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A Pre-Exercise Dose of Muscle Sentry® has no Effect on Performing Repeated Leg Press Sets to Failure

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ABSTRACT

International Journal of Exercise Science 10(7): 1000-1008, 2017. This study compared the number of bilateral leg presses done at 150% of body mass while on either Muscle Sentry® (MS) or placebo (PL). Participants (16 women, 14 men, college students 19-26 years) performed 2 sets of leg press to failure using 150% of their body mass with 5 min rest separating the 2 sets. Each exercise was performed twice (1x MS, 1x PL) at the same time of day with 48 h separating each exercise. Both MS and PL were ingested 30 min prior to performing the exercise. Just prior to starting the exercise and at the end of each set, heart rate, and blood pressure were obtained and the rate pressure product was calculated to determine myocardial workload. Two-way repeated measures ANOVA for lift number showed no significant main effects for either MS vs. PL, or for Set1 vs. Set2 ($p > 0.05$). The interaction was also not statistically different (mean repetitions ± std. dev.: MS1= 28±20, MS2= 26±18, PL1 = 30±24, PL2 = 29±20). Two-way repeated measures ANOVA for rate pressure product showed no significance for either the main effect for MS vs. PL, or supplement x pre-post interaction ($p > 0.05$). The main effect for pre-lift vs. post lift was significant ($p<0.001$) with post being higher than pre. Ingestion of Muscle Sentry® 30 min prior to leg pressing 150% of body mass to failure had no effect upon either total work performance or myocardial workload.

KEY WORDS: Muscle endurance, lactate salts supplementation, red cinchona bark powder

INTRODUCTION

Throughout mankind's recorded history, diet and nutritional strategies have been investigated with the goal of improving work and athletic performance (2). While it is not uncommon currently to read reports about well-known athletes using both accepted and banned substances, the ergogenic aids industry has become a multi-million dollar industry by targeting not only elite athletes, but also the general public as well (2). This has led some

experts to recommend that exercise and health professionals need to become knowledgeable authorities on sport supplements, in order to educate individuals about the efficacy and safety of these supplements (2, 9, 16). Based upon the necessity of providing professionals with said knowledge, Muscle Sentry® is a new supplement that has emerged amongst the ergogenic aid industry claiming to have "clinically proven results." Unfortunately, to our knowledge, there has been no investigations on the purported benefits of Muscle Sentry®. Additionally, the company's website (musclesentry.com) claims that Muscle Sentry® will deliver "Monster gains in stamina and endurance, increased energy levels, improved performance, and increased cardiovascular efficiency," (Note: As of January 2015, the term "Monster" no longer appeared on the website). Therefore, based upon these claims, we felt it was necessary to investigate Muscle Sentry® and the claims the company has purported.

In addition to the claimed benefits of the Muscle Sentry®, their website and associated social media sites contain numerous testimonials by fitness celebrities and pictures of individuals who looked lean and mesomorphic with readily apparent muscle definition. Based on the testimonials and pictures, we assumed that this supplement was developed to enable individuals to work at a higher intensity and longer duration during resistance training workouts. Thus, we expected the website links to the clinical evidence of the supplement's efficacy to be studies dealing with muscle endurance and strength gains, but that was not the case. The clinical evidence consisted of one published study (15) and one published abstract (7) that appears to be the same material as that in the published article. Within the one published study, the significant treatment effects were an increase (~3 $ml \cdot kg^{-1} \cdot min^{-1}$) in VO_{2max} with a concomitant lowering in perceived exertion (15).

A more exhaustive search did not reveal any other studies using the same formulation as that used for Muscle Sentry®. Moreover, the manufacturers do not provide any information as to why their formulation would benefit or increase stamina and cardiovascular efficiency. Nevertheless, it would appear from the listed contents of Muscle Sentry® (see table 1), that a prominent ingredient is lactate complexed with various minerals. Morris (11) has pointed out that lactate consumption could be used as an energy substrate and as a buffering agent. Moreover, ingestions have been shown to increase blood pH and bicarbonate levels and increase time to exhaustion in short, high-intensity work bouts.

