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Sulfur status in judo athletes by XRF

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Abstract. The human biomonitoring, measurement of chemical and/or their metabolites in human fluids, is an important tool for assessing the health condition of subjects, included athletes. In this study, sulfur levels were investigated in blood of judo athletes using Energy Dispersive X-ray Fluorescence (EDXRF) technique. Twenty athletes participated of this study. Two groups of athletes were selected: judo with a balanced diet with multivitamin/mineral supplements consumption and judo with diet not controlled. These data were compared with the control group (subjects of the same age but not involved with physical activities). There was a significant increase of S levels in athletes with diet not controlled. These data can be useful to a well-planned nutritional proposition that can contribute to better performance of athletes.

1. Introduction

Many amateur athletes would like to have a specialized accompaniment program to improve their performance, but today this is still restricted to only a few of them. The training program used consists of long periods, often years, of monitoring by a technical team composed if doctor, nutritionist, and other necessary professionals. Them into accont individual and routine assessments, the focus is on pursuing improvements to benefit and enhance each athlete's performance. Of these programs that, in this area of activity, ‘‘little is a lot’’, which means that any benefit that may add advantages in performance of an athlete should be considered for a better competitiveness. Based on this need, in the last years, the Laboratório de Espectroscopia e Espectrometria das Radiações (LEE) at IPEN (CNEN-SP, Brazil) had performed investigations in sport medicine, focusing on the clinical follow-up of athletes, such as biochemical evaluation in body fluids, using the X-ray Fluorescence (XRF) and Neutron activation Analyses (NAA) techniques as an alternative for clinical practices [1-6]. These alternative procedures are capable to determine elements concentration in whole blood using an efficient, fast and non-destructive analysis. The results led to an increased interest in using this alternative methodology in several sports activities.

Specifically, sulfur plays an important role in training effects: it is present in all cells (representing approximately 0.25% of our weight), having an important role in the growth and metabolic processes, defense and detoxification. Besides, sulfur is present in cartilage and it is essential for collagen synthesis. In Sports Medicine a shortage of sulfur can cause the syndrome of physical fatigue after activity (muscle injury and decreased elasticity of the lung tissue) while excess can cause ulcerative colitis, acidosis and diarrhea. The major source of inorganic sulfate for humans derive from proteins and of several organic and inorganic sulfur compounds present

in food. However, athletes usually make use of supplements rich in amino acids, most of them rich in sulfur composts, such as methionine ($C_5H_{11}NO_2S$), cysteine ($C_3H_7NO_2S$) and taurine ($C_2H_7NO_3S$). In this study, sulfur levels were investigated in blood of judo athletes submitted to different diet using EDXRF technique. The data from athletes were compared with those obtained from a group of same age and weight, but not involved in intense physically activities. These results of this comparison useful for evaluating the performance of athletes during the preparation period of competitions, as well as to propose new nutritional evaluation protocols in sport medicine.

2. Experimental

Twenty physically healthy professional (9 woman and 11 men) that were in constant training for the last 2 years, with average age of 20.2 ± 4.4 years, average weight of 73.2 ± 26.0 kg and training intensity of 8–10 h/ week participated in the study. Two groups of athletes were selected: judo athletes with multivitamin and mineral supplements consumption added to the diet for a period of 6 months (G1: 07 man and 05 woman) and judo athletes with not controlled diet (G2: 04 man and 04 woman). The blood samples were collected before the physical training with the approval of the Ethical Committee (CAAE: 15388713.0.0000.0081). Venous blood was collected (before the training) in a vacuum tube. About 50 μL of whole blood is transferred to the filter paper (~2.2 cm^2), in duplicate. The control group (CG) was composed of 20 health subjects, (10 man and 10 woman) selected from Paulista Blood Bank (at São Paulo city, Brazil) with the same range of age and weight, but not involved in intense physical activities. The CG sample preparation was the same as described for the athletes. A mini-X spectrometer with Ag target (XR-100SDD model, Amptek) was used to perform the EDXRF measurements. Each whole blood sample was irradiated for 900 s using 30 kV and 5 μA of excitation conditions and the analysis of the spectrum was performed using the WinQxas Software.

