



Original Research

Effects of 5-Hour ENERGY® Shot on Oxygen Consumption, Heart Rate, and Substrate Utilization During Submaximal and Maximal Exercise

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ABSTRACT

International Journal of Exercise Science 9(5): 685-693, 2016. The purpose was to examine the effects of a 5-Hour ENERGY® shot (5HES) on aerobic performance in recreational athletes. Maximal Aerobic capacity (VO₂max), substrate utilization and time to fatigue were determined in twenty-three male participants (21.7±3.3 years, Mean±SD), with a BMI of 25.6±3.7 kgm⁻²(Mean±SD). Each participant was tested twice in a randomised, double-blind cross-over study design, during which participants were provided with either a 5HES or a placebo shot to ingest prior to exercise. Participants completed a VO₂ max treadmill test with RER and RPE values also being measured. Ingestion of a 5HES shot before exercise had no effect on peak VO₂ (p=0.194), peak heart rate (p=0.507), peak RER (p=0.678), peak ventilation (p=0.056), and running time to exhaustion (p=0.091) as compared with the ingestion of a placebo shot before exercise. Test results also showed that at the end of each stage there was no difference between heart rate and RER, with *P* values ranging from 0.226 to 1.000, with an exception being RER at 6 minutes, where p=0.009. The results of this study indicate a 5HES shot before exercise does not have an effect on oxygen consumption, heart rate, or substrate utilization during submaximal and maximal exercise.

KEY WORDS: Energy drinks, aerobic capacity, exercise performance, caffeine, supplements, vitamins

INTRODUCTION

Emerging evidence indicates that in both elite and recreational athletes, there is an upsurge in the use of energy drinks to enhance athletic performance. In fact, recent anecdotal reports

demonstrate that even in college students energy drinks are routinely consumed during fitness workouts. Athletes report using energy drinks in events ranging from power to endurance competitions, with the assumption that some combination of the caffeine, amino acids, B vitamins, or other varied ingredients, are effective ergogenic aids (11). However, current scientific evidence on the performance enhancing effects of energy drinks is equivocal. For instance, empirical studies on pre-exercise ingestion of energy drinks suggest they may improve aerobic performance (18, 19, 21, 29, 32). On the other hand, several other studies have indicated that energy drinks do not appear to improve aerobic capacity (5, 29, 30).

Previous studies have demonstrated the ergogenic potential of caffeine, including improved endurance performance, strength performance, reaction time, fat oxidation and a reduction in perceived exertion (2, 15, 17). For these reasons, caffeine was considered to be a doping agent and was thus listed on the prohibited list of the World Anti-Doping Agency (33). However, since the ban on caffeine was lifted by WADA in 2004, its use has been reported by over 75% of athletes across different events (7, 8). Reports from the 2005 Ironman Triathlon World Championships revealed that 89% of the participants were planning to use caffeinated substances before or during the race (9). Taurine, a non-essential amino acid found throughout the brain and skeletal muscle and which serves as a neurotransmitter and neuromodulator (24), is another active ingredient of energy drinks, which is thought to increase aerobic performance (1, 4, 10). Furthermore, taurine and caffeine are ingredients of energy drinks that can directly or indirectly influence cardiovascular function (34) and hence aerobic performance. Thus, in theory, combining caffeine and taurine in proper doses should improve brain and muscle functions (31). As a matter of fact, most of the popular energy drinks currently on the market (such as Red Bull® and 5-Hour ENERGY® (5HES)) combine caffeine with taurine.

The most popular caffeinated energy shot is 5HES, controlling almost 75% of the market (26). 5HES, like most energy shots, contains many of the same ingredients as a typical energy drink, but in a concentrated form. Although energy drinks have more recently been studied for their ergogenic potential, the energy shot market is even newer, and to date there is little research to investigate the effects of this increasingly popular nutritional supplement on human performance. Therefore, the purpose of this study was to determine the effects of pre-exercise ingestion of a 5HES (a caffeine-aurine-vitamin shot) on aerobic performance in young healthy male recreational athletes.

METHODS

Participants

Twenty-three recreational males (21.7±3.3 years, Mean±SD) were recruited to participate in this study. In order to be eligible, participants were required to be currently exercising on a regular basis, but not competing in intercollegiate sports or any other competitive activities, having no chronic or acute health conditions other than high BMI, and to have not had any previous use of 5HES or any similar supplements. Prior to testing, all participants were made aware of the study procedures, requirements, risks, and benefits, and were required to provide

written informed consent in accordance with the University of Tennessee Research ethics board. All study protocols were performed according to the code of ethics of the World Medical Association (Declaration of Helsinki).