For instance, in 2004, Van Montfoort et al. (19) were the first to investigate the buffering capability of lactate via changes in blood pH and bicarbonate following the administration of a 400 $mg \cdot kg^{-1}$ body mass sodium lactate drink. The authors reported that when compared to a placebo (NaCl), the lactate beverage resulted in a 1.7% improvement in performance through an increased running time to exhaustion. In 2011, Morris et al. (10) reported a 17% improvement in cycling capacity after the ingestion of 120 $mg \cdot kg^{-1}$ body mass of calcium lactate. Additionally, it was reported that with the calcium lactate consumption, there was a significant increase in blood bicarbonate, but not pH (10).

While these results appear to be promising, there are no concise conclusions concerning lactate consumption upon performance variables. To highlight this, Bryner el al. (3) found no

difference in performance following the consumption of either a lactate beverage or carbohydrate beverage. Within the Bryner (3) investigation, participants completed a moderate-intensity exercise test to exhaustion, followed by a 30 s Wingate test. The aim of this study was to mimic a competitive situation in which athletes performed a long, exhaustive work bout followed by an all-out sprint at the end of the race. There were no statistical differences between treatments in time to exhaustion, absolute peak power output, or relative peak power output (3). It is interesting to note that the recommended dose of Muscle Sentry® contains lower amounts of the lactate complexed minerals than the doses in the above cited studies.

Table 1. Muscle Sentry® active ingredients.

Supplement	Serving Amount
Niacin	50 mg
Pyridoxine HCL (vitamin B6)	9 mg
Calcium Lactate	32.5 mg
Magnesium Lactate	50 mg
Zinc Oxide	25 mg
Manganese Lactate	16 mg
Potassium Chloride	50 mg
Red Cinchona Bark Powder	600 mg

Lastly, Muscle Sentry® is unique in that it contains red cinchona bark powder, which is a source of the bitter tasting mineral quinine. It has been shown that quinine was able to evoke a greater and longer lasting autonomic nervous system (ANS) response compared with the other five prototypical tastants (sweet, sour, salty, bitter, and umami) (17, 18). Interestingly, Gam et al. (5) reported that ingesting a 2-mM solution of quinine improved the mean power output during a 30 s cycling sprint. Due in part to the possibility of a quinine being able to enhance exercise performance, the need to investigate Muscle Sentry® was further warranted.

Muscle Sentry® is apparently targeted towards individuals involved in resistance training, however, it is interesting to note that its ingredients have only been tested in running and cycling activities. In addition, VO_{2max} is not generally considered a limiting factor in resistance training. Therefore, in order to provide strength and conditioning professionals with scientific evidence to help them counsel clients, we decided to investigate the influence of Muscle Sentry® upon resistance training. Due to the claims of enhanced stamina we decided to first test the influence of Muscle Sentry® on a simple muscle endurance task. Specifically, we compared Muscle Sentry® to a placebo on leg press repeated sets to failure.

METHODS

Participants

Participants consisted of 16 female (age = 22 ± 3 y, height = 169 ± 10 cm, body mass = 69 ± 9 kg; mean ± standard deviation) and 14 male (age = 24 ± 2 y, height = 179 ± 6 cm, body mass = 80 ± 12 kg; mean ± standard deviation), recruited from professional university physical education students. Inclusion criteria included having regularly participated in resistance training for at

least one year, having not taken any ergogenic supplements for at least one year, having no history of leg, knee or hip injuries, and having no stimulant use (e.g. caffeine) for at least 48 hours before each test. Informed written and verbal consent was obtained from each participant prior to taking part in the experiment, and the appropriate institutional human participant review committee approved the study. The participants were not allowed to see the results until the study was completed. The number of participants needed for a statistical power of β=0.20 was determined using an online calculation website (www.sample-size.net).

