Journal of Agricultural Sciences
Vol. 52, No 2, 2007
Pages 155-168

UDC: 628.1.033:663.64
Original scientific paper

DETERMINATION OF FLUORIDE CONTENT IN DRINKING WATER AND TEA INFUSIONS USING FLUORIDE ION SELECTIVE ELECTRODE

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Abstract: Potentiometric analysis of fluoride content (as F^- ion) in solutions by using fluoride ion-selective electrode is simple, reliable and cheap. Very small concentrations of fluoride-ions (to 10^{-6} mol/dm^3) can be determined by fluoride selective electrode, with regulation of ion strength of a solution and control of concentration of hydroxide ions and interfering ions of metals. The influence of pH and complexing ions of metals can be successfully regulated by the TISAB solution and by preserving pH value in the range from 5.00 to 7.00. The content of fluorides in the samples can be determined by the method of direct potentiometer, and in the case of very low concentration by standard addition method.

In this paper it was analysed the determination of fluoride ions concentration in bottled mineral waters and water from Belgrade plumbing in two Belgrade districts (Palilula and Novi Beograd) and in tea, by using the fluoride selective electrode.

It was determined that the content of fluoride ions in bottled mineral water significantly differs from values given on declaration, and that content of fluoride ions varies over a period of time. The content of fluoride ions in water from plumbing in two Belgrade districts at the time of analysis was significantly increased and exceeded values given in Regulation for drinking water quality.

The received results from the analysis of fluorides in teas show that fluorides exist in teas in different concentrations. There are also differences between the same kinds of tea, which is noted with mint (*Mentha piperitae folium*), as a consequence of differences between soils where it was planted.

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As taking of fluorides, according to World Health Organisation recommendation (WHO), is limited in the range from 2 to 4 mg per day, it is necessary to give the content of fluorides on all products that are used in human consumption.

Key words: bottled mineral water, drinking water, fluoride selective electroda, direct potentiometry, standard addition method, Total Ionic Strength Adjustment Buffer (TISAB).

Introduction

Flour belongs to a group of halogen elements and it is the most reactive non-metal. Flour is the lightest member of the group of halogen elements, and its chemical behaviour mainly differs from other halogen elements, and some of these differences are evident in its reaction in natural water.

Fluorides come naturally into water by dissolving minerals that contain fluor, such as *fluorite* (CaF_2), the most common fluor mineral, *apatite* ($Ca_5(Cl,F,OH)(PO_4)_3$), *cryolite* (Na_3AlF_6). Amphibole minerals, such as hornblende and some sorts of mica, can contain fluor that partially replaces hydoxide ion. Rocks rich in alkali metals have a larger content of fluoride than other volcanic rocks. Fresh volcanic ash, as well as the ash of the other sediments can contribute to fluor content increasing in surface waters. Mixed minerals $NaMgAl(F,OH)_6 \cdot H_2O$ and $Al_2(F,OH)_6 \cdot H_2O$ and are rare, but can contribute to the fluoride content increasing while rinsing with water. In water that contains significant amounts of Ca^{2+} ion, it is possible to make balance and create hardly dissolving calcium fluoride. According to values for the dissolving result of calcium fluoride in water, where activity of calcium ion is 0.001 mol/dm^3, concentration of fluoride ions is 3.1 mg/dm^3. Total concentration of fluoride ions will be somewhat higher, which depends on ion strength and complexing effects, and it will be higher in waters where the concentration of Ca^{2+} ion is smaller (that is, in waters with low hardness) (Hem, 1985).

Natural water contains less than 0.1 ppm fluoride ions, and in our waters it moves from 0.05 to more than 0.6 ppm. Mineral waters consist, on average, 0.16 to 6.45 ppm. Recommended limited value for fluoride in drinking water by World Health Organisation (WHO) and European Union (EU) is 1.5 ppm (WHO, 1984), while in our country the standard is 1 ppm (Official Gazette of FRY, 1998; Official Gazette of FRY, 1999).

