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Effects of Energy Drink Functional Ingredients on Running Performance

Original Research

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Abstract

Introduction: The purpose of this study was to evaluate the independent and combined effects of energy drink (ED) functional ingredients, caffeine (CAF), taurine (TAU), and glucose (GLU) on 5-km running time trial (5KTT) performance in recreational endurance runners.

Methods: Twenty recreational endurance runners (10 men, 10 women, 21.3 ± 2.2 years) participated in a double blind, placebo controlled, repeated measures study. In the first session subjects completed the 5KTT without consuming a drink (control trial - CON). Subjects were then randomly assigned to supplement with 500 ml of a commercially available ED, CAF (160 mg), TAU (2g) and GLU (54g) 60 minutes before completing a 5KTT on a treadmill; separated by seven days. Time, heart rate, RPE, and affect were recorded at 500-m intervals during the time trial (TT). Session RPE and session Affect were obtained post TT.

Results: TT performance did not differ across conditions (CON: 1420 ± 161.4 s; ED: 1409.3 ± 153.1 s; CAF: 1414.9 ± 163.2 s; TAU: 1427.7 ± 178.8 s; GLU: 1416.2 ± 167.7; p = .80). HR and RPE increased wile affect decreased during the TT, irrespective of the substance ingested (all $p > 0.05$). Session RPE was significantly higher in the ED trial (8.1 ± 1.1) compared to GLU (7.7 ± 1.2), TAU (7.5 ± 1.3) and CON (7.5 ± 1.3) but not CAF (7.8 ± 1.3) ($p = 0.025$).

Conclusions: The present data does not unequivocally support an ergogenic potential of a popular ED above that of CAF, TAU, and GLU, if consumed sixty minutes before exercise in men and women recreational distance runners.

Key Words: Caffeine, dietary supplements, ergogenic effects

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Introduction

Many energy drinks (EDs) currently being sold are marketed with the claim that they will increase endurance and improve physical performance.[1] Researchers have reported improvements in exercise performance with the use of popular EDs, although these findings are not consistent. In a recent investigation by Prins *et al*.[2] the ED Red Bull® significantly improved treadmill 5-km running

performance in recreational runners. Similarly, Ivy et al.[1] found a 3.0% improvement in cycling time trial performance with the ingestion of 500 ml of the ED Red Bull®. However, in another study by Phillips *et al*.[3] 500 ml of a commercially available ED failed to demonstrate a performance improvement in a 25-mile cycle race. A limitation of the research examining the acute effects of CAF-containing EDs on physical performance is that the ED typically employed contains several potentially ergogenic ingredients including: caffeine (CAF), carbohydrates (CHO), and taurine (TAU) while the placebo drink does not include these substances. Therefore, it is not feasible to identify the specific influence of each of these active ingredients on performance.

The claims for the ergogenic effects of the functional ingredients of EDs such as CAF, TAU, and glucose (GLU), by manufacturers are ambiguous. For instance, Red Bull® markets that its active ingredients improve performance, concentration and reaction speed, vigilance, emotional status, and stimulating metabolism.[4] However, there is simply a paucity of research to support these claims. Researchers generally claim CAF as the primary ingredient responsible for the performance enhancing effects of EDs.[5] Additionally, evidence for the capability of the other active ingredients in EDs, either alone or combination with CAF, to enhance performance is limited. Furthermore, a previous investigation has suggested a synergetic interaction between ED ingredients, with greater performance benefits achieved by the whole beverage, with neither CAF nor GLU in isolation resulting in performance benefits.[6]

It is common for athletes to consume ED prior to competition, [7] yet the efficacy of the functional ingredients contained in these drinks remains to be determined. It is unresolved whether the ED Red Bull® or its functional ingredients improve performance in short duration high intensity middle distance endurance events such as a 5-km race.[2] With close to 8 million people completing a 5-km event in the United States in 2015,[8] identifying the most appropriate pre-exercise dietary supplement to improve exercise performance is merited particularly when it is very challenging to consume appropriate amounts of supplements during running events that last 30 mins or less.

