



Element Assessment in Blood, Serum and Urine of two Italian Healthy sub-Population by INAA

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Abstract

This research, that is a framework of a big project regarding the knowledge of human metabolism in patients affected by renal disease, is aimed to assess the levels of some selected essential (Co, Fe, K, Na, Rb, Se and Zn) and non-essential elements (Br Cr, Cs, Hg, Ni and Sb) in different biological matrices such as whole blood, serum and urine, of two Italian sub-population.

The analytical methodology involved is the Instrumental Neutron Activation Analysis (INAA), a primary analytical technique: the samples (totally 144) were irradiated in the Triga nuclear reactor at the R.C.-Casaccia ENEA for 12 hours at a neutron flux of $2.6 \times 10^{12} \text{ n} \times \text{cm}^{-2} \times \text{s}^{-1}$.

The results show a similar distribution for essential elements whereas quite different for non-essential elements.

Introduction

Among different population the element composition of whole blood, serum and urine is different depending on physiological, natural (dietary, location, etc.) and anthropogenic (lifestyle, pollutant presence, etc.) factors. This study try to investigate the basal essential and non-essential element levels of two healthy population living in North and Central Italy for determining a fingerprint of each matrix.

In assessing the knowledge of the current levels of elements in humans the definition of reference values in such matrices is of paramount importance [1]. Even if the task is well-known, most of the data reported in the literature on trace elements in human tissues are of limited value for the assessment of their toxicological impact. This is not only due to factors above reported, but also to errors caused by analytical inconsistencies, mostly sampling, sample handling and storage. So, this kind of analytical determination is still difficult: the use of a lyophilization process and an analytical nuclear methodology such as INAA allow to achieve more information as possible from the analysis of each sample, to reach high sensitivity and to obtain accurate values for elements at very low concentrations [2].

In this contest whole blood, serum and urine samples of 44 (132 samples) healthy subjects living in two different Italian regions were analyzed for determining essential (Co, Fe, K, Na, Rb, Se and Zn) and non-essential elements (Br Cr, Cs, Hg, Ni and Sb) and a statistical approach was carried out for characterizing the differences between the two groups.

Materials & Methods

The population studied (44 healthy subjects) consisted of people living in the provinces of Brescia (Lombardia region, North Italy) and Pesaro (Marche region, Central Italy). Subjects considered were selected as being representative of a groups resident in urban area: for each subject whole blood, serum and urine were sampled.

Regarding the analysis, lyophilization pre-treatment was necessary: aliquot of 1 mL of each

sample were subjected to lyophilization process and irradiated in the same collection containers.

The irradiation was carried out in the rotating rack (Lazy Susan) of the Triga Mark II nuclear reactor (Casaccia-ENEA) at neutron flux of $2.6 \times 10^{12} \text{ n} \times \text{cm}^{-2} \times \text{s}^{-1}$ with an irradiation time of 12 hours. Along the samples standards such as NIST Orchard Leaves (1571), Animal Blood (IAEA-A-13) e Seronorm (Nycomed Pharma) were irradiated.

Gamma spectrometry measurements were carried out by means of a Ge(HP) detector (ORTEC; FWHM 1.70 keV at 1332.50 keV, efficiency 23% and peak to Compton ratio 58:3).

Results

First of all, the measurements confirm the INAA versatility in such determinations. In fact, Br, Fe, K, Na, Rb and Zn were at $\mu\text{g mL}^{-1}$ whereas Cr, Cs, Hg, Ni, Sb and Se at ng mL^{-1} .

In particular, table 1 shows the average levels of the essential elements. It can be noted that the levels are quite similar between the two different population. The main differences regard Co, K and Zn: Co and Zn are always higher in Brescia samples whereas K is constantly lower. Na does not show significant variation among the samples.

Figure 1 shows the ratios between measurements performed in Brescia and Pesaro. For non-essential elements, the composition is really different depending on the different contributions to their levels.

Cs and Sb are really higher in all Brescia samples than Pesaro whereas Br and Cr are slightly lower. Finally, Hg and Ni are not present in all the samples: these toxic elements are very difficult to determine at ng mL^{-1} (ultra-trace levels) in such biological matrices.

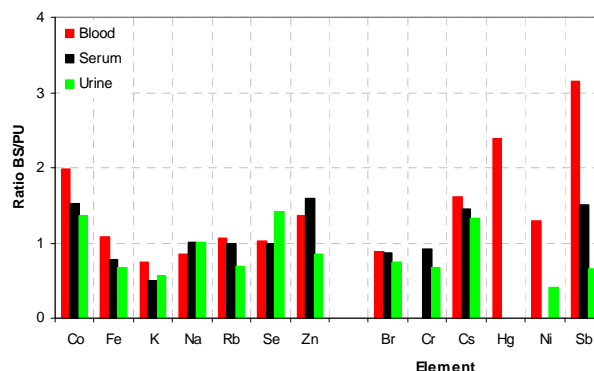


Fig. 1; Concentration level ratio of essential and non-essential element between Brescia (BS) and Pesaro (PU) population.

Table 1; Average concentration levels ($\mu\text{g mL}^{-1}$) of essential elements determined in whole blood, serum and urine samples studied in this research (Brescia/Pesaro).

| | Co | Fe | K | Na | Rb | Se | Zn |
|-------------|----------|-----------|-----------|-----------|-----------|-------------|----------|
| Whole Blood | 4.7/2.4 | 508/473 | 1830/2435 | 1878/2211 | 2.5/2.3 | 0.120/0.116 | 7.2/5.3 |
| Serum | 3.7/2.4 | 3.0/3.9 | 555/1135 | 3970/3920 | 0.38/0.38 | 0.104/0.105 | 3.3./2.1 |
| Urine | 1.2/0.91 | 0.22/0.33 | 1605/2636 | 2672/2636 | 1.3/1.9 | 0.013/0.009 | 1.1/1.3 |

Conclusions

The high number of elements determined by INAA permits a possible correlation to be found. The biochemical characterization of such considered matrices, obtained by analysis of a large number of samples, enables researches on biodynamics of the trace and ultra-trace elements.

For this aim INAA should be considered extremely useful allowing the determination of essential and non-essential elements at trace and ultra-levels in whole blood, serum and urine matrices.

References

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