Fluor content in water is expressed through the free fluoride-ion concentration, whose concentration depends on origin and nature of water. This form is dominant in many water samples, although other forms of dissolved fluor can be present. Fluoride ion has small ion radius, so it shows great tendency to behave as ligand. Fluoride ion, because of that, forms a great number of different complex ions, where central ion has a large coordination number (mostly 6). Fluor forms stable complexes in water with Al^{3+}, Be^{2+} and Fe^{3+} ions, and with boron it forms mixed fluoride-hydroxy complexes. As fluoride ion has the same electricity and almost the same radius as hydroxide ion, these ions can mutually change in mineral structures.

In acid solutions, fluor can be connected with silicium, making complex ions $[SiF_6]^{2-}$ and $[SiF_4]$, however, conditions for stability of these complexes rarely exist in natural water. In the cycles of water circulation, fluorides are mostly transferred in the form of complexes with aluminium (www.inchem.org). Calculations, according to stability constant, show that aluminium fluoride complexes will be present in natural water where pH values are smaller than 7.00. Although the greatest part of dissolved aluminium in such conditions is linked in different complex ions, concentration of fluoride ions in such conditions is usually higher than concentration of aluminium, so a very small part of total fluoride ion is linked into complex compounds with aluminium.

The main source of fluor intake is drinking water and food, and secondary are stomatology prophylactic preparations. To date there are not reliable data about minimal daily nutritive requirements for fluor. Fluoride ion in traces in drinking water helps in growth and development of healthy, resistant teeth and bones. In many researches it was determined that fluorides are efficient in prevention of dental caries. Teeth enamel is mostly made of mineral hydroxyapatite. Hydroxyapatite contains hydroxide ion, which fiercely attacks acids (results of bacteria in mouth where they are feeding with sugar), as a difference from much weaker basis, fluoride-ion in fluoroapatite (Dalmacija, 2000).

Surplus of fluorides in organism can provoke teeth and skeleton fluorose. Fluorides inhibit many enzymes. Affected enzyme contains metal ion which unites with fluoride and creates metal-fluoride complex. Fluor in organism has its optimal, security-tolerant and toxic dose, which depends of person's age, weight and health. In the first year of life the optimal content of fluor is 0.045 mg/kg of body mass, tolerant 0.073 mg/kg, chronically toxic 0.150 mg/kg. Optimal dosage of fluor for adults is 0.020-0.025 mg/kg of body mass (www.mineralwaters.org).

The sources of water pollution with fluorides are above all industrial waste waters from the production of aluminium, copper and nickel, steam-generating stations, then phosphate minerals treatment, production and usage of phosphorus fertilizers, usage of fluor - based pesticides, production of glass, cement, glues and adhesive means. Transport and form of fluorides in water depends on environment pH value, water hardness and the presence of ion changeable substances, such as alumina. In waste waters fluorides can be present in the form of weak and highly toxic hydrofluoric acid (HF) whose toxicity can be seen in its characteristic to penetrate into tissue, because small molecules of HF quickly move through skin to tissue and damage it permanently.

Fluoride selective electrode

The most important electro analytic method for determination of fluoride ion in water solution is usage of ion selective electrode for fluorides. Fluoride selective electrode is very sensitive, and temperature range of electrode goes from 0 to 50°C. For potentiometric analysis of fluoride ion, in commercial usage, there are mostly used electrodes with homogenic membrane made from fluoride lantana (LaF_3), which was first suggested by Frant and Ross (Frant and Ross, 1966; Frant, 1994). Active phase of fluoride selective electrode makes monocrystal LaF_3 which is doping by Eu^{2+} ions, in order to decrease membrane ohm resistance. The great selectivity of electrode is in the fact that only fluoride ions are included in the process of diffusion (Cammann, 1979). Commercially available electrodes are made by putting the electro-active material into the electrode carrier. The electrode carrier is the most common organic polymer substance (PVC, epoxy resin, polypropylene, *Teflon* etc.). The interior of the electrode carrier is filled with sodium chloride solution of 1 mol/dm^3 concentration and sodium fluoride solution of 0.01 mol/dm^3 concentration, inner referent electrode is Ag/AgCl electrode. The detection limit of monocrystal ion selective electrodes depends on the product of solubility of hardly dissolved compound in test solution. Even if the test solution doesn't contain fluoride ions, when the fluoride selective electrode plunge into the solution it will come to LaF_3 dissolving, and concentration of La^{3+} and fluoride ions will be adequate to values that are countable from the product of LaF_3 dissolving (Bralić et al., 2001). This means that in the solution there will always be present low, constant, concentration of fluoride ions, so the applicability of ionometria for fluoride ion is from $5\cdot10^{-7}$ mol/dm^3 to 1 mol/dm^3 of fluoride.

