Asian Journal of Chemistry Vol. 21, No. 3 (2009), 2189-2192

Effect of the Training to the Levels of the Serum Zn and Cu

FATMA ARSLAN
Department of Chemistry, Faculty of Art and Science, Gazi University, 06500 Ankara, Turkey
E-mail: fatma@gazi.edu.tr

The purpose of this study is to investigate serum levels of zinc and copper in well-trained male boxers during and after an anaerobic maximal exercise. Eleven well-trained young male completed the exercise protocol. Blood samples were collected before the exercise, immediately after exercise and 1 h after the exercise. Serum was analyzed for Zn and Cu by using inductively coupled plasma optical emission spectrometry (ICP-OES) method. It was observed that the maximal anaerobic exercise didn't have a significant effect on the serum levels of zinc and copper in elite boxers ($p > 0.05$).

Key Words: ICP-OES, Anaerobic exercise, Zn, Cu, Boxers.

INTRODUCTION

Zinc is associated with more than 200 enzymatic systems. It is involved in the synthesis of nucleic acids, protein synthesis, growth inflammatory syndromes, testosterone secretion and cerebral function. The systemic availability of zinc in tissues is highly influenced by the balance of anabolic and catabolic processes regulating the renewal of soft and skeletal tissues. Most of the body zinc content is present in muscle (60 %) and bone (30 %). No hormone has been identified in zinc metabolism specifically and uniquely, but Mg-and Ca-regulating hormones may effect zinc metabolism directly or indirectly[1].

Zinc status has an important effect upon the physical performance. Zinc is essential for many enzymes involved in energy metabolism during exercise (*e.g.*, carbonic anhydrase, lactate dehydrogenase, superoxide dismutase). This trace element plays a role in tissue repair[2,3]. Because of these reasons, zinc's role in exercise and its relationship to athletic performance are receiving attention. However there is no consensus regarding to the blood levels of zinc after the exercise. Some researchers claimed that blood zinc level was depleted after the exercise while others alarmed the opposite[4]. Low blood zinc levels were reported in professional football players who participated in a daily physical training program of progressively increased workloads[5]. During exercise, zinc may be redistributed from less to more metabolically active tissues. Runners were found to have lower blood zinc levels but higher red blood cell zinc concentrations, possibility suggesting a redistribution of zinc during exercise[6]. Dekker's *et al.*[7] reported that zinc levels in sportmen's plasma involved in anaerobic training were significantly higher when it was compared to aerobic activity.

Copper is present in more than 30 enzymes in the body. About 23.3 % of an adult's total body Cu is found in muscle. Copper is a critical nutrient involved in many aspects of energy metabolism and an important component for the synthesis of hemoglobin, myoglobin, cytochromes and some peptide hormones. It is also the cofactor of proteins involved in redox processes, such as mitochondrial cytochrome oxidase. Plasma ceruloplasmin which is a Cu-transport protein is also an oxidoreductase[4].

The studies reveal that there is no correlation between the copper deficiency and the physical exercise taken[8,9]. In this study, serum levels of Zn and Cu before the exercise, immediately after the exercise and 1 h after maximal anaerobic (75 %) exercise were investigated in elite boxers.

EXPERIMENTAL

Eleven male subjects who are Turkish national boxers participated to this study. The median age of the participating subjects was 20.20 ± 1.23 (year) ranging from 18 to 22. The other physical characteristics of the subjects were as follows (mean ± SD): weight (Kg) 72.20 ± 16.18 (range 48-101), height (cm) 175.60 ± 6.90 (range 163-188).

Exercise protocol: The participants were subjected to a 1.5 h, 80-100 % density conditioning and technical exercise (75 % anaerobic maximal exercise).

Blood sampling: Blood samples were drawn from the antecubital vein of the subjects right before, immediately after and 1 h after exercise.

