# Effect of Pre-Exercise Drinks on Anaerobic Endurance Performance

**Ben Stayton**

**Abstract:**

This study was undertaken to discover the effects of pre-exercise drinks on anaerobic endurance performance. Fifteen ODU baseball players (ages 18-22) volunteered to perform the running-based anaerobic sprint test (RAST) after ingesting 8oz. of water, Gatorade, or Red Bull energy drink. The fifteen players were randomly divided into three groups which were assigned a schedule of beverages to ingest on each day of the test. Each group started with one beverage each on the first day and rotated around the three drinks. Six days of testing were used to allow for each athlete to ingest each beverage twice so that performance increases from the general exercise would not be a factor. A RAST calculator was used to measure the peak, average, and minimum power output for each test along with a fatigue index. Four out of the original fifteen athletes completed the basic requirements with only one athlete completing the entire testing regimen by testing through both rounds of procedures while ingesting all three beverages for each round. After all tests were completed a repeated measures ANOVA was used on the fatigue indexes for each athlete for each beverage to determine statistical significance. Gatorade and Red Bull were found to have no significant endurance

performance increase over water during an anaerobic sprint test ($F(2,6)= 0.241$, $P > 0.05$).

**Introduction:**

The prospect of increased performance drives athletes to discover ways to gain that peak performance. The fastest and most widely used method of gaining increased performance is through performance enhancing substances. Not all of these substances are illegal and some of them are actually very natural. Three examples of legal substances that could help improve endurance performance are water, Gatorade, and Red Bull energy drink. The basic physiological effect created by these three drinks acts to help cool down the body during exercise (among other effects), making it work longer than it normally would at the continually increasing temperature. Both Gatorade and Red Bull have additional nutrients (carbohydrates) to help feed the body's metabolic demand to keep endurance up as well. Gatorade has other specialized nutrients which help maintain cellular response along with other properties during exercise. Red Bull alone has two final ingredients which could further extend the time an athlete could exercise: caffeine and taurine. By looking at the effects of pre-exercise drinks on anaerobic performance we may establish how much of a performance gain one can get with Gatorade and Red Bull over water. With the carbohydrates and additional nutrients (electrolytes) in Gatorade and the carbohydrates and caffeine and taurine in Red Bull the athletes expect to see a significant increase in performance over the water. All athletes did receive some kind of liquid since rehydration is necessary to keep up a minimum level of performance

endurance (von Duvillard et al. 2004) and this study was done to show the advantages of Gatorade and Red Bull over water and not over dehydration itself.

**Literature Review:**

One key ingredient in both the Gatorade and Red Bull that should decrease fatigue is carbohydrates. Winnick et al. (2005) tested athletes using basketball style testing, running 20m sprints and using maximal vertical leap. After four quarters of play the athletes who ingested carbohydrates had faster sprint times as well as significantly higher leaps. Jeukendrup (2004) also provides many examples of how carbohydrates increase endurance performance. Carbohydrates are a necessary ingredient in muscle contraction, helping provide metabolic fuel and while they may act to increase the active temperature of the body through these continued muscle contractions. The water that is in the drinks helps to decrease core temp through sweating, expiration, and other normal cooling methods (von Duvillard et al. 2004).

Since carbohydrates are a natural source of energy for all living organisms it would make sense that an overabundance would continue to provide athletes with more energy. The biggest problem with carbohydrate absorption during exercise is the actual amount of carbohydrates that are absorbed in the small intestine do not equal that which was initially ingested. Lang et al. (2006) experimented on glucose absorption during exercise and found that both active and passive intestinal absorption is significantly decreased. This is due to the loss of blood flow and thus performance throughout the gastrointestinal system.

