

# Potassium Concentration in Blood of Brazilian Athletes Using NAA

Luciana Kovacs<sup>a</sup>, Cibele B. Zamboni<sup>a</sup>, Thiago F. Lourenço<sup>b</sup>, Lázaro A. S. Nunes<sup>b</sup> and Denise V. Macedo<sup>b</sup>

<sup>a</sup>*Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)  
Av. Professor Lineu Prestes 2242  
05508-000 São Paulo, SP - Brazil*

<sup>b</sup>*Universidade Estadual de Campinas, UNICAMP, Brazil  
Laboratório de Bioquímica do Exercício - LABEX  
Cidade Universitária  
13083-970 - Campinas, SP - Brazil - Caixa-Postal: 6109*

**Abstract.** In this study the potassium levels in blood were determined in male athletes, age 18 to 26 years, before, during and after the treadmill exercise protocol using Neutron Activation Analyses (NAA). These data are important to check the potassium imbalance in blood during the period of competition preparation.

**Keywords:** <sup>24</sup>K, blood, neutron activation, gamma spectrometry, athletes.

**PACS:** 87.10.Jp

## INTRODUCTION

The body's K contained in blood is critical for maintaining normal functioning of the muscles, heart, and nerves. Low blood potassium levels (hypokalemia) and high blood potassium levels (hyperkalemia) can lead to arrhythmia (abnormal heart rhythms). According to nutrition sources, human body needs per day at least one gram of potassium to maintain the body's balance. The interest in its evaluation in blood has increased in the sports medicine due the disorders caused, mainly, its deficiency or even low instantaneous concentration diminishing the athlete performance causing disorientation, nervous irritability, muscular fatigue and, in more severe situation, cardiac arrhythmias. The LABEX (UNICAMP, Sao Paulo, Brazil) in the last years has investigated metabolic correlations that occur with these athletes during physical activities by serum analyses (Ion Specific Electrode) [1]. To perform this analyses, serum samples (each 3 mL of blood, at least) must be collected before, during and after the physical exercise. However, this is very stressing and can interfere in the results.

In this study potassium levels were investigated in athletes submitted to physical exercise (treadmill) in the LABEX using Neutron Activation Analyses (NAA) technique. This procedure was applied due some advantages: it uses small quantities of blood (15  $\mu$ L); agile execution (it is not necessary waiting for blood coagulation procedure neither performing the serum-plasma separation) and it is not destructive (the blood sample can be storage for future reexamination, for long period, without the need of refrigeration) [2].

*XXXIII Brazilian Workshop on Nuclear Physics*  
AIP Conf. Proc. 1351, 336-339 (2011); doi: 10.1063/1.3608984  
© 2011 American Institute of Physics 978-0-7354-0908-8/\$30.00

## COLLECTION AND PREPARATION OF THE SAMPLES

Ten male athletes from LABEX, age 18 to 26 years, participated of this study. They were submitted to constant load exercise at treadmill: The aim was performing 10km in optimized time. The blood collection was performed at LABEX before, during and after the exercise. During the exercise, blood samples were collected every 2km. A small capillary was inserted in the athlete's fingertip and about 50 $\mu$ L of blood were collected. Immediately after the collection, exactly 15 $\mu$ L were transferred to Whatman filter paper (in duplicate) and dried for few minutes using an infrared lamp. The same procedure was used for standard preparation. For the control group the blood samples were collected from healthy male donors selected blood banks, with ages ranging from 18 to 26 years and weighing 50 to 85 kg.

## EXPERIMENTAL PROCEDURE

The samples and standard (IAEA-A-13 Body Fluids certified reference material) were sealed into individual polyethylene bag and irradiated for 60s in a pneumatic station in the nuclear reactor (IEA-R1, 3.5MW, pool type) at IPEN, in a thermal neutron flux of  $8.13 \cdot 10^{12}$  n/cm<sup>2</sup>.s<sup>-1</sup>. After the irradiation, the blood sample and standard were  $\gamma$ -counted for 10 minutes using an HPGe detector (FWHM = 1.87keV for 1.33MeV of <sup>60</sup>Co) and the area of the 1525keV peak, corresponding to  $\gamma$  transition related to the <sup>42</sup>K, was evaluated. The potassium concentration was calculated using the software *ATIVAÇÃO* [3].

