10): p. 624-638.*
6. *Owen, L. and B. Corfe, The role of diet and nutrition on mental health and wellbeing. Proceedings of the Nutrition Society, 2017. 76(4): p. 425-426.*
7. *Péter, S., et al., Nutritional solutions to reduce risks of negative health impacts of air pollution. Nutrients, 2015. 7(12): p. 10398-10416.*
8. *Mabahwi, N.A.B., O.L.H. Leh, and D. Omar, Human health and wellbeing: Human health effect of air pollution. Procedia-Social and Behavioral Sciences, 2014. 153: p. 221-229.*
9. *Revich, B., 11. Social inequality and environmental health in the Russian Federation. Environment and health risks: of social inequalities, 2010: p. 238.*
10. *Gupta, A. and A. Gupta, Environmental challenges in Aral Sea basin: Impact on Human health. Int. J. Res. Soc. Sci, 2016. 6: p. 419-440.*
11. *Matthys, B., et al., Prevalence and risk factors of helminths and intestinal protozoa infections among children from primary schools in western Tajikistan. Parasites & vectors, 2011. 4(1): p. 1-13.*
12. *De Marco, R., G. Clarke, and B. Pejcic, Ion-selective electrode potentiometry in environmental analysis. Electroanalysis: An International Journal Devoted to Fundamental and Practical Aspects of Electroanalysis, 2007. 19(19-20): p. 1987-2001.*
13. *Fuge, R. and M.J. Andrews, Fluorine in the UK environment. Environmental Geochemistry and Health, 1988. 10(3-4): p. 96-104.*
14. *Adams, D.F., A quantitative study of the limed filter paper technique for fluorine air pollution studies. Int. J. Air Wat. Pollut., 1961. 4: p. 247-255.*
15. *Thrane, K., Application of air pollution models: a comparison of different techniques for estimating ambient air pollution levels and source contributions. Atmospheric Environment (1967), 1988. 22(3): p. 587-594.*