International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Formulation of Beetroot Juice and Coconut Water Fluid-Based Gel for Enhanced Sports Performance

Hemant Singh[1], Ankita Sharma[2]

[1]Student, Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Manav Rachna International Institute of Research and Studies

[2]Assistant Professor, Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Manav Rachna International Institute of Research and Studies

Abstract: ***This study aims to focus on formulation of gel for athletes to enhance their performance during the workout and their hydration status. There are various studies shows effects of fluid-based gel may be considered as a good nutritional strategy to improve performance, strength of cyclist, runners, and swimmer's athletes. Some other study also shows that chia seed can be used for formulation of energy gel. The fluid-based gel formulation with beetroot juice, coconut water which are plant-based ingredient. Beetroot juice is a good source of nitric oxide. Nitric oxide is an intracellular and extracellular messenger for regulating certain cellular functions and causes vasodilation of blood vessels and increases blood flow. Coconut water is high in potassium, sodium, and magnesium, making it an excellent hydration alternative. Coconut water also contains less sodium than sports drinks, which is critical for replenishing after sweaty workout sessions. While endurance athletes should probably reach for something else, coconut water is proven to be a great option for lighter and heavy workouts. The fluid-based gel was prepared using beetroot juice 30%, coconut water 30%, sugar 20%. It is a formulation that can be consumed before, during and after training.***

Keywords: Beetroot juice, nitric oxide, coconut water, athletes

1. Introduction

Athletes train and compete for anything between 8 and 40 hours per week. One hour of physical activity around for a man, 70 percent VO2max necessitates about 1, 000 kcal for a female, 600/700 kcal. This quantity of energy intake is necessary merely to maintain energy balance throughout training and competition to fulfill this energy requirement (Tarnopolsky et al., 2005).

Carbohydrate (CHO) is an important fuel for intense muscular contractions and the ability of the body to fill it in the form of glycogen in the muscle and liver. Whether a leisure athlete or an expert cyclist, a 70 kg well-fed person would have roughly 400/600 g of carbohydrate stored accessible to power muscle action. A professional cyclist may use up to half of their available CHO in the body during a 1-hour a time trial and nearly empty during a stage race or lengthy training cycle, compared to the average recreational athlete. A distinction between elite athletes and the general population is that exceptional athletes require significantly more to fuel the demands of the intensive workout, you'll need a lot of energy and CHO. the daily allowance for generally active persons, the daily energy and CHO need is 40 calories per kilogram of body weight, with CHO accounting for 60% of the energy or a 6 g/kg per day CHO requirement. Acyclist, for example, is an endurance athlete who rides for several hours every day and has a daily energy need of /80 kcal/kg body weight, which is more than twice as much as a leisure a CHO requirement for the athlete of more than 12 grams per kilogram day. This huge calorie, In addition, CHO consumption must be monitored reached regardless of realistic limits such as the amount of time available for meals and hunger suppression after strenuous activity. The fundamental CHO consumption requirements for endurance athletes are listed in the table, based on endurance cyclist criteria. (Tarnopolsky et al., 2005).

Situation	Recommended CHO intake
Light training (one hour per day, or low-intensity exercise) is best for daily muscle glycogen storage.	5-7 g/kg/day
Typical training (i. e., 1-4 hours of moderate to high-intensity exercise every day)	7-12 g/kg/day
Extreme exercise (four hours of moderate to high-intensity physical activitya day)	10–12 g/kg per day
Muscle glycogen recovery is quick after an event.	For up to 5 hours after the occurrence, 1.2 g/kg/h
Before a long event, eat a pre-race meal to boost CHO availability.	1-4 g/kg eaten 1-4 hbefore the event
CHO consumption during the event	0.5-1.0 g/kg/h

Tarnopolsky et al., 2005

CHO consumption before the competition

Elite cyclists appear to prefer meals for "Pre-stage intake and post-stage" intake are two different types of consumption rehabilitation to fulfill dietary objectives during cycling tours and stage races. An elite rider with a daily requirement of CHO of greater than800 g would need to ingest a significant quantity of CHO at breakfast. To satisfy daily CHO requirements as well as increase CHO availability throughout the ensuing activity phase, consumption of200-300 g CHO It is a before exercise for 3-4 hours is an effective strategy (Tarnopolsky et al., 2005).

CHO consumption when exercising

Ingesting CHO to improve contract is another significant dietary objective during exercise. The beneficial effects of CHO during exercise appear to be due to a reduction in life sustain a high rate of CHO oxidation in the muscles er glucose synthesis and, presumably, hepatic glycogen sparing as a result of elevated blood glucose. In trials that indicated improved performance with CHO feedings, 30-60 g of CHO was consumed every hour in the form of glucose, sucrose, or glucose polymers. Fructose consumption alone is ineffective in increasing CHO oxidation and might produce gastrointestinal irritation, resulting in poor performance. When consumed at the recommended rate of 625-1250 ml/h, 30 to 60 grams of CHO per hour is the same as 0.5-1.0 grams per kilogram of body mass per hour or the amount of CHO present in a typical sports drink (4-8 percent CHO). (Tarnopolsky et al., 2005).

