Sodium Analysis in Whole Blood of Athletes Using NAA

Luciana Kovacs[a], Cibele B. Zamboni[a], Lázaro A. S. Nunes[b] and Denise V. Macedo[b]

[a] *Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)*
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP - Brazil
[b] *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 investigation the sodium levels in blood were analyzed in athletes submitted to constant load exercise at treadmill (LABEX, UNICAMP, Brazil) by NAA. These data were compared with the rest condition (before starting the exercise program) as well as with the sodium levels of the healthy group (control group) select from Blood Banks. The results showed alterations in sodium levels of the athletes during the exercise training, mainly increase, suggesting the necessity of its evaluation during physical activities.

Keywords: athletes, ^{40}Na, blood, neutron activation, gamma spectrometry.
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INTRODUCTION

The serum levels variation, including excess or deficiency of metals in the organism, have been used as a told for diagnosis or prognostic of diseases. Currently, these analyses are also useful to monitor training effects. The physical training can adapt or damage the muscles, depending on the intensity and duration of the effort, provoking detectable metabolic alterations in blood. The concentration of some elements in the blood depends of both the modality and the amount of muscular mass involved in the execution of physical exercises. About 55% of the body's Na is contained in blood. It is an essential nutrient for: control the pH fluid, ionic balance maintenance of blood pressure and its concentration in blood depends on the total amount of sodium and water in arteries, veins and capillaries (the circulatory system). The amount of sodium required per day is unknown, but the recommend varies from a minimum of 0.2g to an upper limit of 3g.

According to health and nutrition sources the mean daily intake of salt for Americans is around 10g/day. This alimentary habit has increase of 30% the cases of Hyponatremia in American athletes [1-3]. For Brazilian population the sodium ingestion it is not established, but the interesting in this evaluation is increase in Brazil, mainly in the sportive medicine and nutritional areas due the disturbers caused

by sodium imbalance, mainly, Hyponatremia (increase of sodium levels in blood) and Hypernatremia (deficiency of sodium in blood).

The goal of this study was to determine the sodium levels by Neutron Activation Analyses technique in athletes submitted to 10km of constant load exercise at treadmill (LABEX, UNICAMP, Brazil). This nuclear procedure was applied due some advantages: it uses small quantities of blood (10μL) and its execution became agile because is not necessary waiting for blood coagulation procedure neither performing the serum-plasma separation. In addition, several samples (at least 10) can be analyzed simultaneously when elements of medium half-life are involved, case of Na^{24} ($T_{1/2}$ = 14hs). This procedure has been successfully used in the public health helping the diagnostics of common deficiencies in Brazilian population [4].

COLLECTION AND PREPARATION OF THE SAMPLES

Twenty male athletes, age 18 to 26 years, participated of this study. The blood collection was performed at LABEX (UNICAMP, Brazil) before the exercise program. Starting the exercise the collection was performed every to 2 km. For blood collection small capillary pins was inserted in the athlete's tinge and about 25μL to 30μL were collected. Immediately after the collection, before blood coagulation, exactly 10μL were dropped in a Whatman filter paper filter paper (in duplicated) and dried for few minutes using an infrared lamp. The same procedure was used for standard (certified reference material) preparation.

Considering the population of the study (male athletes, 18-26 years) for the controls group the whole blood samples were collected from healthy group (male donators), with ages varying from 18 to 26 years, weighing from 50 to 85 kg, select from Blood Banks.

EXPERIMENTAL PROCEDURE

The basic principle of the NAA technique is the irradiation of the biological material (blood sample) with standard (IAEA-A-13 Body Fluids certified reference material) followed by the measurement of γ-ray activities induced in these biological materials, where the elements can be identified by its nuclear properties.

To determine the sodium concentration samples and standard were sealed into individual polyethylene bags and irradiated in a pneumatic station in the nuclear reactor (IEA-R1, 2-4MW, pool type) at IPEN, in a thermal neutron flux of $3.31 \cdot 10^{11}$ $n/cm^2.s^1$, allowing the simultaneous activation of these materials. Using this procedure the γ-ray activity induced in the blood samples as well as in the standard can be obtained under the exact same irradiation conditions. After the irradiation, the activated materials (blood samples and standard) were γ-counted using an HPGe detector (FWHM = 1.87keV for 1.33MeV of ^{60}Co) and the area of the 1368 keV peak, corresponding to γ transition related to the Na^{24}, was evaluated. The concentration was calculated using the software *ATIVAÇÃO* [5]. The irradiated time of 1 minute

followed by a counting time of 2 minutes for sample, standard and the background radiation, making this nuclear procedure very fast.