Protocol

Participants visited a weight room twice on two different days separated by a minimum of 48 hours to test their muscle stamina. On both days, the participants performed two sets to failure on a leg press machine with the number of repetitions recorded for analysis. The days varied with respect to supplement ingested 30 minutes prior to the visit, and were administered in a randomized counter-balanced order. The supplements ingested were either the recommended dose Muscle Sentry® (i.e. 1 capsule of Muscle Sentry® for body weights <160 lbs.; 2 capsules for body weights between 160 lbs. and 240lbs. and 3 capsules for body weights >240 lbs.), or a placebo (powdered cellulose). In addition to counting the total number of repetitions, heart rate and blood pressure were measured at the beginning and end of each set to failure.

Muscle stamina was determined for each test day by the number of correctly completed leg presses a participant could perform. The leg press exercise was chosen because it employs most of the large muscles of the legs. It was our belief that the greater muscle mass involved, the greater the caloric usage, and hence, help needed to enhance stamina. The muscle stamina test was done twice each day. Between the two sets to failure, a ten minute rest period was allowed in order for heart rate and blood pressure to return to resting values. The leg press was performed in a seated position using a LifeFitness (Brunswick Corp., Lake Forest, IL) leg press machine. Prior to beginning the test, each participant was seated in the apparatus and the seat position was adjusted so that the individuals starting knee angle was approximated at 60^{o}. The participants were instructed to push on the foot plate until they reached full knee extension as quickly as possible. Once full extension was reached, each participant was instructed to return to the starting position and to make sure that the weight plates came in contact with the stationary (unmoved) plates. To ensure that all repetitions were performed correctly, two members of the experimental team watched the participant to ensure; first, their knees achieved full extension, and, second, the weight plates were returned to the starting position (i.e. contacted the stationary plate stack). They also ensured that each extension and flexion were done without any rest at either full extension or when the weight plate touched the weight stack. A third individual who was unaware of the supplement taken that day counted the number of repetitions. The test was stopped when participants could no longer reach full knee extension. For all tests, the resistance was set to the nearest 22 N (5 lb.) of 150% of the participant's body mass. The task resistance of 150% of body mass was chosen because this load had been established previously in our laboratory as the approximate weight wherein most people fatigued after two minutes of exercise. A two minute fatigue test was desired because it has been shown that tasks where fatigue is reached at two minutes equally

involved both the aerobic and anaerobic metabolic systems (i.e. 50% aerobic, 50% anaerobic) (9).

Besides improving stamina, the manufacturers claim that the supplement improves cardiovascular efficiency. To test this it was decided to compare the post exercise rate pressure product (the product of heart rate and systolic blood pressure). The rate pressure product has been shown to be a reliable and meaningful predictor of myocardial oxygen consumption during static and dynamic exercise (13). Therefore, heart rate and blood pressure were obtained just prior to commencing and immediately after each set to failure. Heart rate and blood pressure were measured using an automated device (Omron BP710, Omron Healthcare, Inc., Bannockburn, IL) which had previously been shown to provide reliable and accurate values (11). For analysis, the post rate pressure products were normalized by dividing the product by the total weight lifted in each respective lift (i.e. Heart rate $\cdot$systolic blood pressure $\cdot$total weight lifted^{-1}).

Statistical Analysis

Initially, a three-way (gender x supplement x set) ANOVA with repeated measures (SigmaStat v2.0, Jandel Scientific Software, San Jose, CA) was used to determine if males and females responded differently to the treatments. To test the effects of the supplement upon stamina, a two-way (supplement x set) ANOVA with repeated measures was used to compare the number of repetitions for each treatment. Since it was possible that sets to failure could be influence by task familiarization, an additional two-way (day x set) ANOVA with repeated measures was used to determine whether or not there was a difference between the two different days (i.e. the results were collapsed across days). Additionally, the normalized post exercise rate pressure products were analyzed using a 2-way (treatment vs. set) ANOVA with repeated measures. Post-hoc ANOVA analysis involved, where appropriate, the use of Tukey's protected t-test. Statistical significance was accepted at an alpha level of 0.05.