A number of randomized, placebo-controlled, crossover studies have documented the effectiveness of ED as thermogenic, ergogenic, or cognitive aids.[7, 9] ED frequently contain other ingredients (e.g. GLU, CAF, TUA, etc.) which may exert independent and interactive effects on performance. However, there have been very few studies to date that have investigated the independent effects of the main functional ingredients found in the commercially available ED Red Bull®. Further study of the independent and interactive effects of ED constituents is required before conclusions are drawn concerning their relative efficacy. Therefore, the purpose of this investigation was to evaluate the independent and combined effects of ED functional ingredients, caffeine, taurine, and glucose on running performance as well as related physiological and perceptual responses of recreational endurance runners on a 5-km running time trial (5KTT). We hypothesized that both sources of caffeine (ED and CAF treatments) would enhance performance compared to the control and non-CAF-containing conditions, but there would be no performance difference between CAF-containing treatments.

Methods

Participants

Twenty recreational distance runners volunteered to participate in this study. Subjects were recruited directly from local running clubs and also by advertising

within the local community. Included were men and women who (a) had completed a 5-km distance run under 30 minutes, (b) currently run a minimum of 20 miles per week, and (c) were between the ages of 18 and 35 years. Subjects were prohibited from using any ergogenic aids for one month preceding the study, and were asked to refrain from taking any performance enhancing supplement(s) other than the experimental beverage during the course of the study. Subjects were instructed not to change their regular exercise training and dietary habits for the duration of the study, and were told not to exercise prior to testing. Subjects were instructed to refrain from CAF and alcohol consumption for 48 hours, physical activity for 24 hours, and food and drink for 3 hours before each exercise test.[10, 11] The participants were instructed to maintain a training and dietary log for 2 days before the first experimental trial. They were provided with a copy of their pre-trial log and instructed to have the same dietary intake and physical activity participation during the 48 hours before the other trials. In addition, participants were instructed to keep their CAF consumption stable throughout the period of study participation.[1] Subjects were also provided with a habitual caffeine consumption questionnaire before the experimental testing began in order to assess each subject's daily average caffeine intake. Before enrolling in the investigation, participants were fully informed of any risks and discomforts associated with the experiments prior to giving their written informed consent to participate. The experimental protocol was approved by the Institutional Review Board of Grove City College. The study conforms to the Code of Ethics of the World Medical Association (approved by the ethics advisory board of Swansea University) and required subjects to provide informed consent before participation.

Table 1**.** Physical characteristics (mean ± SD) of subjects (n = 20)

Characteristic	Males (n = 10)	Females (n = 10)
Age, years	20.8 ± 1.3	21.7 ± 2.9
Height (cm)	182.5 ± 8.3	167.4 ± 5.5
Weight (kg)	75.9 ± 9.2	59.3 ± 5.9
BMI (kg/m^2)	23.3 ± 2.2	21.1 ± 2.2
Body Fat (%)	9.9 ± 4.4	20.8 ± 3.2
Fat-Free Mass (kg)	68.3 ± 7.6	46.4 ± 3.6
Running Distance per week (km)	34.6 ± 5.5	37.2 ± 7.4
Caffeine Intake (mg)	72.5 ± 85.2	184 ± 142.9

Protocol

Familiarization Testing. At the first laboratory visit, all the experimental procedures were explained to the subjects. The subjects underwent an orientation involving practice of treadmill running and familiarization of the various measurement instruments, equipment, affect measures and perceived exertion. Affect was measured using a validated 11-point Feeling Scale, [12] with participants informed that their responses should reflect the affective or emotional components of the exercise and not the physical sensation of effort or strain. The OMNI Walk/Run Perceived Exertion Scale [13] was used to measure the physical perceptions of exertion for overall body (RPE-O), legs (RPE-L) and chest (RPE-C). Following the orientation session, anthropometric measures were obtained including height (cm), weight (kg), fat free mass (kg) and fat mass (% and kg). Height (cm) was measured using a physician's scale (Detecto, Webb City, MO). Weight (kg) and body composition (fat and lean mass) was measured using a Tanita bioelectrical impedance analyzer (BIA) (TBF-310GS Tanita Corporation of America, Arlington Heights, Illinois). Next, the participants performed a 5KTT familiarization trial, followed by a further five separate visits

requiring the completion of the same exercise following the ingestion of either ED, CAF, TAU, GLU, or a control treatment entailing no supplementation in a randomized order. A control trial was conducted to obtain a reference point measure of performance.