At 25°C the potential of the fluoride selective electrode is determined by the following expression:

$$E_{\mathrm{j}} = \mathrm{k_e} + \mathrm{k} \cdot \log a_{\mathrm{F^-}} \qquad (1)$$

where k_e is an electrode constant, k has theoretical value $2.303\cdot RT/nF$, a_F the activity of fluoride ion in a solution. If the activity of fluoride ion in a solution is expressed through the concentration and the coefficient of activity, the following expression is received:

$$E_{\mathrm{j}} = \mathrm{k_e} + \mathrm{k} \cdot \log(\gamma_{\mathrm{F^-}}[\mathrm{F^-}]) \qquad (2)$$

In practical measurements, ion intensity of a solution is kept by regular adding of the constant solution amount with high ion intensity, which is called mixed buffer TISAB (*Total Ionic Strenght Adjustment Buffer*), both to standard solutions and to sample solutions (Rekalić, 1989; Harris, 2003). Then the coefficient of fluoride ions activity is constant and goes into constant k_e, so the electrode potential is linear with logarithm of fluoride ions concentration:

$$E_{\mathrm{j}} = \mathrm{k}_e^{'} + \mathrm{S} \cdot \log[\mathrm{F^-}] \qquad (3)$$

Fluoride selective electrode is very selective to fluoride ions, but at the same time, in a certain amount, it is selective to hydroxide ion. Adjustment of pH value with buffer is necessary because fluoride and hydroxide ions have the same electricity and similar ion radius, so hydroxide ions can interfere in the measurement of the fluoride selective electrode. In acid solutions hydrofluoric is formed, to which the fluoride selective electrode is not sensitive. In that way, with solution pH values decreasing, the activity of fluoride ion in solution also decreases, so the measurement will not be reliable.

On the other hand, in highly base solutions a thin layer of $La(OH)_3$ is formed on the surface of the sensor part:

$$LaF_{3(s)} + 3OH^{-} \rightarrow La(OH)_{3(s)} + 3F^{-}$$

In this way, the concentration of fluoride ions in solution increases, that is, with the increasing of solution pH values, electrode potential of the ion selective electrode becomes more negative.

Accordingly, it can be concluded that pH value of the solution during the measurement by the fluoride selective electrode must be in the range 5.00-7.00. Before the measurement with the fluoride selective electrode, all precautions must be taken to remove all organic uncleanness from the solution, above all *chloroform* ($CHCl_3$).

Determination by the fluoride selective electrode means previous calibration with the solution with known concentration. During the measurement of concentration by the fluoride selective electrode, it is advisable, instead of calibration with two points, to construct calibration diagram, by *EMS* measurement in 5-6 standard solutions of different concentrations. This calibration diagram is then used to determine of fluoride ions concentration in the sample by *EMS* measurement and reading from calibration curve. If the fluorides solutions are highly dilute, concentration of fluoride ions is determined by standard addition method.

Methods of fluoride ions determination in biological fluids (liquids) (above all in whey) are in detail explained in the monograph (Fuchs, 1976) and the book by Bailescu and Cosofret (Bailescu and Cosofret, 1980). Determination of fluorides by direct potentiometric is shown in Luthi and Sahlia's work (Luthi and Sahli, 1974), and the method is also elaborated by Novaković and associates (Novaković and Rajaković, 2004; Novaković et al., 2005a).

Fluoride-selective electrode today has primary role for determination of fluorides in drinking water, and it is used for determination of fluorides in: drinking water (Li and Liu, 1995; Li and Ge, 1991; Ji, 1985; Wang, 2003), mineral water (Dimitrijević et al., 1990; Gigos et al., 1984), waste waters (Yamada et al., 1988; Lai and Tang, 2003; Golovanova and Sivokonev, 1986), ground waters (Ion et al., 2005; Kaniewski et al., 1985) and sea water (Sun, 2002).

