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# Influence of sports drink taste preference on consumption in adult recreational soccer players

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# Influence of Sports Drink Taste Preference on Consumption in Adult Male Soccer Players

by

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**Abstract**

Sports drinks provide nutrients that improve athletic performance. This study investigated whether a preference in taste leads to an increased consumption of a sports drink prior to and after an endurance event in athletes. Male amateur soccer players (n=16) first participated in a blind sensory evaluation to determine their taste preference for two (designated as Drink A and Drink B) similarly flavored sports drinks. Subjects were divided into two groups based on their taste preference for either drink. They then participated in 9 soccer matches and were presented with either Drink A, Drink B, or water (3 trials each) before and after matches. Volumes of drinks voluntarily consumed were measured and averaged. Both groups consumed similar amounts of either Drink A or Drink B, before and after matches. Taste preference for a drink did not influence the amount of a sports drink that athletes consumed pre- or post- exercise.

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## Chapter 1: Introduction

The manufacturing of sports drinks has become a powerful industry, which earned 6.3 billion dollars in revenue in 2012 (Mintel, 2012). Mintel, a market research firm, has projected the industry to grow by 52% from 2013 to 2017. Gatorade, which is currently owned by PepsiCo, was the first sports drink manufacturer when it introduced its product commercially in 1967 (Kays & Philips-Han, 2003). Since then, several other manufacturers such as All-Sport, Coca-Cola's PowerAde, and smaller brands such as Seattle-based Golazo have attempted to gain market share in the industry. Many of these manufacturers incorporate similar ingredients in their drinks. Some of the homologous ingredients include simple carbohydrates such as sugar, electrolytes such as potassium and sodium, and water. These ingredients enhance athletic performance by providing fuel, hydrating the body, and by replenishing minerals lost through sweat. In addition to these ingredients, each manufacturer incorporates flavor into their products to enhance taste, making the drink attractive to potential consumers.

One of the goals of sports drink manufacturers is to maximize sales to consumers. According to the Mintel (2012) report, about two in five adults consume sports drinks, with the Hispanic population being the heaviest users, as well as individuals in the 18-to-24-year-old age group. People buy these products for several reasons. Two of the main reasons are taste and the potential benefits for the body during athletic competitions. As for the benefits, a study by Von Duvillard, Braun, Markofski, Beneke, and Leithäuser (2004) advocated that athletes should consume fluids containing carbohydrates and electrolytes for events lasting longer than an hour. The study further stated that failure to do so may result in hampered performance and may lead to serious medical problems

such as dehydration. Another study by Friedman and Elliot (2008) showed that mere exposure and not consumption of popular sports drinks increased endurance in persistent tasks. This suggests that sports drinks have an added psychological effect on performance (Friedman & Elliot, 2008).

Gatorade's web site (Kays, 2003) elaborates the four main ways their product helps improve athletic performance: rapid fluid absorption; rapid rehydration; providing carbohydrate energy to working muscles; and encouraging consumption, due to its palatability, until thirst is fully quenched. Rapid fluid absorption is important during strenuous activity in order to avoid dehydration. A 6% carbohydrate level by volume along with the presence of salt is optimal for fluid absorption (Caldwell, 1997). Rapid rehydration is achieved through the presence of sodium, which helps maintain body fluids. Carbohydrate energy in the form of sugar (sucrose in Gatorade) provides fuel for the body. Lastly, the presence of glucose and sodium encourage people to drink until they are fully hydrated as sugar makes the product sweeter therefore increasing palatability, while salt enhances the thirst mechanism by increasing extracellular sodium concentrations (Johnson & Thornhorst, 1997). A researcher (Caldwell, 1997) from Vanderbilt University investigated these claims and concluded that they were largely accurate.

The Academy of Nutrition and Dietetics, along with the Dietitians of Canada and the American College of Sports Medicine (2009), issued a joint position statement on nutrition and athletic performance. According to this position statement, carbohydrates for athletes are recommended in a range from 6 to 10g/kg of body weight per day to maintain blood glucose levels during exercise and replace muscle glycogen.

Furthermore, sodium is an important electrolyte as it regulates blood volume, blood pressure, osmotic equilibrium, and pH. Potassium is also an important electrolyte that controls fluid and electrolyte balance, nerve transmission, and active transport mechanisms. Sports drinks containing sodium and potassium are recommended for athletes, especially those participating in high-endurance events. Dehydration, due to water deficits from exercising, can decrease exercise performance. Active individuals need to drink enough fluids to replace sweat losses during exercise in order to maintain maximum potential for athletic performance.

Taste and palatability may be another reason individuals consume sports drinks, although according to the Mintel report mentioned earlier, only 40% of consumers surveyed cited taste as being a major reason they consume sports drinks (Mintel, 2012). The sensory pathway of taste begins with receptor cells which are located on taste buds (Lindermann, 1996). Food appraisal is associated with a hedonic tone, which describes the pleasure-related acceptance of a given taste. It involves the activation of midbrain dopamine neurons and may be accompanied or induced by the release of endogenous opiates in the hypothalamus. Whether positively perceived tastes can influence higher consumption of a sports drink is not known and remains to be investigated. This is significant as sports drink manufacturers could potentially optimize their sales by making a better tasting product than their competitors. Other major reasons for intake of sports drinks include being a thirst quencher, as a beverage to drink during and after exercise, and as an anytime beverage.

The objective of this study was to determine how taste can influence how much of a drink is consumed prior to and after sports competition. This information may help to

develop current and new sports drinks for optimal nutrition and marketability since consumers cited in previous studies (Mintel, 2012) that only 40% of their choice to consume a sports beverage was dependent on taste. It has been shown that optimal nutrition can enhance performance in athletes (Academy of Nutrition and Dietetics, 2009). The participants of this study were athletes who competed in a sport, rather than people in the general population. If taste is shown to influence consumption levels, then athletes may get more of the nutrients that could help them perform better in their sport. It should be noted that performance will not be evaluated in this study, just taste and consumption at various points of exercise.

The two drinks that were studied were designated as "Drink A" and "Drink B," which were chosen for various reasons. Drink A is an established brand and a popular sports drink. Drink B is from a smaller company based on the west coast. Drink B specifically markets their products to soccer players, as well as their fans. Since the participants of the study were soccer players, then a sports drink marketed toward these players was a logical fit for testing.

**Purpose and Objectives**

The purpose of this study was to investigate whether a preference in taste leads to an increased consumption of a sports drink prior to and after an endurance event such as a recreational league soccer match. The main objective of this study was to determine whether there was a correlation between perceptions of taste preference and consumption. First, to determine taste preference, a taste test survey with two sports drinks was conducted. To better understand the participants taste perceptions, a sensory evaluation

questionnaire was utilized during the taste test portion of this study. Subsequently in nine separate trials, consumption levels were monitored prior to and after an exercise activity.

This study specifically determined the extent to which taste preferences and perceptions for sports drinks play a role in pre- and post-exercise consumption. Companies who develop sports drinks may alter their methods to consider taste as a stronger factor when developing a product intended to supply an athlete with the nutrients necessary to perform at an optimal level.

**Research Hypothesis**

Athletes who prefer the taste of one sports drink over another will drink more of that preferred drink before and after exercise, which would then potentially provide them with additional nutrients and fluids compared to the drink that was preferred less.

## Chapter 2: Literature Search

A literature search was conducted using Pub Med and Proquest, accessed through Eastern Michigan University's online library system. Key words that were used for this search were "sports drinks," "taste," and "endurance" with relevant studies appearing from 1971 to 2015. There were few articles that directly linked taste to sports drink consumption and exercise performance. Lee, Nio, Ang, Law, and Lim (2011) included a taste evaluation questionnaire in their consumption and performance study, which will be discussed later. Other articles that were chosen for review independently centered on either taste perception or the effects of sports drinks on exercise performance.

### Sensory Perception of Sports Drinks Pre- and Post-Exercise

Exercise has been shown to change sensory perceptions of sports drinks (Ali, Duizer, Foster, Grigor, & Wei, 2011). The pleasantness of a beverage is important for fluid replacement during exercise and the likelihood of consumption increases when the fluid is perceived as pleasant. Ali (2011) conducted a study to examine sensory perceptions of different formulations of sports drinks when consumed prior to, during and after exercise. Fourteen recreational runners were recruited for this study in a single blind counterbalanced design. Four trials were conducted with different concentrations of carbohydrate and/or electrolyte fluids: 7.5% carbohydrate, 421 mg/L electrolyte, 7.5% carbohydrate 140 mg/L electrolyte, 1.3% carbohydrate, 421 mg/L electrolyte, and water. Subjects were provided with 50 ml samples of each solution to ingest. They then rated the intensity of sweetness, saltiness, thirst-quenching ability, and overall liking of each solution before, during, and after running on a treadmill for two hours. Ratings of

sweetness for the two higher carbohydrate drinks were higher during exercise relative to pre- or post-exercise. Sweetness ratings for the low carbohydrate, high electrolyte drink increased with duration of exercise. Saltiness intensity ratings decreased for all energy-containing drinks during and post-exercise when compared to pre-exercise. Overall likability and thirst-quenching ability increased with exercise when compared to pre-conditions. The investigators concluded that significant changes in sensory perceptions and likeability/thirst-quenching ability occurred when subjects consumed sports drinks during and after exercise compared to pre-exercise conditions. These results may indicate that overall consumption of sports drinks increases post-exercise when compared to pre-exercise conditions.

**Methods of Taste Comparisons and Evaluation of Taste Perceptions**

The taste of a sports drink may make a difference in the amount of a drink consumed by a subject. Taste influences caloric intake and warns the body against ingesting harmful substances (Scott, Yan, & Rolls, 1995). It is a sense that is capable of detecting bitter, sweet, sour, salty, and umami stimuli (Lindemann, 1996). Distinguishing between these modalities provides valuable sensory input. When creating a product for consumption, it is assumed that sports drink manufacturers incorporate a pleasant taste into their drinks. In addition, a palatable intake is known to enhance fluid intake during exercise (Minehan, Riley, & Burke, 2002). Though preference for tastes is subjective and differs from person to person, studies have been conducted that help objectify taste perceptions, which will be discussed in the following paragraphs.