Table 1. Descriptive statistics of participants.

	Mean \pm SD	Range
Age (years)	21.7 \pm 3.3	[18-35]
Height (metres)	1.8 \pm 0.01	[1.68-1.93]
Weight (kg)	82.5 \pm 15	[61.7-(119.7)]
BMI (kg m ⁻²)	25.6 \pm 3.7	[20.5-33.9]

Protocol

The overall design was a randomised, cross-over protocol conducted in a double-blind fashion. Each participant was randomly assigned to receive either a placebo or the 5HES prior to completing a VO₂ max treadmill test. Upon arrival at the laboratory, body mass (kg) (Detecto Physicians Scale, Webb City Mo) and height (metres) (Detecto Physicians Scale, Webb City, Mo) were measured and used to compute BMI as body mass divided by height squared and expressed as Kg m⁻². Additionally, a HR monitor (Polar Electro, Kempele, Finland) was attached to the participant prior to each test. Participants reported to the laboratory on the day of testing following a 3 h fast and having refrained from alcohol, caffeine and strenuous exercise the previous day. Prior to these performance trials, familiarization trials were completed to minimise intra-individual variation in aerobic performance. Participants were required to schedule two separate testing times, each one week apart and each at the same time of day, with all testing conducted in the university's exercise physiology laboratory. Participants were instructed to get the same amount of sleep and eat the same evening meal the night before each test in order to standardise the testing as much as possible. For both visits, participants waited 30 minutes post-consumption of the supplements before commencement of the cardio-pulmonary assessments.

5HES is sold in 1.93-ounce bottles, containing an estimated 100 mg of caffeine per shot. It also contains 18mg Sodium and 1870 mg of Energy Blend. The Energy Blend consists of Taurine, Glucuronic acid (glucuronolactone), Malic Acid, N-Acetyl L-Tyrosine, L-Phenylalanine and Citicoline. The other ingredients are: 30mg Niacin (Niacinamide), 40mg Vitamin B6 (Pyridoxine Hydrochloride), 400mcg Folic Acid and 500mcg Vitamin B12; which is approximately 2000% of the daily value for vitamins B6 and 8333% of the daily value for vitamin B12. 5HES is sweetened with sucralose and contains 4 calories per bottle. No attempt was made to verify the presence of the active ingredients in the 5HES. The placebo shots were mixed in a large pitcher and then poured individually into empty 5HES bottles. The original placebo mix consisted of: 3.8L of water, 226.8g of Splenda, and 13g of Grape Kool-Aid mix. Grape Kool-Aid mix contains 0 calories, 0g of fat, and 0g of sugar. The supplements differed in colour, but the taste was similar. Participants were instructed not to look at or smell the supplements while ingesting the supplements and to drink them as fast as possible. On test days, participants received either a 5HES or a placebo shot, and the person administering the drinks was unaware of the actual content of each bottle. It was confirmed at the end of each

experimental protocol that participants were not able to distinguish which treatments they received.

All VO_2 max tests were conducted under the same environmental conditions with a metabolic CART (ParvoMedics TrueOne Metabolic System, Model mms-2400, Sandy, UT) that was calibrated immediately before each test according to the manufacturer's guidelines. Breath-by-breath gas analysis was conducted using a validated portable indirect calorimetry system connected to the metabolic Cart using a mouth piece connected to a Hans Rudolph T-Shape two-way non-rebreathing valve (Hans Rudolph Inc., Shanwee, KS). Participants were also required to wear a Polar heart rate monitor (Polar Electro, Kempele, Finland), so heart rate could be collected every minute. Baseline/resting values for heart rate (HR), minute ventilation (V_E), oxygen uptake (VO_2) and respiratory exchange ratio (RER) were recorded prior to commencement of the exercise test and during the incremental running protocol. The VO_2 max test was performed on a treadmill using a Bruce protocol to volitional exhaustion. Following a brief warm up period and familiarization to the equipment, participants began with a three-minute walk. The test was terminated when the participant could not cope with the treadmill speed in spite of verbal encouragement. Tests were considered acceptable if at least two conditions were met: maximum heart rate was $>95\%$ of the age-predicted maximal heart rate, RPE >18 (3), if there was a plateau in HR and VO_2 in spite of increasing workload. All cardiopulmonary variables (minute ventilation (V_E), RER and HR)) were measured during the last 30 second of each stage.

