LONG-TERM GLUTAMINE SUPPLEMENTATION IN ELITE GYMNASTS

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Abstract

This study investigates the potential benefits of high-glutamine daily supplementation with $1.0 g \cdot kg^{-1}$ during 90 days of strenuous training and sport performance. Thirty top female aerobic gymnasts took part in this study, randomly assigned to either the glutamine supplementation (GS group; n=15) or a *placebo* group (P group; n=15). Both groups had the same program of strenuous training and a controlled food intake. Physical, biochemical and hormonal evaluation included aerobic (maximal oxygen uptake) and anaerobic (total work performed) effort capacity testing, creatine kinase and growth hormone plasma levels measurement. At the end of the study, significant increases in maximal oxygen uptake and growth hormone level and decreases of creatine kinase were observed in the GS group ($p < 0.05$), suggesting a better oxidative metabolic activity of the skeletal muscles cells during training. Anaerobic capacity did not change significantly between the two groups. In conclusion, supplementing the diet of top female aerobic gymnasts with high-glutamine wheat protein isolate improved significantly their aerobic performance with less muscle damage during training and a better post exercise recovery.

Rezumat

Acest studiu investigheaza potenţialele beneficii pentru performanţa sportivă ale suplimentării zilnice cu glutamină pe o periodă de 90 de zile de antrenament intens. 30 de sportive de performanţă din gimnastica aerobică au luat parte la acest studiu, fiind aleator împărţite într-un grup cu suplimentare de glutamină (grupul GS, n=15) şi altul *placebo* (grupul P, n=15). Ambele grupuri au avut acelaşi program de antrenament şi un regim alimentar controlat. Evaluarea fizică, biochimică şi hormonală a inclus testarea capacităţii de efort aerobe (consumul maxim de oxigen) şi anaerobe (travaliu total realizat), măsurarea nivelelor plasmatice ale creatinkinazei şi hormonului de creştere. La sfârşitul studiului, au fost observate creşteri semnificative ale consumului maxim de oxigen şi hormonului de creştere şi scăderea nivelului plasmatic al creatin kinazei în grupul GS ($p<0.05$), sugerând o îmbunătăţire semnificativă a activităţii metabolice de tip oxidativ a musculaturii scheletice în timpul antrenamentului. Capacitatea anaerobă nu s-a schimbat semnificativ între cele două grupuri. În concluzie, suplimentarea cu glutamină a dietei sportivilor din gimnastica aerobică a îmbunătăţit semnificativ performanţa aerobă cu diminuarea distrucţiei musculare caracteristică antrenamentului şi o mai bună refacere post efort.

Keywords: glutamine, effort capacity, recovery, gymnasts.

Introduction

Glutamine is the most abundant aminoacid in the blood and in the free aminoacid pool of skeletal muscle. In fact, it makes up approximately 50-60% of the free amino acids in muscle and is intimately linked to protein synthesis and glucose metabolism [10]. Glutamine promotes muscle anabolism and skeletal muscle glycogen storage and resynthesis while also modulating glucose homeostasis during and after exercise by interacting with the tricarboxylic acid cycle (aerobic metabolism) *via* pyruvate [2, 7, 9].

In addition, there is also increasing evidence that glutamine supplementation may protect tissues from oxidative damage [8]. Thus glutamine has great potential for improving muscle activity and recovery after training especially for athletes engaged in intensive exercise training [1]. The effect of glutamine on the muscular tissue is related to the abundance of nitrogen in its structure, its central role in deamination or transamination of amino acids, as well as its ability to prevent ammonia toxicity during physical exercise [3]. *Via* gluconeogenesis, glutamine is also involved in the recovery processes after catabolic stress conditions such as the ones generated by the practice of physical exercise [5]. Additionally, it has been suggested that the recovery processes may be modulated by the increase in growth hormone levels in subjects with glutamine intake or by preventing glucocorticoid-induced muscle atrophy mediated by myostatin [14, 11].

The aim of this study was to confirm the results of our previously pilot- study about the effects of high-glutamine wheat protein isolate supplementation on exercise capacity and recovery after physical stress on top athletes [6].

Materials and Methods

Thirty female aerobic gymnasts took part in this study, investigating the changes resulting from a 90 days training period. In a blind, random selection 15 athletes, group GS (age = 21.3 ± 1.3 years , body mass = 53.7 ± 1.9 kg, height = 1.57 ± 0.12 m) received daily supplementation with glutamine $1 g \cdot kg^{-1}$ body weight (high glutamine hydrolyzed wheat protein isolate, containing 30% glutamine as Gempro HiQ, Manildra Group, Auburn, NSW, Australia), while the other 15, group P (age = 20.4 ± 2.1 years, body mass body mass = 52.9 ± 2.0 kg, height = 1.60 ± 0.04 m) received a *placebo*. This was a complete, dynamic, bio-evaluation period involving identical training, feeding and support medication conditions.

