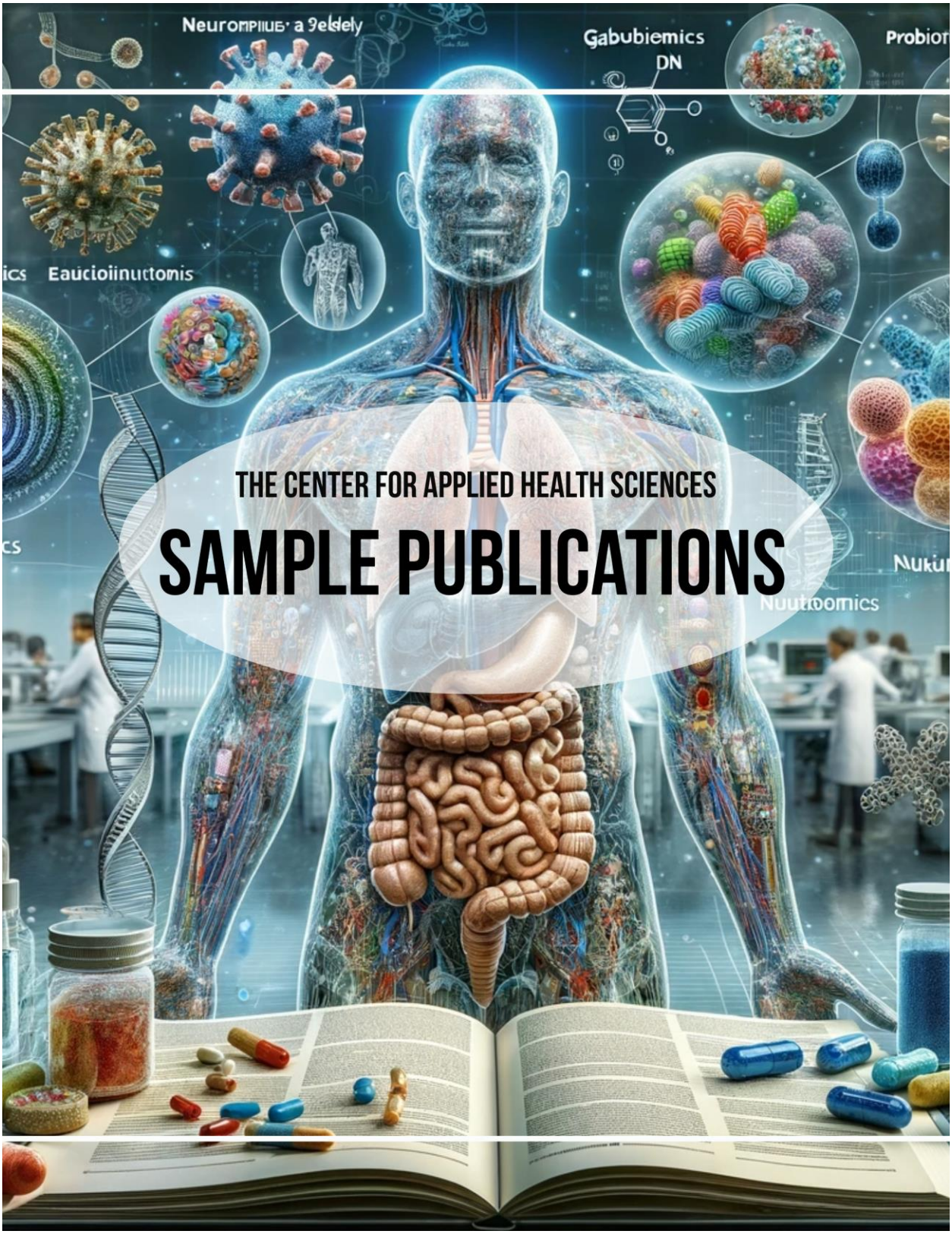
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SAMPLE PUBLICATIONS

Journal of Strength and Conditioning Research, 2003, 17(1), 47–52

Effects of Ribose Supplementation on Repeated Sprint Performance in Men

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ABSTRACT

This study used a randomized, placebo-controlled, crossover design to evaluate the effects of oral ribose supplementation on short-term anaerobic performance. After familiarization, subjects performed 2 bouts of repeated cycle sprint exercise (six 10-second sprints with 60-second rest periods between sprints) in a single day. After the second exercise, bout subjects ingested 32 g of ribose or cellulose (4 × 8-g doses) during the next 36 hours. After supplementation, subjects returned to the laboratory to perform a single bout of cycle sprinting (as described above). After a 5-day washout period, subjects repeated the protocol, receiving the opposite supplement treatment. Ribose supplementation lead to statistically significant increases in mean power and peak power in sprint 2 (10.9 and 6.6%, respectively) and higher (although not significant) absolute values in sprints 1, 3, and 4. In conclusion, ribose supplementation did not show reproducible increases in performance across all 6 sprints. Therefore, within the framework of this investigation, it appears that ribose supplementation does not have a consistent or substantial effect on anaerobic cycle sprinting.

Key Words: anaerobic power, nucleotide synthesis, ergogenic aids, nucleotide depletion

Reference Data: Berardi, J.M., and T.N. Ziegenfuss. Effects of ribose supplementation on repeated sprint performance in men. *J. Strength Cond. Res. 17(1):47–52. 2003.*

Introduction

Numerous food supplements have flooded the market, promising a variety of positive effects including, but not limited to, increased vigor and energy, improved quality of life, and enhanced athletic performance. One such popular nutritional supplement is ribose. Ribose is a pentose (5 carbon) sugar present in small quantities in several foodstuffs. In addition, most of the body's ribose is synthesized endogenously through the pentose phosphate pathway. This substrate is used as a key component in both de novo nucleotide synthesis and in nucleotide salvage pathways, the most relevant to anaerobic performance being its incorporation into adenosine triphosphate (ATP). Skeletal muscle uses the high-energy phosphate bonds present in both adenosine diphosphate (ADP) and ATP to fuel muscular work during bouts of exercise. As a result, hydrolysis and depletion of adenine nucleotides during intense exercise is inevitable, especially in fast-twitch skeletal muscle fibers. In fact, research by Hellsten-Westing et al. (5, 6) has shown that the concentration of total adenine nucleotides ([TAN]; ATP, ADP, and adenosine monophosphate [AMP]) in skeletal muscle declines in response to acute and chronic (6 weeks) high-intensity cycle exercise. This research has important implications for ribose supplementation.

If increased skeletal muscle ribose availability during and after exercise could either increase the production of new nucleotides (de novo synthesis) or increase the recovery of lost nucleotides (salvage), then the administration of ribose would increase [TAN], improve performance, and improve recovery. Data indicate that increased in vitro ribose availability after exercise leads to a three- to fourfold increase in de novo nucleotide synthesis (14). If these data are applicable to skeletal muscle in vivo, ribose may increase the ability of skeletal muscle to regenerate lost nucleotides like ATP, ADP, and AMP. This could lead to improved intermittent exercise performance (as seen with creatine supplementation) or increased recovery between bouts of exercise. The latter mechanism is more likely.

In clinical populations, ribose has shown promise as an energy-providing supplement, enhancing de novo synthesis of purine nucleotides, reducing muscle cramping, and increasing exercise tolerance (3, 4, 15–17). However, ribose has also gained popularity in the athletic and fitness communities despite the lack of convincing data supporting its use. Manufacturers have suggested that oral supplementation of ribose can increase anaerobic performance because of its potential to improve skeletal muscle energy and nucleotide balance. Therefore, ribose is marketed as an anabolic agent and an ergogenic aid. No investigations have been conducted to examine the proposed ergogenic benefits of ribose in healthy populations, the very populations that are now embracing its use.

IMMUNOLOGY AND MICROBIOLOGY

Effect of Extracts from *Rhodiola Rosea* and *Rhodiola Crenulata* (*Crassulaceae*) Roots on ATP Content in Mitochondria of Skeletal Muscles

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 136, No. 12, pp. 664-666, December, 2003
Original article submitted September 16, 2003

We studied the effects of oral treatment with extracts from *Rhodiola rosea* (50 mg/kg) and *Rhodiola crenulata* (50 mg/kg) roots on the duration of exhaustive swimming and ATP content in mitochondria of skeletal muscles in rats. Treatment with *R. rosea* extract significantly (by 24.6%) prolonged the duration of exhaustive swimming in comparison with control rats and rats treated with *R. crenulata*. *R. rosea* extract activated the synthesis or resynthesis of ATP in mitochondria and stimulated reparative energy processes after intense exercise. Experiments proved different pharmacological characteristics of *R. rosea* and *R. crenulata*: *R. rosea* is most effective for improving physical working capacity.

Key Words: *ATP; mitochondria; Rhodiola rosea; Rhodiola crenulata; rosavines; salidroside*

Rhodiola rosea (*Crassulaceae*) or golden root grows in Arctic highlands and is used for phytotherapy in Russia, Scandinavia, and Asia [5]. Extract of *Rhodiola rosea* root is characterized by stress-protective and antidepressive action. It alleviates emotional, mental, and physical disorders [10,11], reduces the severity of exhaustion after intensive physical exercise [1,4], elevates concentrations of norepinephrine, dopamine, and serotonin in the brain, and acts as a nicotinic cholinergic agonist in the CNS [7]. Professional athletes use *R. rosea* for increasing physical activity, stimulating anabolic processes in skeletal muscles, increasing endurance during maximum physical exercise, and promoting subsequent recovery of the cardiovascular system [1,4].

The main components determining the phytochemical and pharmacological characteristics of *R. rosea* are rosavine (cinnamic alcohol vicyanoside), rosine, rosarine (common name rosavines, which seem to be components of *R. rosea* alone), and hydroxyphenylethanol-2-D-glucopyranoside (salidroside) [3]. On the other hand, all plants of the *Rhodiola* genus contain salidroside [13,14].

Medicinal plant *R. crenulata* grows in Uzbekistan, China, and other Asian countries. It seems to possess the effects of "informing" or "preventing" which are due to salidroside. However, this hypothesis was not confirmed clinically.

We studied the effects of extracts from *R. rosea* roots and *R. crenulata* root on ATP content in the muscle mitochondria of rats before and after the exhaustive swimming test.

MATERIALS AND METHODS

The underground parts of *R. rosea* were collected in East Siberia. *R. crenulata* Fish et Mey roots were received from the Academy of Sciences of China. The plants were collected during the late blooming period;

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APPLIED NUTRITIONAL INVESTIGATION

Effect of Creatine Loading on Anaerobic Performance and Skeletal Muscle Volume in NCAA Division I Athletes

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OBJECTIVE: We measured the effect of 3 d of creatine (Cr) supplementation on repeated sprint performance and thigh muscle volume in elite power athletes.

METHODS: Ten male (mean ± standard deviation of body mass and percentage of fat (81.1 ± 10.5 kg and 9.8 ± 3.5) and ten female (58.4 ± 5.3 kg and 15.0 ± 3.4) athletes were matched for sex and 10-s cycle sprint scores, paired by rank, and randomly assigned to the Cr or placebo (P) group. Subjects completed six maximal 10-s cycle sprints interspersed with 60 s of recovery before and after 3 d of Cr (0.35 g/kg of fat-free mass) or P (maltodextrin) ingestion. Before and after supplementation, 10 contiguous transaxial images of both thighs were obtained with magnetic resonance imaging.

RESULTS: Cr supplementation resulted in statistically significant increases in body mass (0.9 ± 0.1 kg, $P < 0.03$), total work during the first sprint ($P < 0.04$), and peak power during sprints 2 to 6 ($P < 0.10$). As expected, total work and peak power values for males were greater than those for their female counterparts during the initial sprint ($P < 0.02$); however, the reverse was true during the last three sprints ($P < 0.01$). Imaging data showed a 6.6% increase in thigh volume in five of six Cr subjects ($P = 0.05$).

CONCLUSION: These data indicate that 3 d of Cr supplementation can increase thigh muscle volume and may enhance cycle sprint performance in elite power athletes; moreover, this effect is greater in females as sprints are repeated. *Nutrition* 2002;18:397–402. ©Elsevier Science Inc. 2002

KEY WORDS: exercise, creatine loading, dietary supplements, ergogenic aid

INTRODUCTION

Exogenous creatine (Cr) feedings (20 g/d × 5–6 d) can add to the body's total creatine pool,[1,2] and up to 30% of this exists as phosphocreatine (PCr). Performance benefits have included increases in peak isokinetic knee[2] and isometric ankle extension and reductions in fatigue during dynamic and isometric exercise.[3–5]

Interestingly, not all studies have shown a performance improvement with Cr supplementation. For instance, reports using swimming[6] and running[7] showed no benefit with Cr supplementation. Further, an investigation by Cooke et al.[8] found no effect of Cr during a single bout of cycling exercise. The underlying reasons for equivocal results are unclear but may be related to design or statistical issues (e.g., lack of a control group, use of repeated *t* tests with no experimentwise correction, or the use of lengthy rest periods between repeated tests) in some of these studies.

Moreover, there is a dearth of published information on Cr supplementation in elite competitive athletes, particularly those involved in power sports (e.g., wrestling, hockey, basketball, and sprinting). We previously observed increased (14%) resting PCr/ATP (^{31}P magnetic resonance spectroscopy) within 48 to 72 h of Cr supplementation (20 g/d), resulting in ergogenic effects during intense repeated muscle contraction in untrained males.[3,9] Thus, we investigated whether 3 d of Cr supplementation in elite power athletes would affect sprint cycle performance and thigh muscle volume.

MATERIALS AND METHODS

Subjects

After Human Subject Review Board approval, 20 (10 males and 10 females) athletes in Division I of the National Collegiate Athletic Association were recruited from the university population to participate in the study. Eight of the 10 male athletes were university wrestlers and the other two were ice-hockey players. The female sample represented a wider range of sports: gymnastics (three), basketball (two), field hockey (two), softball (two), and track (one). For those athletes involved in team sports, care was taken to recruit individuals whose position required brief, intense, repeated activity (e.g., forwards and guards in basketball and midfielders in field hockey) to promote intersubject homogeneity of anaerobic power.[10,11] Subjects were in good health as determined by standard university physical examinations and medical history profiles; none reported the use of tobacco, steroids, diuretics, or oral contraceptives, and all regularly consumed meat in their diets. The female athletes who participated in this study menstruated regularly and were studied at least 7 d before the onset of menses. The nature, purpose, and attendant risks involved in the study were explained carefully to each subject before providing written consent to participate. No monetary compensation was provided.

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Applied nutritional investigation

Effects of creatine on thermoregulatory responses while exercising in the heat

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Abstract

Objective: We hypothesized that creatine supplementation would interfere with normal body fluid shifts that occur during exercise in a hot environment due to its osmotic effect intracellularly. This study examined the effects of acute creatine loading (20 g/d for 5 d) on the thermoregulatory response of the body during a bout of exercise at 39°C.

Methods: Subjects (15 men and 1 woman) performed a cycle test of maximum oxygen consumption to determine the proper work rate for the heat-stress test (40 min at 55% maximum oxygen consumption at 39°C) and were assigned to a creatine group ($n = 8$) or a placebo group ($n = 8$) in a double-blind fashion. Each group performed the heat-stress test on two separate occasions: before supplementation and after supplementation (20 g/d of creatine with Gatorade or Solka-floc plus Gatorade). Dependent variables included rectal temperature, mean skin temperature, mean body temperature, and perceived thermal sensation.