Bartoshuk (2000) compared taste perceptions across individuals using psychophysical advanced methods. Genetic variations in taste are possible as assessed by the development of psychophysical techniques that permit comparisons across individuals. A very early approach (Fechner, 1860) compared taste perceptions using a simple scaling technique, which measured suprathreshold intensities. The "suprathreshold" indicated the stimulus change necessary to produce a noticeable difference in taste intensity (i.e., the level of sweetness, sourness, etc. of a food or drink). This method was discounted by Stevens (1961) many years ago because intensities could not be logically determined. For example, on a hypothetical scale of taste intensity that ranged from 1 to 10, 10 should be twice a strong as 5, but this was not the case. A modern ratio scale was constructed by Stevens (1969) for taste sensation, which created a sense of relativity among the strength and weaknesses of certain tastes. Magnitude estimates were established by asking subjects to assign numbers to perceived intensities, where one stimulus that was twice as strong as another would be assigned a value twice as much as the "weaker" stimulus. Since subjects provide their opinion when defining a stimulus, relative intensities are measured within a subject and not across subjects. A variation of this approach could be used to determine specific taste stimuli such as sweetness and saltiness. Lee et al. (2011) provided a questionnaire to subjects who rated sweetness, saltiness, and pleasantness/palatability of three types of fluids: a carbohydrate-electrolyte drink (similar to a sports drink), a sugar-free and electrolyte-free sweetened placebo drink, and water. Analysis of the questionnaire's answers showed that sweetness was ranked highest with the carbohydrate-electrolyte drink, intermediate with the placebo, and lowest with water. The carbohydrate-electrolyte drink and placebo were

rated similarly salty and both were perceived saltier than water. Pleasantness/palatability was rated higher with the carbohydrate-electrolyte drink than with water. Further details of the Lee et al. (2011) study that focused on consumption and exercise performance will be discussed in a later section. In addition, the participants of the study were "trained" in taste evaluation methods. In the article titled "Sensory Assessment of Food Quality" found in Food Quality Evaluations, Rao (2013) discussed the importance of training individuals before administrating a sensory test. Brief training was required because no instrument had been devised that can reflect the complexity of human taste perception.

**Flavored Drinks on Preference and Fluid Intake in Team Sports**

Palatability, including factors such as flavor has been demonstrated to influence fluid ingestion (Minehan et al., 2002). Minehan (2002) investigated the effect of flavor on preferences and fluid balance in athletes. They sought to determine if flavor was a positive or negative characteristic in determining voluntary fluid intake. Nine elite female netball players, seven female basketball players, and eight male basketball players participated in their study. Fluid intake was measured over nine training sessions for each individual using three formulations of fluid: a high carbohydrate-electrolyte solution, a low carbohydrate-electrolyte solution, and water. Similar training was undertaken in each sport in order to make valid comparisons. During these sessions, subjects were allowed to drink as much fluid as they desired of the drink provided for that session. At the end of each session, subjects were asked to rank the drinks provided in that session according to taste using a 5-point Likert scale.

Results of the study showed no significant differences between the taste preferences of the high and low carbohydrate drinks or water. Subjects consumed significantly more of the flavored drinks than water. There was no difference in fluid intake between the high carbohydrate and low carbohydrate beverages. The investigators concluded that better fluid intake was achieved when beverages were flavored.

**Electrolytes in Sports Drinks and Water Balance**

Electrolytes are ions that form when salts dissolve in fluids (Longe, 2008). Potassium and sodium are the two primary electrolytes in sports drinks. These electrolytes can alter the flavor of sports drinks by producing an extremely mild salty taste. The amount of electrolytes is typically small in relation to the water and sugars that are included in sports drinks. For example, 591 ml (20 fluid ounce) of an orange flavored Gatorade contains 250 milligrams of sodium, 65 milligrams of potassium, and 35 grams of sugar. In addition to altering the taste of sports drinks, sodium and potassium serve important physiological roles, especially in people who exercise. Sodium affects how much urine the kidney produces and is involved in the transmission of nerve impulses and muscle contractions. Potassium ions help to regulate fluid balance in cells, the transmission of nerve impulses, and in muscle contraction. Lindinger and Sjogaard (1991) found that increases in interstitial potassium concentrations of contracting muscles directly stimulate heart rate and the rate of ventilation. In addition, localized potassium causes a vasodilatation of the vascular bed within contracting muscles. This results in increased blood flow to isometrically contracted muscles. These responses to potassium can aid exercise performance. In addition, sodium and potassium have been shown to

help retain water to prevent dehydration during exercise (Maughan & Shirreffs, 1997). A 1 to 2% reduction in bodyweight due to loss of water can affect exercise performance due to potential cramping, dizziness, etc. (Berardi & Andrews, 2010).

**Carbohydrates in Sports Drinks**

Carbohydrates that provide the sweet taste experienced in sports drinks are also the primary source of fuel used to power an athlete and help them continue their workouts when they feel fatigued. Carbohydrates are broken down into glucose molecules, which provide energy for the body's cells and tissues (Longe, 2008). The consumed glucose oxidizes and contributes to energy by preventing a decline in blood glucose concentrations (hypoglycemia), which may cause fatigue (Davison et al., 2008). Most commercially available sports drinks have a 4 to 7% carbohydrate to volume of fluid ratio for optimal nutrition (Ryan, 1997). Carbohydrates are used to create an ergogenic effect on endurance, which is likely related to sparing of liver glycogen, prevention of hypoglycemia, as well as maintaining high rates of carbohydrate oxidation (Jeukendrup, 2008).

**Athletes Who Consume Sports Drinks and Effects on Exercise Performance**

Many studies have been published that examined the nutritional effects of consuming sports drinks on athletes leading to improvements in exercise performance. A study conducted by Lee (2011) tested the effects of sports drinks on endurance capacity. The sports drinks were administered immediately before, during, and after the exercise bout with 12 physically active males. Endurance was tested in a second subsequent bout.

Subjects adhered to the following pre-trial rules: a standardized dietary intake, avoidance of strenuous physical activity, abstinence from alcohol 24 hours prior to each trial, an overnight fast, and ingestion of 500 ml of water 90 min before arriving to the lab; subjects were also prohibited from drinking liquids thereafter. Subject's familiarized themselves with the exercise trial prior to their actual recorded participation. The experimental protocol consisted of three total exercise trials consisting of three phases a piece. The participants ingested either water, sports drink, or a placebo in each of the three trials, respectively. Each trial was randomized and spaced seven days apart, commencing at the same time of day. The treatments were provided in a double-blind, cross-over manner between the sports drink and the placebo. The first phase of each trial consisted of a 75 minute bout of cycling. Portions of test fluid (sports drink, placebo, or water) equivalent to 1.5 ml/kg of body mass were administered immediately before the start of the exercise and at 15, 30, 60 and 75 minute mark of the cycling bout. The second phase of the trial consisted of the five-hour recovery period. The participants ingested an aliquot of the test fluid (sports drink, placebo, or water) during this period and the ingestion time was standardized to minimize differences in fluid retention due to the rate of dehydration. The amount of the test fluid was equivalent to 150% of sweat volume. Sweat loss estimates were taken from the differences in body mass. The third and final phase of the trial consisted of the endurance capacity test. The results showed that endurance capacity after athletes consumed a sports drink was 25.4% greater than with water and 19.3% greater than with a placebo.

A study by Byars, Keith, Simpson, Mooneyhan, and Greenwood (2010) examined the effectiveness of a pre-exercise sports drink on aerobic endurance performance (time

to exhaustion) during a graded exercise test. Twenty-nine recreationally active college students volunteered for this investigation using a citrus flavored drink. The ingredients of this product were aloe vera extract, calcium citrate, L-carnitine, choline bitartrate, citric acid, fructose, lecithin, lemon oil powder, magnesium aspartate, magnesium succinate, medium chain triglycerides, potassium aspartate, potassium succinate, silicon dioxide, gum ghatti, arabinogalactan, and glucosamine hydrochloride. The participants of this study ran on a treadmill at low intensity and no incline at the beginning of the trial. At every subsequent three-minute interval, speed and incline increased. Two trials were conducted within a week of each other with at least 48 hours between trials. Subjects were asked to adhere to the following pre-test conditions: wear comfortable, loose-fitting clothing; drink plenty of fluids over the 24-hour period preceding the test; avoid food, tobacco, alcohol, and caffeine for three hours prior to taking the test; avoid exercise or strenuous physical activity the day of the test; and get an adequate amount of sleep (6 to 8 hours) the night before the test. Each subject was given the recommended dosage of a pre-exercise sports drink or a placebo (citrus-flavored water). The results showed a significant mean difference in time to exhaustion between the group who consumed the sports drink and the group who did not. Subjects who consumed a pre-exercise sports drink showed an average of 2.55% increase in time to exhaustion than subjects who consumed a placebo drink. Therefore, this study observed that aerobic performance improved and endurance activities enhanced when participants consumed a pre-exercise sports drink prior to the test.

**Sports Drink Consumption with Soccer Players**

Siegler, Mermier, Amorim, Lovell, McNaughton, and Robergs (2008) focused on sports drinks and exercise performance, but with an additional test treatment, glycerol. The addition of glycerol was not relevant to the current study, but other elements of this study, namely involvement of sports drinks, exercise, and the subjects being soccer players were relevant. This study used athletes that performed their activities on the field (i.e., during a scheduled practice), rather than during a separate workout protocol, such as using a stationary bike or performing drills, like a shuttle run. Two types of sports drinks were used: one with a 5% carbohydrate solution and another with a combination of 5% carbohydrate and a low dose of glycerol. Both of these drinks were similar in flavor. The drinks were supplied in a balanced, double-blind format. The subjects consisted of ten soccer players. When these individuals arrived at the testing facility, they were asked to void their bladders and then sit for five minutes to allow for postural stability. The exercise protocol called for consumption of 500 ml of either the carbohydrate drink or carbohydrate-glycerol solution before the training session trial, which consisted of four periods of 15 minutes of training. Temperature measurements were taken at the start of each trial using a wet bulb thermometer. At the end of the second period (halftime), an additional 500 ml of sports drink or carbohydrate-glycerol drink was required to be consumed. At the end of the fourth period, all subjects participated in a structured endurance test. There was a 48-hour washout period between two trials where the drinks were alternated for each of the trials. The results of this study showed that there were no significant differences in time to exhaustion between the 5% carbohydrate drink and the one with glycerol added. There was no significant difference in endurance performance

between the athletes who drank the carbohydrate-glycerol drink and those who drank the carbohydrate-only drink as noted by the similar times of the time to exhaustion test.

**Amount and Timing of Consumption**

Many sports drink manufacturers use similar flavor profiles in their drinks. Fruit punch, lemonade, and orange are some of the more common flavors. Although flavors may be similar, the discrepancies in taste may make for a large difference in how much an athlete consumes before and after their workout. If an athlete does not drink enough fluid that contains carbohydrates and electrolytes, they may not get the benefits of turning food energy into sustained performance. Carbohydrate consumption is especially critical for performance. Fielding, Costill, Fink, King, Hargreaves, and Kovaleski (1985) determined that there may be a minimum amount of 22 grams of carbohydrates per hour required to observe a performance benefit. Their study showed that when half of this amount was administered to subjects, no performance benefit was observed. In contrast, there was a point of sports drink consumption where additional ingestion of carbohydrates becomes unnecessary. Large amounts of carbohydrate administrations greater than 75 grams per hour have shown no additional benefits in endurance capacity (Jeukendrup, 2004). This suggests that there is an optimal and maximal amount of carbohydrates that provides benefits for athletes. No further enhancement in carbohydrate bioavailability was speculated to be a potential cause of the limit.

The timing of administration of a sports drink was examined in a 2004 study by Davidson (2008). This study focused on the endurance effect of consuming a sports drink beverage 15 minutes prior to exhaustive exercise. Ten recreationally active male subjects

volunteered for this randomized, double-blind experiment. The performance test called for four intermittent shuttle runs of 15 minute blocks. Each block consisted of ten 90 second segments of 3 x 20 minute walks, 1 x 20 minute max sprints, 3 x 20 minute jogging, and 3 x 20 minute fast runs. The final block was completed to exhaustion. Each of the participants was provided with either a 6% carbohydrate-electrolyte drink, water, or no fluid 15 minutes before each trial. No fluid was provided during the test. The participants were required to follow their usual diet for three days prior to the first trial, and each trial was spaced seven days apart. The results of the time to exhaustion test showed that with sports drinks (649 ± 95 seconds) there was a significant improvement in endurance over the placebo (601 ± 83 seconds) or with no fluids at all (593 ± 107 seconds). Sports drinks taken 15 minutes before exercise can therefore be beneficial to athletes who compete in activities lasting around an hour or longer.