RESULTS

There were no significant differences found between the responses of males and females to the treatments. Therefore, the results of both genders were combined to enhance statistical power.

The Day 1 versus Day 2 average repetitions for both trials are listed in Table 2. The main effects for days ($F(1, 29) = 0.15$, $p = 0.701$) and trials ($F(1, 29) = 0.38$, $p = 0.542$) were not significant. In addition, the day x trial interaction ($F(1, 29) = 1.40$, $p = 0.246$) was not significant.

Table 2. Day-to-day differences in lift number.

	Day 1	Day 2
Trial 1	30 ± 21	31 ± 18
Trial 2	32 ± 20	32 ± 19

Values are means ± standard deviation.

The average repetitions for each experimental condition is presented in Table 3. Neither the main effect for treatments [F (1, 29) = 2.19, p = 0.150] nor the main effect for trials [F (1, 29) = 0.64, p = 0.430] was significant. The lack of significance was also found for the treatment x trial interaction [F (1, 29) = 0.34, p = 0.564].

Table 3. Supplement differences in lift number.

	Placebo	Muscle Sentry®
Trial 1	30 ± 17	32 ± 21
Trial 2	31 ± 18	33 ± 20

Values are means ± standard deviation.

The results for the normalized rate pressure product (see table 4) were similar to the results for the muscle endurance tests. In other words, the main effects for treatment [F (1, 29) = 2.12, p = 0.156] and trials [F (1, 29) = 0.40, p = 0.532], as well as the treatment x trial interaction [F (1, 29) = 0.19, p = 0.666] were not significant.

Table 4. Normalized rate pressure product. (Heart rate x systolic blood pressure x total weight lifted-1).

	Placebo	Muscle Sentry®
Trial 1	9.3 ± 13.1	7.3 ± 5.6
Trial 2	10.6 ± 16.6	7.6 ± 6.5

Values are means ± standard deviation.

DISCUSSION

A major purpose of this study was to determine if Muscle Sentry® would increase muscle stamina (i.e. endurance). Muscle endurance was evaluated on both the basis of a single task and repeated tasks. The main finding was that the number of repetitions did not differ between the Muscle Sentry® and placebo treatments for either the initial or repeated sets. Thus, it appears that the supplement has no influence upon stamina when leg pressing a weight which fatigues the leg muscles after doing approximately 2 minutes of work.

Research into the mechanisms of fatigue is a multifaceted process, with some examples during volitional activities including an impairment in metabolic stability, O_2 and substrate availability, and ATPase function; increased glycolytic flux, pH changes, temperature and ROS production; altered excitability of sarcolemma Na^+/K^+ pump, and motor unit recruitment patterns may be (8, 9, 16). Therefore, if a dietary supplement, such as used in this study was going to increase stamina (i.e. reduce fatigue), one would expect that the supplement would allay the effect of at least one of the aforementioned mechanisms. As mentioned above, it has been proposed that lactate complexed compounds may be effective in improving exercise performance, either as an energy substrate or as a modality to enhance blood buffering capacity during exercise. Since insufficient energy substrate during short duration exercise (< five min) is not generally a major concern, more recent research has focused on the blood buffering potential (11). Two studies have investigated the effect of lactate compound ingestion upon short duration exercise, and their findings are equivocal (10, 14). First, Morris et. al. (10) investigated graded cycling to exhaustion following ingestion of either calcium

lactate (120 mg · kg^{-1} body mass) or placebo. Calcium lactate ingestion both increased mean HCO^{3-} levels, and mean time to exhaustion (168 s vs. 137 s) over placebo. On the other hand, Painelli and colleagues (14) looked at the performance of three Wingate tests separated by three minutes of rest. When compared to placebo ingestion, these researchers found that ingesting both 300 mg · kg^{-1} body mass and 150 mg · kg^{-1} body mass of calcium lactate resulted in higher HCO^{3-} levels, but no change in Wingate performance. Therefore, it may be possible for the ingestion of lactate complexed minerals to improve blood buffering capacity. In their review, Lambert and Flynn (8), however, point out that acidosis is only one of several different factors that produce fatigue during resistance training. Thus improved buffering will only increase stamina if acidosis was the major fatigue inducing factor. Evidently other factors were more important fatigue inducers for the Painelli et al (14) study as well as the current study. Thus, the ingestion of buffering agents did little to improve stamina, and thus, no treatment effect was noticed.