CHO consumption during exercise recovery

It is generally known that taking CHO shortly after exercise has a short-term effect on muscle glycogen resynthesis and that muscle glycogen is preserved by delaying CHO consumption by several hours. resynthesis is reduced by 50%. A bit of frequent advice for sportspeople is to ingest 1.5 grams of CHO per kilogram of body weight “kilogram of body mass” immediately after exercise and every 2 hours thereafter. With a CHO ingestion of 1.2 g/kg/h, maximum muscle glycogen resynthesis rates appear to occur. (Tarnopolsky et al., 2005).

Fluid loss, exercise, and performance

Only roughly 200 kcal of energy is utilized for movement for every 1000 kcal of energy consumed, while the other 800 kcal is squandered as heat. To keep body temperature within limited physiological limitations, metabolic heat created by exercise must be eliminated. When the ambient temperature is higher than the skin temperature, this is the only way to shed heat. is by perspiration evaporation from the surface of the skin. Significant sweat generation will also take place in a chilly setting if the rate of work is high. Rates of sweat surpassing 2 liters per hour may be sustained by people who have been taught and acclimated persons working out in hot, humid environments for several hours. The greatest sweat rate ever measured was 4.2 liters per hour. It's important to remember that water balance is influenced by sweat losses and air saturation in the lungs, and lipid and CHO metabolism reserves in the body (Tarnopolsky et al., 2005).

Pre-competition training fluid intake

Dehydration can impair exercise performance, thus it's crucial to begin exercising when you're dehydrated. It is normally suggested that you consume 400/600 ml of liquids 2 hours before you begin exercising. This amount of fluid ensures proper hydration and enables the elimination of any excess water consumed. Hyperhydration may also help athletes who have problems drinking enough water during exercise or who lose bodily fluids at an excessive pace when working out in the scorching heat of India. In hot temperatures, Hyperhydration has been identified as a problem demonstrated to aid with exercise performance and thermoregulation. Hyperhydration has thermoregulatory benefits such as lower core temperature rises and increased perspiration rates during exercise (Tarnopolsky et al., 2005).

During competition fluid intake

Hypohydration should be avoided at all costs during exercise, and athletes appear to be well aware of the dangers. According to studies, cycling improves when a larger volume of fluid is used in the heat, and performance improves by 6% is consumed during exercise before the performance trial. However, consuming huge amounts of food is not always recommended. At intensities of more than 70%, gastric emptying is considered to be harmed. When cycling at 85 percent VO2peak, the maximal rate of absorption of intestinal fluid is 0.5 L/h., according to VO2max. While cycling at 85 percent VO2peak, the participants ingested 1.5 L of water in 1 hour. At the end of the workout, 0.9 L was predicted to be left in the stomach and intestine, and respondents complained of abdominal fullness, indicating that consuming big volumes may not be beneficial. It's important to strike a balance between keeping the working muscle hydrated and supplying CHO. Fluid absorption is related to the quantity of CHO in the drink, with high CHO levels restricting fluid transport. Because both fluid and CHO dosage will be substantial, CHO concentrations in the range of 5-8 percent appear to be ideal.60-70 grams of CHO should be ingested every hour, with water consumption focused on avoiding weight loss. All beverages should contain salt (10-30 mmol/L) for optimal absorption and to avoid hyponatremia. (Tarnopolsky et al., 2005).

Fluid competition after exercise for recovery

Fluid balance restoration is an important part of the healing process after exercise, and it's much more important in hot and humid conditions. It has been hypothesized that efficient rehydration during exercise can only be achieved if both sweat loss and salt loss in sweat are replenished. To guarantee total rehydration, at least 150 percent of the fluid lost during physical activity is required. Due to continuing urine production, adequate rehydration may not be obtained when lower amounts of fluid are ingested to match sweat losses. Even though significant consumption in large quantities (1.5/2 times the amount of sweat lost) was unable when the salt level of the drinks was low (23 mmol/l), the fluid balance was restored. There appears to be the inverse of association “between the sodium content of the” consumed fluid and the sodium content of the urine output, implying that when liquids have a salt content ranging from mild to high concentration (>50 mmol/l) are consumed, more fluid is retained. Water is not the most efficient rehydration liquid, according to several researches. The impact of sodium concentrations of “2, 26, 52, or 100 mmol/l” in beverages given following a dehydrating activity increased urine production and led to less successful re-establishment of net fluid equilibrium in comparison to combining beverages containing glucose and electrolytes. The participants were forced to exercise in the heat until they had dropped 1.9 percent of their body weight. After 30 minutes of rest, individuals ingested a volume equal to 1.5 times the mass lost in the previous 30 minutes. Urine was collected for the next 5.5 hours after the drink was consumed. It was discovered that the lower the salt level, the less urine was produced. Only the 56 and 100 mmol/l beverages restored salt levels throughout the body after consuming the 100 mmol/l drink raising salt throughout the whole – body levels above-mentioned pre-exercise values. The volume of plasma was restored. Similarly linked to beverage salt content. The sodium content of most sports drinks has a mmol/l concentration of 10/35.