**Summary**

To summarize, the review of literature provided information on taste perception and consumption of sports drinks on athletes. Two methods used to evaluate taste perceptions are scaling techniques and questionnaires. In the proposed study, a questionnaire was used to determine taste perceptions on sweetness, saltiness, and palatability. A scale between 0 and 10 was used to quantify these perceptions. Carbohydrates and electrolytes have shown to positively benefit exercise performance. Electrolytes can regulate fluid balance and help to retain water to prevent dehydration. Carbohydrates serve as fuel that propels subjects to perform longer during events that test endurance. There is potentially a minimum amount of carbohydrate consumption that

provides benefits for endurance capacity. There is also potentially a maximum amount of consumption, beyond which any additional consumption does not have any advantage on endurance capacity. Consuming a sports drink in the period just before exercise improved effects in endurance capacity. In all, this information was used to design the methods of the study.

## Chapter 3: Research Methodology

The objective of this study was to determine whether taste can influence how much of a sports drink is consumed prior to and after sports competition.

### Sample Population

Twenty-five ethnically diverse adult male participants, aged 29 to 58 years, from various men's soccer recreation leagues in the greater Seattle area were recruited for this single-blind crossover study.

### Research Design

Prior to the start of the study, a recruitment e-mail (see Appendix A) was sent out to 30 prospective participants informing them of the study protocol, which included a section discussing specific restrictions on dietary intake and physical activity. These participants were asked to adhere to these restrictions, which were agreed upon prior to participation of the study. Participants needed to eat three regular meals (breakfast, lunch, and dinner) on the days that the study was conducted, as well as the prior day. They were to have no strenuous physical activity prior to participation on the day of the study and were to abstain from alcohol 12 hours prior to each trial. They also had to fast for two hours prior to participation in the study. Participation in this study was completely voluntary and individuals could choose to decline participation. This recruitment process occurred through the investigator's friends and family who have participated in various men's soccer recreation leagues. Those who replied that they were willing to participate were contacted further. Those who chose to participate first

read and signed an informed consent agreement (see Appendix B) which was provided, in person, by the investigator. The study proceeded after all agreements and informed consent forms were received by the investigator.

For the first part of this study, a taste test survey and sensory evaluation were conducted that compared the taste preferences between sports drinks from two different manufacturers. They were designated as "Drink A" and "Drink B." In addition, two specific tastes (sweet and salty) as well as palatability of the drinks were analyzed. The flavor of both drinks was orange in order to keep the tastes similar between the two products. The ingredients in Drink A's orange drink were sucrose, dextrose, citric acid, salt, sodium citrate, natural orange flavor with other natural flavors, monopotassium phosphate, partially hydrogenated soybean and cottonseed oils, and Yellow 6. The ingredients in Drink B's orange drink were water, cane sugar, coconut water concentrate, vegetable juice, citric acid, natural flavors, and salt. To conceal the identity of the beverages, the drinks were poured into two color-coded small cups. A different color represented each manufacturer's drink.

The test was administered to 25 amateur soccer players who consented to participate in the study. To keep the participants identity concealed, they were given random identification (ID) numbers by the investigator, which was used for the taste test and the subsequent consumption study. Prior to consumption of the first drink, the participants were given a written questionnaire (see appendices C and D). This questionnaire was prepared using a combination of a standard taste test questionnaire from "Sensory Assessment and Food Quality" in *Food Quality Evaluation* by Rao (2013) and questions developed in a previous study (Lee et al., 2011), which were modified by

the investigator using guidelines from *Food Quality Evaluation*. When the questionnaire was administered, participants were instructed to write their provided ID numbers on the paper and informed to read the instructions written. The taste test section of the questionnaire consisted of a scale that ranged from 0 to 10. Answers to this portion of the questionnaire were in the form of a Likert scale. The sensory evaluation part of the questionnaire consisted of three questions. A ratio scale that ranged from 0 to 10 accompanied each question of the questionnaire. This type of scale was used as it best estimates the relationship between sensory magnitudes (Stevens, 1969). Participants circled a value from 0 to 10 that corresponded to their answer. For example, one of the questions was "On a scale of 0 to 10, how sweet would you say this beverage is?" Participants sipped the first drink and answered the first question on the questionnaire (see Appendix C) by circling a number from 0 through 10 to express their approval or disapproval of the drink. They then answered the three sensory evaluation questions. Two of the questions evaluated specific tastes: sweetness and saltiness intensities. Before answering the questions, subjects were "trained" for sensory evaluation of drinks.

Pure sugar and salt sample packets in their original packaging were provided to train subjects to accurately assess sweetness and saltiness intensities. Subjects opened the sugar packet (sucrose, C&H) first and sprinkled a small amount on their tongue. The intensity of sweetness of sugar was assigned a value of 10, which corresponded to the 10 on the ratio scale of the questionnaire. Next, the participants were provided a cup of water to rinse their mouths, which "cleansed their palate." This water was spit out into a container that was provided by the investigator. Following this cleansing period, the participants took another sip of the first drink from the same cup as before and answered

the questions regarding sweetness. The same design method occurred with the salt packet (Morton's), with the salt intensity being assigned a value of 10 on the ratio scale of 0 to 10. This method was a standard means of conducting sensory evaluations because it allowed participants a way of comparing what would be considered the highest intensity of sweetness/saltiness in a sports drink. For example, if pure sugar was considered a 10 on a scale of 0 to 10 and a participant believed that one of the sports drinks tasted half as sweet as the sugar packet, then logically they would rate the sweetness of that drink a 5 on the scale.

After this section of the questionnaire was filled out, each participant consumed a plain, unsalted cracker and sipped water to cleanse his palate before tasting the second drink. After this washout period, the participants took a sip of the second drink and completed the second questionnaire (see Appendix D) which followed the same pattern as the first. As previously described, the participants did not know the identity of the drink and the investigator did not know who preferred one drink over another. The results of the sensory evaluation were recorded, and one drink was determined to be the preferred drink in terms of taste for that specific individual.

The second part of the study took place on multiple days when participants engaged in physical activity by voluntarily participating in an indoor recreational league soccer match, for which they had previously signed up. The average environmental temperatures recorded were $65^{\circ} \pm 1.0^{\circ}$ F (mean ± SE). The same subjects who participated in the taste test participated in the second part of this study. These participants were asked to adhere to certain restrictions that were agreed upon prior to participation of the study, which were outlined earlier in this chapter.

On match days, participants were provided with a 64 fluid ounce coded container (with their assigned number) of orange flavored Drink A or orange flavored Drink B sports drink or tasteless tap water (as a control) 15 minutes prior to the beginning of their match. Participants were instructed to drink only from containers with their assigned numbers. Participants then drank as much fluid as they felt comfortable drinking. The remaining fluid was retained and later measured using a 2-liter graduated measuring container. Subsequently, subjects participated in a soccer match and were physically active.

At the conclusion of the match, subjects were again provided with 64 ounces of the same drink that was consumed earlier and asked to drink as much as they wanted. Again, the drinks were poured into clean containers to conceal their identities from the participants. The remaining fluid was retained and the volume measured using a 2-liter graduated measuring container. This protocol was repeated at the next match using the alternative sports drink as the test beverage. A water control was administered at the following subsequent match. Volumes of sports drinks consumed for all participants was measured and correlated with their preferred drink. A total of three trials per fluid were administered and the results were averaged. Subjects who felt ill on any day were excluded from participation. If a subject was not able to participate on a trial one day, the trial was made up at the next match until all participants completed three trials of each drink. In all, there were a total of nine trials per individual.

**Comparisons and Statistical Analysis**

In the first part of this study, preference for taste perception between orange-flavored Drink A and orange-flavored Drink B of participants was determined. The second part of the study compared how much of each drink was consumed prior to and after physical activity. Specifically, an individual's taste preference was compared to how much of a beverage they consumed. Therefore, the second part of the method attempted to identify correlations with the first part (i.e., the drink subjects preferred was examined with how many milliliters were consumed of the preferred drink compared to the non-preferred drink). Answers to the sensory evaluation questionnaires were compared between both drinks. Specifically, sweetness and saltiness intensities of the drinks as well as palatability were compared and analyzed to see if these traits caused differences in preferences and consumption levels between two groups: the group that preferred the taste of Drink A and the group that preferred the taste of Drink B. A paired t-test was used to determine statistical significance between the differences in the sensory evaluation of these groups, and another paired t-test was used to determine statistical significance between preferences of the drinks and levels of consumption of the groups. SPSS software was used to conduct the statistical analysis.

## Chapter 4: Results

Twenty-five (n=25) subjects participated in the study. Sixteen (n=16) of the twenty-five completed the taste test, sensory evaluation, and the three drink consumption trials with Drink A, Drink B, and water, respectively. Results of those who did not complete all the trials were not included in the study. All results are provided as mean ± standard error (SE).

### Demographics

The subjects' average age, height, and weight are shown in Table 1. The average age of subjects was 42.1 ± 10.5 years, their average height was 67.1 ± 10.5 inches, and their average weight was 171.6 ± 19.2 pounds.

Table 1

*Age, Height, and Weight Demographics of the Subjects*

| | **Mean (n = 16)** |
|---|---|
| **Age (years)** | 42.1 ± 10.5 |
| **Height (inches)** | 67.1 ± 4.3 |
| **Weight (lbs)** | 171.6 ± 19.2 |

*Note*. Sixteen subjects participated in the study. Age, height, and weight statistics were collected and averaged. Results are provided as mean ± SE.

### Preference for the Sports Drinks

To determine drink taste preference, subjects were provided with samples of both sports drinks and then asked to evaluate their tastes using written surveys/questionnaires on a scale of 0 to 10. Zero indicated they extremely disliked the taste, 10 indicated they extremely enjoyed the taste, and 5 indicated a neutral taste representation. The subject's preferred drink was determined by the higher score given between the two drinks on the

questionnaires. Seven of the 16 subjects preferred the taste of Drink A (n = 7), while nine preferred Drink B (n = 9). No subjects rated the tastes of each drink equally.

The subjects who preferred the taste of Drink A rated it with a score of 7.43 on a scale of 10 for Drink A, which suggested that they enjoyed the taste. They rated the taste of Drink B as 5.00 on the scale, indicating a neutral taste perception for Drink B. There was a significant (p = .0001) difference between the taste of Drink A and Drink B for subjects who preferred the taste of Drink A. Subjects who preferred the taste of Drink B rated the taste of Drink A as 4.0 on the scale, which suggested a mild dislike of the taste versus 7.33 for Drink A, which suggested they enjoyed the taste (Table 2). There was a significant (p = .020) difference between the taste of Drink A and Drink B for subjects who preferred the taste of Drink B.