Statistical Analysis

Data were analysed using SPSS (SPSS v18, IL, Chicago, USA.) following a Shapiro-Wilk test for Normality. Peak VO_2 , HR, V_E and RER were all normally distributed. A paired samples t-test was used to identify significant differences in cardiopulmonary parameters following 5HES supplementation. All data were reported as mean \pm standard deviation.

RESULTS

Participants had a mean age of 21.7 ± 3.3 years, Body mass 82.5 ± 15 kg and height 1.8 ± 0.01 metres. In addition, the average BMI was 25.6 ± 3.7 kg m^{-2} (Mean \pm SD) (Table 1). There was no significant difference in VO_2 max between 5HES and placebo, respectively (50.3 ± 7.0 vs. 51 ± 7.2 ml/kg/min ($P > 0.05$)). Similarly, there was no significant difference in peak HR between 5HES and placebo (190 ± 10 vs. 193 ± 10 bpm, respectively, $P > 0.05$). Furthermore, 5HES did not significantly alter peak RER compared to placebo (1.2 ± 0.1 vs. 1.2 ± 0.1 , respectively, $P > 0.05$) (Table 2). There was no significant difference in peak V_E for 5HES vs. placebo (139 ± 24 vs. 144 ± 28 ml/kg/min; respectively, $P > 0.05$). In addition, supplementation did not significantly improve running time to exhaustion for either 5HES or the placebo group (12.5 ± 1.6 vs. 12.8 ± 1.8 min; respectively, $P < 0.05$) (Table 2).

Figure 1 shows the HR response between the two conditions, and that there was no significant difference during at baseline or across the different workloads. Similarly, 5HES did not

significantly improve RER at any workload, nor was it different at rest between the two conditions.

Table 2. Results of 5HES on $VO_{2\max}$, Peak HR, Peak RER, Peak V_E , and Time to Fatigue.

	5-hES [range]	Placebo [range]
$VO_{2\max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	50.3±7 [34.2-63.7]	51±7.2 [36-65.2]
Peak HR (bpm)	192±10 [173-208]	193±10 [175-212]
Peak RER	1.2±0.1 [1.1-1.4]	1.2±0.1 [1.1-1.4]
Peak V_E ($ml \cdot kg^{-1} \cdot min^{-1}$)	139±24 [100-185]	145±28 [76-186]
Time to fatigue (min)	12.5±1.6 [9.2-14.6]	12.8±1.8 [9.8-15.5]

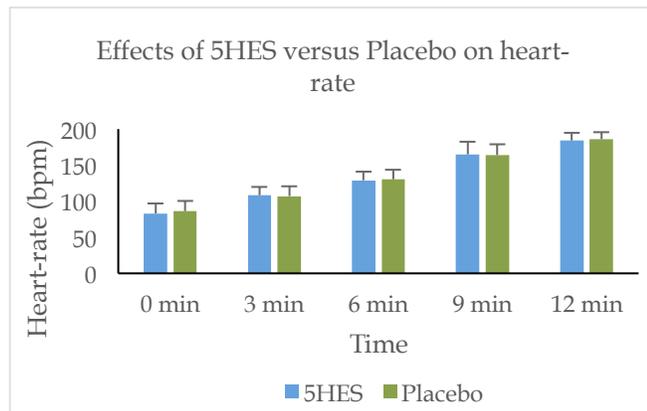


Figure 1. The effect of 5HES versus placebo on heart-rate.

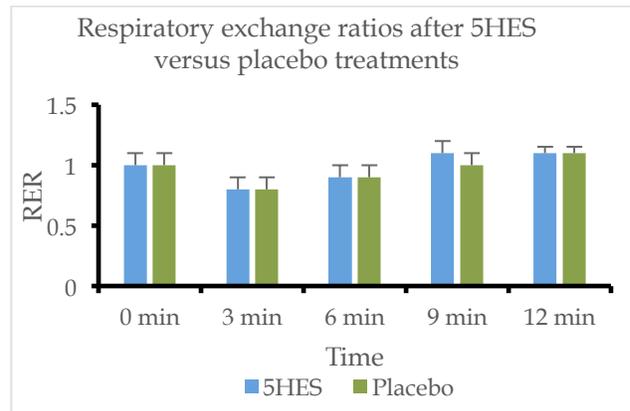


Figure 2. The effect of 5HES versus placebo on respiratory exchange ratio.