Results: Repeated measure analysis of variance showed a significant ($P \leq 0.05$) increase in body weight in the group supplemented with Gatorade. Core temperature was significantly lower after supplementation for both groups combined (before supplementation at 37.85°C and after supplementation at 37.7°C), with no difference between groups. A significant three-way interaction (group × trial × time) was also found for rectal temperature, with both groups having significantly lower rectal temperature after supplementation. Mean body and mean skin temperatures showed no differences.

Conclusions: Short-term creatine supplementation (20 g/d for 5 d) did not have a negative effect on thermoregulatory responses during exercise at 39°C.

Keywords Creatine; Heat; Submaximal exercise; Thermoregulation; Ergogenic aid

Introduction

Many creatine (Cr) studies [1–4] have been conducted over the past years because of the role of Cr in energy metabolism. During high-intensity exercise (of short duration), the energy for resynthesis of adenosine triphosphate is supplied from the breakdown of phosphocreatine (PCr) and anaerobic glycolysis [5]. The amount of available PCr appears to correlate with force development and may contribute to the delay of fatigue in high-intensity exercise [6]. It has been documented that acute Cr supplementation is effective in anaerobic performance by increasing free Cr and PCr within skeletal muscle cells [7]. Greenhaff et al. [8] evaluated this effect of Cr supplementation on PCr resynthesis. After 20 electrically evoked isometric contractions of the quadriceps muscle, the results supported an increased

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Extract of *Rhodiola rosea* Radix Reduces the Level of C-Reactive Protein and Creatinine Kinase in the Blood

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The effects of extracts of *Rhodiola rosea* radix on blood levels of inflammatory C-reactive protein and creatinine kinase were studied in healthy untrained volunteers before and after exhausting exercise. *Rhodiola rosea* extract exhibited an antiinflammatory effect and protected muscle tissue during exercise.

Key Words: *C-reactive protein; creatinine kinase; Rhodiola rosea; muscle protection; adaptogen*

Professional athletes effectively use *Rhodiola rosea* ("golden radix") extract as a safe nonsteroid food additive improving endurance and rapid recovery of muscles during several decades [7]. *Rhodiola rosea* extract improves muscle work due to mobilization and more economic expenditure of energy resources of muscles [1]. The use of adaptogens including *R. rosea* improved physical endurance of male athletes, reducing blood lactate level and accelerating recovery after exhausting exercise [2,6,7].

Muscle injury involves inflammation (increase in blood IL-6 level) and increases the risk of myocardial infarction in subjects with latent cardiovascular diseases (particularly in those neglecting regular exercises) [9]. The inflammatory process plays an important role in the etiology of coronary disease. The relationship between increased blood concentrations of C-reactive protein (CRP) and creatinine kinase (CK) and muscle injuries in untrained subjects after exhausting physical exercise was demonstrated [12].

Here the effect of regular treatment with *R. rosea* extract and plasma levels of CRP and CK in untrained subjects before and after maximum exercise was evaluated in a double-blind placebo-controlled study.

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MATERIALS AND METHODS

The study was carried out in 36 healthy untrained volunteers aged 21-24 years. All were non-smokers without symptoms of cardiovascular diseases for 12 months preceding the study and took no antiinflammatory drugs for 6 months before the study. Caffeine or ethanol-containing drinks were prohibited during the study. Vo_2max, weight, fat percentage (by Moreno's method [13]), and initial blood levels of CRP and CK were measured before the study, after which the volunteers were randomly divided into 3 groups. The test for normal distribution and analysis of dispersions showed no appreciable differences between the groups.

Group 1 (n=12) received 340 mg RHODAX (preparation containing 30 mg active substances of *R. rosea* extract) twice a day (in the morning and evening) and group 2 (n=12) received 340 mg placebo for 30 days before and 6 days after exhausting physical exercise. Group 3 (n=12) served as the control. Exhausting physical exercise test was carried out on a computer-aided bicycle ergometer. The initial exercise of 20 W was gradually increased by 10 W/min. The test was discontinued after attaining physical exhaustion, when the volunteer could no longer rotate the pedals at a rate of 60 cycle/min.

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Research article

EFFECTS OF CREATINE, GINSENG, AND ASTRAGALUS SUPPLEMENTATION ON STRENGTH, BODY COMPOSITION, MOOD, AND BLOOD LIPIDS DURING STRENGTH-TRAINING IN OLDER ADULTS

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ABSTRACT

The effects of supplemental dietary creatine and a botanical extract consisting of ginseng and astragalus were evaluated in 44 adults aged 55-84 years participating in a 12-week strength-training program. Participants consumed creatine only (Cr), creatine plus botanical extract (CrBE), or placebo (PL), and performed bench press, lat pull down, biceps curl, leg press, knee extension, and knee flexion for 3 sets of 8-12 reps on 3 days per week for 12 weeks. The 1-repetition maximum for each exercise, body composition (full-body DEXA), blood lipids, and mood states were evaluated before and after the intervention. Training improved ($p < 0.05$) strength and lean mass for all groups, however greater gains were observed with Cr and CrBE compared with placebo (but no difference was found between Cr and CrBE). Only CrBE improved blood lipids and self-reported vigor, and the CrBE group lost significantly more body fat and gained more bench press strength than Cr. These results indicate that strength and lean mass gains achieved by older adults participating in a strength training program can be enhanced with creatine supplementation, and that ginseng and astragalus may provide additional health and psychological benefits. However, these herbs do not appear to have an additive effect on strength and lean mass gains during training.

KEY WORDS: Exercise, aging, creatine loading, strength training, dietary supplements.

INTRODUCTION

Creatine is a naturally occurring compound that is found in the skeletal and cardiac muscles, and exogenous creatine feedings can add to the body's total creatine pool (Harris et al. 1992). The ability of supplemental creatine monohydrate to enhance skeletal muscle strength has been the subject of numerous studies in the last decade. It has been shown to increase peak strength, mean power output,

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Effects of a Water-Soluble Cinnamon Extract on Body Composition and Features of the Metabolic Syndrome in Pre-Diabetic Men and Women

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ABSTRACT

Purpose: The purpose of this study was to determine the effects of supplementation with a water-soluble cinnamon extract (Cinnulin PF®) on body composition and features of the metabolic syndrome. **Methods**: Twenty-two subjects with prediabetes and the metabolic syndrome (mean ± SD: age, BMI, systolic blood pressure [SBP], fasting blood glucose [FBG]: 46.0 ± 9.7 y; 33.2 ± 9.3 kg/m^2; 133 ± 17 mm Hg; 114.3 ± 11.6 mg/dL) were randomly assigned to supplement their diet with either Cinnulin PF® (500 mg/d) or a placebo for 12-weeks. Main outcome measures were changes in FBG, SBP, and body composition measured after 12-weeks of supplementation. The primary statistical analyses consisted of two factor (group x time), repeated-measures ANOVA for between group differences over time. In all analyses, an intent-to-treat approach was used and significance was accepted at $P<0.05$. **Results**: Subjects in the Cinnulin PF® group had significant decreases in FBG (-8.4%: 116.3 ± 12.8 mg/dL [pre] to 106.5 ± 20.1 mg/dL [post], $p<0.01$), SBP (-3.8%: 133 ± 14 mm Hg [pre] to 128 ± 18 mm Hg [post], $p<0.001$), and increases in lean mass (+1.1%: 53.7 ± 11.8 kg [pre] to 54.3 ± 11.8 kg [post], $p<0.002$) compared with the placebo group. Additionally, within-group analyses uncovered small, but statistically significant decreases in body fat (-0.7%: 37.9 ± 9.2 % [pre] to 37.2 ± 8.9 % [post], $p<0.02$) in the Cinnulin PF® group. No significant changes in clinical blood chemistries were observed between groups over time. **Conclusions**: These data support the efficacy of Cinnulin PF® supplementation on reducing FBG and SBP, and improving body composition in men and women with the metabolic syndrome and suggest that this naturally-occurring spice can reduce risk factors associated with diabetes and cardiovascular diseases. ***Journal of the International Society of Sports Nutrition***. 3(2): 45 – 53, 2006.

Key Words: prediabetes, glucose, body fat, insulin, systolic blood pressure, dyslipidemia

INTRODUCTION

A number of spices and herbs have a long history of traditional use in treating elevated blood sugar levels [1]. One such compound that has recently been the subject of intense research is cinnamon, a compound granted GRAS (Generally Recognized As Safe) status by the United States Food and Drug Administration. The beneficial effects of cinnamon on glucose control appear to be in part due to doubly-linked polyphenol type-A compounds [2]. Over the past two decades, *in vitro* and *in vivo* data have been accumulating which support the role of cinnamon on glycemic control. For example, Jarvill-Taylor et al. [3] reported that cinnamon stimulated glucose uptake, glycogen synthesis, and activated glycogen synthase in 3T3-L1 adipocytes. In rats, cinnamon enhanced glucose uptake by enhancing insulin-stimulated tyrosine phosphorylation of insulin receptor-β, insulin receptor substrate-1, and phosphatidylinositol 3-kinase in a dose-dependent fashion [4,5]. To date, human studies demonstrating beneficial effects of cinnamon supplementation on glucose regulation have studied subjects with type II diabetes [6,7]. In a dose-response study, Khan et al. [6] reported that 40-days of supplementation with 1, 3, or 6 grams of whole cinnamon per day resulted in dose-dependent decreases in fasting blood glucose (FBG), and

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Commentary

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International Society of Sports Nutrition position stand: creatine supplementation and exercise

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A Position Statement and Review of the Literature

Position Statement: The following nine points related to the use of creatine as a nutritional supplement constitute the Position Statement of the Society. They have been approved by the Research Committee of the Society.

1. Creatine monohydrate is the most effective ergogenic nutritional supplement currently available to athletes in terms of increasing high-intensity exercise capacity and lean body mass during training.

2. Creatine monohydrate supplementation is not only safe, but possibly beneficial in regard to preventing injury and/or management of select medical conditions when taken within recommended guidelines.

3. There is no scientific evidence that the short- or long-term use of creatine monohydrate has any detrimental effects on otherwise healthy individuals.

4. If proper precautions and supervision are provided, supplementation in young athletes is acceptable and may provide a nutritional alternative to potentially dangerous anabolic drugs.

5. At present, creatine monohydrate is the most extensively studied and clinically effective form of creatine for use in nutritional supplements in terms of muscle uptake and ability to increase high-intensity exercise capacity.

6. The addition of carbohydrate or carbohydrate and protein to a creatine supplement appears to increase muscular retention of creatine, although the effect on performance measures may not be greater than using creatine monohydrate alone.

7. The quickest method of increasing muscle creatine stores appears to be to consume ~0.3 grams/kg/day of creatine monohydrate for at least 3 days followed by 3–5 g/d thereafter to maintain elevated stores. Ingesting smaller amounts of creatine monohydrate (e.g., 2–3 g/d) will increase muscle creatine stores over a 3–4 week period, however, the performance effects of this method of supplementation are less supported.

8. Creatine products are readily available as a dietary supplement and are regulated by the *U.S. Food and Drug Administration (FDA)*. Specifically, in 1994, U.S. President Bill Clinton signed into law the Dietary Supplement Health and Education Act (DSHEA). DSHEA allows manufacturers/companies/brands to make structure-function

International Journal of Sport Nutrition and Exercise Metabolism, 2008, 18, 389-398

Effect of Creatine Supplementation and Resistance-Exercise Training on Muscle Insulin-Like Growth Factor in Young Adults

Darren G. Burke, Darren G. Candow, Philip D. Chilibeck, Lauren G. MacNeil, Brian D. Roy, Mark A. Tarnopolsky, and Tim Ziegenfuss

The purpose of this study was to compare changes in muscle insulin-like growth factor-I (IGF-I) content resulting from resistance-exercise training (RET) and creatine supplementation (CR). Male ($n = 24$) and female ($n = 18$) participants with minimal resistance-exercise-training experience (≥1 year) who were participating in at least 30 min of structured physical activity (i.e., walking, jogging, cycling) 3–5 ×/wk volunteered for the study. Participants were randomly assigned in blocks (gender) to supplement with creatine (CR: 0.25 g/kg lean-tissue mass for 7 days; 0.06 g/kg lean-tissue mass for 49 days; $n = 22$, 12 males, 10 female) or isocaloric placebo (PL: $n = 20$, 12 male, 8 female) and engage in a whole-body RET program for 8 wk. Eighteen participants were classified as vegetarian (lacto-ovo or vegan; CR: 5 male, 5 female; PL: 3 male, 5 female). Muscle biopsies (vastus lateralis) were taken before and after the intervention and analyzed for IGF-I using standard immunohistochemical procedures. Stained muscle cross-sections were examined microscopically and IGF-I content quantified using image-analysis software. Results showed that RET increased intramuscular IGF-I content by 67%, with greater accumulation from CR (+78%) than PL (+54%; $p = .06$). There were no differences in IGF-I between vegetarians and nonvegetarians. These findings indicate that creatine supplementation during resistance-exercise training increases intramuscular IGF-I concentration in healthy men and women, independent of habitual dietary routine.

Keywords: peptide hormone, muscle biopsy, sport nutrition, vegetarians

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REVIEW Open Access

ISSN exercise & sport nutrition review: research & recommendations

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Abstract

Sports nutrition is a constantly evolving field with hundreds of research papers published annually. For this reason, keeping up to date with the literature is often difficult. This paper is a five year update of the sports nutrition review article published as the lead paper to launch the JISSN in 2004 and presents a well-referenced overview of the current state of the science related to how to optimize training and athletic performance through nutrition. More specifically, this paper provides an overview of: 1.) The definitional category of ergogenic aids and dietary supplements; 2.) How dietary supplements are legally regulated; 3.) How to evaluate the scientific merit of nutritional supplements; 4.) General nutritional strategies to optimize performance and enhance recovery; and, 5.) An overview of our current understanding of the ergogenic value of nutrition and dietary supplementation in regards to weight gain, weight loss, and performance enhancement. Our hope is that ISSN members and individuals interested in sports nutrition find this review useful in their daily practice and consultation with their clients.

Introduction

Sports nutrition professionals need to know how to evaluate the scientific merit of articles and advertisements about exercise and nutrition products so they can separate marketing hype from scientifically-based training and nutritional practices. In order to help ISSN members keep informed about the latest in sports nutrition, we have updated the ISSN Exercise & Sports Nutrition Review that was used to help launch the JISSN (originally called the Sports Nutrition Review Journal). This paper provides an overview of: 1.) The definitional category of ergogenic aids and dietary supplements; 2.) How dietary supplements are legally regulated; 3.) How to evaluate the scientific merit of nutritional supplements; 4.) General nutritional strategies to optimize performance and enhance recovery; and, 5.) An overview of our current understanding of the ergogenic value in regards to weight gain, weight loss, and performance enhancement supplements. We have also categorized nutritional supplements into 'apparently effective', 'possibly effective', 'too early to tell', and 'apparently ineffective' as well a description of our general approach into educating athletes about sports nutrition. Over the last five years there have been many changes to our original categorization of supplements. In addition, a number of new supplements have been introduced to the market are reviewed in this article. While some may not agree with all of our interpretations of the literature and/or categorization of a particular supplement, and some classifications may change over time as more research is forthcoming, these interpretations are based on current available scientific evidence and have been well received within the broader scientific community. Our hope is that ISSN members find this information useful in their daily practice and consultation with their clients.