## RESULTS AND DISCUSSION

Table 1 shows the results for potassium concentration in blood to the control group and for the athletes (before the exercise). According to this table the potassium levels for all the athletes (at rest) are in agreement with the normal range. The potassium concentrations for the control group are shown in Figure 1; the range, considering  $\pm 1SD$  (1.28 – 1.84 gL<sup>-1</sup>),  $\pm 2SD$  (1.00 - 2.12 gL<sup>-1</sup>) and  $\pm 3SD$  (0.72 – 2.40 gL<sup>-1</sup>) were also included for comparison. In figure 2 is presented the behavior of potassium concentration in blood before and after the exercise program (immediately in the end of the physical exercise) for all the athletes.

TABLE 1. The potassium concentration in blood samples.

K, gL <sup>-1</sup>	Mean	$\pm 1SD$	Median	Mode	Minimum value	Maximum value
Control group, n=30	1.560.	28	1.54	1.53	1.21	2.54
Athletes (at rest), n=10	1.470.	54	1.35	1.61	1.00	2.71

n: number of samples

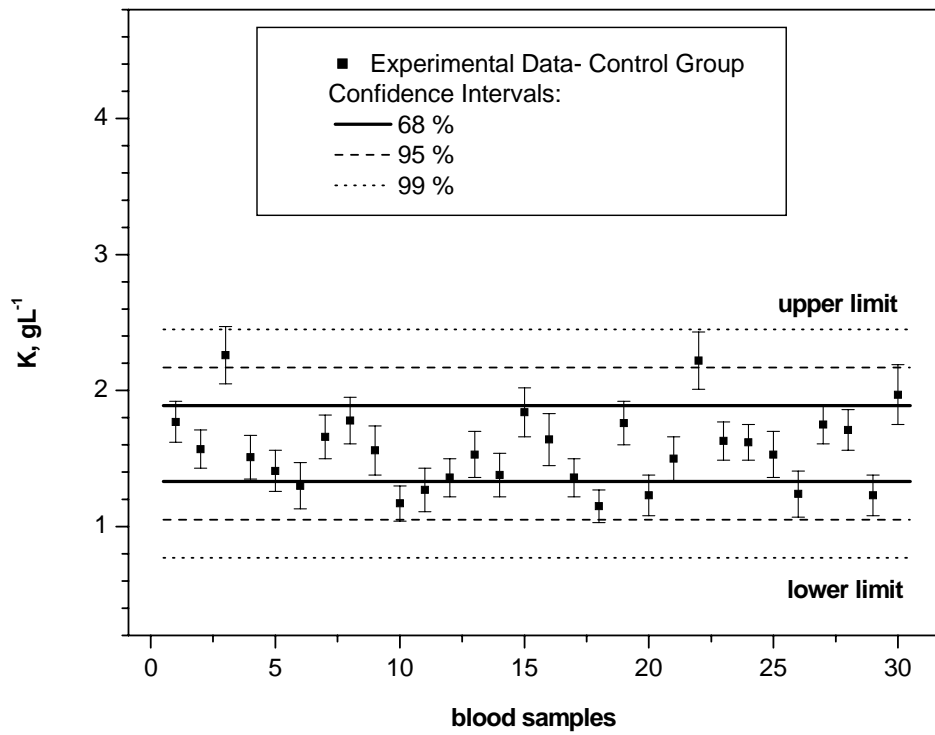


FIGURE 1. The K data for control group

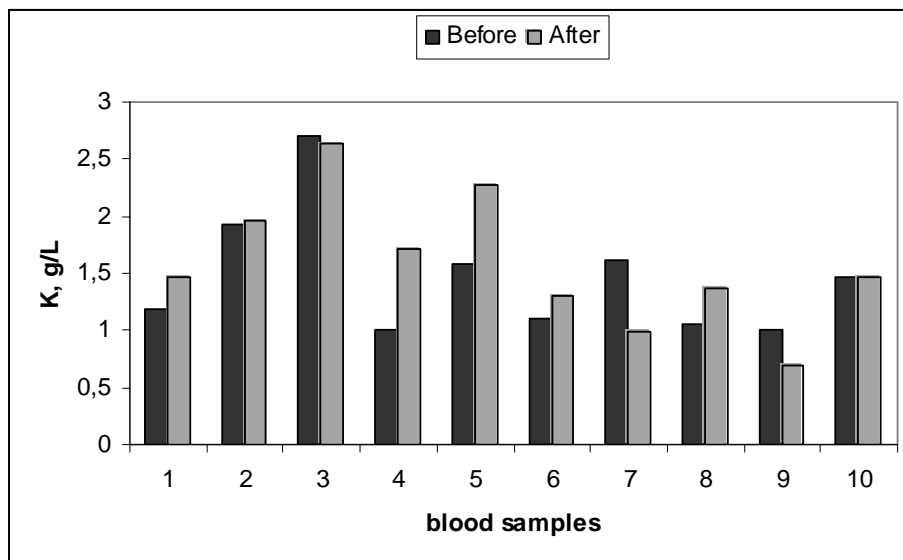
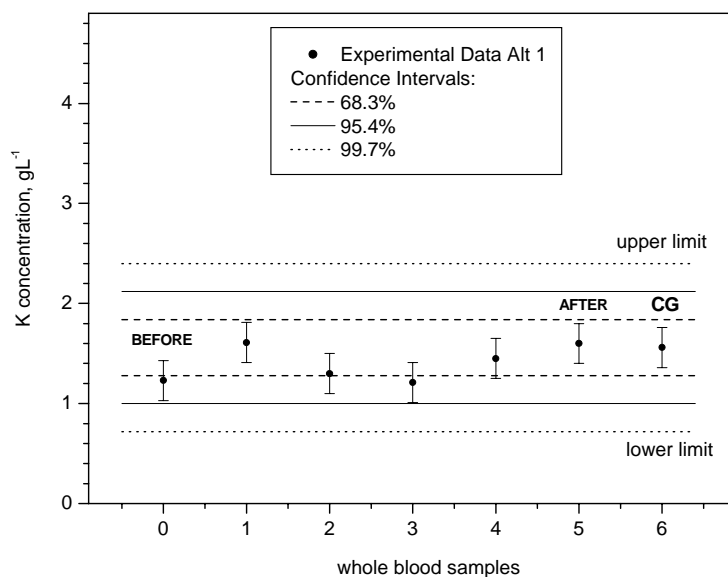


FIGURE 2. The K data before and after the exercise

According to figure 2 all the athletes finished the physical exercise without symptoms of severe fatigue (K levels in whole blood  $<1.00 \text{ gL}^{-1}$ ).