In this paper, it is analysed the usage of fluoride selective electrode for determination of fluoride ion content in the samples of bottled mineral water and drinking water from water-supply system in two Belgrade districts: Palilula and Novi Beograd, and in different tea solutions. By the usage of the ion selective electrodes the fluoride ion content can be determined in concentrations higher than 0.1 mg/dm^3. The advantage of ion selective electrode usage for determination of fluoride ion is in a wider range of linearity, short time of response, non-destructivity of samples and there is no contamination of samples.

Material and Methods

Measurements of fluoride ion in bottled mineral water and drinking water from water-supply system were done on ion meter type PHM240 (Radiometer, France). Fluoride selective electrode was used as sensor electrode (type ISE25F) and saturated calomel electrode (SCE) as a reference electrode.

In order to construct a calibration curve, for fluoride ion determination in drinking water, standard solutions were prepared. First, the standard working solution R_o of 100 mg/dm^3 concentration was prepared by dissolving the necessary amount of sodium fluoride. Before the measurement, sodium fluoride was dried for an hour at 110°C. Solutions of 0.1-10 mg/dm^3 concentration of fluoride ion were prepared by diluting the standard working solution (for determination of fluoride in drinking water and 0.1-5 ppm fluoride ions for determination of fluoride in tea, respectively). Diluted solutions were prepared in 0.1 mol/dm^3 solution of potassium nitrate, in order to regulate ion intensity (Novaković et al., 2005b).

Concentration of fluoride ion in tea solutions was measured on ion meter type C863 (Consort, Belgium), and combined fluoride selective electrode was used as a sensor electrode (type ISE27B).

Tea solutions were prepared as follows: in a glass of 100 cm^3 it was measured about 1 g of sample on analytic scale and was added about 80 cm^3 of boiled distillate water. Leaves of tea remained in water for 5-30 minutes, according to the manufacturer's manual for tea preparing. Then tea was filtered, cooled and put into 100 cm^3 measuring glass. Tea that was in bags was measured in the way that bags were torn, and the complete content was put into a glass during the measurement (Novaković and Rajković, 2007).

Before distilled water was added to the measurement line in measuring glass, 10.00 cm^3 of standard fluoride solution of 10 ppm concentration was added.

Mixed buffer solution, which was used for pH values of TISAB solution adjustment and for regulating ion intensity of tea solution, was prepared in the following way: in 500 cm^3 distilled water 58 g sodium chloride, 30.00 g of sodium nitrate and 57 cm^3 glacial acetic (ethanoic) acid were dissolved. Before final dilution pH value of mixed buffer solution was adjusted to 5.50 with 5 mol/dm^3 of sodium hydroxide solution. After regulating pH values, received solution was put into 1 dm^3 measuring glass and filled with distilled water to measurement line.

Standard solutions were put into separate flasks, the magnetic nucleus was inserted and the stirring speed was adjusted. Electrode was put into the solution and after a few seconds the measurement was done.

Potential in a standard solution and in the samples was measured in the same way. 25.00 cm^3 standard solution (sample) was measured with pipette into separate flasks, 25.00 cm^3 solution of TISAB buffer was added, the magnetic nucleus was inserted and the stirring speed was adjusted. Electrode was put into the solution and after five minutes the potential was read.

Then the standard solutions potential was measured, according to which calibration curve was constructed. In every sample the fluoride ion content was measured five times in order to evaluate precision and reproductivity of received results.

The results of statistic processing of data are shown through standard deviation (σ), medium deviation (σ_m) and relative mistake of average values (Lacroix, 1978; Rajković, 2004). Relative mistake was not determined because there did not exist the referential value of fluoride content in all analysed samples according to which the received results could be checked.

In Table 1 the names of analysed water, which are on the declaration are shown. Together with bottled mineral water where fluoride ion content is known, there were selected waters that do not have the fluoride ion content on the declaration, and also water from water-supply system of the city of Belgrade.

T a b. 1. - The names of analysed water and its producers

Sample	Producer
Water from water-supply system of Novi Beograd	Beogradski vodovod
Water from water-supply system of Palilula	Beogradski vodovod
„Vujić voda”	*Vujić*, Valjevo
„Rosa”	*Vlasinka*, Beograd
„Duboka”	*Bambi*, Požarevac
„Voda-voda”	*Voda-voda*, Gornja Toplica
„Aqua viva”	*Knjaz Miloš*, Aranđelovac
„Knjaz Miloš”	*Knjaz Miloš*, Aranđelovac

In order to determine fluorides dissolved in tea, water solutions were made from the tea of different manufacturers, which were bought in a store, and which are shown in Table 2.