Table 2

*Taste scores for subjects who preferred the taste of Drink A or Drink B*

| | **Preferred Drink A (n = 7)** | **Preferred Drink B (n = 9)** |
|---|---|---|
| **Drink A Taste Score** | 7.43 ± .787* | 4.00 ± 2.64** |
| **Drink B Taste Score** | 5.00 ± 1.12* | 7.33 ± 1.00** |

*Note*. Taste scores from subjects who preferred the taste of either Drink A or Drink B were averaged for Drink A and Drink B. Scores were based on a scale from 0 to 10, where 0 represents extreme dislike, 10 represents extreme like and 5 is neutral. Paired t-test between the taste scores of Drink A and Drink B resulted in a significant difference for subjects who preferred the taste of Drink A or Drink B ($P<.05$). Results are provided as mean ± SE.

* Taste scores of Drink A and Drink B were significantly different (p = .0001) for subjects who preferred the taste of Drink A.

** Taste scores of Drink A and Drink B were significantly different (p=.020) for subjects who preferred the taste of Drink B.

All subjects filled out a questionnaire that evaluated the sweetness, saltiness, and palatability of the drinks on a scale from 0 to 10. Table sugar and salt samples were provided for the subjects as references for what constituted a 10 on the sweetness and saltiness scales. The subjects were grouped based on their taste preferences, and the

results were tabulated into an average score. It was then determined whether subjects who preferred the taste of Drink A or Drink B found the drinks "sweet" or "salty."

**Sweetness of the Drinks**

The group that preferred the taste of Drink A reported a sweetness score on their questionnaire of 6.14 for Drink A and 4.14 for Drink B. The group that preferred the taste of Drink B reported a sweetness score of 4.44 for Drink A and 5.22 for Drink B (Table 3).

Table 3

*Sweetness Scores for Subjects Who Preferred the Taste of Drink A or Drink B*

| | **Preferred Drink A (n = 7)** | **Preferred Drink B (n = 9)** |
|---|---|---|
| **Sweetness of Drink A** | 6.14 ± 0.71 | 4.44 ± 0.80 |
| **Sweetness of Drink B** | 4.14 ± 0.91 | 5.22 ± 0.52 |

*Note.* Table showing sweetness intensity scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. Scores were based on a scale from 0 to 10, where 0 represented no sweetness relative to sugar, 10 represented the sweetness of sugar, and 5 represented a value that is half as sweet as sugar. Results are provided as mean ± SE.

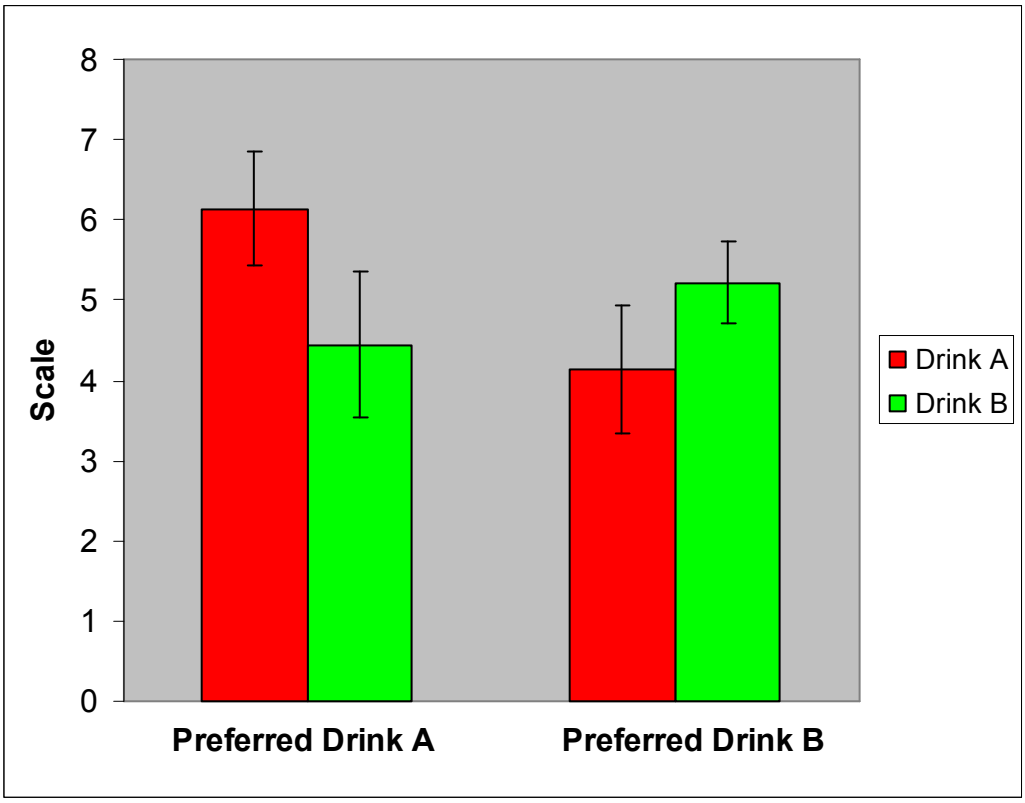


*Figure 1*. Visual display of sweetness results for subjects who preferred the taste of Drink A or Drink B. Bar graph showing sweetness intensity scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. No significant differences in sweetness by paired sample t-test were evident ($P > .05$) for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

Subjects who preferred the taste of Drink A marked that Drink A was slightly more than three-fifths as sweet as table sugar and they marked the sweetness of Drink B to be slightly less than half of that of sugar. Subjects who preferred Drink B marked that the sweetness of Drink A was slightly less than half the sweetness of sugar and Drink B was slightly more than half the sweetness of sugar.

The sweetness of a drink may be a trend of taste preference since those subjects who preferred the taste of Drink A gave sweetness a higher average score for Drink A than Drink B. Subjects who preferred taste of Drink B marked that Drink B was sweeter than Drink A. A paired t-test indicated that there was no significant difference between

sweetness intensity scores for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

**Saltiness of the Drinks**

The group that preferred the taste of Drink A reported a saltiness score on their questionnaire of 5.29 for Drink A and 4.14 for Drink B. The group that preferred the taste of Drink B reported a saltiness score of 1.22 for Drink A and 2.20 for Drink B (Table 4).

Table 4

*Saltiness Questionnaire Results for Subjects Who Preferred the Taste of Drink A or Drink B*

| | **Preferred Drink A (n = 7)** | **Preferred Drink B (n = 9)** |
|---|---|---|
| **Saltiness of Drink A** | 5.29 ± 0.68 | 1.22 ± 0.47 |
| **Saltiness of Drink B** | 4.14 ± 1.03 | 2.20 ± 0.69 |

*Note.* Table showing saltiness intensity scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. Scores were based on a scale from 0 to 10, where 0 represented no saltiness relative to table salt, 10 represented the saltiness of table salt, and 5 represented a value that is half as salty as table salt. Results are provided as mean ± SE.

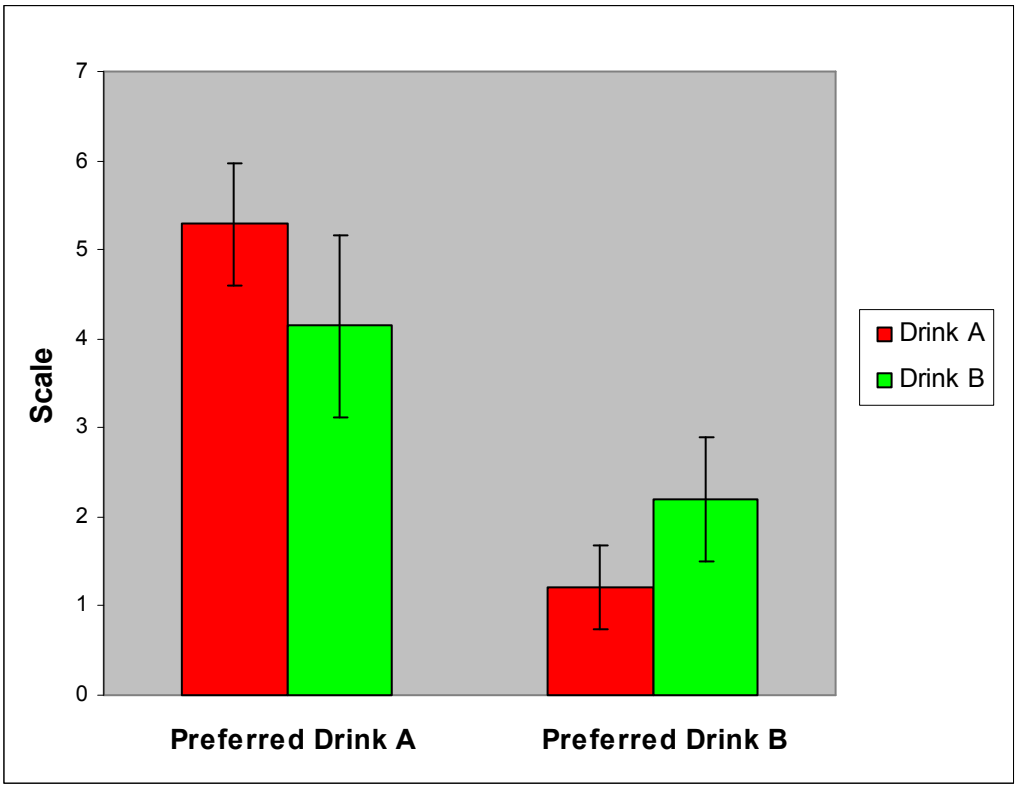


*Figure 2.* Visual Display of Saltiness Results for Subjects Who Preferred the Taste of Drink A or Drink B. Bar graph showing saltiness intensity scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. No significant differences in saltiness by paired sample t-test were evident ($P > .05$) for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

Subjects who preferred the taste of Drink A indicated that Drink A was about half as salty as table salt. The subjects indicated that Drink B was a little less than half as salty as pure salt. Subjects preferring the taste of Drink B indicated that Drink A was barely salty, but they found Drink B to be nearly a quarter as salty as pure salt.

The saltiness of a drink may be a trend of taste preference since those subjects who preferred the taste of Drink A gave saltiness a higher score for Drink A than Drink B. Subjects who preferred the taste of Drink B marked that Drink B was saltier than Drink A. A paired t-test indicated that there was no significant difference between saltiness intensity scores for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

**Palatability of the Drinks**

The group that preferred the taste of Drink A reported a palatability score on their questionnaire of 7.86 for Drink A and 5.29 for Drink B. The group that preferred the taste of Drink B reported a palatability score of 6.55 for Drink A and 8.11 for Drink B (Table 5).

Table 5

*Palatability Questionnaire Results for Subjects Who Preferred the Taste of Drink A or Drink B*

| | **Preferred Drink A (n = 7)** | **Preferred Drink B (n = 9)** |
|---|---|---|
| **Palatability of Drink A** | 7.86 ± 0.80 | 6.55 ± 0.62 |
| **Palatability of Drink B** | 5.29 ± 1.04 | 8.11 ± 0.65 |

*Note.* Table showing palatability scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. Scores based on a scale from 0 to 10, where 0 represents that the drink was extremely difficult to consume, 10 represents the drink was extremely easy to consume and 5 represents that the drink was neither easy nor difficult to consume. Results are provided as mean ± SE.