While red cinchona bark is a centuries old source of quinine, however, the influence of quinine upon exercise stamina has not been studied extensively. Gam and colleagues have reported two studies that looked at the effects of either mouth rinsing (10 mM) (6) or mouth rinsing and ingestion (2 mM) (5) of a quinine containing solutions have upon a 30 s cycle sprint. When compared to placebo, rinsing with 10 mM of quinine had no effect upon either mean or peak power output during the 30 s cycle sprint. On the other hand, the 30 s cycle sprint performance following 2 mM quinine administration yielded mean and peak power outputs that were significantly greater than control. Thus, it would appear that quinine ingestion would improve muscle stamina. On the other hand, in 1989 Fung and Holbrook (4) noted that research on quinine administration had shown it to decrease the excitability of the motor end-plate region resulting in a reduced response to repetitive nerve stimulation. Moreover, they noted that quinine lowered the response to tetanic stimulation by increasing the muscle's refractory period (4). Notwithstanding these contradicting results with quinine use, red cinchona bark is only a source of quinine with the general method of obtaining quinine from the powdered bark is done so by drinking either a tea brewed from the bark or from drinking the bark mixed with an alcoholic beverage (1). Unfortunately, the blood quinine concentration derived from ingesting 600 mg of plain cinchona bark powder encased in a gelatin capsule is unknown. Nevertheless, based on the results of this study, it is impossible to attribute any ergogenic benefit to the 600 mg of cinchona bark powder encased in a gelatin capsule.

As mentioned above, research has reported a significant mean increase of 3 ml□kg^{-1}□min^{-1} in VO_{2max} following ingestion of Muscle Sentry®. It is assumed that this increase is the basis for the manufacturer's claims of an increased cardiovascular efficiency through the consumption of this supplement. Since whole body VO_{2max} is influenced by the oxygen consumption of the working skeletal muscle, the decision was made to investigate cardiovascular efficiency during this study's work bouts by measuring the rate pressure product, which is an estimator of myocardial oxygen consumption. Moreover, since heart rate increases with increased work, the rate pressure product was normalized to the total weight lifted. Thus, one would expect that a more efficient heart would be one that would have a lower oxygen consumption for the amount of work being done. Since there was no statistical significance between the

normalized rate pressure products, it is difficult to support the manufacture's claim of enhanced cardiovascular efficiency.

Muscle Sentry® ingestion failed to increase stamina when doing leg press sets to failure at an intensity designed to induce fatigue within two minutes. In retrospect, Morris et al. (10), using the ingredients (calcium lactate) found in this supplement albeit in larger doses (120 mg $\cdot kg^{-1}$ body mass vs 0.45 mg $\cdot kg^{-1}$ body mass) have shown positive effects when doing short duration and higher intensity exercise. Thus, it is still possible that Muscle Sentry® might have an effect if used in work scenarios of differing volumes and durations. For instance, a main limitation within the current investigation was the use of only two sets of leg press to failure. If the current protocol incorporated multiple sets to failure, multiple different exercises, or if the intensity was varied to not equal the 50% contribution of both anaerobic and aerobic systems, then the current supplement may have been shown to be effective. Therefore, due to the main limitation of the current investigation, further research is warranted amongst Muscle Sentry® and its subsequent ingredients to determine if it can alter muscular endurance performance. On the other hand, at the current moment, there is not enough evidence supporting the use of Muscle Sentry® that would persuade strength and conditioning professionals to recommend its use for these muscle endurance activities.

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