

## THE POTASSIUM REFERENCE VALUE IN WHOLE BLOOD USING NUCLEAR ACTIVATION

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### ABSTRACT

The aim of the present study is to establish an indicative interval for reference value for K in whole blood, using the Absolute Neutron Activation Analysis Technique. The necessity of this measurement is related to the fact that the conventional clinical analysis for K quantification is performed using plasma, so there are no reference value established for K in whole blood. Ours results provide information which can help in diagnosis of patients and permit to perform a discussion about the advantages and limitations of using this nuclear methodology in hematological examinations.

### 1. INTRODUCTION

In the present study we intend to use the Absolute Neutron Activation Analysis (ANAA) technique to perform hematological analysis in human beings using whole blood aiming its application, in the future, for studying in more details the common deficiencies in Brazilian population helping their diagnostic. Basically, the idea is to determine the concentration of the elements that could be activated in whole blood using neutrons for establishing the indicative interval for their reference values.

The reference values for trace elements in human specimens can facilitate the interpretation of data deriving from clinical practice because they reflect the findings in a select group of individuals [1]. The necessity to perform measurements in whole blood is related to the fact that most of conventional clinical analyses in the hematology area are performed using mainly serum or plasma [2], which demand time and is expensive because different apparatus must be used [2,3], consequently there are no reference value established in whole blood.

This study is part of a larger project: Determination of reference values for concentrations of trace elements in human whole blood using nuclear methodology, nowadays in development at IPEN (Instituto de Pesquisas Energéticas e Nucleares) in collaboration with Blood Banks and Hematological Laboratories from different regions of Brazil.

To check the viability of using this nuclear methodology for hematological investigation, the chlorine concentration was first measured in human serum ( $3.41 - 3.69 \text{ gL}^{-1}$ ) [4] for

comparing the nuclear data with the reference value adopted by conventional techniques ( $3.44 - 3.76 \text{ gL}^{-1}$ ) [2,3]. Considering the agreement obtained, we intend to apply this nuclear analysis to quantify other elements in whole blood.

In the present work we selected the potassium (K) to be analyzed in whole blood because it takes part in the human being metabolism and it is very important for preservation of the osmotic and acid–base equilibria of human fluids, so its variations are generally associated to pathological processes.

## 2. EXPERIMENTAL PROCEDURE

In this study the samples came from Blood Banks and Hematological Laboratories from different parts of Brazil. The biological samples were obtained from a select healthy group (male and female blood donors), age between 25 and 60 years at 50 and 85 kg, following the procedure conventionally establish for blood donation. About 2 mL of whole blood were collected in a vacuum plastic tubing attached to the donor's arm and immediately after the collection, before its coagulation, a small quantity (100  $\mu\text{L}$ ) was transferred to the filter paper using a calibrated micropipette and dried for few minutes using an infrared lamp. It is important to emphasize that the amount of biological material drawn up in the filter paper is less than approximately 2  $\text{cm}^2$ . Besides, these samples can be stored without any refrigeration.

To determine the concentration of K in whole blood, each biological sample was sealed into individual polyethylene bag, together with the Au monitor (small metallic foil of approximately 1 mg) used for measurement of the neutron flux [5], and irradiated for few minutes in a pneumatic station in the nuclear reactor (IEA-R1, 3MW, pool type) at IPEN, allowing the simultaneous activation of these materials. Using this procedure the  $\gamma$ -ray activity induced in the Au monitor as well as in the biological sample was obtained under the exact same irradiation conditions. After the irradiation, the activated materials (blood and monitor) were gamma-counted using a HPGe Spectrometer and the areas of the peaks, corresponding to gamma transitions related to the nuclides of interest, were evaluated. The gamma spectra analysis was performed using the IDEFIX computer software [6] and the concentration using the ATIVAÇÃO software developed by Medeiros [7].

To perform this investigation a total of 45 whole blood samples were collected in duplicate. The irradiation time of 3 minutes, counting time of 1 minutes for the Gold activation detector and 10 minutes for the biological sample and background radiation (Bg) allowed us to conclude the analysis of each sample in about one hour.

