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Multivariate Analysis Applied to Trace and Ultra-trace Elements in Italian Potable Waters Determined by INAA

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Abstract

In this paper we have applied a chemometric treatment to investigating and comparing the element composition in potable water samples collected in two Italian urban areas, Rome and Florence, and analyzed by INAA.

The spectrum of drinkable Roman water shows very low limits of potentially toxic elements (Sb, Hg, Cr, Ni, etc.): in particular, they are present at levels below the values suggested by the European laws and the World Health Organization (WHO) guidelines. Further, it is also evidenced that the elemental composition is quite similar to that of uncontaminated natural waters. According to the Florence drinking water element characterization the concentration values show an almost good situation except for Al. Comparing the two water systems an higher level of I, Se and some anthropogenic elements (Cu, Na, Zn) is found in Florence samples.

A statistical treatment such as multivariate analysis was performed for identifying the contribution of each element to the chemical composition in Roman water.

Introduction

The element composition of drinking water is a very important task for the human health and in particular, the interest on the effects on humans and other animals of heavy metals and metalloids like arsenic taken in through drinking and use of thermal waters has increased in recent years.

The definition of the maximum allowable concentration (MAC) values for certain elements (recently classified as trace elements) in spring, drinking, thermal and surface waters has been and still is the subject of chemical and biological research, and of political debate, in several countries. For instance, arsenic [1] is usually relatively abundant in sulfide-containing mineral deposits such as pyrite and ‘soft’-metal mineralizations, as well as in hydrous iron oxides; therefore, monitoring of waters in volcanic areas and in districts that are rich in heavy-metal sulfide ores can be important to assess possible health risks. Other examples are related to the increasing interests on the content of vanadium and cobaltum [2] in drinking and thermal waters of Italy because they can affect the relative quality.

In this paper the trace element concentrations in potable waters of two Italian cities, Rome and Florence, are investigated by means of Instrumental Neutron Activation Analysis (INAA) and a chemometric treatment is involved. It should be noted that Rome represents the only case in the world of a city where the water supply is essentially furnished from spring water. On the other hand, Florence has a really different situation. Its water supply is directly the Arno river and the only intercepting station is located just upstream the city: after a strong potabilization process [3] the potable water is distributed to the city.

Materials & Methods

29 samples were collected in the two Italian cities, Rome (20 samples) and Florence (9 samples). Nine samples collected in Rome were subjected to pre-concentration process by lyophilization for determining very important toxicological and nutritional elements present at ultra-trace levels.

The short-term and long-term irradiations were performed at rotatory rack and pneumatic device of the Casaccia TRIGA Mark II nuclear reactor. A deep analytical description of the total procedure with the relative nuclear data is reported in ref. 4.

The γ-spectrometry measurements were performed by means of Ge(HP) and planar Ge(HP) Ortec detectors connected to multi-channel analyzers Silena. The Silgamma software (Silena, Milan, Italy) was involved for the emission spectra analysis. Primary (pure elements) and secondary ("Trace Elements in Water" NIST-SRM 1643d) standards were irradiated along with the samples.

Results

Comparing Rome and Florence data, differences are evident expecially for some important toxicological and nutritional elements. Elemental composition is higher in Florence than in Rome.

In particular for some elements such as Al, Br, Co (up to 50-times), Cr, I (very low levels in Rome), Mn (up to 10-times), Se, Ti (up to 4-times), V (up to 4-times) whereas the concentration levels of Fe and Ni are 2-times higher in Rome. As and Hg, 70 and 32 ng/L respectively, are determined only in Rome water samples. Finally, all the element concentration levels are below the law limits except for the Al in the Florence water ranging between 103 and 267 μg/L (law limit value is 200 μg/L): the reason is due to the strong potabilization process involving aluminum salts [3].

No relevant differences between our data and other Italian and world regions can be noted except for some elements such Ba, Co, Hg and La.

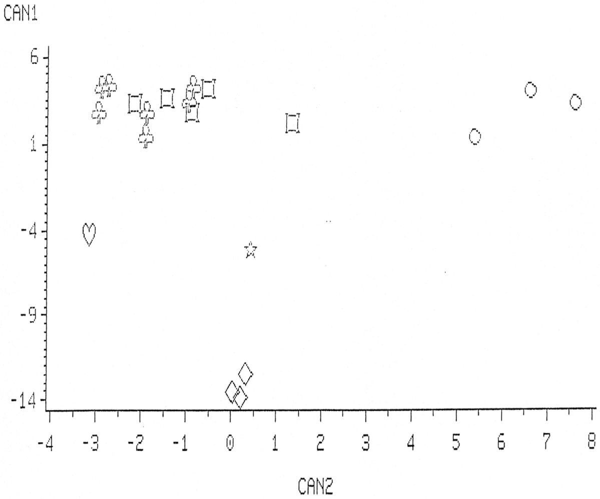

Fig. 1; Canonic discriminating analysis of Roman water (aqueducts: ¤Pescheria, ○Paolo Traiano, ✧Appio Alessandrino, ⊛Pescheria+Marcio, ♥Marcio)

Using the multivariate analysis (Fig. 1) it can be possible to investigate the contribution of the different springs to the Roman water supply: in this way we identify the five aqueducts and the chemical composition of each one.

Conclusions

This paper show the nutritional and toxicological information on the potable water in an Italian megacity like Rome. The other city considered is Florence, where the waters are distributed to each house after a strong potabilization process. The elemental composition of each water is investigated by INAA and compared with others present in literature: no relevant differences are found among Rome and Florence (almost all the data are higher than in Rome) water composition and other Italian and world potable waters.

References

1) C. Hogue, A sip of arsenic? Debate over allowable level in drinking water focuses on health effects, removal cost, Chem. Eng. News, 79 (2001) 50-55
2) D.G. Barceloux, Cobalt, J. Toxicol. Clin. Toxicol., 37 (1999) 201-206
3) P. Blasi, G. Capannesi, A. Cecchi, F. Lucarelli, F.A. Sedda, An application of INAA and PIXE on the analysis of nutritional and toxicological elements in samples of drinkable water, Biol. Trace Element Res., 26 (1990) 363-375
4) P. Avino, G. Capannesi and A. Rosada, L'Analisi Strumentale per Attivazione Neutronica, un potente strumento nella determinazione della contaminazione ambientale: teoria ed applicazioni, Prev. Today, 3 (2007) 13-38