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The Effects of a Multi-Ingredient Pre-Workout Supplement on Repeated Sprint Ability: A Randomized, Double-Blinded, Placebo-Controlled, Crossover Study

Research Brief

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Abstract

Introduction: Pre-workout supplements have become increasingly popular for exercisers; however, the efficacy of newly marketed supplements may be uninvestigated. The purpose of this study was to assess the effect of a multi-ingredient pre-workout supplement (MIPS) on repeated sprint ability and muscle excitability.
Methods: A total of 20 women (age: 20.95 ± 1.62; mass: 66.23 ± 10.81) and 18 men (age: 22.70 ± 2.94; mass: 84.71 ± 12.76) completed two testing sessions separated by 48 hours and were provided the placebo or MIPS in a randomized order. After ingestion, participants waited 25 minutes before completing ten, 6-second sprints against a resistance of 7.5% of body mass with 45-second rest periods. For each sprint, peak power (PP) was recorded. Surface electromyography was recorded on the vastus lateralis of the subject's dominant leg to determine muscle activation. The ratio of PP to muscle activation was calculated as muscle excitability.
Results: MIPS significantly improved (p=0.005) PP in men on sprint 5 (mean difference ± SD: 62.6 ± 83.3W). In women, MIPS had no effect in PP (p=0.140). Muscle excitability was unaffected by MIPS in men (p=0.255) and women (p=0.501).
Conclusions: An acute dose of MIPS does not appear to improve repeated sprint ability nor muscle excitability in men and women.

Key Words: Performance, supplementation, anaerobic capacity

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Introduction

Use of oral supplementation to enhance performance and training adaptations has become customary in the current era of fitness.[1,2] Multi-ingredient pre-workout supplements (MIPS) have sparked the interest of researchers and fitness enthusiasts. MIPS is an oral supplement and contains products such as caffeine, beta-alanine, nitrates, etc., that may work synergistically to improve exercise performance. Chronic use has been shown to lead to training adaptations.

While MIPS research cannot definitively state which ingredient causes physiological effects, the multiple ingredients in the formula may have augmented effects if taken alone.[2]

Conflicting evidence exists when examining the effects of MIPS on power production. Previous literature has shown an increase in peak and mean power during a Wingate anaerobic power test, and an anaerobic sprint test [3,4]; however other research reported no difference in power when compared to a placebo.[5] This may be attributed to a difference in ingredients in MIPS formulas.[6]

Recently, ATP products have been added to MIPS products. Independently of other ingredients, ATP supplementation has been shown to improve muscular function.[7–9] Furthermore, long term supplementation of 400 mg of ATP was shown to improve strength, power and lean body mass.[10] It has been suggested that chronic supplementation of ATP is necessary to elicit a response [11]; however, to the best of our knowledge, an acute dose within a MIPS formula has not been studied. Therefore, the purpose of this study is to evaluate the effectiveness of an acute dose of a MIPS formula containing ATP on muscle excitability and repeated sprint ability.

Scientific Methods

Participants

18 men and 20 women were recruited to complete this study. Prior to enrollment in the study, subjects were asked to complete a physical activity readiness questionnaire (PAR-Q) to ensure the subjects were able to complete the study with minimal risk. Any subject who did not pass the PAR-Q was excluded from the study. After completing and passing the PAR-Q subjects provided written informed consent. Descriptive information for the subjects is available in Table 1. Testing occurred at the same time on each day of testing for all subjects. This study was approved by Bloomsburg University of Pennsylvania's IRB (#2018-27).

Table 1: Subject Descriptive Data.

Sex	Age	Mass	Height	BMI	% Body Fat
Male	22.7±2.94	84.71±12.76	178.24±5.52	26.17±3.02	18.48±5.42
Female	20.95±1.62	66.23±10.81	165.57±7.30	24.25±2.78	28.36±8.21

Supplementation

Subjects were instructed to adhere to the following pre-testing guidelines: no physical exercise within 12 hours of the test, no eating or drinking within two hours of the test, no alcohol consumption within 48 hours of the test, and no diuretic medications within seven days of the test. The subjects were instructed to not consume any caffeine on the day of the test and were asked to refrain from any supplement usage a week prior to their first test date. The MIPS provided in this study was supplied by the manufacturer (Cenegenics, Las Vegas, NV). The placebo (PLA) was matched for flavor and color in the Bloomsburg University Exercise Physiology Laboratory. Per the manufacturer's instructions each supplement was mixed in a shaker bottle with 8 oz. of water, and the serving was ingested by the subject 25 minutes before performing exercise, as per manufacturer guidelines in order to mimic a real-world use of the supplement. Subjects were monitored for any adverse events and/or side effects from both the MIPS and PLA. No adverse events or side effects were reported by any of the subjects. The MIPS ingredients are presented in Table 2 and placebo information is presented in Table 3.