## 3. RESULTS AND DISCUSSION

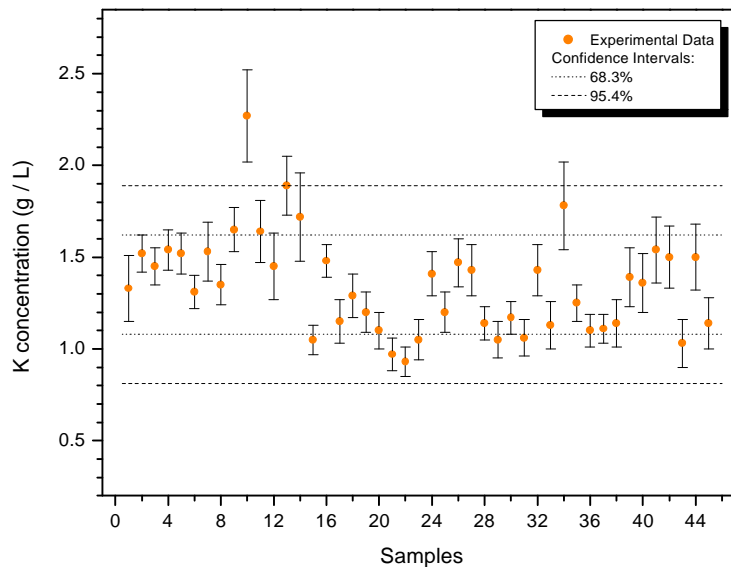
The mean value for K concentration in whole blood is shown in Table 1 as well as the results related to the basic statistical treatment of the data.

In Fig. 1 the concentration results in whole blood are shown and the indicative interval defined by the mean value considering one and two standard deviations (SD). In addition, in

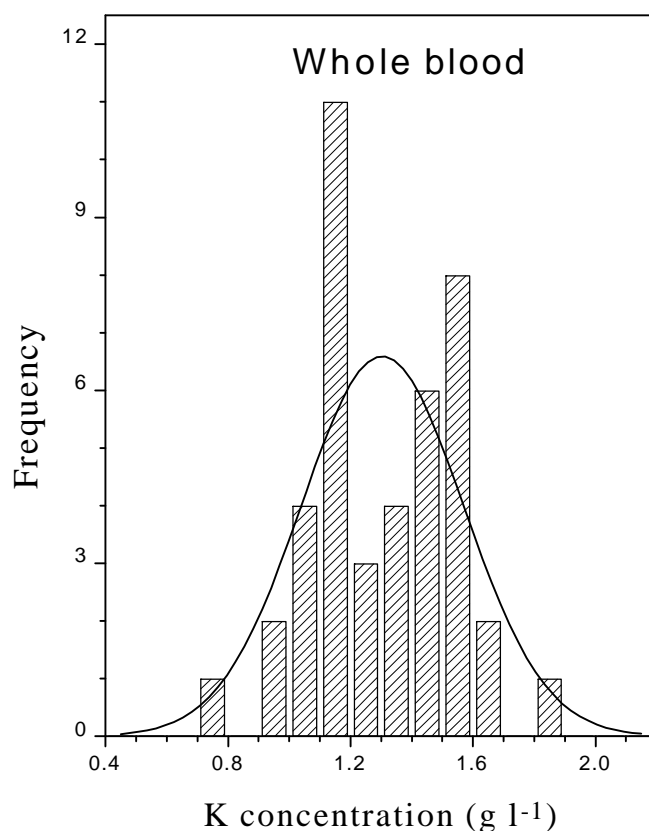
Fig. 2 the frequency distribution of K concentration is shown, with class intervals defined as 0.1, as well as the fitted normal distributions. According to these figures we can notice that the maximum of Gaussian curve distributions is in agreement with the frequency interval of the calculated arithmetic mean value (see Table 1).

**Table 1. Indicative interval for the reference values of the element K in whole blood by using the ANAA technique.**

Element concentration	K (g L <sup>-1</sup> )
Mean	1.35
1 SD (67%)	0.27
Minimum Value	0.93
Maximum Value	2.27
2 SD (95%)	0.54



**Figure 1. K concentration in whole blood and the indicative interval for the reference value; the individual error bars represent the propagated uncertainty associated with each measurement.**



**Figure 2. Histogram and Gaussian fit of K concentration in whole blood samples.**

In this study the ANAA technique was applied to analyze K in whole blood for the proposition of an indicative interval. Though the sample population is relatively small yet, the results have a near Gaussian-like distribution.

Related to the use of this nuclear methodology to perform hematological examinations, some advantages could be appointed: it does not require the serum-plasma separation; it allows the storage of the sample, for long periods, without the need for refrigeration and, due to the short irradiation time and to the use of small amounts of biological material, low activity is induced, therefore no shielding is necessary after just a few days.

#### 4. CONCLUSIONS

Considering the advantages appointed it is possible to perform clinical analysis in whole blood in an agile, fast and economic way using ANAA.

These data from the present report give an indicative interval for the element measured in whole blood but, more systematic and large scale studies are needed to establish reference value with high precision aiming its application in hematological investigations helping the diagnostic of common deficiencies in Brazilian population.

### ACKNOWLEDGMENTS

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