T a b. 2. - Different samples of tea

Sample of tea	Producer
1. Wild mint (*Mentha piperitae folium*)	Tea collected in nature.
2. Sage (*Salviae officinalis*)	Fructus DOO, Bačka Palanka
3. St.John's wort (*Hypericum perforatum*)	LOCUS, Drina Pak, Ljubovija
4. Domestic mint (*Mentha piperita L.*)	LOCUS, Drina Pak, Ljubovija
5. Chamomile (*Chamomillae flos*)	Vitamin, Horgoš

Results and Discussion

Calibration curve was received by combined fluoride selective electrode used to determine fluoride ions content in analysed water, shown in Fig. 1. According to calibration curve, fluoride ion content in samples of bottled waters and water from water-supply system from different Belgrade districts was determined, which is shown in Table 3. for all measurements per sample.

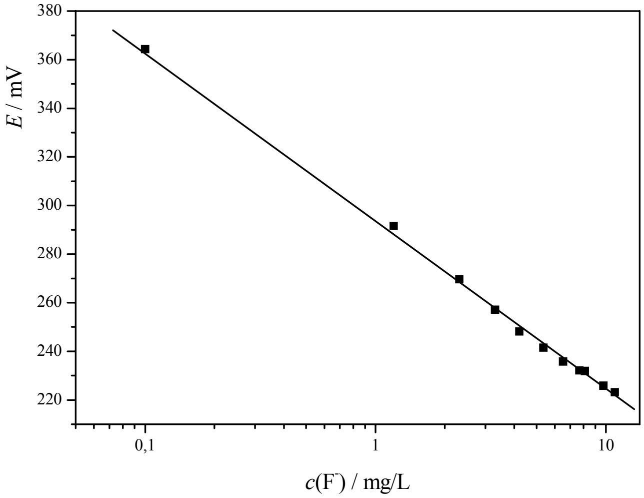

Fig. 1. - Calibration curve for fluoride ion in drinking water determination

T a b. 3. - Contents of fluoride in tea samples

Drinking water	Standard deviation (σ)	Mean deviation (σ_m)	Declaration	Found value (ppm)	Relative error of mean value (%)
sample 1.	0.382	0.220	1	2.44	38.85
sample 2.	0.060	0.035	1	1.86	8.01
„Vujić voda”	0.102	0.059	0	1.28	19.77
„Rosa”	0.064	0.037	0	0.89	17.66
„Duboka”	0.064	0.037	0	0.78	6.86
„Voda-voda”	0.115	0.067	0.48	1.32	7.26
„Aqua viva”	0.399	0.230	0.20	1.46	22.66
„Knjaz Miloš”	0.065	0.037	1.71	0.99	5.46

The obtained results show the reliability of the method by determining fluorides in drinking water in most samples. Lack of referential value (especially in bottled waters) refers to the fact that manufacturer has to analyse water that is put on the market regularly, because significant deviations from measured values, which are given and/or are not given on declaration are noticed. In the analysis of drinking water samples, taken in two Belgrade districts, it is seen that fluoride ion content is higher than maximum allowed concentration (Official Gazette of FRY, 1998, 1999), but it varies in certain amount. Namely, water-supply system of Novi Beograd and Palilula are supplied from different systems, so the differences in fluoride ion content are expected and proven.

In order to follow the changes in fluoride ion content, the analyses of a number of samples were done in September 2004 (Novaković and Rajaković, 2004). Comparison of received results with results shown in Table 4. shows the important changes in fluoride ion content during these several months. The tendency of fluoride ion content can be clearly seen in almost all the samples. The increasing of fluoride ion content in drinking water from water-supply system is especially important. Analysis, done in September 2004, showed that the content of fluoride ion in drinking water was changed and that in some period of time it highly increased.

Calibration curve is received by the combined fluoride selective electrode used for F^- ion content determination in analysed tea, shown in Fig. 2.