Body Composition Testing

Before beginning exercise, height was measured using a wall mounted stadiometer (Seca, Hamberg, Germany), and mass was measured using a digital scale (BWB-800, Tanita Corporation, Tokyo, Japan). Dual-energy x-ray absorptiometry (General Electric, Boston, MA) was used to determine body composition.

Repeated Sprints

The repeated sprint protocol was adopted from Purpura and colleagues.[8] All subjects were previously familiar with maximal intensity sprints on the cycle ergometer. Subjects completed an adequate warm-up on a cycle ergometer, with 0.5 kp of resistance. The subjects were instructed to maintain a speed of 50 RPMs for the duration of the warm-up. Following the 2-minute warm-up, subjects completed 3 sprints lasting 7-15 seconds, with increasing resistance, in order to find the subject's maximum RPMs. The subjects were then given 5 minutes rest before beginning the anaerobic test. The anaerobic test was done on a Monark cycle ergometer (Ergomedic 894 E, Monark, Sweden).

Subjects completed 10, 6-second sprints, against 7.5% of the subject's body mass. 45-seconds of active rest was provided in between each sprint. 90% of the maximum RPM was required during the test to drop the weight basket. The peak power (PP) of each sprint was collected for analysis.

Table 2: Supplement ingredients.

Serving Size: 1 Scoop (~12.1g)	
	Amount per Serving
Calories	25*
Total Carbohydrates	1 g
Niacin	50 mg
L-Glutamine	5 g
CarnoSyn® Beta-Alanine	1.6 g
Cordyceps Extract (*Cordyceps sinensis)(mycelium)*	1 g
L-Citruline	500 mg
L-Carnitine	500 mg
Red Beet Powder	500 mg
PEAK ATP® (Adenosine 5' Triphosphate Disodium)	450 mg
Taurine	250 mg
Hawthorn Extract (*Crataegua pinnatifida)(leaves)*	250 mg
Caffeine	100 mg

*104.36kJ

Table 3: Placebo ingredients.

Serving Size: 1 Packet (~2.6g)	
	Amount per Serving
Calories	10*
Sodium	20 mg
Potassium	10 mg
Total Carbohydrates	4 g

*41.74kJ

EMG

Muscle activation was assessed via electromyography using wireless bipolar electrode (Delsys Incorporated, Natick, Massachusetts) on the vastus lateralis of the dominant leg, at approximately 66 percent of the line from the anterior superior illiac spine to the superior lateral border of the patella. Muscle activation was recorded during the entire repeated sprint protocol. To analyze muscle activity, high-pass filtering was done to eliminate movement artifacts and muscle activation was quantified as the root mean square of the signal for each sprint. For each sprint, the root mean square was normalized to the first sprint value, which was assigned 100%. Muscle excitability (ME) was calculated as the ratio of PP output to muscle activation.[8]

Statistical Analysis

All data were analyzed using a 2x10 repeated measures ANOVA. The alpha level was set *a priori* to $p \leq 0.05$. Significant trial x sprint interactions for each gender were assessed with Bonferroni adjusted (alpha=0.05/10 sprints) post hoc dependent t-tests for between trial comparisons. For each post hoc t-test, Cohen's d effect sizes were calculated to provide an indication of the magnitude of the effect of the MIPS. Cohen's d effect sizes were interpreted as small (0.2), moderate (0.5), and large (0.8). Main effects of trial were assessed with Bonferroni adjusted (alpha=0.05/2 trials) pairwise comparisons. All statistical procedures were run using SPSS V26 (IBM Corp., Armonk, NY).

Results

Data for PP and ME in males and females can be found in Table 4 and 5 respectively. A significant trial×sprint interaction was observed for PP in men (p=0.002). Post hoc analysis revealed significantly greater PP with MIPS for sprint 5 (p=0.005). Furthermore, small effects were observed for sprint 1 (d=0.238) and 2 (d=0.364) favoring the placebo. Additionally, small effects were observed for sprints 4 (d=0.326), 5 (d=0.444), 6 (d=0.322), 7 (d=0.389), 8 (d=0.440), and 10 (d=0.240) favoring MIPS. There was no significant trial×sprint interaction (p=0.140) or main effect of trial for PP in women. No significant trial×sprint interactions or main effects of trial were noted for muscle excitability in men (p=0.255) or women (p=0.501).

Table 4: Peak Power and Muscle Excitability Data for Males. Data presented as mean (standard deviation).