Running Time Trial. Subjects began a 5 min warm-up run on the treadmill before the start of the 5KTT. Following the completion of the warm-up run, the treadmill was brought to a standstill (0 $km \cdot hr^{-1}$). At this point all timing devices were reset, the distance covered on the treadmill monitor was reset, a 5-s count down was given and the 5KTT began.[2, 14] Subjects were instructed to finish the 5-km run as fast as possible on a motorized treadmill at 0.0% grade. Participants were provided with feedback on the distance (at regular 500-m intervals) covered during each 5KTT and were not informed of the overall performance time until completion of the final testing session. Heart rate (Polar Electro, Kempele, Finland), RPE (RPE-Overall; RPE-Chest; RPE-Legs), and affect (Feeling Scale) were recorded at 500-m intervals during the 5-km time trial. During the 5KTT, participants were allowed to adjust their pace via control buttons located on the treadmill. The speed indicator was concealed from the participant's view throughout the time trial. Therefore, subjects regulated their treadmill pace according to their perceived exertion associated with the intensity of the exercise and their subjective feelings of their running capabilities. During each treadmill run all timing devices were removed from the subject's sight. Immediately upon cessation of treadmill exercise, subjects estimated their perceived exertion, affect and a final heart rate measurement was taken. Lastly, ratings of perceived exertion and affect for the entire exercise session (session RPE and session affect) were obtained 5 minutes following the 5KTT.

Before each TT subjects were re-familiarized with all scales, reminded to go '*all-out*' during exercise, and were asked if they experience any symptoms associated with ingestion of the beverage, which was ingested. All experimental trials took place at the same time of day to avoid circadian variation. Each testing session was separated by one week to ensure adequate recovery between tests, and to allow sufficient time for CAF withdrawal before the next exercise bout.

Once the experimental protocol was completed, but before participants were informed of the values assessed during each condition, participants were asked to identify the differences between trials. The participants were asked "*Please identify which trial was the energy drink Red Bull consumed, which trial was caffeine consumed, which trial was taurine consumed, which trial was glucose consumed*". The researchers recorded the responses and was used as a form of post hoc qualitative analysis. After completion of all conditions, participants were thoroughly debriefed.

Treatment Ingestion. Subjects were randomly assigned to consume a commercially available ED (Red Bull®), CAF (160 mg), TAU (2 g), and GLU (54 g). The CAF, TUA, and GLU conditions were developed with a flavor profile similar to the commercial ED brand (Red Bull®). Carbonated-based water (500 ml, 0 mg caffeine, 0 kcal) was used for the drinks and was artificially colored and flavored (MiO®, Kraft Foods, Northfield, IL). Drinks were artificially sweetened to mask any potential flavor that the functional ingredients might provide. Volumes for the drinks were measured with a graduated cylinder, and the dry ingredients were measured to the nearest 0.001 g on a calibrated balance scale (Denver Instrument, Bohemia, NY). We conducted taste testing to assess the taste profile of beverages 2-4 to ensure that it tasted similar to Red Bull®. The beverages were served cold (~6 °C) and were administered to the

subjects 60 minutes before the test began. The subjects were instructed to drink the beverage within 2 minutes of receiving it. The drinks were consumed 60 minutes before each exercise trial because several studies have shown an ergogenic effect from Red Bull® ED ingestion 60 minutes before exercise.[1, 2, 11] In order to ensure a double-blinded design, each drink was presented to participants in an opaque sports bottle. To avoid the placebo effect in the experimental trials, we did not inform the subjects about the names of the drinks and we presented all drinks as having similar ergogenic properties.