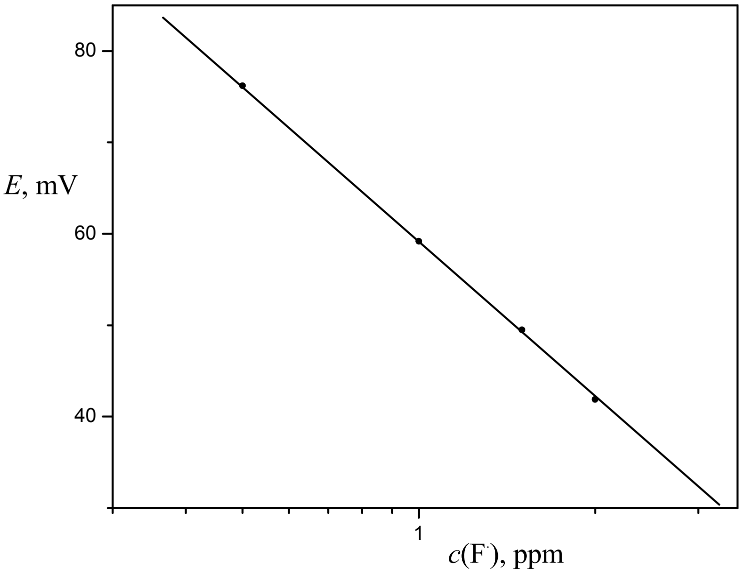

Fig. 2. - Calibration curve for fluoride ion in tea determination

According to the calibration curve, the content of fluoride-ion was determined in solutions of analysed tea by using of combined fluoride-selective electrode, and the obtained results are shown in Tables 4 and 5.

T a b. 4. - Contents of fluoride in tea samples (in mg/dm^3)

No. of measurements	$c(F^-)$, mg/dm^3				
	Wild mint	Sage	Domestic mint	St.John's wort	Chamomile
1	0.1536236	0.288023	0.0267812	0.0030047	0.01098012
2	0.118172	0.231320	0.0291458	0.00298762	0.0115993
3	0.118172	0.277254	0.02527263	0.00298762	0.01298762
4	0.122101	0.249492	0.0298762	0.0023723	0.01298762
5	0.1277057	0.237136	0.0268252	0.0023823	0.0103616

T a b. 5. - Contents of fluoride in tea samples (in ppm)

No. of measurements	$c(F^-)$, ppm				
	Wild mint	Sage	St.John's wort	Domestic mint	Chamomile
1	11.67	28.70	1.86	0.20	1.05
2	11.76	23.08	2.04	0.20	1.03
3	11.72	27.54	1.71	0.20	1.22
4	12.17	24.88	2.14	0.15	1.26
5	12.73	23.45	1.82	0.16	1.06
$\bar{x}$	12.00	25.53	1.91	0.18	1.12

Statistic processing of the results received by the analysis of fluoride in analysed tea is shown in Table 6.

T a b. 6. - Statistical processing of measurement results

Sample	Found value (ppm)	Standard deviation (σ)	Mean deviation (σ_m)	Relative error of mean value (%)	Relative standard deviation (%)
Wild mint	12.00	0.5636	0.2520	5.83	4.70
Sage	25.53	2.4820	1.1100	12.07	9.72
St.John's wort	1.91	0.1734	0.0775	11.26	9.08
Domestic mint	0.18	0.0250	0.0112	17.27	14.00
Chamomile	1.12	0.1074	0.0480	11.90	9.55

The obtained results for determination show the validity of the method of determination of fluoride in tea samples. The results were very reproductive in the samples of hand-picked mint, while in other teas there were certain deviations, especially in „domestic mint”, which can be explained by the lowest concentration of fluorides (just 0.18 ppm).

Different values of fluorides in teas show that teas were grown on different soils, from where they were accumulated into the plant fruit. It is an interesting datum that fluoride content in sage is several times (*ca*. two, ten, twenty), and even several hundred times higher than fluorides content in other teas (for example „domestic mint”). This is significant because in preparing tea – solutions, fluorides from a plant come into the solution even up to 94.90% (WHO, 1984; Fung et al., 1999).

In that way the usage of sage tea over a long time interval and in large quantities can lead to over-dosage of fluoride ion that can produce damaging effects on human health.

Conclusion

Potentiometric determination of fluoride content in solutions by usage of the fluoride electrode is simple, cheap and reliable. All negative interfering effects that can influence the method of determination are eliminated by the usage of TISAB buffer. The content of fluorides in samples is determined by the method of direct potentiometry and, in the case of very low values, by standard addition method.