Variable	Sprint	1	2	3	4	5	6	7	8	9	10
Peak Power (W)	PLA	951.51 (140.20)	923.47 (134.24)	838.58 (113.69)	752.33 (130.01)	701.49 (129.69)	678.34 (158.92)	644.56 (166.24)	639.42 (154.35)	662.10 (147.04)	675.60 (147.99)
	MIPS	921.07 (114.09)	871.46 (150.97)	816.30 (127.89)	794.22 (127.35)	764.06 (151.38*)	726.13 (137.31)	707.46 (156.76)	703.54 (136.80)	688.31 (135.46)	713.77 (168.83)
Muscle Excitability ($W \cdot \mu V^{-1}$)	PLA	142.82 (57.78)	154.55 (68.10)	160.68 (53.11)	168.98 (59.66)	177.11 (59.88)	183.39 (59.18)	184.67 (58.25)	194.43 (98.63)	184.76 (77.26)	179.93 (84.77)
	MIPS	148.76 (58.40)	158.06 (60.79)	155.20 (57.44)	156.08 (62.39)	163.82 (65.23)	170.32 (67.91)	172.65 (75.06)	170.59 (65.03)	171.80 (70.30)	169.10 (63.97)

*Denotes significantly greater than PLA.

Table 5: Peak Power and Muscle Excitability Data for Females. Data presented as mean (standard deviation).

Variable	Sprint	1	2	3	4	5	6	7	8	9	10
Peak Power (W)	PLA	582.68 (93.09)	603.62 (128.48)	577.57 (139.56)	560.10 (137.79)	537.59 (157.18)	526.63 (129.88)	515.80 (133.76)	515.71 (140.05)	497.34 (111.40)	531.23 (145.25)
	MIPS	619.99 (88.03)	609.52 (108.54)	584.12 (125.64)	569.46 (131.92)	557.14 (143.97)	553.59 (153.53)	530.43 (138.57)	532.87 (133.68)	526.73 (138.83)	518.85 (119.80)
Muscle Excitability ($W \cdot \mu V^{-1}$)	PLA	153.53 (62.57)	156.91 (59.78)	159.27 (64.09)	168.87 (65.31)	174.82 (67.15)	167.40 (61.94)	170.55 (59.98)	166.64 (59.55)	173.92 (66.43)	170.02 (67.01)
	MIPS	158.42 (65.34)	165.39 (67.23)	172.47 (66.90)	172.14 (66.05)	175.63 (73.48)	174.76 (69.66)	177.02 (75.12)	177.57 (82.94)	172.68 (78.22)	179.05 (81.78)

Discussion

The purpose of this study was to determine the acute effects of this unique MIPS formula on repeated sprint ability and muscle excitability. Due to the increase in use of pre-workout supplements by exercise enthusiasts, it is important to explore the effects of new multi-ingredient supplement formulas to determine their overall efficacy. Previous literature has shown that MIPS can significantly improve exercise performance during acute bouts, and aid in chronic adaptions to exercise.[2] The current study observed small to medium effect sizes in PP for males.

As shown by the results of this study, there was a significant improvement in PP with MIPS during sprint 5 when compared to PLA in males. No other sprints showed significant differences in PP for males; however, small to medium differences were noted. Furthermore, females showed no difference between MIPS and PLA for PP, indicating that there may be gender difference in the effect of this MIPS. Our findings support previous literature that a single dose of MIPS did not elicit any differences in females.[1,12–14] Additionally, there was no effect of MIPS on muscle excitability. It appears this MIPS has no effect on neuromuscular activation during repeated sprints. The PP improvement may be due to some other mechanistic factor.

In terms of the males, our findings conflict with previous literature assessing MIPS and exercise performance. MIPS has been reported to increase in peak and mean power during a Wingate protocol following the consumption of MIPS in males.[4] Furthermore, it has been observed a delay in fatigue following acute supplement ingestion.[15] Significant increases in mean power during sprinting and increases in repetitions to failure after acute ingestion of a MIPS has been observed.[3] However, previous literature has reported no changes in power during vertical jump or treadmill sprinting, and anaerobic power respectively.[16,17] The current findings of only 1 sprint improving PP may be due to the low dose of caffeine ingestion compared to other MIPS. While previous literature has shown that 2-week ATP supplementation has elicited increases in PP and ME during repeated sprints.[8] Our findings suggest that an acute dose of a MIPS containing ATP may not be sufficient.

Conclusions

Acute ingestion of MIPS containing ATP did not elicit promising differences in PP and ME in males and females. It is possible that chronic supplementation may be required to induce positive performance outcomes. Previous literature observing the effects of ATP supplementation on PP and ME utilized a 2-week supplementation protocol.[8] Furthermore, 12-weeks of ATP supplementation was necessary to elicit changes in strength, power and lean body mass.[10] As previously mentioned, it is challenging to compare MIPS products because of the differing ingredients and dosages. Our results add to the conflicting body of research regarding MIPS and performance.

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