It has been hypothesized that salt has a two-fold favorable influence on net fluid balance during rehydration after exercise. As previously stated, sodium's initial function is to enhance the absorption of glucose in the small intestine. Improved fluid retention is the second suggested benefit of sodium. The absorption of sodium ions can avoid the sodium dilution in plasma that occurs when plain water is consumed. Anti-diuretic hormone (ADH, vasopressin) synthesis is inhibited by low plasma sodium levels, resulting in increased urine volume. In comparison to water alone, sodium-containing beverages may improve post-exercise fluid balance by enhancing the sense of thirst and hence voluntary fluid intake. (Tarnopolsky et al., 2005).

Beet juice and athletic performance

When beet juice is ingested, nitric oxide (NO) is created, which has several effects including enhanced "blood flow, gas exchange, mitochondrial biogenesis and efficiency, and muscle" contraction strengthening. Beet juice may have ergogenic effects on cardio respiratory endurance, which might aid athletes in their performance. Beet juice can help athletes improve their cardio respiratory endurance Increased efficiency improves performance across a wide range of distances, lengthens the time to fatigue at submaximal workloads, and may enhance maximal oxygen consumption and cardio-respiratory performance at anaerobic threshold intensities absorption (VO2max) (Domínguez et al., 2017). According to reports, beetroot is a multifunctional functional food with antioxidant, anti-inflammatory, vasodilator, and cellular regulation effects. This vegetable received a lot of scientific research interest as a potential low-a price supplement for improving performance as well as speeding up recuperation after physical activity (Stander, Z et al., 2021). Beetroot juice supplementation reduced the cost and use of oxygen during exercise by increasing the efficiency of adenosine triphosphate (ATP) generation while lowering ATP consumption. However, the impact appears to be dosage and time-dependent. The influence on workout performance is mixed; it's time to fatigue appears to rise, but the influence on performance in time trials is unclear. Individual aerobic fitness levels may influence ergogenic benefits, with those with a lower degree of fitness benefiting more in terms of athletic performance. (H. Olsson et al., 2019).

Coconut water

Water from coconut is a natural occurrences liquid that is potassium, sodium chloride, and carbs are abundant. It may be used to replenish fluid loss as an oral rehydration aid. Water has been shown to have hydration properties in the same way as carbohydrate-electrolyte sports drinks. It also functions as an antioxidant. Sports drinks are commonplace in both leisure and competitive fitness and sports. The majority of carbohydrate–electrolyte sports beverages are prepared and artificially flavored. A few academics recently investigated the antioxidant properties of coconut water. The growing interest in natural goods' nutraceutical qualities. Coconut water, a natural alternative to artificial sports drinks, has recently received attention, with preliminary research demonstrating efficacy in terms of hydration. The amount of carbohydrates in a drink is determined by the situation. Because carbohydrate concentrations that are too high cause delayed stomach empties, the amount of fluid available for absorption is reduced. Extremely high amounts cause water to be secreted into the colon, increasing the risk of dehydration. When an energy source is required during activity, however, increasing the carbohydrate content of liquids will improve carbohydrate transport to the absorption location in the small intestine. The volume of fluid discharged from the stomach decreases as carbohydrate concentration rises, while the number of carbohydrates accessible for absorption rises. Rehydration after exercise replaces volume loss and electrolyte loss, particularly salt loss in perspiration. Such salt loss can lead to full rehydration and, in some cases, heat cramps during future exertion. The rapid and thorough importance of restoring fluid balance after exercise cannot be overstated healing process. Sweating profusely during exercise might result in fluid losses of more than 1 liter per hour. To recover from dehydration, an individual must consume enough liquids. Rehydration after exercise replaces volume loss and electrolyte loss, particularly salt loss in perspiration. Such salt loss can lead to full rehydration and, in some cases, heat cramping after later exertion (A. Chaubey et al., 2017)

2. Review of Literature

1) **"Nutritional needs of elite endurance athletes. Part I: Carbohydrate and fluid requirements"**

Tarnopolsky et. al (2006)

Dehydration and glucose depletion have been found to reduce performance, and severe dehydration can have negative health consequences. As a result, exercise raises carbohydrate and hydration needs. Ingesting 200–300 g of CHO 3–4 hours before exercise is an excellent technique for meeting daily CHO needs while also increasing CHO availability throughout the activity phase. There is minimal evidence that CHO consumed an hour before exercise has negative consequences such as rebound hypoglycemia. During exercise, CHO consumption has been demonstrated to boost performance as assessed by increased work output or reduced exercise time to complete a set quantity of work.