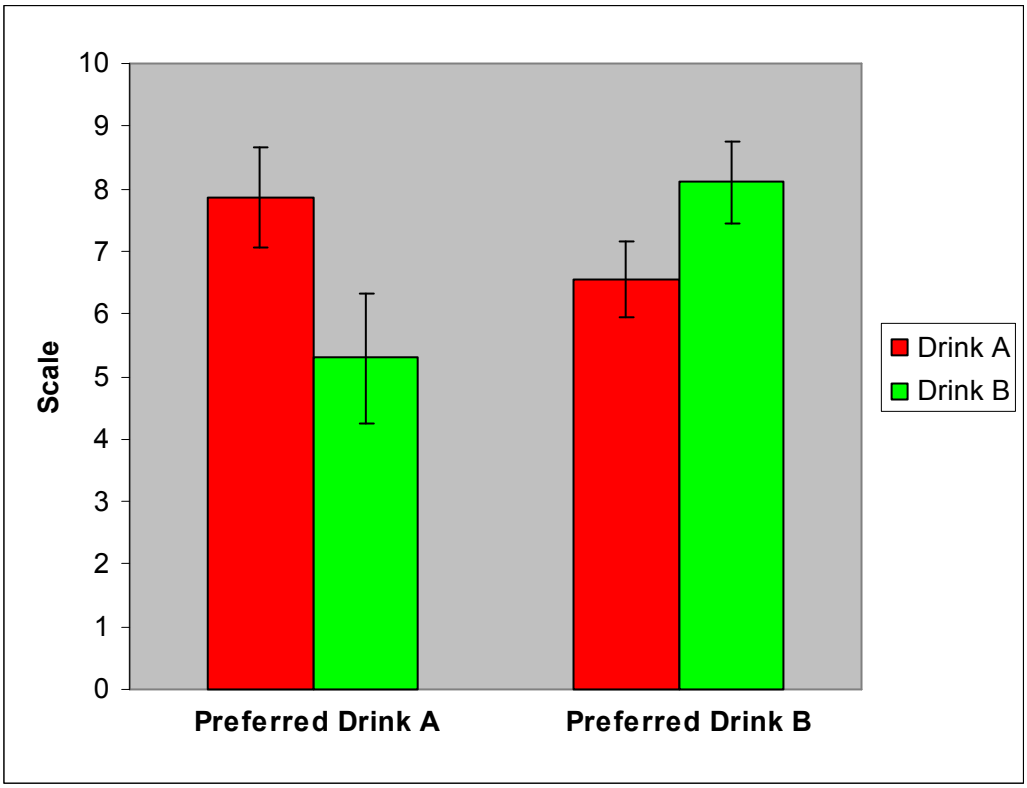


*Figure 3.* Visual Display of Palatability Results for Subjects Who Preferred the Taste of Drink A or Drink B. Bar graph showing palatability scores for Drink A and Drink B of subjects who preferred the taste of Drink A or Drink B. No significant differences in palatability by paired sample t-test were evident ($P > .05$) for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

Subjects who preferred the taste of Drink A indicated the palatability of Drink A was greater and that it was consumed fairly easily. These subjects indicated that Drink B was neither difficult nor easy to consume. Subjects preferring the taste of Drink B indicated that Drink A was mildly easy to consume, while Drink B was very easy to consume.

The palatability of a drink may be a trend of taste preference since subjects who preferred the taste of Drink A gave palatability a higher score for Drink A than Drink B. A paired t-test indicated that there was no significant difference between palatability

scores for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B.

**Pre-Match Consumption Results**

Subjects were provided containers of Drink A, Drink B, or non-flavored (tasteless) water 15 minutes prior to the start of their matches. The subjects voluntarily consumed enough of the drinks until they felt satiated. Three trials of each drink were provided and the results were averaged. The subjects were grouped based on their taste preference of either Drink A or Drink B. Subjects who preferred the taste of Drink A consumed an average of 206.67 ml of Drink A, 195.00 ml of Drink B, and 188.64 ml of water prior to their matches. Subjects who preferred the taste of Drink B consumed an average of 189.95 ml of Drink A, 179.96 ml of Drink B, and 130.89 ml of water (Table 6). Four data points were omitted from the results due to being outliers for exceeding two standard deviations from the mean.

Table 6

*Pre-Match Consumption Results for Subjects Who Preferred the Taste of Drink A or Drink B*

| | **Preferred Drink A (n= 7)** | **Preferred Drink B (n=9)** |
|---|---|---|
| **Pre-match Drink A Consumption** | 206.67 ± 13.55 | 189.95 ± 19.59 |
| **Pre-match Drink B Consumption** | 195.00 ± 30.03 | 179.96 ± 18.07 |
| **Pre-match Water Consumption** | 188.64 ± 17.60 | 130.89 ± 8.99* |

*Note.* Table showing pre-match consumption results for Drink A, Drink B, and water for subjects who preferred the taste of Drink A or Drink B. Subjects were provided unlimited quantities of either Drink A, Drink B, or water 15 minutes prior to their matches. They voluntarily consumed as much of the beverage as they wanted. Three trials of each drink were conducted. Results are in milliliters and provided as mean ± SE.

* Water consumption was significantly different ($p = .028$) from consumption of Drink A and Drink B for subjects who preferred the taste of Drink B.

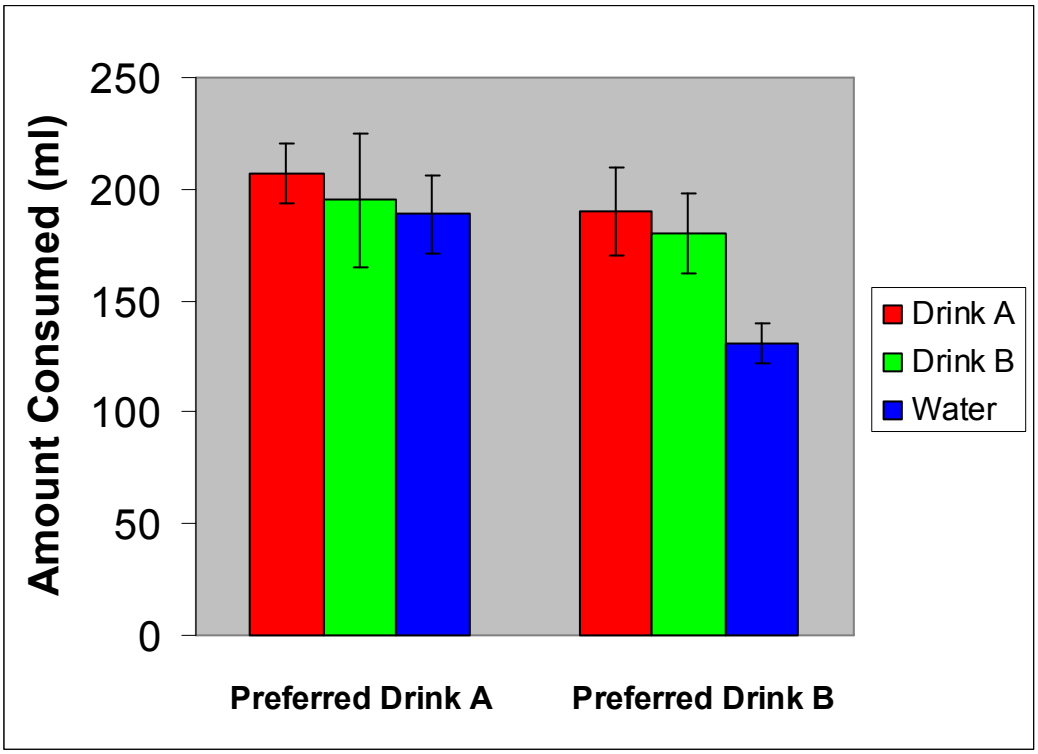


*Figure 4.* Visual display of pre-match consumption results of Drink A, Drink B, and water for subjects who preferred the taste of Drink A or Drink B. Bar graphs showing pre-match consumption results of Drink A, Drink B, and water for subjects who preferred the taste of Drink A or Drink B. No significant differences by paired sample t-test were evident ($P > .05$) between Drink A and Drink B or Drink A and water by subjects who preferred the taste of Drink A. Paired t-test between water and Drink A or Drink B resulted in a significant difference ($P < .05$) in consumption in subjects who preferred the taste of Drink B.

A paired t-test between Drink A and Drink B identified no significant differences for subjects who preferred the taste of Drink A or Drink B. A paired t-test between Drink A and water also showed no significant differences for either group. A paired t-test between Drink B and water demonstrated that there was a significant difference ($p = .028$) between consumption of water and either Drink A or Drink B for subjects who preferred the taste of Drink B.

**Post-Match Consumption Results**

Subjects who preferred the taste of Drink A consumed an average of 377.48 ml of Drink A, 394.91 ml of Drink B, and 274.57 ml of water after their matches. Subjects

who preferred the taste of drink of Drink B consumed an average of 293.56 ml of Drink A, 296.67 ml of Drink B, and 203.22 ml of water (Table 7).

Table 7

*Post-Match Consumption Results for Subject Who Preferred the Taste of Drink A or Drink B*

| | **Preferred Drink A (n=7)** | **Preferred Drink B (n = 9)** |
|---|---|---|
| **Post-match Drink A Consumption** | 377.48 ± 33.14 | 293.56 ± 34.60 |
| **Post-match Drink B Consumption** | 394.91 ± 45.51 | 296.67 ± 28.51 |
| **Post-match Water Consumption** | 274.57 ± 32.09* | 203.22 ± 16.37** |

*Note.* Table showing post-match consumption results for Drink A, Drink B, and water for subjects who preferred the taste of Drink A or Drink B. Subjects were provided unlimited quantities of either Drink A, Drink B, or water immediately after their matches. They voluntarily consumed as much of the beverage as they wanted. Three trials of each drink were conducted. Results are in milliliters and are provided as mean ± SE.

* Water consumption was significantly different ($p = .001$) from consumption of Drink A and Drink B for subjects who preferred the taste of Drink A.

** Water consumption was significantly different ($p = .001$) from consumption of Drink A and Drink B for subjects who preferred the taste of Drink B.