Statistical Analysis

Statistical analyses were performed using SPSS version 23.0 (SPSS Inc., Chicago, IL). Statistical significance was set *a priori* at $p < 0.05$. Descriptive statistics were calculated for all variables. Data were tested for normality using the Shapiro-Wilk test. Performance data (5-km running time), mean exercise heart rate, affect, RPE-Chest, RPE-Legs, RPE-Overall, Session RPE and Session affect were analyzed using a one way repeated measures analysis of variance. A 5 x 10 (condition x distance) repeated measures analysis of variance was conducted to assess the effect of distance, treatment, and interaction between distance and treatment, on heart rate, affect, RPE-Chest, RPE-Legs, RPE-Overall, and time covered at each 500-m interval during the5KTT. *Post hoc* analyses of significant main and interaction effects were conducted where appropriate using the Bonferonni adjustment to determine which conditions were significantly different. The assumption of sphericity was confirmed using Mauchly's test. Greenhouse-Geisser epsilon corrections were used when the sphericity assumption was violated. In addition, a Paired samples *t*-test was used to analyze the overall 5KTT performance and related physiological and perceptual responses between CAF-containing beverages (CCB: CAF and ED) and non-CAF-containing beverages (NCCB: GLU and TAU). For the primary outcome variable of exercise performance, differences in competitive NCAA Division III male and female 5,000-m were calculated from years 2017, 2016, and 2015. Meaningful worthwhile change was defined as the mean difference in performance time between individual positions for the first four finishers in these national competitions (e.g. difference between 1st and 2nd, 2nd and 3rd and 3rd and 4th). National level performance differences between the top four finishers where 0.55 ± 0.15% (0.41 ± 0.35% and 0.69 ± 0.57% for males and females respectively). Since in measures of performance the null hypothesis test (and related *p* value) may fail to detect practical significance, we also used inferential statistics based on interpretation of magnitude of effects.[15] To perform this analysis, the *p* value produced from the paired sample *t*-test on overall 5KTT performance between CCB and NCCB, was inserted into the magnitude-based inference software.[16] The method (spreadsheet) computes quantitative and qualitative probabilities that the true effects of the drinks were beneficial, trivial, and harmful when a value for the smallest worthwhile change is entered. The smallest worthwhile change calculated was 0.4% (4 seconds) for 5KTT because it represents the smallest worthwhile enhancement for runners in time trials lasting less than 30 minutes.[17] Threshold probabilities for a substantial effect based on the 90% confidence limits were: <.5% most unlikely, 0.5-5% very unlikely, 5-25% unlikely, 25-75% possibly, 75-95% likely, 95-99.5% very likely, 99.5 most likely. A custom spreadsheet designed for cross-over trials was used to perform all of the calculations.

Results

Caffeine Consumption

Data from the habitual caffeine consumption questionnaire indicated that before testing, 3 subjects were caffeine naïve, 12 subjects reported consuming less than 200 mg caffeine/day, and 5 subjects reported consuming >200 mg caffeine/day,

and intake ranged from 0 to 420 mg/day. There were no differences in performance variables (5-km time trial performance) between caffeine-consuming subjects and caffeine-naïve subjects or between men and women ($p > 0.05$). Lastly, subjects consumed caffeine (through the ED and CAF) in the range of 1.8-3.2 mg/kg body weight (average 2.4 mg/kg body weight of CAF).

Time Trial Performance

Time trial performance did not differ across conditions ($p = 0.799$) (Fig. 1A; Table 2). Nonetheless, mean time for completion of the 5KTT was lower for the conditions that did contain caffeine, (ED and CAF) relative to the conditions that did not contain caffeine (TAU, and GLU), (overall: 9.8 sec, 0.7%; males: 8.4 sec, 0.6%; females: 11.3 sec, 0.8%) (Figure 1B). The inter-individual range of improvement was 9.5-130 seconds. The aforementioned differences in 5KTT time for the CCB was greater than the defined minimal worthwhile change for related national populations. Using the spreadsheet to calculate the clinical and mechanistic magnitude-based inferences, we found that the difference between CCBs and NCCBs were possibly beneficial in respect to 5KTT performance (Beneficial/Trivial/Harmful: 70/19/11%). Therefore, it can be argued that the CCBs had a small, but meaningful practical effect on race performance in the current study.

