NEUTRON ACTIVATION ANALYSIS OF Br, Ca, Cl, K, Mg, Mn, Na, AND Sr CONCENTRATIONS IN HUMAN SALIVA IN HEALTH AND PARODONTOPATHY

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Introduction

Periodontal diseases and dental caries are the most common diseases in the oral cavity.[1,2] Periodontal diseases are chronic inflammatory disorders encompassing destructive and nondestructive diseases of the periodontal supporting tissues of teeth. Gingivitis is a nondestructive disease ubiquitous in populations of children and adults globally. Aggressive periodontitis is characterized by severe and rapid loss of periodontal attachment often commencing at or after puberty and common among Caucasians. Chronic periodontitis is a common disease and may occur in most age groups, but is most prevalent among adults and seniors world-wide. Approximately 48% of United States adults have chronic periodontitis, and similar or higher rates have been reported in other populations. Moderate and advanced periodontitis is more prevalent among the older age groups, and rates of 70% or more have been reported in certain populations.

However, case definitions and criteria that are used to diagnose periodontal diseases are not yet consistent worldwide. Thus, there are needs to find additional parameters to characterize the periodontal diseases. Salivary main electrolytes and trace element can be involved in the etiology and pathogenesis of periodontal diseases.[3-10]

Aim of the study

The aim of this work was to assess the Br, Ca, Cl, K, Mg, Mn, Na and Sr contents in the samples of mixed saliva using non-destructive instrumental neutron activation analysis with high resolution spectrometry of short-lived radionuclides (INAA-SLR) and to estimate the possibilities of using the data about concentration of some main electrolytes and trace elements in mixed non-stimulated saliva as biomarkers in the diagnosis of periodontal disease.

All studies were approved by the Ethical Committees of the Medical Radiological Research Centre, Obninsk. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Materials and Methods

Samples of the mixed non-stimulated saliva of 52 apparently healthy subjects and 60 patients with parodontopathy (gingivitis and periodontitis) were collected in the dental clinics

of Moscow and Obninsk. The samples of mixed saliva were obtained in period between 10 a.m. and 12 a.m., then cooled and lyophilized. The age of the persons examined (80 females and 32 males) was in the range from 17 to 49 years. There were no any metallic oral inclusions or prosthesis in all persons involved in the study. Dental diseases were diagnosed according to the complex data of special clinical examinations (disease anamnesis, inspection assessment of pathological dental and gingival pouch state, panoramic X-radiography).

For INAA-SLR dry saliva samples each about 50 mg were separately sealed in polyethylene ampules washed beforehand with pure alcohol. The content of Br, Ca, Cl, K, Mg, Mn, Na and Sr were determined by INAA-SLR using a horizontal channel equipped with the pneumatic rabbit system of the WWR-c research nuclear reactor (Branch of Karpov Institute, Obninsk). The neutron flux in the channel was 1.7×10^{13} n cm^{-2} s^{-1}. Ampoules with dry saliva samples, SSB, intralaboratory-made standards, and certified reference material were put into polyethylene rabbits and then irradiated separately for 30 s. Copper foils were used to assess neutron flux.

Measurement and Statistic

The measurement of each sample was made twice, 1 and 180 min after irradiation. The duration of the first and second measurements was 10 and 20 min, respectively. A coaxial 98-cm^3 Ge (Li) detector and a spectrometric unit (NUC 8100), including a PC-coupled multichannel analyzer, were used for measurements. The spectrometric unit provided 2.9-keV resolution at the ^{60}Co 1,332-keV line. Details of used nuclear reactions, radionuclides, and gamma-energies were presented in our earlier publications concerning the INAA-SLR chemical element contents in human bone, thyroid, scalp hair, and prostate.

A dedicated computer program for INAA mode optimization was used. All saliva samples were prepared in duplicate, and mean values of chemical element contents were used in final calculation. Using Microsoft Office Excel, a summary of the statistics, including, arithmetic mean, standard deviation, standard error of mean, minimum and maximum values, median, percentiles with 0.025 and 0.975 levels was calculated for chemical element contents. The difference in the results between two sample groups (Normal and Parodontopathy) was evaluated by the parametric Student's *t*-test and non-parametric Wilcoxon-Mann-Whitney *U*-test.