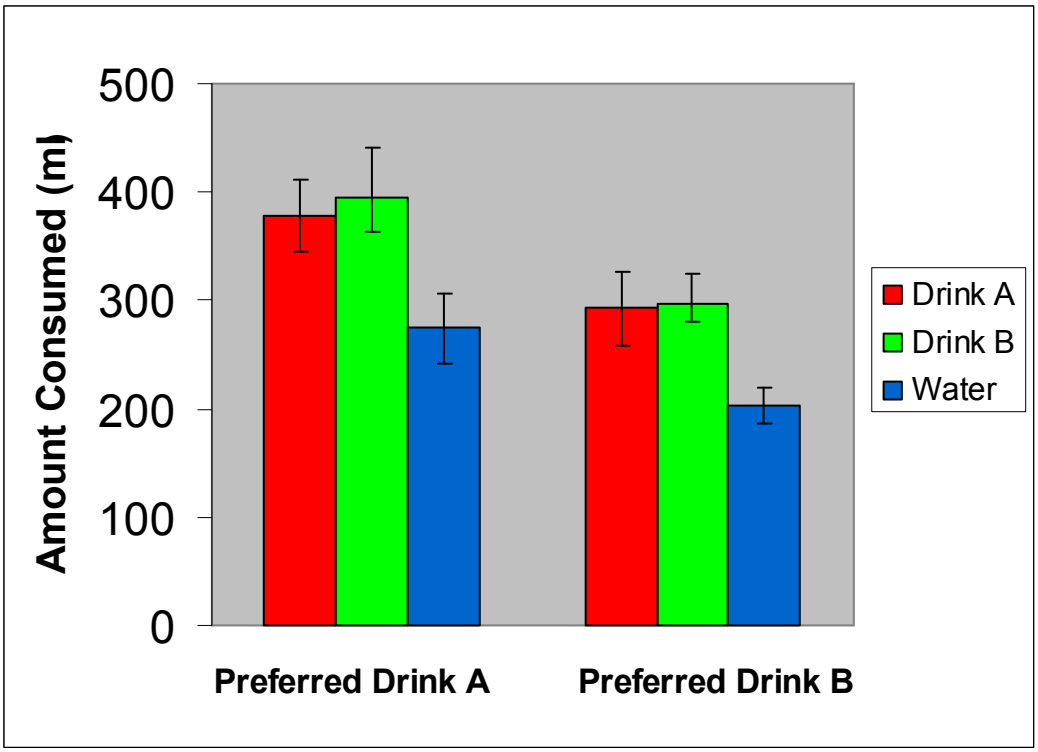


*Figure 5.* Visual Display of Post-Match Consumption Results of Drink A, Drink B, and Water for Subjects Who Preferred the Taste of Drink A or Drink B. Bar graphs showing post-match consumption results of Drink A, Drink B, and water for subjects who preferred the taste of Drink A or Drink B. No significant differences by paired sample t-test were evident ($P > .05$) between the consumption of Drink A and Drink B for subjects who preferred the taste of Drink A or Drink B. Paired t-test between the consumption of Drink A or Drink B and the consumption of water resulted in a significant difference ($P < .05$).

A paired t-test between the consumption of Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B resulted in no significant differences. A paired t-test between the consumption of Drink A and water resulted in a significant difference ($p = .001$) in subjects who preferred the taste of Drink A. Subjects who preferred Drink A consumed 102.91 ml more of Drink A than water. Likewise, a paired t-test between the consumption of Drink B and water showed that there was a significant difference ($p = .001$) in subjects who preferred the taste of Drink B. Subjects who preferred Drink B consumed 93.45 mL more of Drink B than water, post-exercise.

## Chapter 5: Discussion

All subjects distinctly preferred either Drink A or Drink B. Saltiness and sweetness intensities, as well as the palatability of a drink may be trends of taste preference. In all cases, the subjects who preferred one drink over the other marked a higher intensity or palatability on the sensory evaluation questionnaire, on average. However, paired t-tests indicated that the intensity and palatability results for subjects who preferred the taste of either Drink A or Drink B were not significantly different for Drink A or Drink B when compared. A lower than expected number of subjects who participated in this study may account for the lack of significance. Also, the taste perception subtleties caused by the amount of sugar and sodium added to these drinks may not have been apparent to subjects. Drink A used in this study contained 35 grams of sugar and 250 milligrams of sodium per 591 ml (20 fluid ounces). Drink B contained 33 grams of sugar and 125 milligrams of sodium per 591 ml (20 fluid ounces). Drink A only contained two grams more sugar and although Drink A had twice as much sodium than Drink B, the relative amount of sodium to other taste altering nutrients may have caused the perception of saltiness intensity difficult to distinguish between the two drinks.

The study conducted by Lee (2011) showed no significant differences in saltiness intensities and palatability between two similarly flavored drinks when subjects rated each on a questionnaire, which corroborates with the above results. It may be proposed that subjects perceive saltiness and palatability of similarly flavored drinks as equal, independent of taste preferences. The study found sweetness to be perceived higher in a

carbohydrate drink, as opposed to an artificially sweetened drink with no carbohydrates. The study did not use taste preferences as a factor between these drinks.

The pre-match consumption by subjects who preferred the taste of Drink A or Drink B was not significantly different between Drink A and Drink B. Subjects consumed significantly more of Drink B than water, but there were no significant differences between the consumption of Drink A and water. The subjects who preferred the taste of Drink B had two additional subjects and therefore a higher number of data points. The post-match consumption results for subjects who preferred the taste of Drink A or Drink B also showed no significant differences between the consumption of Drink A and Drink B. It may be suggested that thirst was a stronger factor in consumption of the two drinks than taste preference. Subjects may have exerted more energy during one trial as opposed to another trial causing them to lose more water through sweat and inciting a stronger response to thirst independent of whether they enjoyed the taste of one drink to the other. However, there was a significant difference in the level of consumption between both Drink A and Drink B with water in both groups, irrespective of taste preference. Participants preferred to drink the sports drinks compared to water.

When consuming a product, subjects may interpret the taste of an unknown drink similarly. For example, both drinks were scored on the questionnaire as high in sweetness and palatability, while low in saltiness between the groups that preferred the taste of Drink A and Drink B, respectively. Thus, when subjects consumed a flavored drink, they drank based on how easy the drink was to consume and the fact that it was relatively sweet. This can further be explained by subjects consuming far less water, which contains no taste intensities (i.e., sugar, sodium), compared to Drink B of the pre-

match consumption period and compared to both Drink A and Drink B of the post-match periods. These results corroborate the findings in the study by Ali (2011) that athletes drink significantly less water than flavored drinks.

Greater voluntary intake of flavored beverages has previously been reported in the literature (Passe, Horn, & Murray, 1998). In the study by Ali (2011), the investigator conducted taste surveys on flavored drinks and water. The results showed no significant differences in taste preference between flavored drinks and water. This may indicate that taste has no bearings on how much a flavored drink is consumed in relation to tasteless water. One study by Horswill (1988) postulated that water suppresses thirst signals before enough fluid has been consumed to completely replace fluid loss. Another study (Wilk, Kriemler, Keller, & Bar-Or, 1998) discussed that a lack of sodium chloride in water may diminish the osmotic drive for drinking. A third study (Nose, Mack, Shi, & Nadel, 1988) speculated that a lack of flavoring may provide fewer stimuli for voluntary fluid intake of water. The present study did not conduct a taste test with water.

Fielding (1985) determined that there may be a minimum amount of 22 grams of carbohydrates per hour required to observe performance benefits. A study by Maughan, Bethell, and Leiper (1996) determined that 16 grams of carbohydrates per hour was sufficient to provide performance benefits. The study found that ingesting 16 grams of carbohydrates per hour improved endurance capacity of subjects by 14% compared to water. In the current study, Drink A contained 38 grams of carbohydrates per 591 ml of the beverage and Drink B contained 33 grams of carbohydrates per 591 ml. Subjects who preferred the taste of Drink A thus consumed a pre-match average of 13.29 grams of carbohydrates for Drink A and 10.61 grams for Drink B. Subjects who preferred the taste

of Drink A consumed a post-match average of 24.27 grams of carbohydrates for Drink A and 16.39 grams for Drink B. According to the Fielding (1985) and Maughan (1996) studies, subjects who preferred the taste of Drink A did not ingest enough carbohydrates during their pre-match consumption of either Drink A or Drink B to provide performance benefits. However, these subjects ingested the minimum amount of carbohydrates during their post-match consumption of Drink A and Drink B necessary for performance benefits.

Subjects who preferred the taste of Drink B consumed a pre-match average of 12.54 grams of carbohydrates for Drink A and 10.05 grams for Drink B. Subjects who preferred the taste of Drink A consumed a post-match average of 25.39 grams of carbohydrates for Drink A and 16.56 grams for Drink B. Similar to the subjects who preferred the taste of Drink A, subjects who preferred Drink B did not ingest enough grams of carbohydrates during their pre-match consumption of either Drink A or Drink B, but ingested the minimum amount of carbohydrates during their post-match consumption of Drink A and Drink B necessary for performance benefits.

When combining pre- and post-match consumption, subjects who preferred the taste of Drink A consumed 37.56 grams of carbohydrates for Drink A and 27.00 grams for Drink B. Subjects who preferred the taste of Drink B consumed 37.93 grams of carbohydrates for Drink A and 26.61 grams for Drink B. Both groups of subjects consumed the minimum amount of carbohydrates per hour necessary for performance benefits for both Drink A and Drink B. In addition, neither group eclipsed the 75 grams of carbohydrates that results in no additional performance benefits according to a 2004 article by Jeukendrup (2008). In the current study, subjects performed in their matches

for one hour. If they were to continue playing for much longer periods of time, then higher sports drink consumption would be necessary for performance benefits. Table 8 summarizes the amount of carbohydrates ingested for Drink A and Drink B by subjects who preferred the taste of Drink A or Drink B pre-match, post-match, and a combination of pre- and post-match.

Table 8

*Carbohydrate Intake for Subjects Who Preferred the Taste of Drink A or Drink B Pre-Match, Post-Match, and a Combination of Pre- and Post-Match*

| | Preferred Drink A (n=7) | Preferred Drink B (n = 9) |
|---|---|---|
| **Pre-match Drink A** | 13.29 | 12.54 |
| **Pre-match Drink B** | 10.61 | 10.05 |
| **Post-match Drink A** | 24.27 | 25.39 |
| **Post-match Drink B** | 16.39 | 16.56 |
| **Combined pre- and post match Drink A** | 37.56 | 37.93 |
| **Combined pre- and post match Drink B** | 27.00 | 26.61 |

*Note*. Carbohydrate intake between subjects that preferred the taste of Drink A or Drink B. Pre-match, post-match, and a combination of pre- and post match carbohydrate intake was calculated. When pre- and post-match amount are combined, both groups obtained the necessary amount of carbohydrates for Drink A and Drink B. Amounts are in grams and provided as a mean.

A study by Wallis, Yeo, Blannin, and Jeukendrup (2007) showed that the highest rates of exogenous glucose oxidation and the greatest endogenous carbohydrate sparring was observed when carbohydrates were ingested at rates of 60 grams per hour during exercise. No group in the pre-match, post-match, or in the pre- and post-match combined for Drink A or Drink B consumed enough carbohydrates to reach this optimal level. However, as evident from Table 8, both groups consumed approximately similar amounts of carbohydrate prior to or after a match.

There were no significant differences between the amounts of Drink A and Drink B consumed by subjects who preferred the taste of either Drink A or Drink B. Thus, the

hypothesis that subjects who preferred one drink over the other would consume significantly more of the preferred drink was disproved.

Limitations in this study included a small sample size due to poor attendance by some subjects, inconsistent level of physical activity, and potential past drink recognition creating bias toward one or both drinks.

There were a total of 16 subjects who completed all three consumption study trials of Drink A, Drink B, and water. Some subjects did not complete all the trials because they did not show up to several of the matches due to unspecified reasons. This resulted in a smaller sample size than anticipated. A larger sample may have been a better indicator of how a population may react to consuming a sports drink with regards to taste.