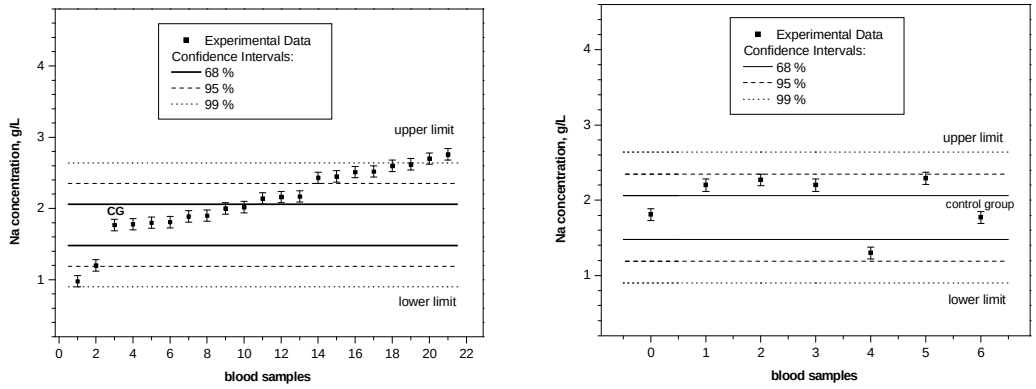
RESULTS AND DISCUSSION

The Na concentrations data in blood samples for the control group (CG) and for the first step (before the exercise program) are shown in Figure 1a. The results are the mean values (obtained by analyzing replicate samples). The normal range, considering ±1SD (1.48 - 2.06 gL^{-1}), ±2SD (1.19 - 2.35 gL^{-1}) and ±3SD (0.90 – 2.64 gL^{-1}) are also included. In Table 1 are presented of the results for Na in blood (mean, ±1SD, median, mode, minimum and maximum values) for the control group and for the athletes before the exercise program.

TABLE 1. The Na concentrations data in blood samples for the control group and for the athletes.

Na, Gl^{-1}	Mean	±1SD	Median	Mode	Min	Max
Control group (*n*=33)	1.77 ± 0.09	0.29	1.74	1.59	1.21	2.54
Athletes *(n=20)*	2.09 ± 0.08	0.47	2.14	1.80	0.98	2.76

n: number of samples
min: minimum value
max: maximum value



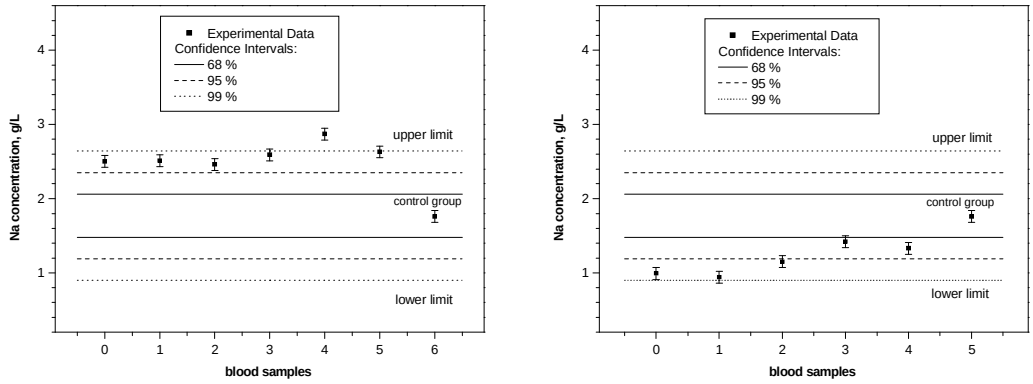
(a) **(b)**

FIGURE 1. The Na data before the exercise program (1.a); the behavior of the Na data for 55% of the cases (1.b).

According to Figure 1a, for a confidence interval of 95% usually adopted for clinical practice (1.19- 2.35 gL^{-1}), 60% of the cases are in the normal range, about 35% of the cases are upper to the normal range, which 10% present severe characteristics of Hypernatremia (Na level in blood >2.7 g/L), and 5% of Hyponatremia (Na level in blood <1.19g/L), but not severe.

During the exercise program was observed that 55% of the cases are keeping the normal the normal range (the Na concentration follows the behavior presented figure 1.b), 40% of the cases are out to confidence interval of 95% (1.19-2.35 gL^{-1}) before and during the exercise training, which 15% present systematic increase in

concentration suggesting a high tendency of Hypernatremia (see figure 2.a) and 5% with Hyponatremia (see figure 2.b).



(a) **(b)**

FIGURE 2. The Na data for Hypernatremia case (2a); the Na data for Hyponatremia case (2b).

CONCLUSIONS

The imbalance of sodium in blood of athletes, mainly increase, suggests that its level must be monitored during the training as well as during all the period of competition preparation. Also a controlled diet is important to keep the normal range for sodium in blood. Related to the nuclear procedure adopted (NAA) it can be an alternative procedure to perform biochemistry analyses in blood, mainly when the biological material is scarce.

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