Table 2. Physiological and Perceptual Data for 5-km Time-Trial Performance (N=20)

Variable	CON	ED	CAF	TAU	GLU
TT (s)	1420.1 ± 161.4	1409.3 ± 153.1	1414.9 ± 163.2	1427.7 ± 178.8	1416.2 ± 167.7
HR (beats·min^{-1})	179.5 ± 8.7	178.7 ± 10.2	180.1 ± 8.3	177.1 ± 7.9	179.2 ± 7.4
RPE-O	6.1 ± 1.2	6.2 ± 0.9	6.3 ± 0.9	6.1 ± 1.2	6.1 ± 0.9
RPE-C	5.6 ± 1.8	6.0 ± 1.3	5.9 ± 1.4	5.8 ± 1.5	5.6 ± 1.5
RPE-L	6.0 ± 1.2	6.2 ± 0.9	6.2 ± 0.9	6.1 ± 1.2	6.1 ± 0.9
Affect	0.32 ± 1.9	0.25 ± 2.0	0.22 ± 1.8	0.43 ± 1.9	0.44 ± 1.7
Session RPE	7.5 ± 1.3	8.1 ± 1.1‡	7.8 ± 1.3	7.5 ± 1.3	7.7 ± 1.2
Session Affect	0.05 ± 2.5	-0.15 ± 2.7	-0.15 ± 2.4	0.15 ± 2.7	0.10 ± 2.7

Data are Mean ± SD. *Note*. TT = time trial; HR = heart rate; RPE-O = RPE for overall body; RPE-C = RPE for chest; RPE-L = RPE for legs; RPE = rating of perceived exertion (OMNI rating of exertion); CON = control; ED = energy drink; CAF = caffeine; TAU = taurine; GLU = glucose.
‡ Significantly different than control, taurine and glucose condition ($p<.05$), but not caffeine condition

