

Koehler K^{1),2)}, Parr MK¹⁾, Geyer H¹⁾, Bode C²⁾, Schänzer W¹⁾

Serum Testosterone and Urinary Steroid Profiles after Administration of a Zinc Supplement

- 1) Institute of Biochemistry, German Sport University Cologne, Germany
- 2) Institute of Biological Chemistry and Nutrition, University of Hohenheim, Germany

Introduction

The nutritional supplement ZMA[®] is labelled to contain zinc (as monomethionine and aspartate; 30 mg per recommended dose), magnesium (450 mg as aspartate), and vitamin B6 (10.5 mg).

According to a supplementation trial by Brilla and Conte [1], the use of ZMA[®] by semi-professional athletes resulted in an increase of plasma testosterone (T) levels of ca. 30 % and significantly improved muscle strength when compared to athletes taking placebo.

These results have to be considered very carefully for two reasons:

- One of the authors, Victor Conte, has been the major player in the BALCO case and was convicted for distributing performance enhancing drugs (e.g. THG, hGH, EPO).
- Numerous studies have demonstrated that nutritional supplements may contain so called prohormones and also synthetic steroids, which are not declared on the label [2-4].

Except for this trial, zinc supplementation has only been reported to increase testosterone in cases of zinc deficiency and in elderly patients [5].

Material and Methods

The ZMA[®] supplement

The product ZMA[®] (SNAC SYSTEM, INC., Burlingame, USA) was ordered from an Internet store [6]. Analysis of the supplement revealed that the zinc and magnesium concentrations were similar to those listed on the label.

Prior to the trial, the supplement was confirmed to contain none of the following anabolic steroids: T, nandrolone, prohormones of T and nandrolone, THG, metandienone, stanozolol,

and trenbolone. The analysis was performed according to a method described by Geyer et al. [2]. For synthetic steroids, this method was slightly adapted to LC/MS-measurement.

Subjects

The placebo-controlled trial included 14 healthy male volunteers. The subjects were randomly assigned to the groups (Table 1) and the study was conducted in a double-blind fashion.

The average daily intakes of zinc and magnesium in both groups (obtained from a diet history interview) exceeded the recommended allowances of 15 mg (zinc) and 400 mg (magnesium).

Table 1: Anthropometric data of the participants of the trial

Group	Age (years)	Weight (kg)	Height (cm)
ZMA [®]	27.0 ± 4.2	83.6 ± 9.2	184.4 ± 7.9
Placebo	27.4 ± 2.7	78.1 ± 6.1	188.0 ± 7.7

Supplementation trial

The subjects took either three capsules per day of ZMA[®] or placebo for eight weeks. Blood and urine samples were taken before the start of the supplementation (week 0), weekly within the supplementation period (week 1-7), and at the end of the trial (week 8).

Analytical methods

Serum and urine zinc were assessed on a Perkin Elmer 2380 atomic absorption spectrometer. Serum total testosterone (totT) was measured on a Modular Analytics E170 (Roche). Free testosterone was calculated from totT, serum SHBG and albumin according to Vermeulen et al. [7]. Urinary free and glucuronidated concentrations of T, epitestosterone, selected metabolites of T, and some 11-OH-steroids were measured with GC-MS method routinely used in doping control [8]. Urinary specific gravity, pH, and creatinine were also recorded.

Results

Serum concentrations

The use of ZMA[®] significantly raised serum zinc concentrations ($p = 0.031$; Figure 1 left).