In future taste and consumption studies, increasing the sample size could result in a better understanding of how the two variables may correlate. To retain more of the initial subjects, a monetary sum or other incentive could be provided to the subjects if they agree to attend all of their research appointments to completion.

The subjects were on the field exerting physical activity for one hour each game. The physical activity included running, jumping, kicking, diving, walking, and sprinting. In the one hour period, most subjects were mainly running and occasionally sprinting. Short periods of walking were observed at times between the running and sprinting. The goalie of each team rarely ran and was observed to exert less energy than the other subjects. The level of physical exertion may have affected post-workout drink consumption during each game. Due to the nature of the game, it was difficult to account for equal levels of physical exertion during each game. For example, in one game, a

subject may exert more energy toward the end of the game than the beginning, and in another game, the subject may exert more energy in the beginning of the game than the end.

In future studies, the methodology of how the subjects exert energy could be changed to display a higher level of consistency. One example of this could be running on a treadmill for a specific amount of time at a specific speed and duration.

While all precautions were taken into account to prevent the subjects from identifying the drinks, potential identification may have occurred due to recognizing the taste of one or both drinks prior to the study. Drink A is a well known sports drink that many individuals who exercise consume regularly. Drink B markets their product specifically for soccer players and some of the subjects may have previously consumed the drink. On one occasion during the taste test portion of the study, a subject informed the investigator that he may have known the identity of both of the drinks. The investigator asked the subject to not reveal his beliefs to the investigator as this would create bias in the study. If a subject believed he knew the identity of a drink, they may have provided a taste score that was different than if the subject did not know the identity. In addition, during the consumption phase of the study, a subject may have consumed more or less of a drink if they were aware of the brand they were consuming.

In future studies, to help prevent prior drink recognition bias, investigators could use less widely recognized brands from smaller manufacturers. Although this method would not ensure a complete absence of bias since less known brands could still be recognized by some subjects, it would help reduce the recognition potential.

To better utilize water as the control drink, future studies should consider performing a taste test on water prior to the consumption study. Although water is assumed to be tasteless due to a lack of taste intensities, it should not be assumed that the taste of water is enjoyed or disliked by people.

In conclusion, although subjects had distinct preferences for drink A or drink B, there were no significant differences between the taste perceptions of sweetness, saltiness, and palatability between subjects who preferred the taste of Drink A or Drink B. Similar levels of sugar in both drinks and relatively low sodium additions compared to other nutrients may have been a factor. There were also no significant differences between consumption levels of Drink A and Drink B between subjects who preferred the taste of either Drink A or Drink B. The thirst mechanism may have been a stronger factor to consumption, independent of taste preference. Subjects did not consume enough of either Drink A or Drink B pre-match to receive performance benefits, regardless of taste preferences. When pre- and post-match consumption of sports drinks are combined, both groups that preferred the taste of one drink over the other received enough carbohydrates to generate performance benefits had they continued performing in a match beyond one hour. Changes that could improve this study include providing a monetary sum or some other incentive to subjects to promote better attendance thereby increasing data; standardizing the exercise portion, so that all subjects exert a similar amount of energy throughout all trials; preventing taste recognition by using smaller sports drink manufacturers that subjects are unfamiliar with; and adding water to the taste test portion of the study.

**References**

Ali, A., Duizer, L., Foster, K., Grigor, J., & Wei, W. (2011). Changes in sensory perception of sports drinks when consumed pre, during and post exercise. *Physiology & Behavior. 102(5),* 437-443.

Bartoshuk, L.M. (2000). Comparing sensory experiences across individuals: Recent psychophysical advances illuminate genetic variation in taste perception. *Chemical Senses*, *25(4),* 447-460.

Berardi J., & Andrews R. (2010). *The Essentials of Sport and Exercise Nutrition*. Toronto, CAN: Precision Nutrition.

Byars, A., Keith, S., Simpson, W., Mooneyhan, A., & Greenwood, M. (2010). The influence of a pre-exercise sports drink of factors related to maximal aerobic performance. *Journal of the International Society of Sports Nutrition, 7*, 12.

Caldwell, J. (1997, April 21). Sports Drinks: Are they effective in improving athletic performance? Retrieved from http://www.vanderbilt.edu/AnS/psychology/health_psychology/gatorade.htm

Davison, G.W., McClean, C., Brown, J., Madigan, S, Gamble, D., Trinick, T., & Duly, E. (2008). The effects of ingesting a carbohydrate-electrolyte beverage 15 minutes prior to high-intensity exercise performance. *Research in Sports Medicine, 16(3)*, 155-166.

Fechner, G.T. (1860). Elemente der pychophysik. Leipzig, Germany: Breitkopf und Härterl.

Fielding, R.A., Costill, D.L., Fink, W.J., King, D.S., Hargreaves, & M., Kovaleski, J.E. (1985). Effects of carbohydrate feeding frequencies and dosage on muscle glycogen use during exercise. *Medicine& Science in Sports & Exercise, 17(4)*, 472-476.

Friedman, R., Elliot, A.J. (2008). Exploring the influence on sports drink exposure on physical endurance. *Psychology o f Sport and Exercise*, *9(6)*, 749–759.

Horswill, C.A. (1988). Effective fluid replacement. *International Journal of Sport Nutrition, 8(2)*, 175-195.

Jeukendrup, A.E. (2008). Carbohydrate feeding during exercise. *European Journal of Sport Science, 8(2),* 77-86.

Jeukendrup, A.E. (2004). Carbohydrate intake during exercise and performance. *Nutrition, 20(7-8)*, 669-677.

Johnson, A.K., & Thornhorst, R.L. (1997). The neuroendocrinology of thirst and salt appetite: Visceral sensory signals and mechanisms of central integration. *Frontiers in Neuroendocrinology*, *18(3)*, 292-353.

Kays, J., & Philips-Han, A. (2003). Gatorade: The idea that launched an industry. Retrieved from http://www.research.ufl.edu/publications/explore/v08n1/gatorade.html.

Lee, J.K.W., Nio, A.Q.X., Ang, W.H., Law, L.Y.L., & Lim, C.L. (2011). Effects of ingesting a sports drink during exercise and recovery on subsequent endurance capacity. *European Journal of Sport Science*, *11(2)*, 77-86.

Lindemann, B. (1996). Taste reception. *Physiological Reviews, 76(3)*, 718–766.

Lindinger, M.I., & Sjogaard, G. (1991). Potassium regulation during exercise and recovery. *Sports Medicine, 11,* 382-401.

Longe, J.L. (2008). Carbohydrates. In *Gale encyclopedia of diets: Guide to health and nutrition.* (Vol. 1, pp. 170-173). Detroit, MI: Thomas Gale.

Longe, J.L. (2008). Electrolytes. In *Gale encyclopedia of diets: Guide to health and nutrition.* (Vol. 1, pp. 342-346). Detroit, MI: Thomas Gale.

Maughan, R.J., Bethell, L.R., & Leiper, J.B. (1996). Effects of ingested fluids on exercise capacity and on cardiovascular and metabolic responses to prolonged exercise in man. *Experimental Physiology, 81(5),* 847-859.

Maughan, R.J., & Shirreffs, S.M. (1997). Recovery from prolonged exercise: restoration of water and electrolyte balance. *Journal of Sports Sciences. 15(3),* 297–303.

Minehan, M.R., Riley, M.R., & Burke, L.M. (2002). Effect of flavor and awareness of kilojoule content of drinks on preference and fluid balance in team sports. *International Journal of Sport Nutrition and Exercise Metabolism, 12(1)*, 81-92.

Mintel. (2012). *The US Sports Drink Market - September 2012*. Retrieved March 3 2013 from Mintel Reports database.

Nose, H., Mack, G.W., Shi, X.R., & Nadel, E.R. (1998). Role of osmolality and plasma volume during rehydration in humans. *Journal of Applied Physiology, 65(1)*, 325-331.

Passe, D.H., Horn, M., & Murray, R. Effect of beverage palatability on voluntary fluid intake during exercise. (1998). *Medicine & Science in Sports & Exercise, 30,* S156.

Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. (2009). *Journal of the American Dietetic Association, 109(3)*, 509-526.

Rao, E.S. (2013). Sensory Assessment of Food Quality. In *Food Quality Evaluation* (pp. 35-56). Variety Books.

Ryan, M. (1997). Sports drinks: Research asks for reevaluation of current recommendations. *Journal of the American Dietetic Association, 97(10),* S197-S198.

Scott, T.R., Yan, Y., & Rolls, E.T. (1995). Brain mechanisms of satiety and taste in macaques. *Neurobiology, 3(3-4)*, 281-292.

Siegler, J.C., Mermier, C.M., Amorim, F.T., Lovell, R.J., McNaughton, L.R., & Robergs, R.A. (2008). Hydration, thermoregulation, and performance effects of two sports drinks during soccer training sessions. *The Journal of Strength and Conditioning Research, 22(5)*, 1394-1401.

Stevens, S.S. (1961). To honor Fechner and repeal his law: a power function, not a log function, describes the operating characteristics of a sensory system. *Science, 133(3446)*, 80-86.

Stevens, S.S. (1969). Sensory scales of taste intensity. *Perceptions & Phychophysics, 6(5),* 302-308.

Von Duvillard, S.P., Braun, W.A., Markofski, M., Beneke, R., & Leithäuser, R. (2004). Fluid and hydration in prolonged endurance performance. *Nutrition, 20(7-8)*, 651-656.

Wallis, G.A., Yeo, S.E., Blannin, A.K., & Jeukendrup, A.E. (2007). Dose-response effects of ingested carbohydrate on exercise metabolism in women. *Medicine and Science in Sport and Exercise, 39*, 131-138.

Wilk, B.S., Kriemler, S., Keller, H., & Bar-Or, O. (1998). Consistency in preventing voluntary dehydration in boys who drink a flavored carbohydrate-NaCl beverage during exercise in the heat. *International Journal of Sport Nutrition, 8(1)*, 1-9.

## Appendix A: Recruitment E-mail

Hello,

My name is Kiarash Molavi and I am a graduate student earning my master's degree in human nutrition at Eastern Michigan University. I am currently working on my thesis project and I would like to invite you to participate in a research study on taste perceptions and consumption levels on male recreational soccer players. The correlation between taste preferences and consumption of two commercially available sports drinks will be investigated. Participation in this research is completely voluntary and you may opt out of the project at any time. Your names and personal information will be kept confidential during this study. You will be required to sign an informed consent form prior to participation. There are a few stipulations that must be agreed upon and followed in order to participate. The stipulations are as follows:

- Do not eat or drink any food or water in the two hours before arriving to the facility on match days.
- Do not drink alcohol for at least 12 hours prior to participating in the study.
- Do not engage in extreme physical activity for at least 12 hours prior to participating in the study.
- Arrive at the facility at least 20 minutes prior to the start of the match in order to have sufficient time to participate in the study.