This research has received the ethical approval of the National Institute of Sports Medicine (Bucharest, Romania).

On a daily basis, the glutamine group received fruit juice blended with the high-glutamine wheat protein isolate, while the *placebo* group received only fruit juice with identical organoleptic properties. All study subjects were under medical supervision and followed a controlled program in which they trained 4 hours/day, 5 days/week. The food intake was controlled (50-60 $kcal \cdot kg^{-1} \cdot day^{-1}$ and 2 g protein $kg^{-1} \cdot day^{-1}$) during the entire period of the study.

To avoid a possible circadian effect, the athletes' evaluations were performed between 10:00-12:00 a.m. The testing was completed at 2 hours after standardized meals and 24 hours after the last training.

Aerobic effort capacity has been evaluated by measuring the maximal oxygen uptake (VO_2max) with direct measurement of oxygen consumption using the gas exchange analyser FitMate (Cosmed, Rome, Italy) and concurrent assessment of heart rate. All athletes performed the test on the treadmill, using Bruce protocol [4]. Anaerobic capacity was evaluated trough Total Work Performed Test (TWPT), proposed by Szogy and Cherebetiu [12]. Subjects performed a maximal pedalling effort on a Monark Ergomedic 894E Peak Bike. The anaerobic parameters analysed were Total Works Performed (TPW) during specific time intervals, TPW20s ($Kgm \cdot kg^{-1}$) on the first 20s, and TPW45s ($Kgm \cdot kg^{-1}$) on 45s. Venous blood samples were collected from all gymnasts using the same protocol, at 12 hours after the last training. Creative Kinase (CK) plasma levels were measured using enzymatic assays, using guidelines from DGKC (German Society of Clinical Chemistry) and IFCC (International Federation of Clinical Chemistry and Laboratory Medicine) and growth hormone (GH) plasma levels by radioimmunoassay (Pharmacia, RIA 100 kit).

Statistical analysis

Differences in parameters before and after treatment, between the two groups were evaluated by a repeated-measures analysis of variance (Proc Mixed, SAS 9.1, SAS Institute Inc., Cary, NC, USA). Time was the repeated factor; glutamine treatment (positive or *placebo*) was the independent variable, while measurements of physiological parameters (e.g. VO_2max, TWP, CK, GH) were dependent variables. Statistical significance was established at $p \leq 0.05$. The TWP data were log transformed before the analysis to satisfy the assumption of normality [13]. When the overall p was significant, *post-hoc* multiple comparisons were conducted using the Tukey-Kramer adjustment.

Results and Discussion

Initially, there were no significant differences in the mean of the physical effort capacity and metabolic characteristics of the research subjects. Group GS (means ± SD): VO_2max ($m\cdot kg^{-1}\cdot min^{-1}$) = 44.7 ± 0.91, TPW20s ($kgm\cdot kg^{-1}$) = 13.51 ± 0.73, TPW45s ($Kgm\cdot kg^{-1}$) = 21.20 ± 0.69; CK ($UI\cdot L^{-1}$) = 243 ± 10.8, GH ($ng\cdot L^{-1}$) = 2.49 ± 0.40. Group P (means ± SD): VO_2max ($ml\cdot kg^{1}$) = 45.1 ± 0.89, TPW20s ($kgm\cdot kg^{-1}$) = 11.99 ± 0.67, TPW45s ($kgm\cdot kg^{-1}$) = 20.98 ± 0.75; CK ($UI\cdot L^{-1}$) = 246.5 ± 10.1, GH ($ng\cdot L^{-1}$) = 2.45 ± 0.41 (Table I).

After 90 days of training, VO_2max increased for all athletes (Table I, Figure 1). However, the increase was significantly higher for the supplemented group with glutamine compared to *placebo* group ($p<0.05$). The anaerobic capacity evaluated on the basis of the TWP20s and TPW45s parameters, did not reveal significant differences between the two groups, though the TWP20s increased slightly for the group GS.

Table I

Measured parameters before and after research period. Data are presented as mean values with standard deviation (±SD)

Variables	Group GS		Group P	
	Before	After	Before	After
VO_2max ($mL\cdot kg^{-1}\cdot min^{-1}$)	44.7 (0.91)^{ab}	52.3 (0.87)^{c}	45.1 (0.89)^{a}	48.3 (0.9)^{b}
TWP20s ($kgm\cdot kg^{-1}$)	13.51 (0.73)^{ab}	15.42 (0.69)^{b}	11.99 (0.67)^{a}	13.50 (0.7)^{ab}
TWP45 ($kgm\cdot kg^{-1}$)	21.20 (0.69)^{a}	23.75 (0.78)^{a}	20.98 (0.75)^{a}	22.61 (0.62)^{a}
CK ($UI\cdot L^{-1}$)	243.2 (10.8)^{ab}	153.7 (10.3)^{c}	246.5 (10.1)^{a}	200.3 ± 11.0^{b}
GH ($ng\cdot L^{-1}$)	2.49 (0.4)^{a}	6.11 (0.38)^{b}	2.45 (0.41)^{a}	4.38 (0.35)^{c}