Forbes et al., (2007) used Red Bull to elicit a significant increase in upper body muscle endurance. In their research they allowed an hour after ingestion for the full effects of caffeine to occur. Wiles et al., (2006) used 76.5 minutes with 60 minutes of rest and 15 minutes of warm up time and an additional 90 seconds of stretching before their cycle test. These were twice as long as the research done by Alford et al., (2001) in which they stated that a significant amount of caffeine was absorbed into the body after 30 minutes. Wiles et al. (2006) found that caffeine significantly increased short term, high intensity exercise verses a placebo (71.1+2.0 vs. 73.4+2.3) and Alford et al. (2001) had similar findings ($P < 0.05$). Forbes et al. (2007) had a positive mention for upper body muscle endurance but no significance for average or peak power output with a Wingate cycle test.

Caffeine has a similar physiological effect on the body to other stimulants, but runs some unique pathways. Caffeine increases glucose absorption in the intestines (Van Nieuwenhoven et al. 2000). With this increased glucose absorption, along with the increased carbohydrates (including glucose) present in the Red Bull, the caffeine should increase the available amount of glucose to the body, specifically making it more available to the muscles to increase output. Because of decreased gastrointestinal flow during exercise from sympathetic nerve regulation (Van Nieuwenhoven et al. 2000) the increased absorption of glucose aids in keeping glucose levels more even. While not increasing output it could extend the normal functioning levels of the body, thus increasing endurance while keeping max performance at normal levels.

The taurine that is included in Red Bull also has an increased effect on endurance. Many researchers have found a link between decreasing taurine levels and fatigue

(Hamilton et al. 2006, Zhang et al. 2003, Miyazaki et al. 2004). Taurine provides fuel for skeletal muscle contraction which then decreases with exertion like other nutrients. When the sarcoplasmic reticulum releases $Ca^{+2}$ into the muscle filament to bind to troponin taurine increases the amount of $Ca^{+2}$ released and causes the cells to be more sensitive to the $Ca^{+2}$ which would further increase contractibility (Hamilton et al. 2006). Taurine's contribution to increasing $Ca^{+2}$ then increases the availability for continued stimulation.

Taurine also has many properties that help the body continue functioning at optimum levels. Some of the properties are being an antioxidant, helping with detoxification and osmoregulation, and helping maintain membrane stabilization (Zhang et al. 2003). The body produces its own amount of taurine but with taurine supplementation such as that in Red Bull the endurance effects should be observably significant.

The carbohydrates in the Gatorade replenish this spent fuel by the body but the essential part of this beverage is the added electrolytes. Nerve conduction for muscle stimulation as well as any other required action potential in the process of the muscle contraction expend these electrolytes and require additional electrolytes to continue functioning at peak levels. Khanna and Manna (2005) looked at the effects of carbohydrate-electrolyte fluid on exercise performance and determined that the added nutrients provided in the sports drinks reduce the onset of fatigue and keep performance levels higher. Replenishing the electrolytes gives the cells more nutrients necessary to continue driving contraction through stimulation by action potentials.

The research done by von Duvillard et al., (2004) has confirmed that well hydrated athletes do have generally increased performance endurance over dehydrated

athletes. Hill et al. (2004) also state that even a 2-3% decrease in body weight from fluid loss can cause significant decreases in performance. Even with water alone the increased fluid content in the body would aid in keeping core body temperature lower which maintains some normal level of performance for a short period. Just like how a computer chip can overheat and become less efficient so our bodies can overheat from our internal metabolic processes and we fatigue. Hill et al. (2004) found that with water even between exercise and resting groups all liquid was absorbed into the body after 30 minutes.

The repeated measure ANOVA statistical test used was necessary due to the nature of the study. The Statistical Services department at the University of Texas at Austin through a joint website with the UCLA states that a repeated measures ANOVA is used when the measured samples are tested under many different conditions (1997). The samples are the athletes being tested under the three different conditions of each beverage. This necessitated this type of ANOVA test.