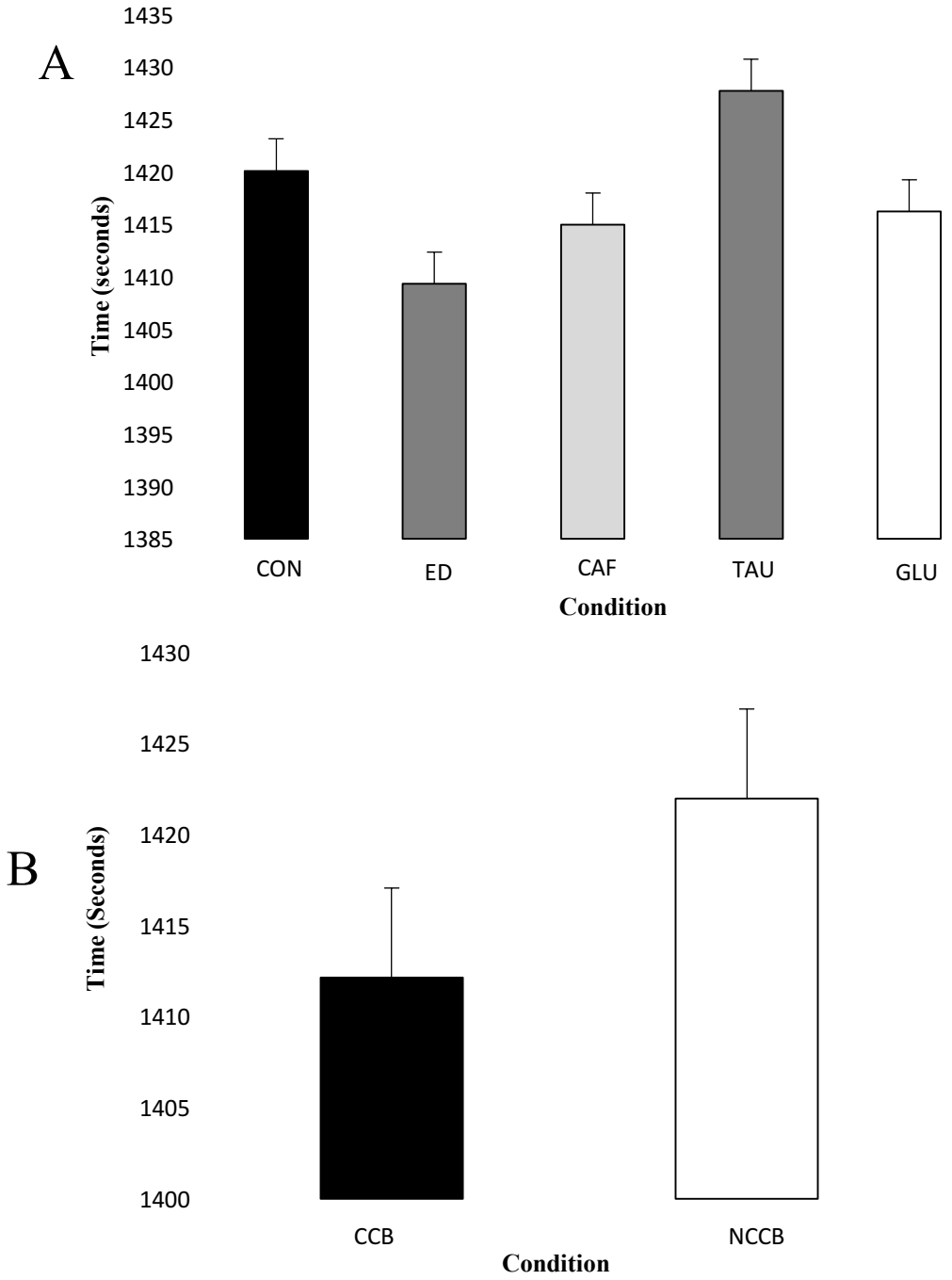

Figure 1. A) Mean ± SD Time to complete the 5KTT expressed in seconds. CON = control; ED = energy drink; CAF = caffeine; TAU = taurine; GLU = glucose. $p > 0.05$. B) Time to complete the 5KTT for CCBs and NCCBs. CCBs = caffeine containing beverages (caffeine and energy drink); NCCB = non caffeine-containing beverages (glucose and taurine). Black bars = CCB; White bars = NCCB. Values are Mean ± SD. ($n = 20$).

Session RPE

Results indicated a significant difference for session RPE between conditions (p = 0.025) (Table 2). *Post hoc* analysis showed that session RPE ratings were significantly higher in the ED trial (8.1 ± 1.1) compared to GLU (7.7 ± 1.2), TAU (7.5 ± 1.3) and CON (7.5 ± 1.3) but not CAF (7.8 ± 1.3) condition (Fig 5A). There was not a significant condition × gender interaction (p = 0.437). Results from a paired sample t-test indicated significant differences (p = 0.005) in session RPE between the CCB (7.9 ± 1.1) and NCCB (7.5 ± 1.1).

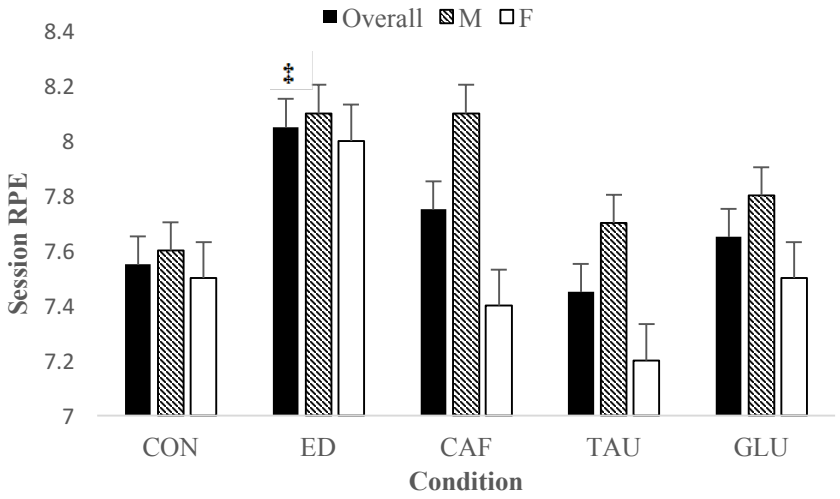

Figure 2. Mean ± SD Session RPE in response to ingestion of CON, ED, CAF, TAU, or GLU. ‡ = ED trial higher compared to GLU, TAU and CON but not CAF condition (p = 0.025)

Heart Rate, RPE, and Affect

Heart rate, and RPE (Chest, legs, and overall) increased significantly during exercise (p<.0001), while affect deceased significantly during exercise (p<.0001), however there was not a significant effect for treatment for any of the aforementioned variables (p > 0.05).