Sample preparations and measurements: On the 1 mL blood samples was added 2.0 mL HNO_3 and the samples were digested in Berghof/Microwave Digestion system MWS-3 microwave apparatus. The microwave were kept at 160 °C for 5 min and at 190, 100 and 80 °C for 10 min each. The totally digested samples were diluted to 10 mL with the addition of deionized water 18.3 mohm cm^{-1}. Zinc and copper were analyzed directly using inductively coupled plasma optical emission spectrometry (ICP-OES, Perkin Elmer, Optima 5300 DV, USA).

Statistical analysis: Statistical analysis was performed with SPSS Ver. 15.0 for Windows. Statistical significance was set at $p < 0.05$ (with 95 % confidence levels). Statistical significance was set at $p < 0.05$. Data are expressed as mean ± SD. One-Sample Kolmogorov-Smirnov test was performed for the normal distribution. For paired samples, student's t-test was used.

RESULTS AND DISCUSSION

Before training, immediately after training and after 1 h training maximal loading (anaerobic) in serum zinc levels, respectively were found to be 53.84 ± 26.89, 56.84 ± 26.97 and 45.56 ± 17.66 mg/L (Table-1). These values for copper were 22.85 ± 9.79, 25.03 ± 9.32 and 23.63 ± 8.43 mg/L (Table-1).

It was observed that the application of maximum load anaerobic exercise to the elite boxers caused no significant change in their copper and zinc serum levels just after the exercise and 1 h after the exercise as regards to their pre-exercise values ($p > 0.05$) (Table-2).

TABLE-1
COPPER AND ZINC LEVELS BEFORE, JUST AFTER AND ONE HOUR AFTER THE EXERCISE

Variables		N	$(\overline{X})$ (μg L^{-1})	Standard deviation
Zn	Before training	11	53.84	26.89
	Just after training	11	56.84	26.97
	1 h After training	11	45.56	17.66
Cu	Before training	11	22.85	9.79
	Just after training	11	25.03	9.32
	1 h After training	11	23.63	8.43

TABLE-2
p-VALUES OF THE SERUM METAL LEVELS BETWEEN VARIOUS TIMES

Metals	Test group	p (> 0.05)
Zinc	Before and just after the exercise	0.726
	Before and 1 h after the exercise	0.419
	Just and 1 h after the exercise	0.379
Copper	Before and just after the exercise	0.346
	Before and 1 h after the exercise	0.707
	Just and 1 h after the exercise	0.128

Copper is a critical nutrient involved in many aspects of energy metabolism. It is needed for proper utilization of Fe and protection against oxidative damage to cells[10,11].

Dressenp Dorfer and Sockolov[12] reported no difference between male runners and non-running control subjects (15.1 *vs.* 14.7 μmol/L). Although some workers claimed that the level of copper in blood increases[13] as a result of physical activity, there is no consensus here as well, as in zinc. Resina *et al.*[14] found that the serum copper levels were lower in athletes between elite athletes and 24 control groups.

Zinc is an essential micronutrient for human body. Acute zinc deficiency results loss of weight, exhaustion, loss of endurance, osteoporosis and increase in viscosity of blood[15,16].

Van Loan *et al.*[17] found that isokinetic extension resulted a decrease of 67 % in plasma zinc levels which cause a significant decrease in muscle strength and total work capacity.

Rodriguez Tuya *et al.*[18] reported a higher plasma-Zn level in anaerobic (judo and fencing) than aerobic (cycling and endurance). There are also studies in literature indicating that zinc levels remained unchanged after exercise. A study reported that the serum zinc levels in rats subjected to heavy exercise did not change[19]. In another study it was claimed that sub-maximal exercise did not effect the plasma zinc levels[20].

The reason why the Cu serum level didn't show any change with exercise may be due to exercise was anaerobic. Copper is present in cytochrom oxidase enzyme and carries electrons to oxygen during glucose metabolism. In aerobic exercise

there is no need for outside oxygen. That explains the fact that the serum copper levels remains highly stabile during an anaerobic exercise.