In addition to the above stipulations, participants are requested to consume an unspecified dietary intake of three regular meals (breakfast, lunch, and dinner) on the days the study will be conducted. There will be two parts to this study. The first part is a taste test between the two sports drinks. Participants will fill out a short taste

questionnaire after the taste test. This is estimated to take about 4 - 7 minutes. This part of the study will only occur one time. The second part of the study is a consumption evaluation of the sports drinks. Participants will be provided 64 fluid ounce drinks in clean containers. They will be asked to consume the drinks prior to, during, and after participation in a men's recreational league soccer match. The remaining balance of the drinks will be collected, to be measured later by the researcher. For this part of the study, there will be 9 total trials which will happen on match days. For three of the trials, water will be provided (as a control) rather than sports drinks. The purpose of this research study is to examine the relationship between taste and consumption of two different sports drinks with regard to performing in an endurance activity. Specifically, I am researching how taste preferences of participants affect their overall consumption of a sports drink.

I will be providing the drinks free of charge to everyone who chooses to participate in the study. If you have any questions or would like to see a copy of the informed consent, please contact the investigator via e-mail at kmolavi@emich.edu. Further details of this study will be provided to you at a later date if you choose to participate.

Thank You,

Kiarash Molavi

## Appendix B: Informed Consent

# INFORMED CONSENT FOR PARTICIPATION IN RESEARCH Influence of Sports Drink Taste Preference on Consumption in Adult Male Soccer Players

Kiarash Molavi, Eastern Michigan University – Principal Investigator

1. **Purpose of Study and How Long It Will Last**: The purpose of this research study is to examine the relationship between taste and consumption of two different sports drinks with regard to performing in an endurance activity. Specifically, the investigator is researching how taste preferences of participants affect their overall consumption of a sports drink. The first part of this study is a taste test between two sports drinks. Participants will fill out a short taste questionnaire during the test. This is estimated to take about 4 - 7 minutes. The second part of the study is a consumption evaluation of the sports drinks. Participants will be provided 64 fluid ounce drinks, which will be poured into clean containers, and asked to consume the drink prior to, at half-time, and after participation in a men's recreational league soccer match. The time it will take to drink the beverage is estimated to take about two minutes each time.

2. **Participation Withdrawal or Refusal to Participate**: Participation in this study is completely voluntary and you may choose to quit the research project at any time without any penalty.

3. **Description of Study Procedures**: To complete the first part of the study, you will meet at the facility where the match is played. The investigator will provide two sports drinks that will be poured into small clean cups that will have either a red or black dot drawn on the cup (for identifying purposes). You will drink from one of the cups, and then fill out a taste-test/sensory evaluation questionnaire. You will then eat an unsalted cracker and rinse your mouth with water. You will then drink the other sports drink from the second cup and finish filling out the questionnaire. Samples of sugar and salt in their original packaging will be provided in order to help participants evaluate taste sensations of "sweet" and "salty" and answer the questionnaire. This questionnaire will only be completed one time.

The second part of the study occurs on nine match days that participants voluntarily participate in. When you arrive at the facility where you will play in a match, you will be provided with 64 fluid ounces of either one of two different sports drinks or water which will be poured into clean containers. These drinks will have the standard ingredients found in commercial sports drinks or water. You will be asked to consume as much of the beverage to the point that they feel satiated (satisfied). Following the consumption, the principal investigator will collect the containers for measurement of the remaining liquid at a later time. During halftime and after the match or practice, you will again be provided with 64 ounces of a sports drink or water and asked to consume enough where you feel satiated. Afterwards, the containers will be collected again for measurement of the remaining liquid at a later time.

Ingredients in sports drink #1: Water, Cane Sugar, Coconut Water Concentrate, Vegetable Juice (Color), Citric Acid, Natural Flavors, Salt.

Ingredients in sports drink #2: Sucrose, Dextrose, Citric Acid, Salt, Sodium Citrate, Natural Orange Flavor with Other Natural Flavors, Monopotassium Phosphate, Partially Hydrogenated Soybean and Cottonseed Oils, Yellow 6

_____ I agree to participate in this study and to allow Kia Molavi to provide sports drinks, water, crackers, and salt/sugar packets for a test taste (part 1). I allow Kia Molavi to provide sports drinks and water before, during half-time, and after (part 2). I understand that my name and identifying information will not be included in the database analyzed for this study.

4. **Guidelines of participation**: A requirement of participation is to follow these guidelines which correspond to activities occurring prior to participation in the study:

- Do not eat or drink any food or water in the two hours before arriving to the facility on match days.
- Do not drink alcohol for at least 12 hours prior to participating in the study.
- Do not engage in extreme physical activity for at least 12 hours prior to participating in the study.
- Arrive at the facility at least 20 minutes prior to the start of the match in order to have sufficient time to participate in the study.

_____ I agree to follow the guidelines mentioned above to the best of my abilities.

5. **Confidentiality of Information Obtained**: Results of the surveys and amount of drink consumed will be kept confidential. You will be given a random identification number for identification purposes and the researcher will use this number on all survey materials. Individual survey responses and drink consumption amounts will be kept separately from any identifying information. All information obtained will be stored in a folder and kept in a locked cabinet accessed only by the principal investigator. Information from this study may be reported or published in aggregate form, but your identity will be kept confidential in any publications or presentations.

6. **Expected Risks of the Study**: There are no known or anticipated risks for participating in the study. All consumables (i.e. drinks, salt/sugar samples) will be in their factory sealed containers prior to administration thereby minimizing any potential risk from possible containments in the products. Sports drinks will be poured into clean containers prior to administration.

*Disclaimer*: Although every precaution will be taken by the investigator to ensure the safety of the consumables, the investigator will not be responsible for any manufacturing flaws that could lead to potential illness from the consumables. All products provided are commercially available in the marketplace.

**Allergy Warning**: A list of all ingredients in the drinks is provided above. **If you are allergic or sensitive to any of the ingredients, do not participate in the study.**

7. **Expected Benefits of the Study**: There are no direct benefits expected to the participants. The rationale for conducting this study is to provide some information on taste perception and sports drink consumption.

8. **Compensation**: Sports drinks will be provided to you free of charge to participate in this study. There will be no additional compensation provided.

9. **Use of Research Results**: Findings from this study may be published in journals and may also be presented at professional conferences. Research results from this study will be used in aggregate form and participants will not be individually identified. Research results will be submitted to EMU as part of a thesis analysis.

10. **Future Questions**: If, at any time, you have questions about study procedures or your participation in the study, please contact the principal investigator *(Kiarash Molavi; Phone: 206-818-2452; Email: kmolavi@emich.edu).*

11. **Human Subjects Review Board:** This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from _____ to _____. If you have questions about the approval process, please contact Jayne Yatczak (734.487.0461, human.subjects@emich.edu).

**CONSENT TO PARTICIPATE:** I understand my rights as a research participant and I voluntarily consent to participate in this study and follow its requirements. I additionally understand the purpose, intent, and necessity of the present study. I will receive a copy of this consent form for my future reference.

_____ _____
*Participant Signature* *Date*

_____
*Participant Name (Print)*

**Appendix C: Taste Test and Sensory Evaluation Questionnaire (form 1)**

Taste-test questionnaire ID Number_____ Date _____

Height _____ Weight (lbs) _____ Age _____

**Instructions**: Take a sip from one of the cups with either a black or red dot on it.

What color was the dot of the cup you took a sip of? _____

1. How did you prefer the taste of the beverage? Please circle the number below that best corresponds to your answer:

| Extremely Dislike | | Dislike | | | Neutral | | | Like | | Extremely Like |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Instructions**: For question 2, please sprinkle a pinch of sugar on your tongue using the sugar packets that are provided. On a ratio of 1 to 10, this sugar would be considered a 10 (extremely sweet). Then rinse your mouth with the provided cup of water and spit into the provided container. **Continue this until the taste of the sugar no longer lingers in your mouth**. Have a sip of your sports drink and answer question 2. This method is essential to train your mind regarding sweetness intensities.

2a. How sweet would you consider this beverage?

| Not Sweet | | | | | | | | | | Extremely Sweet |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

2b. Did the taste of the sugar packet linger in your mouth after rinsing your mouth with water? Please circle an answer.

Yes No

**Instructions:** For question 3, please sprinkle a pinch of salt on your tongue using the salt packets that are provided. On a ratio of 1 to 10, this salt would be considered a 10 (extremely saltiness). Then rinse your mouth with the provided cup of water and spit into the provided container. **Continue this until the taste of the sugar no longer lingers in your mouth**. Have a sip of your sports drink and answer question 3.

3. How salty would you consider this beverage?

| Not Salty | | | | | | | | | | Extremely Salty |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

3b. Did the taste of the salt packet linger in your mouth after rinsing your mouth with water? Please circle an answer.

Yes No

**Instructions**: Take a gulp of the drink and answer question 4

4. How palatable (easily consumed) would you consider this drink?

| Hard to Drink | | | | | | | | | | Consumed Easily |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Wash-out period Instructions:** Eat a plain, unsalted cracker and rinse your mouth out with water.

## Appendix D: Taste Test and Sensory Evaluation Questionnaire (form 2)

**Instructions**: Take a sip from the cup with the colored dot that you did NOT take a sip from in form 1. (i.e. if you took a sip from a cup with a blue dot, then take a sip from a cup with a black dot)

What color was the dot of the cup you took a sip of? _____

1. How did you prefer the taste of the beverage? Please circle the number below that best corresponds to your answer:

| Extremely Dislike | | Dislike | | | Neutral | | | Like | | Extremely Like |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Instructions**: For question 2, please sprinkle a pinch of sugar on your tongue using the sugar packets that are provided. On a ratio of 1 to 10, this sugar would be considered a 10 (extremely sweet). Then rinse your mouth with the provided cup of water and spit into the provided container. **Continue this until the taste of the sugar no longer lingers in your mouth**. Have a sip of your sports drink and answer question 2. This method is essential to train your mind regarding sweetness intensities.

2a. How sweet would you consider this beverage?

| Not Sweet | | | | | | | | | | Extremely Sweet |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

2b. Did the taste of the sugar packet linger in your mouth after rinsing your mouth with water? Please circle an answer.

Yes No

**Instructions:** For question 3, please sprinkle a pinch of salt on your tongue using the salt packets that are provided. On a ratio of 1 to 10, this salt would be considered a 10 (extremely saltiness). Then rinse your mouth with the provided cup of water and spit into the provided container. **Continue this until the taste of the sugar no longer lingers in your mouth**. Have a sip of your sports drink and answer question 3.

3. How salty would you consider this beverage?

| Not Salty | | | | | | | | | | Extremely Salty |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

3b. Did the taste of the salt packet linger in your mouth after rinsing your mouth with water? Please circle an answer.

Yes No

**Instructions**: Take a gulp of the drink and answer question 4

4. How palatable (easily consumed) would you consider this drink?

| Hard to Drink | | | | | | | | | | Consumed Easily |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

## Appendix E Human Subjects Approval Letter

6/26/14

Dear Kiarash,

Congratulations! After careful review, your proposal "Influence of taste of sports drinks on their consumption in adult male soccer players" has been accepted by the College of Health and Human Services Human Subjects committee.

The current version of your submission is available here:
http://commons.emich.edu/cgi/preview.cgi?article=1158&context=chhs_hs

To view attachments to this decision, click here:
http://commons.emich.edu/cgi/preview.cgi?article=1158&context=chhs_hs&window=viewdecision&decision=0

We stress that you do not stray from your proposed plan. Good luck with your research effort.

Jayne Yatczak, PhD, OTRL
Chair, CHHS-HSRC