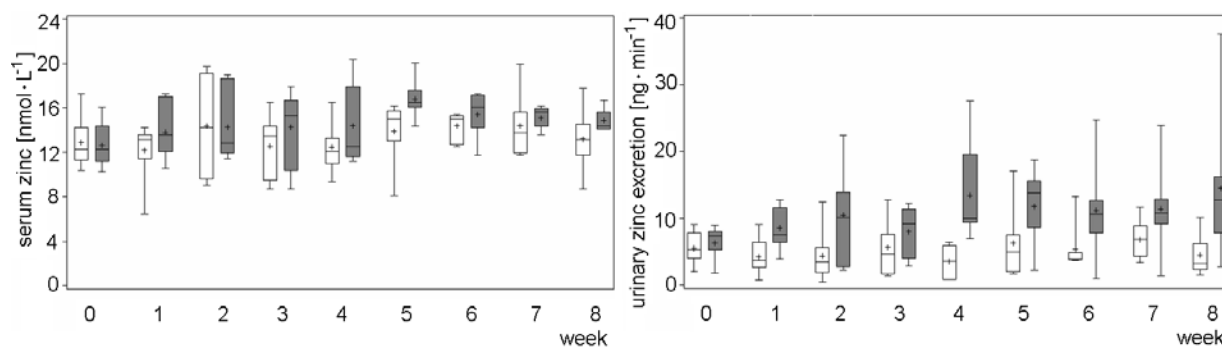


Figure 1: Serum zinc concentrations and urinary zinc excretion in response to ZMA[®] (grey bars) and placebo supplementation (white bars)

Serum total T ($p = 0.42$) and serum free T ($p = 0.33$) concentrations were not significantly altered after ZMA[®] supplementation (Figure 2).

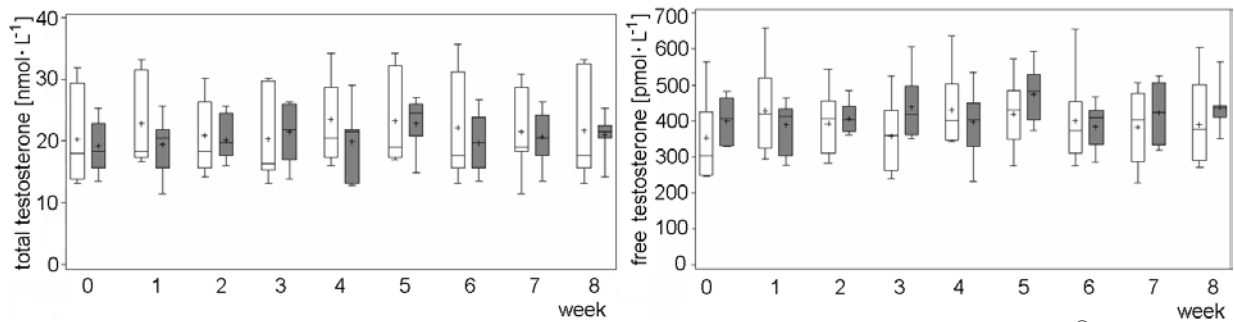


Figure 2: Serum total testosterone and serum free testosterone after use of ZMA[®] (grey) or placebo (white)

Urinary parameters

ZMA[®] use led to a significant increase in urinary zinc excretion ($p = 0.035$, Figure 1 right).

There were no significant changes in the urinary excretion of the monitored urinary steroids and metabolites. Consequently, no changes were seen in the steroid profiles of ZMA[®] users (Figure 3).

Supplementation of ZMA[®] significantly increased the urinary pH ($p = 0.034$) and urine flow ($p = 0.045$; Figure 4). Urinary creatinine and specific gravity were not affected.

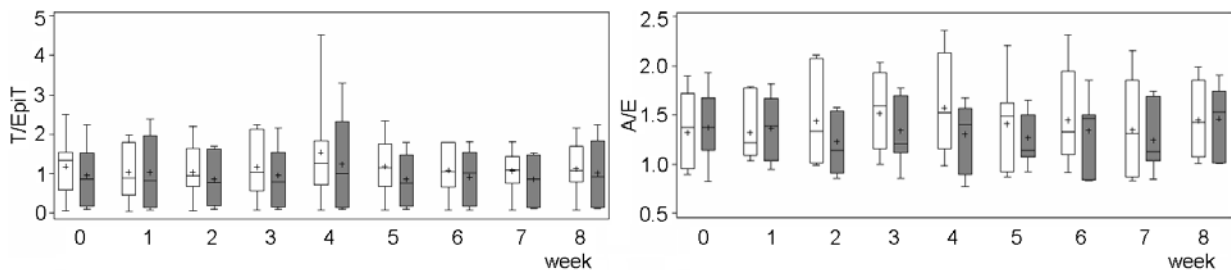


Figure 3: Testosterone/epitestosterone and androsterone/etiocolanalone ratios in the ZMA[®] (grey) and control group (white)