Testing was done using a Running-based Anaerobic Sprint Test or RAST (Mac, 2008). This test was engineered by researchers at the University of Wolverhampton in the United Kingdom in response to the Wingate cycle test. The Wingate cycle test is a cycling test that measures anaerobic power output using a specialized cycle ergometer. Because many sports do not use cycling as a standard movement set this test does not meet the full potential for athletes whose body is mechanically better and more proficient at running. The RAST was then developed to account for this mechanical efficiency in most athletes so that a better power output could be measured (Mac, 2008). The Wingate cycle ergometer equipment can also be expensive and if similar, more reasonable testing methods are available they can be used to keep costs down.

**Materials and Methods:**

In order to reduce any outlying variables that could skew the data many steps were taken to ensure their validity. Baseball players were chosen for their general physical fitness as athletes and for their more uniform anatomical and physiological makeup as opposed to other sport teams where these factors differ greatly within the sport (such as football). Baseball players were given instructions in print and verbally on the basis for the test and the possible risks/outcomes of the test. Testing procedures were approved by the Internal Review Board at Ohio Dominican University. To rule out climate variables all tests were performed in the gymnasium at Ohio Dominican which remains at the same or similar temperature, humidity, and wind speed (0mph) during every trial.

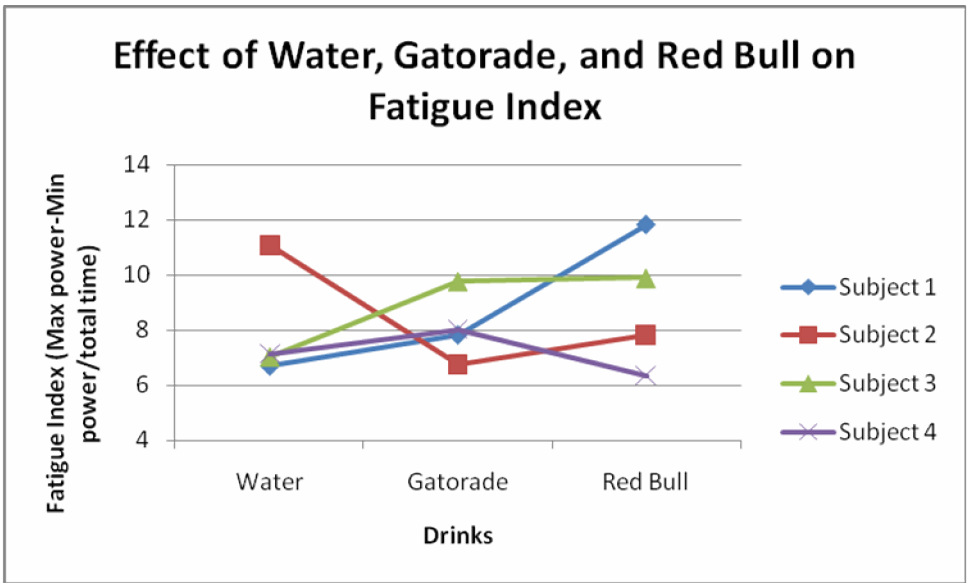
All drinks were stored at room temperature in same compartment in Saint Albert's Hall room 113 at ODU for all trials. Eight ounces of each drink were given to each athlete for each trial. Ice Mountain natural spring water, Gatorade, and Red Bull energy drink were the three liquids tested. The water may have contained some ingredients other than pure water such as natural minerals but were not labeled. Eight ounces of Gatorade contained 50 calories with 110mg Na, 30mg K, and 14g sugar (based on Gatorade label). Eight ounces of Red Bull contained 107 calories with 193mg Na and 26g sugar also including significant amount of niacin (93% RDA), vitamin B6 (240% RDA), vitamin B12 (80% RDA), and pantothenic acid (47% RDA) along with taurine and caffeine (based on Red Bull can label).