Ergogenic Aid

An ergogenic aid is any training technique, mechanical device, nutritional practice, pharmacological method, or psychological technique that can improve exercise performance capacity and/or enhance training adaptations [1-3]. This includes aids that may help prepare an

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POSTER PRESENTATION Open Access

The effects of Teacrine™, a nature-identical purine alkaloid, on subjective measures of cognitive function, psychometric and hemodynamic indices in healthy humans: a randomized, double-blinded crossover pilot trial

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From The Eleventh International Society of Sports Nutrition (ISSN) Conference and Expo
Clearwater Beach, FL, USA. 20-21 June 2014

Background

Aside from caffeine, there is a relative dearth of evidence regarding natural ingredients that enhance subjective "energy" levels. We have studied a unique, naturally occurring purine alkaloid, present in *Camellia assamica* variety kucha tea (amongst other botanical sources) that acts on both adenosinergic and dopaminergic pathways that appears to influence multiple neurochemical pathways. As a first step in a series of experiments, we examined the effects of TeaCrine™, a nature-identical, chemically equivalent bioactive compound known as theacrine (1,3,7,9-tetramethyluric acid), in humans.

Methods

Using a randomized, double-blinded, within-subject (crossover) design, 15 healthy subjects (mean ± SD age, height, wgt, BMI: 28.3 ± 6.1 y, 175.7 ± 11.5 cm, 89.8 ± 21.7 kg, 29.1 ± 4.7) volunteered to ingest 200 mg of TeaCrine™ (Compound Solutions, Inc., Carlsbad, CA) (TC) or Placebo (PLA). Anchored VAS questionnaires were used to detect changes in various aspects of physical and mental energy and performance; side effect profiles, hemodynamics and biochemical markers of safety were also collected over a 3-hr post-dosing period. A subset of 6 subjects underwent a separate 7-day, open-label, repeated dose study comparing 100 mg, 200 mg and 400 mg of TC. Consent to publish the results was obtained from all participants.

Results

The 200 mg dose of TC caused significant improvements in energy (TC: +8.6% vs. PLA: -5.7%, P=0.049) and reductions in fatigue (TC: -6.7% vs. PLA: +5.8%, P=0.04). A trend for improved concentration was also noted (TC: +2.4% vs. PLA: -1.3%, P=0.07). No changes in systemic hemodynamics or side effect profiles were noted. The N=6 cohort study demonstrated moderate to large effect sizes (0.50 to 0.71) with the 200 mg dose of TC over a 7-day period of assessment for the following subjective measures: energy, fatigue, concentration, anxiety, motivation to exercise and libido.

Conclusion

These preliminary data support the benefits of acute TeaCrine™ supplementation on subjective "energy" levels and some indices of mental performance. Future studies are underway to confirm these neurotropic effects and also explore potential benefits of TeaCrine™ on objective measures of cognitive and physical performance, inflammation, pain perception, and functional capacity.

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RESEARCH ARTICLE Open Access

Eight weeks of supplementation with a multi-ingredient weight loss product enhances body composition, reduces hip and waist girth, and increases energy levels in overweight men and women

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Abstract

Background: Numerous natural products are marketed and sold claiming to decrease body weight and fat, but few undergo finished product-specific research demonstrating their safety and efficacy.

Objective: To determine the safety and efficacy of a multi-ingredient supplement containing primarily raspberry ketone, caffeine, capsaicin, garlic, ginger and Citrus aurantium (Prograde Metabolism™ [METABO]) as an adjunct to an eight-week weight loss program.

Methods: Using a randomized, placebo-controlled, double-blind design, 70 obese but otherwise healthy subjects were randomly assigned to METABO or a placebo and underwent 8 weeks of daily supplementation, a calorie restricted diet, and exercise training. Subjects were tested for changes in body composition, serum adipocytokines (adiponectin, resistin, leptin, TNF-α, IL-6) and markers of health including heart rate and blood pressure.

Results: Of the 45 subjects who completed the study, significant differences were observed in: body weight (METABO -2.0% vs. placebo -0.5%, $P < 0.01$), fat mass (METABO -7.8 vs. placebo -2.8%, $P < 0.001$), lean mass (METABO +3.4% vs. placebo +0.8%, $P < 0.03$), waist girth (METABO -2.0% vs. placebo -0.2%, $P < 0.0007$), hip girth (METABO -1.7% vs. placebo -0.4%, $P < 0.003$), and energy levels per anchored visual analogue scale (VAS) (METABO + 29.3% vs. placebo +5.1%, $P < 0.04$). During the first 4 weeks, effects/trends for maintaining elevated serum leptin ($P < 0.03$) and decreased serum resistin ($P < 0.08$) in the METABO group vs. placebo were also observed. No changes in systemic hemodynamics, clinical blood chemistries, adverse events, or dietary intake were noted between groups.

Conclusions: METABO administration is a safe and effective adjunct to an eight-week diet and exercise weight loss program by augmenting improvements in body composition, waist and hip girth. Adherence to the eight-week weight loss program also led to beneficial changes in body fat in placebo. Ongoing studies to confirm these results and clarify the mechanisms (i.e., biochemical and neuroendocrine mediators) by which METABO exerts the observed salutary effects are being conducted.

Keywords: Dietary supplement, Raspberry ketone, Adipokine, Body composition, Fat loss, Capsaicin

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PILOT STUDY

Evaluation of the Effects of BioCell Collagen, a Novel Cartilage Extract, on Connective Tissue Support and Functional Recovery From Exercise

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Abstract

Context: Little is known about the effect of nutritional supplementation on metabolic optimization for enhancing adaptation and recovery of the connective tissue elements that support musculoskeletal function.

Objective: The study aimed to determine the potential effect of supplementation with a novel, hydrolyzed chicken sternal cartilage extract—called BioCell Collagen—on biomarkers and functional indices of recovery from intense exercise.

Design: The research team designed a randomized, double-blind, placebo-controlled pilot study.

Setting: The study was conducted at the Center for Applied Health Sciences in Stow, OH, USA.

Participants: Participants were 8 healthy, recreationally active individuals, with a mean age of 29.3 y.

Intervention: Participants ingested either 3 g of a novel, hydrolyzed chicken sternal cartilage extract called BioCell Collagen ("supplement") or 3 g of a placebo daily for 6 wk prior to challenge with an upper-body, muscle-damaging resistance exercise (UBC) on day 43 and a rechallenge on day 46 to assess functional recovery.

Outcome Measures: Primary endpoints were levels of 3 blood biomarkers—creatine kinase (CK), lactate dehydrogenase (LDH), and C-reactive protein (CRP)—and scores on a clinical pain scale and a perceived recovery scale (PRS).

Results: The extract attenuated the post-UBC increase in serum markers for muscle tissue damage: CK, LDH, and CRP. For the intervention group vs the placebo group, the mean changes were as follows: (1) an increase in CK of 20 U/L vs 4726 U/L, respectively; (2) a decrease in LDH of 3.5 U/L vs an increase of 82.9 U/L, respectively; and (3) an increase in CRP of 0.07 mg/L vs an increase of 0.7 mg/L, respectively. The performance decrement in bench press repetitions to failure was 57.9% on day 43 and 57.8% on day 46 for the intervention group vs 72.2% on day 43 and 65% on day 46 for the placebo group. The overall trend for the performance decrement, together with the results for the PRS, suggested that a more robust muscular recovery and adaptive response occurred with use of the extract. The supplement was well tolerated.

Conclusions: The study's preliminary data are promising with regard to the beneficial effects of the extract on connective tissue protection and recovery in those engaged in routine resistance training and cardiovascular exercise. A larger study is warranted to confirm and refine these findings.

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The use of mechanical stressors that overload skeletal muscle and associated connective tissue often result in some degree of exercise-induced muscular damage (EIMD). EIMD results in delayed-onset muscle soreness (DOMS) in association with an increased presence of muscle-specific proteins in the blood, muscle edema, and fiber swelling.[1] Traditionally, DOMS has largely been explained by myogenic factors associated with structural alteration of the sarcolemmal membrane, damage to Z disks of sarcomeres and disruption of cytoskeletal proteins (ie, dystrophin, desmin, titin, integrins, and fibronectin).[2,3] However, it is clear that shear stress and injury to other extramuscular elements of connective tissue (extracellular

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REVIEW Open Access

International society of sports nutrition position stand: Beta-Alanine

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Abstract

Position statement: The International Society of Sports Nutrition (ISSN) provides an objective and critical review of the mechanisms and use of beta-alanine supplementation. Based on the current available literature, the conclusions of the ISSN are as follows: 1) Four weeks of beta-alanine supplementation (4–6 g daily) significantly augments muscle carnosine concentrations, thereby acting as an intracellular pH buffer; 2) Beta-alanine supplementation currently appears to be safe in healthy populations at recommended doses; 3) The only reported side effect is paraesthesia (tingling), but studies indicate this can be attenuated by using divided lower doses (1.6 g) or using a sustained-release formula; 4) Daily supplementation with 4 to 6 g of beta-alanine for at least 2 to 4 weeks has been shown to improve exercise performance, with more pronounced effects in open end-point tasks/time trials lasting 1 to 4 min in duration; 5) Beta-alanine attenuates neuromuscular fatigue, particularly in older subjects, and preliminary evidence indicates that beta-alanine may improve tactical performance; 6) Combining beta-alanine with other single or multi-ingredient supplements may be advantageous when supplementation of beta-alanine is high enough (4–6 g daily) and long enough (minimum 4 weeks); 7) More research is needed to determine the effects of beta-alanine on strength, endurance performance beyond 25 min in duration, and other health-related benefits associated with carnosine.

Introduction

Beta-alanine is a non-proteogenic amino acid that is produced endogenously in the liver. In addition, humans acquire beta-alanine through the consumption of foods such as poultry and meat. By itself, the ergogenic properties of beta-alanine are limited; however, beta-alanine has been identified as the rate-limiting precursor to carnosine synthesis [1, 2], and has been consistently shown to increase levels of carnosine in human skeletal muscle. Doses of 4 to 6 g/day of beta-alanine have been shown to increase muscle carnosine concentrations by up to 64 % after 4 weeks [1], and up to 80 % after 10 weeks [3]. Baguet et al. [4] demonstrated that individuals vary in the magnitude of response to 5 to 6 weeks of beta-alanine supplementation (4.8 g/day), with high responders increasing muscle carnosine concentrations by an average of 55 %, and low responders increasing by an average of only 15 %. The difference between high and low responders seems, at least in part, to be related to baseline muscle carnosine content and muscle fiber composition [5].

While evidence suggests that athletes engaged in resistance training and high-intensity exercise have higher concentrations of muscle carnosine [6, 7], longitudinal training studies have demonstrated equivocal changes in intramuscular carnosine [8–11]. The variability of increases in carnosine appears to be reflective of baseline levels, with vegetarians having greater increases in carnosine concentrations compared to carnivores. In humans, muscle carnosine contents generally range from 10 – 40 mmol/kg dry weight [5, 6, 12] with average values around 20–30 mmol/kg dry weight [5, 13–15], although these contents can be influenced by a number of factors. Carnosine concentrations tend to be higher in males compared to females [15], and in fast-twitch compared to slow-twitch muscle

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RESEARCH ARTICLE Open Access

Effects of a dietary supplement on golf drive distance and functional indices of golf performance

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Abstract

Background: Limited research exists examining the impact of nutrition on golfing performance. This study's purpose was to determine the impact of daily supplementation with an over-the-counter dietary supplement on golf performance.

Methods: Healthy men (30.3 ± 6.9 y, 183.1 ± 5.6 cm, 86.7 ± 11.9 kg), with a 5–15 handicap were assigned in a double-blind, placebo-controlled manner to ingest for 30 days either a placebo (PLA, n = 13) or a dietary supplement containing creatine monohydrate, *coffea arabica* fruit extract, calcium fructoborate and vitamin D (Strong Drive™, SD, n = 14). Subjects ingested two daily doses for the first two weeks and one daily dose for the remaining two weeks. Participants followed their normal dietary habits and did not change their physical activity patterns. Two identical testing sessions in a pre/post fashion were completed consisting of a fasting blood sample, anthropometric measurements, 1-RM bench press, upper body power and golf swing performance using their driver and 7-iron. Data were analyzed using two-way mixed factorial ANOVAs and ANCOVA when baseline differences were present. Statistical significance was established *a priori* at $p \leq 0.05$.

Results: ANCOVA revealed significantly greater (post-test) best drive distance ($p = 0.04$) for SD (+5.0% [+13.6 yards], ES = 0.75) as well as a tendency ($p = 0.07$) for average drive distance to increase (+8.4% [+19.6 yards], ES = 0.65), while no such changes were found with PLA (−0.5% [−1.2 yards], ES = 0.04 and +1.3% [+2.8 yards], ES = 0.08, respectively). Both groups experienced significant increases in body mass and 1-RM bench press ($p < 0.001$). No other significant group × time interactions were found. For the SD group only, within-group analysis confirmed significant improvements in set 1 average (+8.9%, $p = 0.001$) and peak velocity (+6.8%, $p < =0.01$). No changes were noted for reported adverse events, pain inventories, quality of life or any measured blood parameter.

Conclusions: SD supplementation for 30 days significantly improved best drive distance more than placebo. Supplementation was well tolerated and did not result in any clinically significant changes in markers of health or adverse events/side effect profiles.

Keywords: Golf, Performance, Creatine, Drive distance, Velocity, Driver

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Timing, Optimal Dose and Intake Duration of Dietary Supplements with Evidence-Based Use in Sports Nutrition

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[Purpose] The aim of the present narrative review was to consider the evidence on the timing, optimal dose and intake duration of the main dietary supplements in sports nutrition, i.e. β-alanine, nitrate, caffeine, creatine, sodium bicarbonate, carbohydrate and protein.

[Methods] This review article focuses on timing, optimal dose and intake duration of main dietary supplements in sports nutrition.

[Results] This paper reviewed the evidence to determine the optimal time, efficacy doses and intake duration for sports supplements verified by scientific evidence that report a performance enhancing effect in both situation of laboratory and training settings.

[Conclusion] Consumption of the supplements are usually suggested into 5 specific times, such as pre-exercise (nitrate, caffeine, sodium bicarbonate, carbohydrate and protein), during exercise (carbohydrate), post-exercise (creatine, carbohydrate, protein), meal time (β-alanine, creatine, sodium bicarbonate, nitrate, carbohydrate and protein), and before sleep (protein). In addition, the recommended dosing protocol for the supplements nitrate and β-alanine are fixed amounts irrespective of body weight, while dosing protocol for sodium bicarbonate, caffeine and creatine supplements are related to corrected body weight (mg/kg bw). Also, intake duration is suggested for creatine and β-alanine, being effective in chronic daily time < 2 weeks while caffeine, sodium bicarbonate are effective in acute daily time (1-3 hours). Plus, ingestion of nitrate supplement is required in both chronic daily time < 28 days and acute daily time (2-2.5 h) prior exercise.