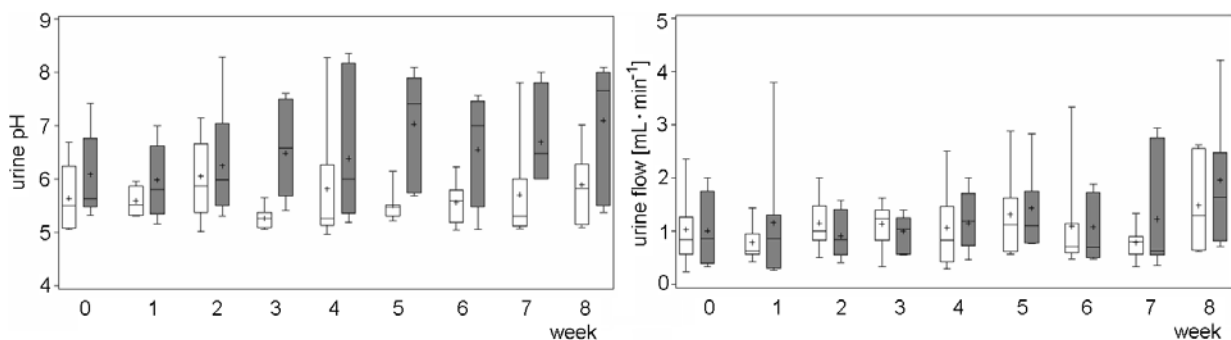


Figure 4: Urine pH and urine flow in subjects using ZMA[®] (grey) or placebo (white)

Conclusion

The present trial could not confirm the results of the previous study conducted by Brilla and Conte, who reported an increase of plasma testosterone levels after use of ZMA[®] [1].

Even though the supplementation of ZMA[®] raised serum and urine zinc and therefore contributed to the zinc nutrition of the subjects, it had no effects on serum and urine markers of testosterone and its metabolism. This is most likely due to the sufficient dietary zinc intake of the participants of the trial.

Prolonged use of ZMA[®] might have adverse effects: The upper limit of 40 mg zinc·day⁻¹, which is considered to be safe, is exceeded by use of ZMA[®] (30 mg·day⁻¹) additionally to a normal diet (approximately 15 mg·day⁻¹). Anaemia, impaired immune functions, and changes of lipoprotein levels have been reported after a prolonged zinc intake beyond 40 mg·day⁻¹ [9].

So, athletes are unlikely to benefit from use of ZMA[®] with respect to their anabolic hormone profile but may face negative side effects due to the high zinc content of the supplement.

Acknowledgements

The authors would like to acknowledge the support from Manfred Donike Gesellschaft e.V.

References

- [1] Brilla LR and Conte V. Effects of a novel zinc-magnesium formulation on hormones and strength. *JEPonline*. 2000, 3:26-35
- [2] Geyer H, Parr MK, Mareck U, Reinhart U, Schrader Y, and Schänzer W. Analysis of non-hormonal nutritional supplements for anabolic-androgenic steroids - results of an international study. *Int J Sports Med*. 2004, 25:124-9
- [3] Geyer H, Bredehöft M, Mareck U, Parr MK, and Schänzer W. High doses of the anabolic steroid metandienone found in dietary supplements. *Eur J Sport Sci*. 2003, 3:1-5
- [4] Parr MK, Geyer H, Opfermann G, and Schänzer W. Prescription drugs and new anabolic steroids in nutritional supplements. In: Schänzer W, Geyer H, Gotzmann A, and Mareck U (eds.), *Recent advances in doping analysis (12)*. 2004:71-80
- [5] Prasad AS. Zinc deficiency in humans: a neglected problem. *J Am Coll Nutr*. 1998, 17:542-3
- [6] Bodybuilding.com SNAC ZMA. <http://www.bodybuilding.com/store/snac/snac.htm> (accessed May 2005)
- [7] Vermeulen A, Verdonck L, and Kaufman JL. A critical evaluation of simple methods for estimation of free testosterone in serum. *J Clin Endocrinol Metab*. 1999, 84: 3666-72
- [8] Geyer H, Schänzer W, Mareck-Engelke U, Nolteernsting E, and Opfermann, G. Screening procedure for anabolic steroids - The control of the hydrolysis with deuterated androsterone glucuronide and studies with direct hydrolysis. In: Schänzer W, Geyer H, Gotzmann A, and Mareck-Engelke U (eds.), *Recent advances in doping analysis (5)*. 1998:99-102
- [9] Barceloux DG. Zinc. *J Toxicol Clin Toxicol*. 1999, 37:279-92