Results and Discussion

The concentration of almost all elements studied in mixed saliva of patients with parodontopathy is higher than the normal level in 1.9-6.3 times (Table 1). The exception is only for Sr which mean concentrations in the Normal and Parodontopathy groups are similar. The level of changes correlates with the severeness of parodontopathy. The data about changes of main electrolytes and trace element contents in saliva can be useful for more detail understanding of parodontopathy etiology and pathogenesis, for more accurate diagnostics and individual prognosis of these diseases, as well as for developing on new methods for their treatment.

Conclusions

In this work, the Br, Ca, Cl, K, Mg, Mn, Na and Sr measurements were carried out in the mixed non-stimulated saliva of 52 apparently healthy subjects and 60 patients with

parodontopathy (gingivitis and periodontitis) using non-destructive instrumental INAA-SLR method developed by us. It was shown that this method is an adequate analytical tool for the non-destructive determination of Br, Ca, Cl, K, Mg, Mn, Na and Sr concentration in the samples of human non-stimulated saliva. The great differences between chemical element concentrations in non-stimulated saliva of Normal and Parodontopathy groups were found.

Table 1. Concentrations of main electrolytes and some trace elements (M±SEM, mg/L) in mixed non-stimulated saliva of health persons and patients with parodontopathy

Element	Norm	Parodontopathy	Student's *t*-test	U-test	M_2/M_1
	M_1 (n=52)	M_2 (n=60)	$p<$	p	
Br	1.50±0.09	2.87±0.24	0.001	≤0.01	1.91
Ca	37±7	109±9	0.001	≤0.01	2.95
Cl	288±18	684±31	0.001	≤0.01	2.38
K	416±30	817±41	0.001	≤0.01	1.96
Mg	7.9±1.1	30.2±3.7	0.001	≤0.01	3.81
Mn	0.0095±0.0010	0.0593±0.0068	0.001	≤0.01	6.27
Na	51±4	176±14	0.001	≤0.01	3.42
Sr	0.180±0.035	0.172±0.018	>0.05	>0.05	0.96

Acknowledgements

The authors are extremely grateful to Dr Shamil Bagirov for his help in supplying saliva samples.

References

1. Costa F.O., Susin C., Cortelli J.R., Pordeus I.A., Epidemiology of Periodontal Disease. Int. J. Dent. 2012; 2012: 848641.
2. Natto Z.S., Abu Ahmad R.H., Alsharif L.T., Alrowithi H.F., Alsini D.A., Salih H.A., Bissada N.F., Chronic Periodontitis Case Definitions and Confounders in Periodontal Research: A Systematic Assessment. Biomed. Res. Int. 2018 Nov. 28; 2018: 4578782. doi: 10.1155/2018/4578782. eCollection 2018.
3. Bagirov Sh.T., Zaichick V.Ye., Kalashnikov V.M., Physiological changeability of the element concentrations in mixed non-stimulated human saliva. I. Na, Cl, Ca. Azerbaijan Med. Zhurnal 1985; **8**: 29–35.
4. Bagirov Sh.T., Zaichick V.Ye., Trace elements of mixed human saliva for paradontosis pathology in accordance with the data of *X*-ray fluorescent analysis. In: Application of Mathematical and Engineering Methods for Radiological Study, Obninsk, 1985, pp.75–78.
5. Bagirov Sh.T., Zaichick V.Ye., Kalashnikov V.M., Physiological changeability of the element concentrations in mixed non-stimulated human saliva. II. K, Mg, Mn, W. Azerbaijan Med. Zhurnal 1986; **2**: 14–20.

6. Bagirov Sh.T., Zaichick V.Ye., Physiological changeability of the element concentrations in mixed non-stimulated saliva. III. Fe, Cu, Zn, Br, Rb, Sr, I, Ba. Azerbaijan Med. Zhurnal 1987; **10**; 29–35.
7. Zaichick V.Ye., Bagirov Sh.T., The chemical composition of human saliva as an indicator of environmental quality. In: Nuclear Analitical Methods for Environmental Monitoring. Gidrometeoisdat, Leningrad, 1987, pp.61−67.
8. Zaĭchik V.E., Bagirov Sh.T., The chemical element content of mixed unstimulated saliva from a healthy subject. Stomatologiya (Moscow). 1991; **70**(1): 14−17.
9. Zaĭchik V.E, Bagirov Sh.T., The chemical element content of mixed unstimulated saliva in periodontal diseases. Stomatologiya (Moscow). 1994; **73**(1): 8−11.
10. Zaichick V., Tsyb A., Bagirov Sh., Neutron activation analysis of saliva: Application in clinical chemistry, environmental and occupational toxicology. J. Radioanal. Nucl. Chem. 1995; **195**(1): 123−132.