[Key words] Sports nutrition, Dietary supplements, Timing, Dose, Intake duration

INTRODUCTION

An increased health awareness among athletes and the public will favor the global sports nutrition market which is predicted to have an annual growth rate of 9% from 2013 to 2019, to an estimated value of USD 37.7 billion in 2019 (http: //www.transparencymarketresearch.com/sports-nutrition-market.html). High use of dietary and nutritional supplements has been reported in various regions. For example, supplement intake by elite Finnish athletes was 81% in 2002 and 73% in 2009[1]. In Iran, women and men body builders reported use of 11% and 87%, respectively[2]. Athletes use dietary supplements to: 1. aid recovery from training; 2. acquire health benefits; 3. treat illness; and/or 4. compensate for a poor diet[3]. According to the US Food and Drug Administration, a dietary supplement is a product (other than tobacco) to supplement the diet and contains one or more of the following ingredients; a vitamin, a mineral, an amino acid, a herb or other botanical. It supplements the diet by increasing its total daily intake, or a concentrate, metabolite, constituent, extract, or combination of these ingredients[4]. Many sport supplements are available, however, it is only a few that are supported by enough evidence to have a performance effect including β-alanine, beetroot juice (nitrate), caffeine, creatine, sodium bicarbonate, carbohydrate and protein[5]. Additionally, studies have also addressed supplementation and nutrient timing. Supplementation timing can be described as the strategy for intake at a specific time. For example, muscle protein synthesis (MPS) may be higher with protein ingestion after resistance exercise compared to intake before exercise[6]. In addition, creatine monohydrate immediately after body building exercise provided greater improvement of fat-free mass and body composition compared to intake before exercise[7]. However, there is still no consensus for the timing for these supplements. In addition to supplementation timing, the optimal dosage also needs to be considered. For example, a dose of 20 g of post-exercise protein did further increase mTOR signaling in skeletal muscle compared to 10 g[8], and it was observed that a dose higher than 300 mg/kg of sodium bicarbonate likely causes gastrointestinal discomfort[9].

This narrative review focuses on timing and optimal dosage and in-

A Two-Part Approach to Examine the Effects of Theacrine (TeaCrine®) Supplementation on Oxygen Consumption, Hemodynamic Responses, and Subjective Measures of Cognitive and Psychometric Parameters

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Abstract

Theacrine (1,3,7,9-tetramethyluric acid) is a naturally occurring purine alkaloid, present in Camellia assamica variety kucha tea. Using a two-part approach in humans, the impact of theacrine (TeaCrine®, TC) was used to examine subjective dose-response, daily changes in cognitive and psychometric parameters, and changes in gas exchange and vital signs. All indicators were chosen to better ascertain the previously reported animal and human outcomes involving theacrine administration. Part 1 was a randomized, open-label, dose-response investigation in nine healthy participants whereby three participants ingested 400 mg TC per day and six participants ingested 200 mg/day. Participants recorded subjective changes in cognitive, psychometric, and exercise attributes using 150-mm anchored visual analog scale (VAS) before, and 1, 4, and 6 hours after ingestion every day for 7 consecutive days. Part 2 was a randomized, double-blind, placebo-controlled, crossover investigation in 15 healthy subjects in which all participants ingested a single 200 mg dose of TC or Placebo (PLA). Anchored VAS questionnaires were used to detect subjective changes in various aspects of physical and mental energy along with changes in gas exchange and hemodynamic parameters before, and 1, 2, and 3 hours after acute ingestion. Energy, focus, and concentration increased from baseline values in both doses with no dose-response effect. VAS responses in the 200 mg for willingness to exercise, anxiety, motivation to train and libido increased across the measurement period while no such change was seen with the 400 mg dose. After consuming a single 200 mg dose, significant group × time interaction effects were seen for energy, fatigue, and concentration. No changes in resting heart rate, gas exchange, systemic hemodynamics or side effect profiles were noted.

The Combined Effects of Exercise, Diet, and a Multi-Ingredient Dietary Supplement on Body Composition and Adipokine Changes in Overweight Adults

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Abstract

Background: Very few weight and fat loss supplements undergo finished-product research to examine efficacy. The purpose of this study was to determine the effects of an 8-week diet and exercise program on body composition, hip and waist girth, and adipokines and evaluate whether a dietary supplement containing raspberry ketone, capsaicin, caffeine, garlic, and Citrus aurantium enhanced outcomes. Methods: Overweight men and women completed this randomized, placebo-controlled, double-blind study. Participants consumed 4 capsules/d of supplement (EXP; n = 18) or placebo (PLA; n = 18). Participants underwent 8 weeks of daily supplementation, calorie restriction (500 kcal < RMR [resting metabolic rate] × 1.2), and supervised progressive exercise training 3 times a week. Body composition, girth, and adipokines were assessed at baseline and postintervention (T1 and T2). Results: Significant decreases in weight (−2.6 ± 0.57 kg, $p < 0.001$), fat mass (−1.8 ± 0.20 kg; $p < 0.001$), and percentage body fat (−3.7% ± 0.29%, $p < 0.001$) and a significant increase in lean body mass (LBM; 1.5 ± 0.26 kg; $p < 0.001$) were seen from T1 to T2 in both groups. For men, only those in the EXP group increased LBM from T1 to T2 (1.3 ± 0.38 kg; $p < 0.05$). Hip girth was also reduced, with the women in the EXP group (−10.7 ± 2.15 cm, $p < 0.001$) having a greater reduction. There was a time by group interaction, with significant decreases in leptin ($p < 0.001$) and significant increases in adiponectin ($p < 0.05$) in the EXP group. Conclusions: Significant improvements in adipokines and leptin support the utility of exercise, diet, and fat loss for impacting inflammatory biomarkers. The improvement in adiponectin with EXP may suggest a unique health mechanism.

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REVIEW Open Access

International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine

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Abstract

Creatine is one of the most popular nutritional ergogenic aids for athletes. Studies have consistently shown that creatine supplementation increases intramuscular creatine concentrations which may help explain the observed improvements in high intensity exercise performance leading to greater training adaptations. In addition to athletic and exercise improvement, research has shown that creatine supplementation may enhance post-exercise recovery, injury prevention, thermoregulation, rehabilitation, and concussion and/or spinal cord neuroprotection. Additionally, a number of clinical applications of creatine supplementation have been studied involving neurodegenerative diseases (e.g., muscular dystrophy, Parkinson's, Huntington's disease), diabetes, osteoarthritis, fibromyalgia, aging, brain and heart ischemia, adolescent depression, and pregnancy. These studies provide a large body of evidence that creatine can not only improve exercise performance, but can play a role in preventing and/or reducing the severity of injury, enhancing rehabilitation from injuries, and helping athletes tolerate heavy training loads. Additionally, researchers have identified a number of potentially beneficial clinical uses of creatine supplementation. These studies show that short and long-term supplementation (up to 30 g/day for 5 years) is safe and well-tolerated in healthy individuals and in a number of patient populations ranging from infants to the elderly. Moreover, significant health benefits may be provided by ensuring habitual low dietary creatine ingestion (e.g., 3 g/day) throughout the lifespan. The purpose of this review is to provide an update to the current literature regarding the role and safety of creatine supplementation in exercise, sport, and medicine and to update the position stand of International Society of Sports Nutrition (ISSN).

Keywords: Ergogenic aids, Performance enhancement, Sport nutrition, Athletes, Muscular strength, Muscle power, Clinical applications, Safety, Children, Adolescents

Background

Creatine is one of the most popular nutritional ergogenic aids for athletes. Studies have consistently shown that creatine supplementation increases intramuscular creatine concentrations, can improve exercise performance, and/or improve training adaptations. Research has indicated that creatine supplementation may enhance post-exercise recovery, injury prevention, thermoregulation, rehabilitation, and concussion and/or spinal cord neuroprotection. A number of clinical applications of creatine supplementation have also been studied involving neurodegenerative diseases (e.g., muscular dystrophy, Parkinson's, Huntington's disease), diabetes, osteoarthritis, fibromyalgia, aging, brain and heart ischemia, adolescent depression, and pregnancy. The purpose of this review is to provide an update to the current literature regarding the role and safety of creatine supplementation in exercise, sport, and medicine and to update the position stand of International Society of Sports Nutrition (ISSN) related to creatine supplementation.

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REVIEW Open Access

International Society of Sports Nutrition Position Stand: protein and exercise

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Abstract

Position statement: The International Society of Sports Nutrition (ISSN) provides an objective and critical review related to the intake of protein for healthy, exercising individuals. Based on the current available literature, the position of the Society is as follows:

1) An acute exercise stimulus, particularly resistance exercise, and protein ingestion both stimulate muscle protein synthesis (MPS) and are synergistic when protein consumption occurs before or after resistance exercise.
2) For building muscle mass and for maintaining muscle mass through a positive muscle protein balance, an overall daily protein intake in the range of 1.4–2.0 g protein/kg body weight/day (g/kg/d) is sufficient for most exercising individuals, a value that falls in line within the Acceptable Macronutrient Distribution Range published by the Institute of Medicine for protein.
3) Higher protein intakes (2.3–3.1 g/kg/d) may be needed to maximize the retention of lean body mass in resistance-trained subjects during hypocaloric periods.
4) There is novel evidence that suggests higher protein intakes (>3.0 g/kg/d) may have positive effects on body composition in resistance-trained individuals (i.e., promote loss of fat mass).
5) Recommendations regarding the optimal protein intake per serving for athletes to maximize MPS are mixed and are dependent upon age and recent resistance exercise stimuli. General recommendations are 0.25 g of a high-quality protein per kg of body weight, or an absolute dose of 20–40 g.
6) Acute protein doses should strive to contain 700–3000 mg of leucine and/or a higher relative leucine content, in addition to a balanced array of the essential amino acids (EAAs).
7) These protein doses should ideally be evenly distributed, every 3–4 h, across the day.
8) The optimal time period during which to ingest protein is likely a matter of individual tolerance, since benefits are derived from pre- or post-workout ingestion; however, the anabolic effect of exercise is long-lasting (at least 24 h), but likely diminishes with increasing time post-exercise.

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Journal of the International Society of Sports Nutrition

REVIEW Open Access

International society of sports nutrition position stand: nutrient timing

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Abstract

Position statement: The International Society of Sports Nutrition (ISSN) provides an objective and critical review regarding the timing of macronutrients in reference to healthy, exercising adults and in particular highly trained individuals on exercise performance and body composition. The following points summarize the position of the ISSN:

1. Nutrient timing incorporates the use of methodical planning and eating of whole foods, fortified foods and dietary supplements. The timing of energy intake and the ratio of certain ingested macronutrients may enhance recovery and tissue repair, augment muscle protein synthesis (MPS), and improve mood states following high-volume or intense exercise.
2. Endogenous glycogen stores are maximized by following a high-carbohydrate diet (8–12 g of carbohydrate/kg/day [g/kg/day]); moreover, these stores are depleted most by high volume exercise.
3. If rapid restoration of glycogen is required (< 4 h of recovery time) then the following strategies should be considered:
    a) aggressive carbohydrate refeeding (1.2 g/kg/h) with a preference towards carbohydrate sources that have a high (> 70) glycemic index
    b) the addition of caffeine (3–8 mg/kg)
    c) combining carbohydrates (0.8 g/kg/h) with protein (0.2–0.4 g/kg/h)
4. Extended (> 60 min) bouts of high intensity (> 70% VO_2max) exercise challenge fuel supply and fluid regulation, thus carbohydrate should be consumed at a rate of ~30–60 g of carbohydrate/h in a 6–8% carbohydrate-electrolyte solution (6–12 fluid ounces) every 10–15 min throughout the entire exercise bout, particularly in those exercise bouts that span beyond 70 min. When carbohydrate delivery is inadequate, adding protein may help increase performance, ameliorate muscle damage, promote euglycemia and facilitate glycogen re-synthesis.
5. Carbohydrate ingestion throughout resistance exercise (e.g., 3–6 sets of 8–12 repetition maximum [RM] using multiple exercises targeting all major muscle groups) has been shown to promote euglycemia and higher glycogen stores. Consuming carbohydrate solely or in combination with protein during resistance exercise increases muscle glycogen stores, ameliorates muscle damage, and facilitates greater acute and chronic training adaptations.
6. Meeting the total daily intake of protein, preferably with evenly spaced protein feedings (approximately every 3 h during the day), should be viewed as a primary area of emphasis for exercising individuals.
7. Ingestion of essential amino acids (EAA; approximately 10 g)either in free form or as part of a protein bolus of approximately 20–40 g has been shown to maximally stimulate muscle protein synthesis (MPS).

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RESEARCH ARTICLE Open Access

Effects of an amylopectin and chromium complex on the anabolic response to a suboptimal dose of whey protein

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Abstract

Background: Previous research has demonstrated the permissive effect of insulin on muscle protein kinetics, and the enhanced insulin sensitizing effect of chromium. In the presence of adequate whole protein and/or essential amino acids (EAA), insulin has a stimulatory effect on muscle protein synthesis, whereas in conditions of lower blood EAA concentrations, insulin has an inhibitory effect on protein breakdown. In this study, we determined the effect of an amylopectin/chromium (ACr) complex on changes in plasma concentrations of EAA, insulin, glucose, and the fractional rate of muscle protein synthesis (FSR).

Methods: Using a double-blind, cross-over design, ten subjects (six men, four women) consumed 6 g whey protein + 2 g of the amylopectin-chromium complex (WPACr) or 6 g whey protein (WP) after an overnight fast. FSR was measured using a primed, continuous infusion of ring-d_5-phenylalanine with serial muscle biopsies performed at 2, 4, and 8 h. Plasma EAA and insulin were assayed by ion-exchange chromatography and ELISA, respectively. After the biopsy at 4 h, subjects ingested their respective supplement, completed eight sets of bilateral isotonic leg extensions at 80% of their estimated 1-RM, and a final biopsy was obtained 4 h later.

Results: Both trials increased EAA similarly, with peak levels noted 30 min after ingestion. Insulin tended ($p = 0.09$) to be higher in the WPACr trial. Paired samples t-tests using baseline and 4-h post-ingestion FSR data separately for each group revealed significant increases in the WPACr group (+0.0197%/h, $p = 0.0004$) and no difference in the WP group (+0.01215%/hr, $p = 0.23$). Independent t-tests confirmed significant ($p = 0.045$) differences in post-treatment FSR between trials.

Conclusions: These data indicate that the addition of ACr to a 6 g dose of whey protein (WPACr) increases the FSR response beyond what is seen with a suboptimal dose of whey protein alone.