Discussion

The purpose of this investigation was to evaluate the independent and combined effects of ED functional ingredients, caffeine, taurine, and glucose on exercise performance time as well as related physiological and perceptual responses of recreational endurance runners on a 5-km running time trial. To our knowledge this is the first study to evaluate the effects of ED functional ingredients on 5KTT performance. These data demonstrated no change in 5KTT performance between treatments.

Our primary findings are in agreement with some studies[3, 18] while contradicting others.[1, 2] In regards to the effects of ED ingestion of high intensity middle distance TT performance, Prins *et al*.[2] studied the effect of 500 ml of the ED Red Bull when provided 60 minutes before exercise in male and female recreational endurance runners. The authors found that the ED significantly improved 5KTT performance by 2.12% compared with a placebo condition. Similarly, Ivy *et al*.[1] found that 500 ml of a commercially available ED (Red Bull®) resulted in ~4.7% performance improvement during a cycling time trial. However, previous findings regarding the ergogenic potential of EDs are not

consistent. For example, in a study by Schubert *et al*.[18] six male runners completed three 5KTT after the ingestion of either two caffeinated energy shots or a placebo. Results demonstrated no change in 5KTT performance between treatments. Another study by Philips *et al*.[3] failed to demonstrate any performance improvement relative to a CON when ingesting either 500 ml ED (Red Bull®) or a CHO-and CAF-matched cola beverage before undertaking a 25-mile TT. The differing result could be explained by the experimental design. The predominant experimental design that has been used to establish the evidence-based support for EDs has involved a drink and placebo comparison. Given the varied composition of individual EDs, this design does not make it possible to ascribe any positive effects to a single ingredient or to an interactive effect between ingredients.[19] Therefore, the current study provides novel data for the literature regarding the effects of acute ED functional ingredients ingestion on human exercise performance.

The finding that CAF when provided in isolation (CAF) did not improve high intensity short duration endurance TT performance is also in disagreement with some studies. The results from Research by O'Rouke *et al*.[20] demonstrated that consuming 5 mg/kg BM of CAF significantly improved 5KTT performance by 1.1% in recreational runners compared to placebo. In addition, Bridge and Jones, [21] reported improved performance after consumption of 5 mg/kg BM of CAF (1.2%) vs. placebo condition during an 8KTT. It is typically reported in studies where there was no influence of CAF or ED on performance that the dose of CAF administered may not have been great enough to elicit a significant response. Previous research has found CAF dosages between 3-6 $mg \cdot kg^{-1}$ BW is ideal to improve exercise performance.[22] In the present study, CAF dose in the 500 ml of the ED and CAF conditions (CCBs) was 160 mg (2.4 mg/kg BW of CAF). These data provide further evidence that lower CAF doses do not positively impact exercise performance. This finding is of practical importance since lower amounts of CAF more accurately reflect quantities consumed by athletes (i.e. in EDs or cola beverages).

Although CAF is claimed to be the primary ergogenic ingredient in the ED Red Bull®, this commercially available product also contains other potential performance enhancing ingredients including, TAU and CHO. The effects of TAU on performance are not thoroughly understood. However, TAU is currently claimed as a functional ingredient in many commercially available ED, with manufacturers claiming it has numerous ergogenic effects. There has been limited research examining the effect of isolated TAU ingestion on performance. The present study found that acute TUA ingestion (2g) did not improve 5KTT performance. This finding is in agreement with research by Rutherford *et al*.[23] who found that the consumption of 1.66g of TAU 1h before exercise did not improve TT performance. However, the outcome from the study by Balshaw *et al*.[24] somewhat contradict the finding from the present study. The authors found that 1g of TAU significantly improved 3KTT performance by 1.7% compared to a placebo. The difference in results may, in part, be explained by differences in methods employed. The protocol used by Balshaw *et al*.[24] administered TAU two hours before the start of the TT. In the present investigation, all treatments where administered sixty minutes before exercise. A two hour ingestion period has previously been shown to be required to achieve peak plasma TAU levels.[25] Therefore, the lack of an ergogenic effect in the present study could be due to the timing of the administration of TAU.