The content of fluoride ion in analysed bottled waters is remarkably different from values given on declarations. In the majority of analysed bottled waters fluoride ion content is higher than values given on declarations. Although the fluoride ion content is less than maximum allowed, especially significant is the presence of these ions in bottled waters where the content of these ions is not given („Vujić voda”, „Duboka” and „Rosa”).

Changes in fluoride ion content in bottled waters in comparison to previously done analysis show the tendency of growth („Voda-voda” and „Aqua viva”), while only bottled water „Knjaz Miloš” has decreasing tendency.

The analysis of the fluoride ion content in drinking water from water-supply system in two Belgrade districts shows that it is higher in comparison to previous analysis and that it was increased by almost eight times.

The obtained results show that fluorides exist in teas in very different concentrations. There are differences between the same sort of tea, as was noted with mint (*Menthihaepiperitae folium*). As the analysed samples of mint were grown on different soil, variability in fluorides content in the same sort of tea can be attributed to the type of soil as well as conditions in which mint was grown.

As taking of fluorides, according to recommendation of World Health Organisation (WHO), is limited in the range from 2 to 4 mg per day, on all products for human use it is necessary to give the fluoride content.

Acknowledgements

We gratefully acknowledge financial support from the Ministry of Science, Technology and Development, Republic of Serbia (grant number ON 142039) for support of the work.

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Received September 17, 2007
Accepted December 31, 2007

ODREĐIVANJE SADRŽAJA FLUORIDA U VODI ZA PIĆE I ČAJEVIMA FLUORID-SELEKTIVNOM ELEKTRODOM

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Rezime

Potenciometrijsko određivanje sadržaja fluorida (kao F^--jon) u rastvorima upotrebom fluoridne jon-selektivne elektrode je jednostavno, pouzdano i jeftino. Fluorid-selektivnom elektrodom mogu se odrediti veoma niske koncentracije fluorid-jona (do 10^{-6} mol/dm^3), uz regulisanje jonske jačine rastvora i kontrolisanje koncentracije hidroksid-jona i interferirajućih jona metala. Uticaj pH i kompleksirajućih jona metala može se uspešno regulisati rastvorom TISAB-a i održavanjem pH vrednosti u oblasti od 5,00 do 7,00. Sadržaj fluorida u uzorcima može se odrediti metodom direktne potenciometrije, a u slučaju veoma niskih koncentracije, metodom standardnog dodatka.

U radu je vršeno određivanje koncentracije F^--jona u flaširanim mineralnim vodama („Vujić voda", „Rosa", „Duboka", „Voda-voda", „Aqua viva", „Knjaz Miloš") i vodi iz beogradskog vodovoda sa dve beogradske opštine (Palilula i Novi Beograd) i u čajevima (Divlja nana (*Mentha piperitae folium*), Čaj od žalfije (*Salviae officinalis*), Čaj od kantariona (*Hypericum perforatum*), „Domaća nana" (*Mentha piperita L.*), Čaj od kamilice (*Chamomillae flos*)), upotrebom fluorid-selektivne elektrode.

Uočeno je da sadržaj fluorid-jona u flaširanim mineralnim vodama znatno odstupa od vrednosti koje su date na deklaraciji, ali i da sadržaj fluorid-jona varira tokom vremena. Sadržaj fluorid-jona u vodi iz vodovoda sa dve beogradske opštine, u vreme analiziranja je znatno povećan i premašuje vrednosti propisane Pravilnikom o kvalitetu vode za piće.

Dobijeni rezultati ispitivanja fluorida u čajevima ukazuju da se fluoridi nalaze u čajevima u različitim koncentracijama. Do razlike dolazi i među istim vrstama čaja, što je zabeleženo kod nane (*Mentha piperitae folium*), što je posledica pre svega zemljišta na kojem je nana uzgajana.

Kako je, saglasno preporukama Svetske zdravstvene organizacije (SZO), unošenje fluorida limitirano u opsegu 2 do 4 mg dnevno, na svim proizvodima koji se koriste u humanoj upotrebi potrebno je navesti i sadržaj fluorida.

Primljeno 17. septembra 2007.
Odobreno 31. decembra 2007.

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