Keywords: Insulin, Chromium, Insulin sensitivity, Muscle protein synthesis, Amino acids

Background

The metabolism of muscle proteins operates in a continual flux whereby post-absorptive periods result in a dominance of muscle protein breakdown and net catabolism [1]. Alternatively, rates of muscle protein synthesis dominate after periods of feeding, particularly when those feedings include an adequate dose of the essential amino acids (EAA) [2–4]. In recent years, attempts to determine the optimal protein dose to maximize muscle protein synthesis have been undertaken. A number of studies have indicated a maximal anabolic response of muscle protein synthesis. Moore in 2009 first examined the differential ability of titrated doses of egg protein (0, 5, 10, 20 and 40 g) to stimulate muscle protein synthesis (MPS) rates and concluded that a 20-g dose resulted in a maximal response [5]. Yang and colleagues used identical whey protein doses as the Moore study in elderly men and found that after exercise a 40-g dose elicited a maximal response [6]. Wiitard and investigators examined progressive doses of whey protein (up 40 g)

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BMC Complementary and Alternative Medicine

RESEARCH ARTICLE Open Access

Effects of dietary supplementation with a standardized aqueous extract of *Terminalia chebula* fruit (AyuFlex®) on joint mobility, comfort, and functional capacity in healthy overweight subjects: a randomized placebo-controlled clinical trial

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Abstract

Background: Joint and connective tissue integrity, comfort and function are paramount to optimal performance in exercise, recreational and occupational activities. The fruit of *Terminalia chebula* has been used extensively in various traditional health systems for different ailments, with additional preclinical and clinical data demonstrating antioxidant and anti-inflammatory potential. The aim of this study was to evaluate the effects of a standardized aqueous extract of *Terminalia chebula* fruit (AyuFlex®) dietary supplementation on joint mobility, comfort, and functional capacity in healthy overweight subjects.

Methods: One-hundred and five (105) overweight, apparently healthy male and female subjects (35–70 years of age) were pre-screened and randomized to one of three groups for 84 days: placebo, AyuFlex1 (250 mg twice daily) or AyuFlex2 (500 mg twice daily) in a randomized, double-blind, placebo-controlled design. A two-week placebo lead-in period was used to improve data quality/validity. All subjects had no knee joint discomfort at rest, but experienced knee joint discomfort only with activity/exercise of at least 30 on 100 mm Visual Analog Scale (VAS). Primary outcome measures included symptoms of joint health and function as measured by modified-Knee Injury & Osteoarthritis Outcomes Score (mKOOS) global & modified-Western Ontario and McMaster Universities Arthritis Index (mWOMAC) subscales (discomfort, stiffness and function). Secondary outcomes included VAS questionnaires on overall/whole-body joint health, low back health, knee mobility, willingness and ability to exercise, 6-min walk test for distance and range of motion (ROM) of pain-free knee flexion/extension. Tertiary outcome measures included inflammatory (high sensitivity C-reactive protein (hsCRP), tumor necrosis factor (TNF)-α) and extracellular matrix (ECM)/Connective Tissue (COMP) biomarkers, and safety (vital signs and blood markers) & tolerability (Adverse Event (AE)/ side effect profiles).
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A Prospective Evaluation of a Commercial Weight Loss Program on Body Weight and Body Circumferences in Overweight/Obese Men and Women

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Abstract

Background Many commercial diet plans are readily available to the weight conscious consumer; however, evidence on their effectiveness for promoting weight loss is often lacking. In three previous short term (one- and two-week) studies examining the effects of Nutrisystem ® weight loss plans on changes in body weight and other anthropometric indices, subjects observed an average weight loss of ~5 lb after one week with an aggressive 1000 kcal/d diet (Nutrisystem Fast Five™), and similar weight loss when subjects followed varying combinations of less aggressive Nutrisystem ® plans (1200 – 1500 kcal/d) for two weeks. These findings are of interest because previous research has shown that initial weight loss during the first few weeks of treatment is associated with better long-term weight loss outcomes (Handjieva-Darlenska, 2010; Fabricatore, 2009; Craighead, 1981; Dubbert, 1984; Finer, 2006; Wadden, 1992; Dhurandhar, 1999; Hansen, 2001; Hollis, 2008). Objective The primary purpose of this randomized, parallel group study was to determine changes in body weight and body circumferences when generally healthy overweight and obese adults followed the Nutrisystem ® program vs. a self-directed diet (i.e. Dietary Approaches to Stop Hypertension, DASH) for 4 weeks. Methods 84 overweight/obese adults (n = 57 women, n = 27 men) with a mean (± standard error of the mean) age of 40.5 ± 12.1 y, body weight of 95.0 ± 17.1 kg (~210 pounds), and body mass index (BMI) of 34.1 ± 4.9 kg/m ² were stratified by age and BMI prior to being randomized into the Nutrisystem ® program or DASH program. Targets for daily energy intake for each program were 1200 kcal/day for women and 1500 kcal/day for men, except for the first week of the intervention where all groups consumed 1000 kcal/day. Subjects with BMI > 40 added 200 additional kcal to their diet each day through grocery food options. Subjects were required to maintain their current activities of daily living and were encouraged to engage in three, 10-minute exercise sessions per day. Changes in body weight and body circumferences (chest, arm, waist, hip, thigh) were examined in a Per Protocol sample (N=75) using repeated measures analysis of covariance. Statistical significance was accepted at p <0.05. Results Both programs resulted in significant reductions in body weight and body circumference parameters. Subjects on the Nutrisystem ® program lost approximately twice as much weight during weeks 1–4 than subjects on the DASH diet (all values p <0.0005). Subjects on the Nutrisystem ® program lost significantly more total body circumference (i.e. sum of chest, arm, waist, hip, thigh) than subjects on the DASH diet during weeks 2, 3 and 4 (all values p ≤0.002). Across all four weeks and both genders combined, subjects on the Nutrisystem ® program lost significantly more waist circumference than subjects on the DASH diet (p <0.05). Subjects on the Nutrisystem ® program lost significantly more hip and chest circumference than subjects on the DASH diet during weeks 2, 3 and 4 (all values p <0.05). Conclusions Within the framework of the current experimental design, the Nutrisystem ® program is superior to the self-directed DASH diet for weight loss and reductions in waist, hip, chest, and total body (i.e. sum of chest, arm, waist, hip, thigh) circumferences over a 4-week period. Support or Funding Information This study was sponsored by Nutrisystem Inc and conducted by an independent contract research organization (The Center for Applied Health Sciences, Stow, OH). Statistical analyses were completed by an independent 3 rd party statistician (Omega Statistics, Murrieta, CA). Week 1 Week 2 Week 3 Week 4 Body Weight (lb) NS −5.50 ± 0.4 * −7.57 ± 0.5 * −9.75 ± 0.6 * −11.63 ± 0.7 * 95% CI (−6.25, −4.75) (−8.51, −6.62) (−11.00, −8.49) (−13.11, −10.19) DASH −2.73 ± 0.4 −4.38 ± 0.5 −5.37 ± 0.7 −5.94 ± 0.8 95% CI (−3.52, −1.92) (−5.39, −3.37) (−6.71, −4.05) (−7.50, −4.38) Total Body Circumference (inches) NS −3.31 ± 0.6 −5.60 ± 0.6 * −6.38 ± 0.6 * −8.00 ± 0.7 * 95% CI (−4.55, −2.09) (−6.72, −4.49) (−7.67, −5.09) (−9.33, −6.68) DASH −2.05 ± 0.7 −2.61 ± 0.6 −3.26 ± 0.7 −3.75 ± 0.7 95% CI (−3.37, −0.73) (−3.80, −1.41) (−4.64, −1.89) (−5.07, −2.23) Waist (inches) NS −1.10 ± 1.5 −1.59 ± 1.9 −1.82 ± 1.8 −2.40 ± 1.9 ^ 95% CI (−1.68, −0.53) (−2.18, −1.00) (−2.41, −1.23) (−3.00, −1.80) DASH −0.48 ± 1.5 −0.79 ± 1.2 −1.12 ± 1.8 −1.68 ± 2.0 95% CI (−1.00, 0.03) (−1.24, −0.35) (−1.76, −0.49) (−2.38, −0.99) Values reported are change from baseline ± standard error of the mean. statistically significant difference between groups at corresponding weekly time point. statistically significant main effect over time (i.e. group difference). 95% CI = 95% confidence intervals for change from baseline.

A Prospective Evaluation of a Commercial Weight Loss Program in Overweight/Obese Adults

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Abstract

Objective As part of a larger clinical trial comparing the effects of the Nutrisystem ® program on changes in body weight and body circumferences (i.e. body size) vs. a self-directed diet (i.e. Dietary Approaches to Stop Hypertension, DASH), the primary purpose of this prospective sub-study was to determine if healthy overweight and obese men and women responded differently to the Nutrisystem ® program by examining within-group changes during 12 weeks of caloric restriction. Methods Forty (40) overweight/obese adults (mean ± standard error: body weight of 94.27 ± 19.15 kg and a Body Mass Index of 34.05 ± 4.89 kg/m ^{2}) entered the study. Participants started the study following a 1000 calorie a day plan for this first week and then increased to 1200 or 1500 calories per day for women and men, respectively, for the remaining 11 weeks. Subjects who had a BMI > 40 kg/m ^{2} were also given an extra 200 calories per day through grocery food options. For the duration of the study, subjects were required to maintain their normal daily habits and to engage in a cumulative 30 minutes of physical activity per day. Changes in body weight and body size (chest, arm, waist, hip, thigh) were examined in a Per Protocol sample using repeated measures analysis of covariance. Statistical significance was accepted at $p < 0.05$. Results As displayed in the table below, women and men both lost significant amounts of body weight each week ($p < 0.05$), with men losing more weight than women. The difference between sexes was significant at week 4 (−15.15 ± 2.02 vs. −10.12 ± 0.90 lb, $p < 0.048$), week 8 (−24.44 ± 2.68 vs. −14.19 ± 1.12 lb, $p < 0.003$) and week 12 (−27.94 ± 4.00 vs. −16.74 ± 1.67 lb, $p < 0.02$). In addition, both men and women reduced body size throughout the study in a comparable fashion. At week 8, the body size reduction for men was significantly greater than women (−14.67 ± 1.73 vs. −9.11 ± 0.81 inches, $p < 0.008$), while a trend was noted at week 12 (−15.94 ± 2.11 vs. −11.49 ± 0.99 inches, $p < 0.08$). Conclusion In our sample of overweight/obese men and women who followed the Nutrisystem ® program for 12 weeks, significant reductions in body weight and body size occurred. Consistent with prior research, weight loss was greater in men as compared to women, though significant for both sexes. Support or Funding Information This study was sponsored by Nutrisystem Inc and conducted by an independent contract research organization (The Center for Applied Health Sciences, Stow, OH). Statistical analyses were completed by an independent 3 rd party statistician (Omega Statistics, Murrieta, CA). This study was sponsored by Nutrisystem Inc and conducted by an independent contract research organization (The Center for Applied Health Science, Stow, OH). Statistical analyses were completed by and independent 3 rd party statistician (Omega Statistics, Murrieta, CA). Data on file. Week 1 Week 4 Week 8 Week 12 Body Weight (lb) Women −4.88 ± 1.10 −10.12 ± 0.90 −14.19 ± 1.12 −16.74 ± 1.67 95% CI (−5.85, −3.89) (−11.92, −8.29) (−16.45, −11.92) (−20.13, −13.37) Men −6.86 ± 1.10 −15.15 ± 2.02 * 24.44 ± 2.68 * −27.94 ± 4.00 * 95% CI (−9.10, −4.64) (−19.29, −11.02) (−29.89, −18.98) (−36.08, −19.77) Total Body Circumference ^ (inches) Women −2.71 ± 0.67 −7.58 ± 0.75 −9.11 ± 0.81 −11.49 ± 0.99 95% CI (−4.08, −1.34) (−9.11, −6.05) (−10.77, −7.44) (−13.52, −9.46) Men −5.12 ±1.34 −8.81 ± 1.50 −14.67 ± 1.73 * −15.94 ± 2.11 # 95% CI (−8.37, −2.40) (−11.85, −5.78) (−18.20, −11.15) (−20.22, −11.64) Values reported are change from baseline ± standard error of the mean. statistically significant difference ($p < 0.05$) between men and women at corresponding weekly time point. a priori statistical trend ($p < 0.08$). sum of chest, arm, waist, hip, thigh. 95% CI = 95% confidence intervals for change from baseline.

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Article

Effects of an Aqueous Extract of *Withania somnifera* on Strength Training Adaptations and Recovery: The STAR Trial

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Abstract: *Withania somnifera* (Ashwagandha) is an Ayurvedic herb categorized as having "rasayana" (rejuvenator), longevity, and revitalizing properties. Sensoril®is a standardized aqueous extract of the roots and leaves of *Withania somnifera*. **Purpose:** To examine the impact of Sensoril® supplementation on strength training adaptations. **Methods:** Recreationally active men (26.5 ± 6.4 years, 181 ± 6.8 cm, 86.9 ± 12.5 kg, 24.5 ± 6.6% fat) were randomized in a double-blind fashion to placebo (PLA, $n = 19$) or 500 mg/d Sensoril® (S500, $n = 19$). Body composition (DEXA), muscular strength, power, and endurance, 7.5 km cycling time trial, and clinical blood chemistries were measured at baseline and after 12 weeks of supplementation and training. Subjects were required to maintain their normal dietary habits and to follow a specific, progressive overload resistance-training program (4-day/week, upper body/lower body split). 2 × 2 mixed factorial ANOVA was used for analysis and statistical significance was set *a priori* at $p \leq 0.05$. **Results:** Gains in 1-RM squat (S500: +19.1 ± 13.0 kg vs. PLA +10.0 ± 6.2 kg, $p = 0.009$) and bench press (S500: +12.8 ± 8.2 kg vs. PLA: +8.0 ± 6.0 kg, $p = 0.048$) were significantly greater in S500. Changes in DEXA-derived android/gynoid ratio (S500: +0.0 ± 0.14 vs. PLA: +0.09 ± 0.1, $p = 0.03$) also favored S500. No other between-group differences were found for body composition, visual analog scales for recovery and affect, or systemic hemodynamics, however, only the S500 group experienced statistically significant improvements in average squat power, peak bench press power, 7.5 km time trial performance, and perceived recovery scores. Clinical chemistry analysis indicated a slight polycythemia effect in PLA, with no other statistical or clinically relevant changes being noted. **Conclusions:** A 500 mg dose of an aqueous extract of Ashwagandha improves upper and lower-body strength, supports a favorable distribution of body mass, and was well tolerated clinically in recreationally active men over a 12-week resistance training and supplementation period.