Another ingredient in the ED Red Bull® is CHO. Results from the present study indicate that acute CHO ingestion (54 g GLU) does not improve 5KTT performance (1416.2 ± 167.7 sec). It is well documented that endurance exercise

performance can be extended if CHO are included in the fluid consumed during exercise.[26] However, the efficacy of CHO ingestion when provided before exercise on high intensity short duration endurance performance is equivocal. To our knowledge, no studies have demonstrated an ergogenic effect of CHO ingestion when the experimental protocol lasted 30 minutes or less.[27, 28] Palmer *et al*.[28] investigated the effect of CHO ingestion (39 ± 4 g of CHO) immediately before exercise on 20KTT performance in 14 well-trained cyclists and found no effect on performance when compared to a placebo.

In the CCBs, TT performance was 9.8 and 8.0 seconds faster compared to NCCBs and CON, respectively, whereas the CON condition was 1.9 seconds faster than the NCCB. Although these 5KTT values were not statistically different from one another, it could be argued that an 8-9.8 second improvement in 5KTT performance could significantly improve race results. When using the Batterham and Hopkins[15] technique to calculate clinical and mechanistic magnitude-based inferences, we found that a 9.8 second difference in race time within our sample enabled a 70% confidence in the inference that the population effect would be beneficial. Additionally, the reported improvement in performance for the CCB (0.7%) was greater than the defined minimal worthwhile change for related national populations (0.55%). These improvements, albeit small, are meaningful to athletes as differences in performance between first and third place has been calculated to be 0.07% (0.53 seconds) in the 5,000 m event.[29]

Session RPE results indicated higher ratings in the ED trial compared to GLU, TAU and CON, but not CAF. In addition, session RPE was significantly higher in the CCBs (7.9 ± 1.1) than NCCBs (7.5 ± 1.1). Results from the present study seem to contradict the majority of the literature that reveals attenuated RPE in response to CAF ingestion. In a review article, Doherty and Smith[30] examined 21 studies, and data revealed lower RPE during prolonged constant-load exercise. However, they also reported that RPE is unchanged during exhaustive high intensity exercise. It is possible that during short-term, high intensity exercise in which fatigue is due to PCr depletion, acidosis, and/or central fatigue and not glycogen depletion, CAF does not reduce RPE.[31]

There were some limitations to this study. These data can only be applied to active individuals performing lab-based running exercise simulating a 5KTT. The sample size was relatively small and a larger sample size may be optimal to further elucidate the potential impact of ED functional ingredients on running performance. Further, expired gases and blood data were not measured in the present study; these data may have provided mechanistic insight explaining the present findings.

The use of pre-exercise EDs has become a popular supplementation habit among competitive athletic populations. The administration of 500 ml of the ED Red Bull® has improved both psychological and physical performance in previous investigations. However, very few studies have investigated the independent effects of the main functional ingredients found in the commercially available ED Red Bull® on TT performance. The current study found no significant benefit of the ED or the isolated ED functional ingredients on TT performance when consumed sixty minutes before exercise in men and women recreational distance runners. These results may have application for altering pre-exercise nutritional strategies in athletes and exercising individuals.

Media-Friendly Summary

Energy drinks are typically consumed by athletes before exercise with expectations of improved performance. Surprisingly, few studies have examined the independent effects of the main functional ingredients found in energy drinks (for example: caffeine, glucose and taurine). The claims of the performance enhancing effects of the main "active" ingredients contained in energy drinks remain unproven. Is there some unique interaction between the ingredients contained in these drinks or does a singular ingredient provide the benefit? According to the present study, 500 ml of a popular energy drink when provided 60 minutes before exercise did not improve 5-km running performance when compared to the functional ingredients commonly contained within. Data from this study suggests that a commercially available energy drink does not provide any additional performance enhancing effect above that of caffeine, taurine and glucose.

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Author Disclosure Statement

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