The reason for not observing any significant change during anaerobic exercise may be attributed to the fact that there was enough zinc content in the body to meet the demand. There are also studies in literature showing that blood copper and zinc levels do not change with exercise[19,20]. Therefore the results obtained in this study are in good accordance with literature.

Conclusion

This study revealed that there were not any significant changes in the serum zinc and copper levels of elite boxers before, just after and 1 h after the exercise. The results showed that the zinc and copper content of the body were enough to meet the demand and there was no need to supplements after the maximum load anaerobic exercise.

REFERENCES

1. M. Speich, A. Pineau and F. Ballereau, *Clin. Chim. Acta*, **312**, 1 (2001).
2. J.R. Berning and S.N. Steen, Nutrition for Sports and Exercise, Gaithersburg, MD: Aspen Publ. Inc., edn. 2 (1998).
3. D. Konig, C. Weinstock, J. Keul and H. Northoff, *Berg, Exerc. Immunol. Rev.*, **4**, 2 (1998).
4. S. Savas, Ö. Senel, H. Çelikkan, A. Ugras and L. Aksu, *Neuroendocrinol. Lett.*, **27**, 822 (2006).
5. S. Khaled, J.F. Brun, J.P. Micallef, L. Bardet, G. Cassanas, J.F. Monnier and A. Orsetti, *Clin. Hemorheol. Microcirculat.*, **17**, 47 (1997).
6. A. Singh, P.A. Deuster and P.B. Moser, *J. Sports Med. Phys. Fit.*, **30**, 29 (1990).
7. J.C. Dekkers, L.J. van Doomen and H.C. Kemper, *Sports Med.*, **21**, 213 (1996).
8. G. Haralambie and J. Keul, *Arzneim. Forsch.*, **24**, 112 (1970).
9. H.C. Lukaski, W.W. Bolonchuk, L.M. Klevay, D.B. Milne and H.H. Sandstead, *Am. J. Clin. Nutr.*, **37**, 407 (1983).
10. H.C. Lukaski, *Int. J. Sport Nutr.*, **5**, 74 (1995).
11. A. Resina, L. Gatteschi, M.G. Rubenni, M.A. Giamberardino and F. Imreh, *J. Sports Med. Phys. Fitness*, **31**, 413 (1991).
12. R.H. Dressendorfer and R. Sockolov, *Phys. Sports Med.*, **8**, 97 (1980).
13. K.C. Derusseau, S.N. Cheuvront, E.M. Haymes and R.G. Sharp, *Int. J. Sport Nutr. Exerc. Metab.*, **12**, 428 (2002).
14. A. Resina, S. Fedi, L. Gatteschi, M.G. Rubenni, M.A. Giamberardino, E. Trabassi and F. Imreh, *Int. J. Sports Med.*, **11**, 58 (1990).
15. A. Micheletti and R. Rossi, *Sports Med.*, **31**, 577 (2001).
16. S. Khaled, J.F. Brun, G. Cassanas, L. Bardet and A. Orsetti, *Clin. Hemocheol. Microcirc.*, **20**, 1 (1999).
17. M.D. Van Loan, B. Sutherland, N.M. Lowe, J.R. Turnlund and J.C. King, *Int. J. Sport Nutr.*, **9**, 125 (1999).
18. I.R. Tuya, E.P. Gil, M.M. Marino, R.M.G.M. Carra and A.S. Misiego, *Eur. J. Appl. Physiol.*, **73**, 299 (1996).
19. A. Cordova and J.F. Escanero, *Rev. Esp. Fisiol.*, **47**, 87 (1991).
20. A. Singh, F.M. Moses, B.L. Smoak and P.A. Deuster, *Med. Sci. Sports Exerc.*, **24**, 442 (1992).

(*Received*: 14 April 2008; *Accepted*: 17 November 2008) AJC-7044