Keywords: Ashwaganhda; Ayurvedic; resistance training; exercise; placebo; strength; DEXA

1. Introduction

Withania somnifera (ashwagandha) is an Ayurvedic herb belonging to the Solanaceae family. Previous reports have categorized *Withania somnifera* as having "rasayana" (rejuvenator), longevity, and revitalizing properties [1–3], but these reports have yet to be fully substantiated using well-controlled, scientific investigations. Ashwagandha has previously been studied in therapeutic areas surrounding cognitive, mood, psychomotor, joint health [2], antioxidation [3], and anti-inflammation. While a firm

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Article

Proprietary Milk Protein Concentrate Reduces Joint Discomfort While Improving Exercise Performance in Non-Osteoarthritic Individuals

Tim N. Ziegenfuss [1,*], Chad M. Kerksick [2], A. William Kedia [1], Jennifer Sandrock [1], Betsy Raub [1] and Hector L. Lopez [1]

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Abstract: Milk and dairy products are known to contain various bioactives with potential anti-inflammatory and immune modulating effects. Previous research has indicated that milk produced from hyperimmunized cows provided meaningful health benefits to individuals suffering from varying degrees of osteoarthritis and rheumatoid arthritis. **PURPOSE:** To examine the impact of a proprietary milk protein concentrate on joint discomfort and physical function, exercise performance, quality of life and various measures of affect. **METHODS:** Non-osteoarthritic men (42.5 ± 8.9 years, 176.7 ± 6.7 cm, 89.9 ± 11.5 kg, 28.8 ± 3.5 kg/m^2, n = 30) and women (46.4 ± 9.6 years, 163.1 ± 8.2 cm, 72.2 ± 13.1 kg, 27.2 ± 5.3 kg/m^2, n = 28) with mild to moderate knee pain during physical activity were randomized in a double-blind, placebo-controlled fashion to consume daily either a placebo (PLA) or a proprietary milk protein concentrate (MP) for a period of 8 weeks. Participants completed a functional capacity test pre and post-supplementation and completed visual analog scales (VAS), a 6-min walking test, WOMAC and profile of mood states (POMS) to assess changes in joint health, discomfort, physical function, exercise performance and affect. Mixed factorial ANOVA was used for all statistical analysis and significance was set *a priori* at $p \leq 0.05$. **RESULTS:** Distance covered in the 6-min walking significantly improved 9% in MP versus 2% in PLA (mean difference: 110 ± 43 m, p = 0.012) in addition to 11 WOMAC components and 5 VAS reflective of MP improving joint health, discomfort and joint stability (all $p < 0.05$ vs. PLA). Additionally, MP also improved overall perceptions of neck and back health compared to PLA. Serum and whole blood indicators of clinical safety remained within normal ranges throughout the study. **CONCLUSIONS:** In comparison to placebo, daily doses of proprietary milk protein concentrate yielded improvements in several components of the WOMAC, multiple visual analog scales indicative of joint health and stability, discomfort and pain, as well as significant improvements in distance covered during a 6-min walking test. Supplementation was well tolerated with no significant changes in whole-blood or serum markers of clinical safety.

Keywords: milk; protein; immunity; inflammation; concentrate; joint health; osteoarthritis

1. Introduction

According to the results of a National Health Interview Survey released in 2015, approximately 91 million people have some form of arthritis [1]. Of the different forms of arthritis, osteoarthritis is the most common joint disorder in the United States with approximately 10% of men and 13%

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Research Paper

Resistance training increases muscle NAD+ and NADH concentrations as well as NAMPT protein levels and global sirtuin activity in middle-aged, overweight, untrained individuals

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ABSTRACT

We examined if resistance training affected muscle NAD+ and NADH concentrations as well as nicotinamide phosphoribosyltransferase (NAMPT) protein levels and sirtuin (SIRT) activity markers in middle-aged, untrained (MA) individuals. MA participants (59±4 years old; n=16) completed 10 weeks of full-body resistance training (2 d/wk). Body composition, knee extensor strength, and vastus lateralis muscle biopsies were obtained prior to training (Pre) and 72 hours following the last training bout (Post). Data from trained college-aged men (22±3 years old, training age: 6±2 years old; n=15) were also obtained for comparative purposes. Muscle NAD+ (+127%, p<0.001), NADH (+99%, p=0.002), global SIRT activity (+13%, p=0.036), and NAMPT protein (+15%, p=0.014) increased from Pre to Post in MA participants. Additionally, Pre muscle NAD+ and NADH in MA participants were lower than college-aged participants (p<0.05), whereas Post values were similar between cohorts (p>0.10). Interestingly, muscle citrate synthase activity levels (i.e., mitochondrial density) increased in MA participants from Pre to Post (+183%, p<0.001), and this increase was significantly associated with increases in muscle NAD+ (r^2=0.592, p=0.001). In summary, muscle NAD+, NADH, and global SIRT activity are positively affected by resistance training in middle-aged, untrained individuals. Whether these adaptations facilitated mitochondrial biogenesis remains to be determined.

INTRODUCTION

Nicotinamide adenine dinucleotide (NAD^+) is a metabolite involved in numerous biochemical reactions. In particular, NAD^+ is involved with electron transport where the reduced form (NADH) transfers electrons to other substrates and intermediates of metabolism. There is enthusiasm surrounding the role that tissue NAD^+ concentrations play in the aging process (reviewed in [1–3]), and researchers have determined skeletal muscle NAD^+ concentrations are lower in older rodents and humans [4–6]. These findings have led some to suggest that the age-associated loss in skeletal muscle NAD^+ levels contributes to mitochondrial dysfunction (reviewed in [7]). Multiple enzymes act to catalyze the formation of NAD^+ from the amino acid

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Effects of Hemp Extract on Markers of Wellness, Stress Resilience, Recovery and Clinical Biomarkers of Safety in Overweight, But Otherwise Healthy Subjects

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ABSTRACT

We determined the effects of a commercially available, GRAS (Generally Recognized As Safe) by independent conclusion, CBD-containing hemp oil extract on stress resilience, perceived recovery, mood, affect, body composition, and clinical safety markers in healthy human subjects.

Methods: Using a randomized, placebo-controlled, double-blind design, 65 overweight, but otherwise healthy men and women (35.2 ± 11.4 years, 28.5 ± 3.3 kg/m^2) ingested either Hemp Oil Extract [Hemp, 60 mg/d PlusCBD™ Extra Strength Hemp Extract Oil (15 mg hemp-derived CBD)] or a placebo (PLA) every day for six weeks while continuing to follow their normal diet and physical activity patterns. Outcome variables included changes in stress resilience, a 14-item panel of various psychometric parameters, heart-rate variability, plasma chromogranin A, body composition, and general markers of health. Data were analyzed using mixed factorial ANOVA, t-tests with 95% confidence intervals, and effect sizes (ES).

Results: HDL cholesterol significantly improved in the Hemp group ($p = 0.004$; ES = 0.75). No other statistically significant group x time interaction effects were observed. Statistical tendencies for between-group differences were found for 'I Get Pleasure From Life' ($p = 0.06$, ES = 0.48) and 'Ability to Cope with Stress' ($p = 0.07$, ES = 0.46). Sleep quality (Hemp, $p = 0.005$, ES = 0.54) and sleep quantity (Hemp, $p = 0.01$, ES = 0.58) exhibited significant within-group changes. All values for hepato-renal function, cardiovascular health, fasting blood lipids, and whole blood cell counts remained within normal clinical limits with no between-group differences over time being identified.

Conclusions: Hemp supplementation improved HDL cholesterol, tended to support psychometric measures of perceived sleep, stress response, and perceived life pleasure and was well tolerated with no clinically relevant safety concerns. Registered at clinicaltrials.gov: NCT04294706.

KEYWORDS

affect; body composition; cannabis; CBD; endocannabinoid; health; marijuana; mood; phytocannabinoids; supplementation

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JEN

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Effects of Purple Tea on Muscle Hyperemia and Oxygenation, Serum Markers of Nitric Oxide Production and Muscle Damage, and Exercise Performance

Original Research

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Abstract

Introduction: Purple tea exhibits a unique composition of chemical constituents that may exert favorable outcomes related to recovery from muscle damage, improvements in blood flow, perfusion, and recovery. The purpose of this study was to examine the impact of a brief oral dosing period of purple tea in exercising humans after stressful, damaging exercise.

Methods: Using a randomized, placebo-controlled, double-blind, crossover study design, 30 healthy men (33.5 ± 11.4 years, 178.4 ± 7.6 cm, 92.5 ± 13.3 kg) completed an eight day supplementation regimen consisting of either a maltodextrin placebo or 100 mg of purple tea extract (PurpleForce™, Oryza Oil & Fat, Ltd.) interspersed with a two week washout period. After five and eight days of supplementation, changes in muscle oxygenation, body composition, reactive hyperemia, visual analog responses, exercise performance, and muscle damage markers were assessed. Data were analyzed using mixed factorial ANOVA, t-tests with 95% confidence intervals, and effect sizes (ES).

Results: Lactate dehydrogenase was significantly reduced ($p = 0.04$) in PT in comparison to PLA after eight days of supplementation and exercise performance challenge. In comparison to PT, arm circumference increased in PLA after five days of supplementation ($p=0.04$) and tended to be greater after eight days ($p=0.06$). Significantly greater decreases in impedance were observed in PT ($p=0.02$) while between-group differences in oxygen saturation post-leg extension exercise were greater in PT 30s into recovery ($p=0.04$) and tended to be greater 60s after recovery ($p=0.06$). Total bench press repetitions completed were greater in purple tea than PLA ($p = 0.001$). Total leg extension repetitions completed tended to be different between groups ($p=0.09$) while the total number of repetitions completed in purple tea increased from day five to day eight ($p<0.001$) with no change in PLA ($p=0.37$). No between-group changes were observed in the visual analog scales; however, only the PT condition experienced a significant improvement in Willingness to Exercise ($p=0.02$).

Conclusions: Acute supplementation of PT decreased lactate dehydrogenase, a marker of muscle damage, while also improving lower body muscle endurance performance.

Key Words: blood flow, dietary supplement, nitrates

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Journal of the International Society of Sports Nutrition

REVIEW Open Access

International Society of Sports Nutrition position stand: sodium bicarbonate and exercise performance

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Abstract

Based on a comprehensive review and critical analysis of the literature regarding the effects of sodium bicarbonate supplementation on exercise performance, conducted by experts in the field and selected members of the International Society of Sports Nutrition (ISSN), the following conclusions represent the official Position of the Society:

1. Supplementation with sodium bicarbonate (doses from 0.2 to 0.5 g/kg) improves performance in muscular endurance activities, various combat sports, including boxing, judo, karate, taekwondo, and wrestling, and in high-intensity cycling, running, swimming, and rowing. The ergogenic effects of sodium bicarbonate are mostly established for exercise tasks of high-intensity that last between 30 s and 12 min.
2. Sodium bicarbonate improves performance in single- and multiple-bout exercise.
3. Sodium bicarbonate improves exercise performance in both men and women.
4. For single-dose supplementation protocols, 0.2 g/kg of sodium bicarbonate seems to be the minimum dose required to experience improvements in exercise performance. The optimal dose of sodium bicarbonate dose for ergogenic effects seems to be 0.3 g/kg. Higher doses (e.g., 0.4 or 0.5 g/kg) may not be required in single-dose supplementation protocols, because they do not provide additional benefits (compared with 0.3 g/kg) and are associated with a higher incidence and severity of adverse side-effects.
5. For single-dose supplementation protocols, the recommended timing of sodium bicarbonate ingestion is between 60 and 180 min before exercise or competition.
6. Multiple-day protocols of sodium bicarbonate supplementation can be effective in improving exercise performance. The duration of these protocols is generally between 3 and 7 days before the exercise test, and a total sodium bicarbonate dose of 0.4 or 0.5 g/kg per day produces ergogenic effects. The total daily dose is commonly divided into smaller doses, ingested at multiple points throughout the day (e.g., 0.1 to 0.2 g/kg of sodium bicarbonate consumed at breakfast, lunch, and dinner). The benefit of multiple-day protocols is that they could help reduce the risk of sodium bicarbonate-induced side-effects on the day of competition.

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Journal of the International Society of Sports Nutrition

REVIEW Open Access

Common questions and misconceptions about creatine supplementation: what does the scientific evidence really show?

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Abstract

Supplementing with creatine is very popular amongst athletes and exercising individuals for improving muscle mass, performance and recovery. Accumulating evidence also suggests that creatine supplementation produces a variety of beneficial effects in older and patient populations. Furthermore, evidence-based research shows that creatine supplementation is relatively well tolerated, especially at recommended dosages (i.e. 3-5 g/day or 0.1 g/kg of body mass/day). Although there are over 500 peer-refereed publications involving creatine supplementation, it is somewhat surprising that questions regarding the efficacy and safety of creatine still remain. These include, but are not limited to: 1. Does creatine lead to water retention? 2. Is creatine an anabolic steroid? 3. Does creatine cause kidney damage/renal dysfunction? 4. Does creatine cause hair loss / baldness? 5. Does creatine lead to dehydration and muscle cramping? 6. Is creatine harmful for children and adolescents? 7. Does creatine increase fat mass? 8. Is a creatine 'loading-phase' required? 9. Is creatine beneficial for older adults? 10. Is creatine only useful for resistance / power type activities? 11. Is creatine only effective for males? 12. Are other forms of creatine similar or superior to monohydrate and is creatine stable in solutions/beverages? To answer these questions, an internationally renowned team of research experts was formed to perform an evidence-based scientific evaluation of the literature regarding creatine supplementation.

Keywords: Social Media, Anecdotal, Research, Adverse Effects, Safety

Introduction

Creatine (methylguanidine-acetic acid) is endogenously formed from reactions involving the amino acids arginine, glycine and methionine in the kidneys and liver [1]. Exogenously, creatine is primarily consumed from meat and/or as a dietary supplement. According to PubMed (archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine) there are over 500 peer-refereed publications involving various aspects of creatine supplementation. Based on the enormous popularity of creatine supplementation, the International Society of Sports Nutrition (ISSN) published an updated position stand in 2017 on the safety and efficacy of creatine supplementation in exercise, sport, and medicine [2]. This comprehensive paper provided an evidence-based review of the literature examining the effects of creatine supplementation on performance, recovery, injury prevention, exercise tolerance and rehabilitation, neuroprotection, aging, clinical and disease state populations, and pregnancy. Importantly, the safety profile of creatine was also reviewed. As of September 1, 2020, the paper has been viewed 179,000 times and cited 100 times (according to Web of Science). Furthermore, Altmetric data indicates

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JEN

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Effects of TeaCrine® (Theacrine), Dynamine™ (Methylliberine), and Caffeine on Gamer Psychomotor Performance in a First-Person Shooter Video Game Scenario

Original Research

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Abstract

Purpose: To compare the effects of purported cognitive enhancing dietary bioactive ingredients on subjective and objective measures of cognitive and motor performance during a first-person shooter video game.

Methods: Using a placebo-controlled crossover design, nine healthy men (23.4±5.7 yr, 178.9±5.8cm, 86.0±17.1kg) completed four 20-minute gaming sessions designed to assess cognitive, motor, and perceptual skills via artificial intelligence-driven battery of tasks (Aim Lab). Participants ingested either a placebo (PL), caffeine (CAFF), or caffeine + methylliberine (Dynamine™) + theacrine (TeaCrine®) (CMT). Before and after each gaming session participants rated various feelings of affect. Data were analyzed using mixed factorial ANOVA, bootstrapping post-hoc tests with 95% confidence intervals, and effect sizes.

Results: Compared to PL, self-assessed performance was significantly increased in CMT vs. PL ($p=0.035$) and self-assessed jitteriness was increased by CAFF vs. PL ($p=0.043$). CMT was associated with a greater improvement of participants' visuo-spatial working memory from baseline vs. PL ($p=0.04$) and CAFF ($p=0.033$). CAFF had a greater decrease in reaction time for false alarms (indicating diminished cognitive control) from baseline vs. PL ($p=0.002$) and CMT ($p=0.001$) and a greater increase for time on target tracking vs. PL ($p=0.008$) and CMT ($p=0.047$). Compared to PL, CMT was associated with a greater decrease in median kill time (indicating improved speed) ($p=0.017$). Compared to PL, systolic blood pressure was significantly increased by CAFF ($p=0.025$) and CMT ($p=0.020$) but remained within normal limits.