3. Results and discussion

The sulfur blood concentration, mean value (MV), standard deviation (±1SD), minimum value (min), and maximum value (max) for judo athletes and control group are show in Table 1.
The XRF whole blood spectrum is presented in Figure 1.

Table 1. Whole blood sulfur concentrations

g/L	Control Group *[range]**	Groups of Athletes	
	CG *[0.23 – 0.59]*	G1	G2
MV	0.41	0.46	0.59
±1SD	0.09	0.04	0.11
min	0.30	0.39	0.44
max	0.64	0.52	0.70

*considering a confidence interval of 95% (adopted in clinical practices)

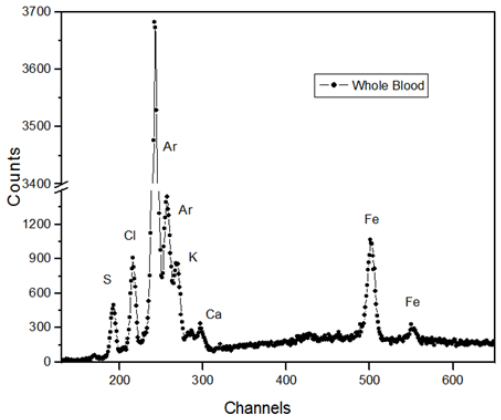

Figure 1. Spectrum of whole blood sample after 900 s of the excitation time

Figure 2 shows the sulfur concentration in whole blood of athletes (G1 and G2). In this figure, the indicate interval of control group, considering ± 1SD and ± 2SD, were also included for comparison.

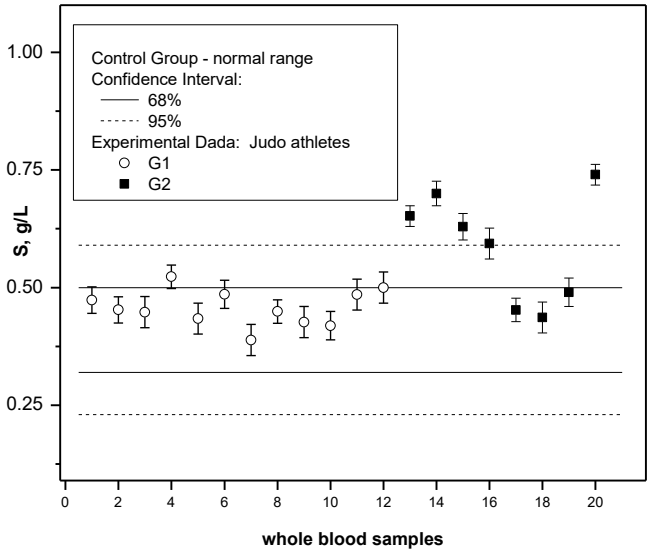

Figure 2. Comparison between the individual concentrations of S (g/L) in whole blood of judo athletes groups (G1 and G2) with the indicate interval of Control Group (CG)

According to the statistical analysis (Student *t-test*), there is a significant difference ($p < 0.05$) increase in the sulfur level in the G2 (athletes with diet not controlled) when compared with G1 group (diet controlled). These data can be useful to a well-planned diet proposition that could contribute to the performance of athletes.

Related to the Portable XRF Spectrometer it has shown to be appropriate for S blood analyses and offers a new contribution for studies in Sports Medicine related to biochemical analyses of blood.

4. Conclusions

The imbalance of S (increase) in athletes (G2) emphasizes the need of balanced diet and suggests that its blood level must be monitored during the training. Moreover, these results may be useful in other areas of research such as health and nutrition.

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