DISCUSSION

The purpose of this study was to evaluate the effect of 5HES on submaximal and maximal exercise in recreational athletes. Previous literature indicates that energy drinks may have some positive effect on aerobic performance (27) but to date there is no evidence of the effects energy shots, a highly condensed version of energy drinks, on performance. The ergogenic potential of 5HES, a popular nutritional supplement, was examined in recreational athletes. The results indicate that the pre-exercise ingestion of a 5HES has no significant effect on aerobic performance. Other than a difference in sub-max heart rate at one time point, there was no difference in any of the physiological variables measured between the 5HES and placebo trials.

The main ingredients in a 5HES are B vitamins, which are involved in mitochondrial and cellular energy production (25). In addition, most energy drinks contain considerable amounts of sugar, with the theory that the B vitamins help to increase the rate of sugar breakdown, thereby expediting energy delivery to exercising muscle (13). In addition, regular use of B vitamin supplements in athletes has been shown to increase endurance exercise capacity compared to controls (20). However, unlike most energy drinks, 5HES does not contain any sugar, and therefore the metabolic synergy between B vitamins and sugars in provision of

optimal energy supplies to muscles is lost, which may account for the lack of ergogenic activity of 5HES. This concept is supported by a similar study done with sugar-free Red Bull, where no difference was found in run time to exhaustion, RPE, or blood lactate levels in participants (5).

5HES also contains citicoline, tyrosine, and phenylalanine, which are known to increase mental alertness and have a mood lifting effect (13). None of these ingredients are directly associated with aerobic performance enhancement, but have been found to improve subjective feelings of energy (35), which may ultimately have an effect on performance. In addition, 5HES contains caffeine, which is a known ergogenic aid. However, the precise amount of caffeine is unknown, other than the statement of 'about the same as a cup of coffee', which could range between 65mg and 200mg of caffeine (23). While this is comparable to most energy drinks per serving, energy drinks typically contain more than one serving per bottle, and therefore more total caffeine. Even so, overconsumption of caffeine is associated with harmful health effects (22). The FDA imposed limit for caffeine is 71 mg caffeine/.12 fl oz or 0.2 mg of caffeine per ML (31). A Typical energy drink contains 0.34 mg of caffeine per ML, 2-4 times the amount of regular filtered coffee (14). Performance enhancing effects of caffeine have been found at 200-400mg. For this reason, WADA is currently monitoring the usage of caffeine by athletes, as it has been suggested that since it was removed from the prohibited list, its use has dramatically increased (36).

The amino acid taurine, another known ergogenic aid, is also found in 5HES. Taurine has been shown to reduce heart rate and improve time to exhaustion during endurance exercise (4, 10). Many energy drinks contain roughly 2000mg of taurine (13), yet 5HES contains considerably less than 2000mg, and therefore may not contain enough taurine to be an effective performance enhancement. The lack of aerobic performance enhancement found with pre-exercise ingestion of 5HES may be explained by its ingredient mix. Having no sugar to interact with the B-vitamins, along with smaller amounts of caffeine and taurine compared to traditional energy drinks, may simply leave 5HES deficient in the critical ingredients required to significantly enhance aerobic performance in athletes.

Consuming even one energy drink prior to exercise, which has become trendy amongst many exercisers, can be wrought with problems, starting with an imbalance between myocardial oxygen supply and demand (14, 16), and in the most extreme cases, resulting in sudden cardiac death (6, 12). Therefore, and the results of this study notwithstanding, the use of energy drinks with aerobic activity should be discouraged for all populations of exercisers, and particularly in those with any risk for cardiovascular disease.

The primary limitation of this study is that the small sample size makes it difficult to generalize the findings. A secondary limitation is the smaller amount of caffeine ingested, however, safety of the participants was of utmost importance. Conversely, the strong research design lends credibility to the outcomes and therefore prompts further study to replicate the results.

In conclusion, the results of this study indicate that ingestion of a 5HES before exercise does not have a significant effect on oxygen consumption, heart rate, or substrate utilization during maximal exercise, and therefore does not produce an improvement in endurance exercise performance.

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