Conclusions: Acute CMT supplementation improved cognitive and motor abilities in recreational gamers. The addition of theacrine and methylliberine to caffeine may lessen some undesirable effects of isolated caffeine ingestion on cognitive control and jitteriness.

Key Words: esports, nootropics, cognitive workload

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Introduction

Video games in the US are a $67-billion-dollar industry with an average growth of 14.7% over the past five years (2015-2020)[1]. The worldwide esports market brought in just over 1 billion dollars in 2020[2]. The popularity among individuals playing games has been on the rise with 64% of adults over the age of 18 playing video games and 75% of households having at least one video game player currently[3].

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Effects of a Single Dose of BURN-XT™ on Resting Metabolic Rate, Substrate Oxidation, and Various Indices of Affect

Original Research

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Abstract

Introduction: Many consumers use dietary supplements in the hopes of increasing energy and burning more calories, which if sustained over time may help accelerate weight loss. The purpose of this clinical trial was to investigate the effects of an over-the-counter thermogenic supplement called Burn-XT™ (BXT) on metabolic rate, substrate oxidation, and various psychometric indices of affect that impact weight management.

Methods: Using a double-blind, placebo-controlled, cross-over design, 16 women and 10 men (29.3 ± 7.3 yr, 169.4 ± 8.6 cm, 75.5 ± 14.3 kg) underwent two testing sessions: placebo (PL) and BXT. Seated metabolic rate and substrate oxidation, vital signs, and anchored visual analogue scale (VAS) assessments of energy, mood, motivation, focus, fatigue, concentration, and appetite were made before supplementation and hourly for three hours post-ingestion. Two-factor (2x4) factorial ANOVAs and paired sample t-tests (corrected for multiple comparisons) were used for analyses.

Results: Significant increases in metabolic rate (oxygen consumption) were noted at 60 minutes in BXT (+11.9 mL O2/min) vs. PL (-2.5 mL O2/min), $p = 0.004$, $d = -0.74$. Only BXT increased metabolic rate compared to baseline at 60 minutes (+11.9 mL O2/min, $p = 0.021$, $d = -0.53$) and 120 minutes (+12.1 mL O2/min, $p = 0.019$, $d = -0.54$). The AUC for resting energy expenditure increased more in BXT vs. PL ($p = 0.007$, $d = -0.57$). VAS detected significant improvements in energy, mood, focus, and concentration for BXT vs. PL at 120 and 180 minutes (all $p < 0.05$, $d = -0.58$ to -0.68). In all cases, within-group changes from baseline for these VAS parameters were significant (all $p < 0.05$, $d = -0.76$ to -1.38) in BXT but not in PL. No within or between group differences in appetite, substrate oxidation, or heart rate were noted. Small (~3-4 mm Hg), but statistically significant ($p < 0.05$, $d = -0.51$ to -0.69) increases in diastolic blood pressure were noted in BXT at 60, 120, and 180 min vs. PL; and in systolic blood pressure at 60 min vs. PL. In all cases, values remained within normal clinical hemodynamic ranges.

Conclusions: A single dose of BXT safely increased metabolic rate, energy, mood, focus, and concentration. Given that these factors are known to favorably impact weight management, future studies should determine whether daily supplementation with BXT reduces body weight and improves body composition.

Key Words: thermogenic, metabolism, resting energy expenditure

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physiologia

MDPI

Article

Enhance Trial: Effects of NAD3® on Hallmarks of Aging and Clinical Endpoints of Health in Middle Aged Adults: A Subset Analysis Focused on Blood Cell NAD$^+$ Concentrations and Lipid Metabolism

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Abstract: Limited pre-clinical and clinical data suggest theacrine or theacrine-based supplements modulate biological processes associated with lipid metabolism and aging. Herein, we sought to examine if 12 weeks of daily supplementation with a theacrine-based supplement (termed NAD3®; 312 mg of combined *Wasabia japonica* freeze-dried rhizome standardized for isothicyantes, theacrine, and copper (I)niacin chelate) altered serum lipids as well as select nicotinamide adenine dinucleotide (NAD$^+$)-associated metabolites in peripheral blood mononuclear cells (PBMCs). Twenty-eight participants (12 males, 16 females) were randomly assigned to receive either NAD3 (n = 13; age: 52 ± 7 years old, body mass index: 29.0 ± 5.0 kg/m^2) or a cellulose placebo (n = 15; age: 51 ± 5 years old, body mass index: 28.3 ± 3.9 kg/m^2). Blood samples were obtained in mornings following overnight fasts prior to supplementation (Pre) and following the 12-week intervention (Post). PBMCs were freshly isolated and prepared for targeted NAD$^+$ metabolomics, and serum as well as whole blood was assayed for blood lipids and other safety markers through a commercial laboratory. Significant interactions ($p < 0.05$) were observed for total cholesterol, LDL cholesterol, and LDL: HDL ratio and post hoc analyses indicated these biomarkers significantly decreased with NAD3 supplementation (Pre-to-Post percent decreases were 11.1, 15.2, and −18.9%, respectively). A significant interaction was also observed for PBMC NAD$^+$: NADH values, where levels trended downward from Pre to Post in the CTL group (p = 0.081) and values at Post were greater in NAD3 versus CTL (p = 0.023). No interactions were observed for systolic/diastolic blood pressure, body mass, or blood markers indicative of clinical safety. Although participant numbers were limited, these first-in-human data demonstrate a theacrine-based NAD3 supplement can favorably alter biomarkers of lipid metabolism and cellular NAD$^+$ status. However, the latter data are limited to targeted NAD$^+$ metabolites, and the effects of supplementation on other cellular metabolites or mechanisms related to the observed outcomes need to be further explored.

Keywords: theacrine; NAD$^+$; PBMCs; cholesterol; cardiovascular disease; *Wasabia japonica*; aging; cellular longevity; cytoprotection

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1. Introduction

Aging is associated with cellular senescence and metabolic dysfunction in the liver, and this can result in low-grade inflammation as well as dyslipidemia [1]. Peripheral blood mononuclear cells (PBMCs) produce higher amounts of proinflammatory cytokines with aging [2], and this phenomenon has been termed "inflamm-aging". Nutritional provision

Effects of different types of resistance exercise failure training on the methylation status of genes that drive skeletal muscle hypertrophy

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Abstract

Objective: We sought to determine how one bout of resistance training to failure with either higher repetitions (30FAIL) or lower repetitions (80FAIL) affected the promoter methylation statuses of genes that drive skeletal muscle hypertrophy. Hypotheses: We hypothesized that a bout of 80FAIL training would lead to a more robust hypomethylation of genes that regulate skeletal muscle hypertrophy compared to 30FAIL training. Methods: Eleven previously-trained college-aged men (age: 23 ± 4 years, 11.42 ± 6.38 percent fat, 4 ± 3 years training experience) volunteered for this study. Each participant underwent two training bouts (spaced one week apart) involving either: i) 30FAIL training; 4 sets of back squats and 4 sets of leg extensors to failure at 30% of one-repetition maximum (1RM), or: ii) 80FAIL training; 4 sets of both exercises at 80% of 1RM. Muscle biopsies from the vastus lateralis were collected prior to each bout (PRE), 3 hours following each bout (3hPOST), and 6 hours following each bout (6hPOST). Following the conclusion of the study, tissue was batch-processed for DNA isolation, and DNA was subjected to the Illumina MethylationEPIC array. In an a priori fashion, genes that have been shown to induce skeletal muscle hypertrophy in genetic mouse models were the target of this investigation (Verbrugge et al. Frontiers Physiol, 2019). Results: Total training volume (sets x reps x load) between the 30FAIL and 80FAIL bouts were not significantly different (p= 0.571). Differentially methylated region changes for the following genes from PRE to 3hPOST and PRE to 6hPOST are presented herein: SKI, FST, AKT1, ACVR2B, MSTN, KLF10, RHEB, IGF1, PAPPA, PPARD, IKBKB, FSTL3, ATGR1, UCN3, MCU, JUNB, NCOR1, GPRASP1, GRB10, MMP9, DGKZ, PPARGC1A, SMAD4, LTBP4, BMPR1A, CRTC2, XIAP, DGAT1, THRA, ADRB2, ASB15, CAST, EIF2B5, BDKRB2, TPT1, NR3C1, NR4A1, GNAS, PLD1, CRYM, CAMKK1, YAP1, INHBA, TP53INP2, INHBB, NOL3, and ESR1. Additionally, significant differences between conditions at each time point are highlighted. Conclusions: This study continues to display how different modalities of resistance training affect the skeletal muscle molecular milieu and furthers our scientific understanding of factors that contribute to training adaptations.

International society of sports nutrition position stand: tactical athlete nutrition International society of sports nutrition position stand: tactical athlete nutrition

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Abstract and Figures

This position stand aims to provide an evidence-based summary of the energy and nutritional demands of tactical athletes to promote optimal health and performance while keeping in mind the unique challenges faced due to work schedules, job demands, and austere environments. After a critical analysis of the literature, the following nutritional guidelines represent the position of the International Society of Sports Nutrition (ISSN). GENERAL RECOMMENDATIONS Nutritional considerations should include the provision and timing of adequate calories, macronutrients, and fluid to meet daily needs as well as strategic nutritional supplementation to improve physical, cognitive, and occupational performance outcomes; reduce risk of injury, obesity, and cardiometabolic disease; reduce the potential for a fatal mistake; and promote occupational readiness. MILITARY RECOMMENDATIONS Energy demands should be met by utilizing the Military Dietary Reference Intakes (MDRIs) established and codified in Army Regulation 40-25. Although research is somewhat limited, military personnel may also benefit from caffeine, creatine monohydrate, essential amino acids, protein, omega-3-fatty acids, beta-alanine, and L-tyrosine supplementation, especially during high-stress conditions. FIRST RESPONDER RECOMMENDATIONS Specific energy needs are unknown and may vary depending on occupation-specific tasks. It is likely the general caloric intake and macronutrient guidelines for recreational athletes or the Acceptable Macronutrient Distribution Ranges for the general healthy adult population may benefit first responders. Strategies such as implementing wellness policies, setting up supportive food environments, encouraging healthier food systems, and using community resources to offer evidence-based nutrition classes are inexpensive and potentially meaningful ways to improve physical activity and diet habits. The following provides a more detailed overview of the literature and recommendations for these populations.

Tactical Athlete Stressors.

cells

MDPI

Article

Skeletal Muscle DNA Methylation and mRNA Responses to a Bout of Higher versus Lower Load Resistance Exercise in Previously Trained Men

Casey L. Sexton [1], Joshua S. Godwin [1], Mason C. McIntosh [1], Bradley A. Ruple [1], Shelby C. Osburn [1], Blake R. Hollingsworth [1], Nicholas J. Kontos [1], Philip J. Agostinelli [1], Andreas N. Kavazis [1], Tim N. Ziegenfuss [2], Hector L. Lopez [2], Ryan Smith [3], Kaelin C. Young [1,4], Varun B. Dwaraka [3], Andrew D. Frugé [5], Christopher B. Mobley [1], Adam P. Sharples [6,*] and Michael D. Roberts [1,4,*]

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Abstract: We sought to determine the skeletal muscle genome-wide DNA methylation and mRNA responses to one bout of lower load (LL) versus higher load (HL) resistance exercise. Trained college-aged males (n = 11, 23 ± 4 years old, 4 ± 3 years self-reported training) performed LL or HL bouts to failure separated by one week. The HL bout (i.e., 80 Fail) consisted of four sets of back squats and four sets of leg extensions to failure using 80% of participants estimated one-repetition maximum (i.e., est. 1-RM). The LL bout (i.e., 30 Fail) implemented the same paradigm with 30% of est. 1-RM. Vastus lateralis muscle biopsies were collected before, 3 h, and 6 h after each bout. Muscle DNA and RNA were batch-isolated and analyzed using the 850k Illumina MethylationEPIC array and Clariom S mRNA microarray, respectively. Performed repetitions were significantly greater during the 30 Fail versus 80 Fail ($p < 0.001$), although total training volume (sets × reps × load) was not significantly different between bouts ($p = 0.571$). Regardless of bout, more CpG site methylation changes were observed at 3 h versus 6 h post exercise (239,951 versus 12,419, respectively; $p < 0.01$), and nuclear global ten-eleven translocation (TET) activity, but not global DNA methyltransferase activity, increased 3 h and 6 h following exercise regardless of bout. The percentage of genes significantly altered at the mRNA level that demonstrated opposite DNA methylation patterns was greater 3 h versus 6 h following exercise (~75% versus ~15%, respectively). Moreover, high percentages of genes that were up- or downregulated 6 h following exercise also demonstrated significantly inversed DNA methylation patterns across one or more CpG sites 3 h following exercise (65% and 82%, respectively). While 30 Fail decreased DNA methylation across various promoter regions versus 80 Fail, transcriptome-wide mRNA and bioinformatics indicated that gene expression signatures were largely similar between bouts. Bioinformatics overlay of DNA methylation and mRNA expression data indicated that genes related to "Focal adhesion," "MAPK signaling," and "PI3K-Akt signaling" were significantly affected at the 3 h and 6 h time points, and again this was regardless of bout. In conclusion, extensive molecular profiling suggests that post-exercise alterations in the skeletal muscle DNA methylome and mRNA transcriptome elicited by LL and HL training bouts to failure are largely similar, and this could be related to equal volumes performed between bouts.

Keywords: resistance exercise; training volume; DNA methylation; transcriptomics

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Article

Different Resistance Exercise Loading Paradigms Similarly Affect Skeletal Muscle Gene Expression Patterns of Myostatin-Related Targets and mTORC1 Signaling Markers

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Abstract: Although transcriptome profiling has been used in several resistance training studies, the associated analytical approaches seldom provide in-depth information on individual genes linked to skeletal muscle hypertrophy. Therefore, a secondary analysis was performed herein on a muscle transcriptomic dataset we previously published involving trained college-aged men (n = 11) performing two resistance exercise bouts in a randomized and crossover fashion. The lower-load bout (30 Fail) consisted of 8 sets of lower body exercises to volitional fatigue using 30% one-repetition maximum (1 RM) loads, whereas the higher-load bout (80 Fail) consisted of the same exercises using 80% 1 RM loads. Vastus lateralis muscle biopsies were collected prior to (PRE), 3 h, and 6 h after each exercise bout, and 58 genes associated with skeletal muscle hypertrophy were manually interrogated from our prior microarray data. Select targets were further interrogated for associated protein expression and phosphorylation induced-signaling events. Although none of the 58 gene targets demonstrated significant bout x time interactions, ~57% (32 genes) showed a significant main effect of time from PRE to 3 h (15↑ and 17↓, $p < 0.01$), and ~26% (17 genes) showed a significant main effect of time from PRE to 6 h (8↑ and 9↓, $p < 0.01$). Notably, genes associated with the myostatin (9 genes) and mammalian target of rapamycin complex 1 (mTORC1) (9 genes) signaling pathways were most represented. Compared to mTORC1 signaling mRNAs, more MSTN signaling-related mRNAs (7 of 9) were altered post-exercise, regardless of the bout, and *RHEB* was the only mTORC1-associated mRNA that was upregulated following exercise. Phosphorylated (phospho-) p70S6K (Thr389) ($p = 0.001$; PRE to 3 h) and follistatin protein levels ($p = 0.021$; PRE to 6 h) increased post-exercise, regardless of the bout, whereas phospho-AKT (Thr389), phospho-mTOR (Ser2448), and myostatin protein levels remained unaltered. These data continue to suggest that performing resistance exercise to volitional fatigue, regardless of load selection, elicits similar transient mRNA and signaling responses in skeletal muscle. Moreover, these data provide further evidence that the transcriptional regulation of myostatin signaling is an involved mechanism in response to resistance exercise.