The RAST uses a 35m straight track to elicit an anaerobic response from test subjects. Subjects perform a full power sprint down track then receive ten seconds to turn around, simulating one repetition in an anaerobic exercise. Athletes perform the sprint six times each with the 10 sec turn around in order to give a maximal, minimal, and average power output as well as a fatigue index for each set of sprints. When performing the test the timer started for each sprint when the athlete took their first step into the sprint for consistency.

After all tests were completed a repeated measures ANOVA test using SPSS software version 12.0 at Ohio Dominican University was used to determine the statistical significance. Though the University of Texas at Austin mentioned in the literature used a different software program both programs use the same kind of statistical programming to determine results.

**Results:**

The athletes (n= 4) showed little change in their fatigue indexes between water (M= 7.99 $\pm$ 2.08W/sec), Gatorade (M= 8.09 $\pm$ 1.26W/sec), or Red Bull (M= 8.98 $\pm$ 2.40W/sec). There was no significant difference in the overall running times based on the fluid ingested, $F(2,6)= 0.241$, $p>0.05$. A graph of the average indexes for the four athletes shows the lack of overall trend.




**Discussion:**

Although this study does not show any relationship between the type of pre-exercise drink and anaerobic endurance performance the biological models of the effect each drink is expected to have on performance theoretically are still sound. Many outlying variables affected the study and brought the directed conclusion. Some of these variables include: lack of full-sprint effort from some athletes, lack of participation by some athletes (because of schedule conflicts or otherwise), change in outside sports conditioning of athletes during the test, improper time recording, and improper time duration for nutrient absorption.

One of the biggest variables affecting the study was the lack of commitment to the study by the participants. Ten participants attended the first trial and the study ended with only one athlete. Because of this outcome insufficient data and no real conclusions can be made. Even with the four athletes who were able to ingest all three beverages no significant trend was shown. A larger sample size might have shown some results but

most likely would have shown this same trend. Because of this trend other variables become more important as to why the ideology doesn't fit with the research. These included differences in body mass and proceeding with a fixed fluid intake system.

The 8 oz. of drink could have affected each athlete differently because of varying body masses. However, most athletes completing the study were within 10kg of each other. Some athletes of higher body mass showed the same amount of drink affected them less than athletes with significantly less body mass. This is the same as observed with other kinds of fluids, such as alcoholic beverages. Larger drinkers of alcohol always have a slight advantage in tolerance levels to smaller built drinkers because their bodies have more cells to spread that alcohol between. In this same way the nutrients and caffeine/taurine in the drinks along with the general fluids would have been less concentrated in a larger individual.

Another large reason that Red Bull did not outperform the other drinks could be the lack of desire from the athletes to ingest the beverage. While initial speculations were that most students drank Red Bull the specific group of student athletes in this study generally stayed away from this beverage because of their knowledge of its poor nutritional value and its poor taste. While I applaud their views on proper nutrition and using better ways to increase alertness and endurance for the purposes of this study their lack of desire could have again hampered the results. This negative psychological outlook on the beverage could have then caused the athletes to run at a slower pace instead of the full-out sprint they were required to perform.

The RAST is a fairly recent invention and could be a poorly designed test for this type of research. Other anaerobic output performance besides the RAST or the Wingate test (no results per Forbes et al. 2007) could be used to uncover any positive results.

**Conclusion:**

More research is needed to determine any causal effects of pre-exercise drinks on anaerobic endurance performance. All of the theoretical models and other research have shown that the ingredients in Red Bull should produce greater endurance than Gatorade, which should in turn produce greater endurance than water alone. With more strict regulations on the surrounding environment of the athletes (such as amount of sleep, caloric intake, type of clothing, etc.) and an increased motivation to properly perform the test perhaps a significant difference could have been seen between the three drinks and their resultant fatigue indexes. Other factors such as the amount of beverage per kg ingested by each athlete, the pre-existing knowledge of each drink received (using a double blind study), and the type of testing methods used could also be adjusted accordingly to try and find some positive results in future studies.

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