During the exercise was observed that 70% of the cases were kept the normal range ( $1.00 - 2.12 \text{ gL}^{-1}$ ) following the behavior presented figure 3 (athlete 1); 20% of the cases were upper to the normal range (during and after the exercise) suggesting a light tendency of Hyperkalemia ( $>2.12 \text{ gL}^{-1}$ ) and only one case of Hypokalemia (K level in blood  $<1.00 \text{ g/L}$ ) was observed, but not severe.



**FIGURE 3.** The K data during the exercise; the mean value for the control group (CG) was also include for comparison.

## CONCLUSION

The use of the NAA technique has allowed a quantitative estimation of K in blood samples of athletes during the physical exercise in agile way using small quantities of blood ( $15 \mu\text{L}$ ) something not recommended by using the conventional clinical analysis, due the necessity to perform several blood collection (at least four of  $3 \text{ mL}$  each) in small period (minutes).

## REFERENCES

1. L. Versieck et al, *Anal. Chim. Acta* **204**, 63 (1988).
2. L. Kovacs, C. B. Zamboni, L. Oliveira, V. L. R. Salvador, I. M. Sato, M. R. Azevedo. Analysis of serum and whole blood using NAA for clinical investigation. *J. Radioanal. Nucl. Chem.* **278**, 543-545, (2008).
3. J. A. G. Medeiros, C. B. Zamboni, G. S. Zahn, L. C. Oliveira, L. Dalaqua Jr. Software para realização de análises hematológicas utilizando processo radioanalítico. Proceeding of 39° Congresso Brasileiro de Patologia Clinica (SP, Brasil, 2005).

Copyright of AIP Conference Proceedings is the property of American Institute of Physics and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.