Keywords: mRNA; protein; acute resistance exercise; gene expression

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1. Introduction

Resistance training promotes increases in strength and skeletal muscle hypertrophy [1]. Increasing interest has surrounded how implementing different volume loads affects the

A novel deep proteomic approach in human skeletal muscle unveils distinct molecular signatures affected by aging and resistance training

Short title: Aging, resistance training, and deep skeletal muscle proteomics

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International society of sports nutrition position stand: coffee and sports performance

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ABSTRACT

Based on review and critical analysis of the literature regarding the contents and physiological effects of coffee related to physical and cognitive performance conducted by experts in the field and selected members of the International Society of Sports Nutrition (ISSN), the following conclusions represent the official Position of the Society:

(1) Coffee is a complex matrix of hundreds of compounds. These are consumed with broad variability based upon serving size, bean type (e.g. common Arabica vs. Robusta), and brew method (water temperature, roasting method, grind size, time, and equipment).
(2) Coffee's constituents, including but not limited to caffeine, have neuromuscular, antioxidant, endocrine, cognitive, and metabolic (e.g. glucose disposal and vasodilation) effects that impact exercise performance and recovery.
(3) Coffee's physiologic effects are influenced by dose, timing, habituation to a small degree (to coffee or caffeine), nutrigenetics, and potentially by gut microbiota differences, sex, and training status.
(4) Coffee and/or its components improve performance across a temporal range of activities from reaction time, through

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KEYWORDS
Coffee; caffeine; bioactives; chlorogenic acids; polyphenols; ergogenic

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The effects of resistance training on denervated myofibers, senescent cells, and associated protein markers in middle-aged adults

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Probiotic supplementation of pea-derived protein alters the gut microbiome balance in favor of increased protein degradation, reflected in increased levels of essential amino acid in human plasma

Abstract

Aim: The primary aim of this clinical study was to determine if dietary supplementation with the probiotic, BIOHM FX (BFX), altered the gut microbiome balance following ingestion of 15g pea protein (PP) and enhanced the absorption of non-animal proteins determined via quantification of essential amino acids (EAAs). Thus, we compared the effects of pea protein alone vs. pea protein + BFX on microbiome changes and plasma levels of EAAs.

Methods: A placebo-controlled crossover clinical study in active men (n=40) was performed during which quantification of abundance levels of gut bacterial and fungal (bacteriome and mycobiome) organisms were assessed. In addition, plasma EAAs were measured pre- and post- ingestion of the pea protein +/-BFX for 180 min. Stool samples were analyzed for changes in microbiome composition from baseline and compared for PP versus PP+BFX. Self-reported changes in gastrointestinal (e.g., bloating, flatulence) and quality of life (e.g., fatigue, mood, and energy) indices were also measured.

Results: Participants ingesting PP + BFX exhibited a distinct microbiome profile compared to baseline and ingestion of PP. Differences in plasma EAAs showed a trend for an interaction (P=0.097) and post hoc testing at 120 min showed a significant difference (P=0.047) between PP and PP+BFX. Microbiome analysis of stool samples showed that the pathogens *Escherichia coli, Prevotella copri, Shigella flexneri,* and *Brevundimonas diminuta* were lower in PP+BFX compared to PP. The abundance of *Candida albicans* was lower and the level of *Saccharomyces cerevisiae* was higher in PP+BFX compared to PP. Interestingly, the abundance of *Pseudomonas* species, cyanobacteria phyla and the fungal species *Galactomyces geotrichum* were elevated when the combination of PP+BFX were consumed by study subjects (P<0.05). Other than main effects of time there were no significant differences between treatments in self-reported gastrointestinal (GI) and well-being markers.

Conclusion: Our results indicate that the addition of BFX to PP alters the gut microbiome composition, aiding in the absorption of dietary non-animal proteins and increasing essential amino acid appearance in plasma.

Keywords: probiotic, gut health, amino acid absorption, microbiome

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A Randomized, Single-Blind, Crossover Study to Evaluate the Efficacy of a Novel Dietary Supplement Blend with L-Citrulline on Biomarkers of Hydration, Muscle Size, Affect, Inflammation, and Muscular Endurance

Original Research

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Abstract

Introduction: Citrulline is a non-essential amino acid that has previously been shown to improve athletic performance, reduce fatigue, and increase blood flow. The purpose of this study was to examine the efficacy of a novel dietary supplement blend (3D PUMP BREAKTHROUGH®, 3DPump) vs. citrulline alone on changes in muscle volume, fluid shifts, markers of hydration, inflammation, recovery, affect, and muscular endurance.

Methods: Twenty-eight recreationally active subjects (6 women, 22 men) participated in a randomized, positive-controlled, single-blind, crossover study which involved 4 testing visits (2 workout visits each with a 24-hr follow-up visit). Participants ingested 3DPump (containing 3g L-citrulline, 1.2g glycerol, 165mg Amla fruit extract) or 8g of L-citrulline alone 45min before an aerobic and resistance training workout. Assessments of body fluid shifts (via BIA), markers of hydration (urine and serum osmolality, USG, hemoglobin), and appendicular girth were taken before and after exercise while markers of damage and inflammation (neutrophils, CK, ESR, MCP-1, CRP) were taken before and 24 hours after exercise, muscular endurance (reps to failure) was assessed during resistance exercises, and subjective measures of affect and recovery were taken before, after and 24 hours after exercise. Mixed factorial ANOVAs with dependent t-tests were used to compare treatments.

Results: A significant interaction occurred for right thigh circumference; however post hoc testing indicated both groups increased similarly in post workout girth ($p<0.05$). A significant interaction occurred for ECF/TBW indicating post workout was greater than pre workout in 3DPump only ($p=0.002$). An interaction trend ($p\leq0.010$) occurred for SBP and DBP indicating that 3DPump was uniquely able to significantly lower blood pressure (SBP and DBP) post workout compared to baseline and 24 hours after exercise ($p<0.001$).

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Article

Acute Effects of Naturally Occurring Guayusa Tea and Nordic Lion's Mane Extracts on Cognitive Performance

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Abstract: The aim of this study was to assess the effects of guayusa extract and Nordic Lion's Mane (LM) on cognition. Using a randomized, double-blind, placebo-controlled, crossover design, we examined the effects of a single dose of 650 mg guayusa extract (AMT: AmaTea® Max) vs. 1 g Nordic-grown Lion's Mane (LM) vs. placebo (PL). Participants attended three testing visits consisting of neuropsychological tests (Go/No-go, N-Back, and Serial 7 s tasks) assessing performance, subjective assessments of cognitive perception, and vital signs. Each assessment was measured at baseline (pre-ingestion) and 1 and 2 h post ingestion. AMT significantly ($p \leq 0.05$) improved the number of attempts during Serial 7s, total score, number of correct responses, total number of responses, and reaction time during N-Back and improved Go stimulus reaction time, but it reduced the percentage of correct responses in the No-go stimulus response during Go/No-go. LM significantly ($p \leq 0.05$) improved the number of attempts during Serial 7s and reaction time during N-Back and improved Go stimulus reaction time in Go/No-go. AMT improved mental clarity, focus, concentration, mood, and productivity at 1 and 2 h ($p < 0.05$); the ability to tolerate stress at 1 h; and had greater ratings than LM and PL for mental clarity, focus, concentration, and productivity. PL improved focus and concentration at 1 h from baseline ($p \leq 0.05$). AMT and LM improved subjective ratings of "happiness compared to peers" and "getting the most out of everything" ($p < 0.05$); however, this occurred earlier in LM (i.e., 1 h post ingestion). AMT uniquely elevated blood pressure from baseline. AMT significantly improved cognitive performance and self-perceived cognitive indices of affect over a 2 h period and perceptions of happiness 2 h post ingestion. In comparison, LM helped improve working memory, complex attention, and reaction time 2 h post ingestion and perceptions of happiness over a 2 h period.

Keywords: cognitive function; mood; focus; concentration; nootropics; *Hericium erinaceus*

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Article

Methylliberine Ingestion Improves Various Indices of Affect but Not Cognitive Function in Healthy Men and Women

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Abstract: This study assessed the acute effects of oral methylliberine (Dynamine^{TM}) supplementation on cognitive function and indices of well-being. This was a double-blind, randomized, within-subject crossover trial. In total, 25 healthy men and women (33.5 ± 10.7 yr, 172.7 ± 8.6 cm, 73.3 ± 11.0 kg) underwent pretesting before ingesting methylliberine (100 mg) or a placebo (PLA) for 3 days. On the fourth day, the participants were tested before their fourth dose (baseline) and every hour post-ingestion for 3 h. After a one-week washout period, the participants repeated testing with the alternate investigational product. The testing battery consisted of vitals, Stroop test, Trail Making Test-B, and visual analog scales that assessed various indices of well-being. Mixed factorial ANOVAs with repeated measures were used to assess all variables. There were significant ($p \leq 0.050$) interactions in terms of concentration, motivation, and mood. Methylliberine improved concentration at 1 and 3 h, motivation at 3 h, and mood at 1, 2, and 3 h ($p \leq 0.050$). Methylliberine improved energy, sustained energy, and mood in all participants to a greater extent than PLA at 1 h and 3 h relative to baseline ($p \leq 0.050$). PLA improved motivation at 1 and 2 h and mood at 2 h ($p \leq 0.050$). Methylliberine improved concentration, well-being, and the ability to tolerate stress to a greater extent than PLA at 3 h relative to baseline ($p \leq 0.050$). Women observed elevations in sustained energy at 1 and 3 h ($p \leq 0.050$) with methylliberine vs. PLA. Methylliberine had a negligible influence on cognitive function and vitals ($p > 0.050$), and no adverse events were reported. Methylliberine significantly improved subjective feelings of energy, concentration, motivation, and mood, but not cognitive function. PLA improved motivation and mood at hours 1 and 2, while methylliberine sustained these benefits for longer. Methylliberine also improved concentration, well-being, and the ability to tolerate stress to a greater degree than PLA, while having no detrimental effects on vital signs. Methylliberine also seemed to have a positive impact on sustained energy in women.

Keywords: cognitive flexibility; mood; energy; concentration; motivation; nootropics

Citation: La Monica, M.B.; Raub, B.; Malone, K.; Hartshorn, S.; Grdic, J.; Gustat, A.; Sandrock, J. Methylliberine Ingestion Improves Various Indices of Affect but Not Cognitive Function in Healthy Men and Women. *Nutrients* **2023**, *15*, 4509. https://doi.org/10.3390/nu15214509

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Article

The Effects of a Multi-Ingredient Supplement Containing Wasabia Japonica Extract, Theacrine, and Copper (I) Niacin Chelate on Peripheral Blood Mononuclear Cell DNA Methylation, Transcriptomics, and Sirtuin Activity

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Abstract: Herein, we determined if a multi-ingredient supplement (NAD3; 312 mg of combined Wasabia japonica extract, theacrine, and copper (I)niacin chelate) versus a placebo (CTL) affected peripheral blood mononuclear (PMBC) transcriptomic, DNA methylation, and sirtuin activity profiles in middle-aged adults after 12 weeks of supplementation. Several mRNAs demonstrated interactions (n = 148 at ±1.5-fold change, $p < 0.01$), and more stringent filtering indicated that 25 mRNAs were upregulated and 29 were downregulated in the NAD3 versus CTL group. Bioinformatics on these 64 mRNAs suggested that DNA conformational alterations may have been promoted with NAD3 supplementation, and this was corroborated with more CpG sites being hypermethylated ($p < 0.001$) in the CTL versus the NAD3 group when examining pre- to post-intervention changes (369 versus 35). PBMC SIRT activity decreased in CTL participants ($p < 0.001$), but not in NAD3 participants ($p = 0.289$), and values at 12 weeks trended higher in NAD3 participants ($p = 0.057$). Interestingly, the pre- to post-changes in SIRT activity values significantly correlated with changes in PBMC NAD^+: NADH values obtained from a previous investigation in these participants ($r = 0.534$, $p = 0.015$). In conclusion, the current mRNA and DNA methylation data indirectly suggest that NAD3 supplementation may affect PBMC DNA conformation, while other direct assays suggest that NAD3 supplementation maintains SIRT activity through the potential maintenance of NAD^+: NADH levels. However, these results are preliminary due to limited n-sizes and the study being performed in middle-aged adults.

Keywords: theacrine; NAD^+; PBMCs; sirtuins

Citation: Roberts, M.D.; La Monica, M.B.; Raub, B.; Sandrock, J.E.; Ziegenfuss, T.N.; Smith, R.; Dwaraka, V.B.; Lopez, H.L. The Effects of a Multi-Ingredient Supplement Containing Wasabia Japonica Extract, Theacrine, and Copper (I) Niacin Chelate on Peripheral Blood Mononuclear Cell DNA Methylation, Transcriptomics, and Sirtuin Activity. *Physiologia* **2023**, *3*, 233–246. https://doi.org/10.3390/physiologia3020016

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RESEARCH ARTICLE

A probiotic amylase blend reduces gastrointestinal symptoms in a randomised clinical study

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Abstract

A randomised, placebo-controlled, double-blind, parallel clinical study was performed to examine the effects of a probiotic- amylase (PRO) blend on gastrointestinal (GI) symptoms. Sixty men and women (44.4 ± 8.9 yr; 82.0 ± 18.4 kg; 170.3 ± 11.5 cm; 28.1 ± 4.6 kg/m²) were randomised into PRO (n = 29) or placebo (PLA: n = 31) groups. Participants exhibited mild to moderate GI symptoms and severity [via Gastrointestinal Symptom Rating Scale (GSRS)] to be eligible for participation. Participants were tested before (Baseline) and after (POST) 6 weeks of supplementation on various gastrointestinal indices, the GSRS (to assess GI symptoms, frequency, and severity), an anxiety questionnaire (GAD-7), and an overall well-being questionnaire (SF-36). Two (PRO vs PLA) × 2 (Baseline vs POST) mixed factorial ANOVAs were completed to assess group, time, and (group × time) interaction effects. Fifty-two subjects who completed the entire study were analysed (PRO: n = 25, PLA: n = 27). There were statistically significant ($P \leq 0.05$) interactions for bloating, GSRS score, and abdominal discomfort but time effects for flatulence, constipation, stool regularity, and GAD-7 total score. PRO significantly reduced GSRS score (~60 vs 25%, d = 0.72), bloating (~49% vs 25%, d = −0.63) and abdominal discomfort (59% vs 32%, d = −0.66) to a greater degree than PLA. PRO significantly reduced subjective feelings of irritability, pain, and overall health interference. Oral supplementation of the probiotic-amylase blend was very well tolerated. Our study showed that the probiotic-amylase blend reduced the GSRS score and other GI symptoms to a greater degree than PLA.
Clinical trial registration: clinicaltrials.gov #NCT05614726