Data followed by the same letter were not significantly different; means that do not share letters were statistically different at $p \leq 0.05$ in *post hoc* Tukey-Kramer multiple comparisons tests. GS=glutamine supplementation; P=placebo; VO_{2max} = oxygen uptake; TWP20s = Total Work performed on 20s; TWP45s = Total Work performed on 45s; CK = creatine kinase plasma level; GH = Grow Hormone plasma level.

CK levels decreased for both groups at the end of the study, but the decrease was higher for the glutamine group ($p < 0.05$; Table I, Figure 2). GH levels were significantly higher for both groups after 90 days of training compared to the initial values. However, GH levels for the athletes of GS group were higher than P group ($p<0.05$) and higher than the initial values ($p<0.05$) (Table I, Figure 3).

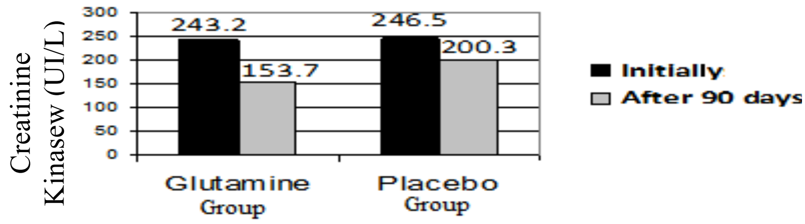

Figure 1
CK plasma levels* (UI·L^{-1}) initially and after 90 days.
*Data are presented as mean values

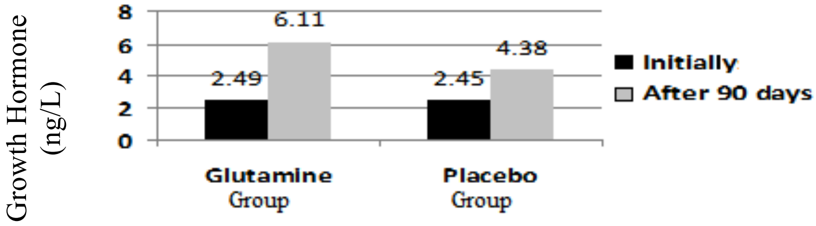

Figure 2
GH plasma level* (ng·L^{-1}) initially and after 90 days
*Data are presented as mean values

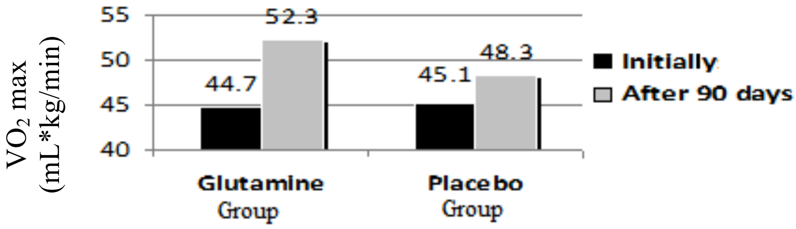

Figure 3
VO_2max* (mL·kg·min^{-1}) initially and after 90 days
*Data are presented as mean values

The results suggest that peptide-bound glutamine supplementation significantly improved training efficiency by increasing muscle conditioning as well as increasing the ability to withstand and recover from strain. Gymnasts in the GS groups had a significant increase of their aerobic capacity, measured via VO_2max, compared to those who received *placebo*. The greater increase of aerobic capacity in the glutamine group could be related to the improvement of the muscle glycogen storage, to a better glucose homeostasis and a positive effect of glutamine on nitrogen balance [2, 10]. While it has been known that glutamine contributes to protein synthesis and anti-catabolic effect [10], these effects may be mediated by an increase in growth hormone (GH) levels following increased glutamine intake [14]. Intensive training alone appeared to stimulate GH levels, but training and glutamine supplementation led to an even higher increase ($p<0.05$). Plasma CK values of the athletes who received glutamine supplementation were lower than those on *placebo* ($p<0.05$). Plasma CK concentration is a measure of muscular stress and an indicator of cell membrane damage and necrosis of the muscle fibres, thus lower values trigger less muscle damage.

Conclusions

Glutamine supplementation in aerobic female high-performance gymnasts may significantly improve their training efficiency and recovery rate, minimizing muscle fatigue. We suggest that glutamine supplementation should begin three months prior to major competitions in order to have an effective contribution to achieving maximum performance, based on aerobic capacity improvement.

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