2) **"Effects of Beetroot Juice Supplementation on Cardiorespiratory Endurance in Athletes."**

Dominguez et. al (2017)

Nutritional supplementation is used by athletes to increase the benefits of training and improve their athletic performance. Nitric oxide (NO) is produced when beet juice is consumed, and it has a variety of activities including improved blood flow, gas exchange, mitochondrial biogenesis and efficiency, and muscular contraction strengthening. These biomarker improvements suggest that beetroot juice supplementation may have ergogenic benefits on cardio respiratory endurance, which might help athletes perform better.

3) **"Beetroot juice — a suitable post-marathon metabolic recovery supplement?"**

Stander et. al (2022)

Beetroot is a multifunctional functional food with anti-inflammatory, antioxidant, vasodilator, and cellular regulatory effects, according to reports. This vegetable has received a lot of scientific interest as a potential low-cost supplement for improving performance and speeding up recuperation after physical activity. To yet, no research has looked at the impact of increasing beet juice consumption on athletes' metabolic recovery following an endurance race. This study looked at the benefits of beetroot juice supplementation on the metabolic recovery trend of athletes 48 hours after finishing a marathon, as well as the favorable glucose and insulin regulating roles of beetroot.

4) **"Physiological Effects of Beetroot in Athletes and Patients"**

Olsson et. al (2019)

Beetroot juice, a naturally high supply of nitrate, is a topic that both professional athletes and leisure exercisers are interested in. Although nitrate and nitrite were formerly assumed to be mostly ultimate excretion products of nitric oxide (NO), evidence suggests that both molecules can be transformed to NO in vivo. We performed a narrative review of the literature on the effects of beetroot as a dietary supplement on training physiology and athletic performance in healthy and sick populations.

5) **"Comparative Study on Coconut Water, Carbohydrate Electrolyte Sports Drink and Sodium Enriched Coconut Drink on Measures of Hydration and Physical Performance in Athletes"**

Chaubey et. al (2017)

Coconut water is a rehydration fluid that contains salt, chloride, potassium, and glucose. Coconut water, a natural alternative to artificial sports drinks, has recently received attention, with preliminary research demonstrating efficacy in terms of hydration. The researchers wanted to see how coconut water, sodium-enriched coconut water, carbohydrate electrolyte sports drink, and sodium-enriched coconut drink affected athletes' hydration and performance.

6) **"A single oral dose of beetroot-based gel does not improve muscle oxygenation parameters but speeds up handgrip isometric strength recovery in recreational combat sports athletes"**

Oliveira et. al (2020)

It was suggested Beetroot supplementation on exercise performance has been shown to boost the performance of cyclists, runners, and swimmers, however, the effect on combat sports is yet unknown. The impact of beetroot-based gel (BG) supplementation on maximum voluntary contraction (MVC), exercise time until exhaustion (ETF), muscle O2 saturation (SmO2), and blood volume (tHb) in recreational combat sports athletes was investigated in this study. In a randomized, crossover, double-blind trial, 14 combat sports athletes did three sets of HIE (at 40% MVC) until fatigued following BG or nitrate-depleted gel (PLA) administration, with forearm SmO2 and tH b, measured continuously using near-infrared spectroscopy.

7) **"A Single Dose of Beetroot Gel Rich in Nitrate Does Not Improve Performance but Lowers Blood Glucose in Physically Active Individuals"**

Vasconcellos et. al (2017)

Beetroot eating has already been shown to boost performance while exercising because the nitrogen nitrate component of this meal can stimulate nitric oxide generation. The effects of 100 g beetroot gel containing 10 mmol nitrates on the production of nitric oxide, and metabolic and physiological markers, regarding physical activity performance people were investigated.

8) **"Fracture energy of gels"**

Tanaka et. al (2002)

The images depict the acrylamide gels' fracture energy. We assessed the fracture surface's roughness and calculated the fracture energy using that information. In a rapid crack speed area, the fracture energy grows linearly with crack speed V and the growth when the number of cross-links in the gels increases, the rate of fracture energy with V decreases. The fracture energy is more heavily dependent on crack speed in the slow crack speed area than in the rapid crack speed zone. This shows that the gels' fracturing process has changed qualitatively.

9) **"Consumer behavior of energy gel in male runners"**

Suksaard et. al (2021)

An energy gel is one of the sports supplements that runners pick in competition, according to this study. An energy gel is a semi-solid carbohydrate supplement. It comes in a tiny packet that is both handy and simple to transport. The majority of energy gels include significant levels of glucose and other electrolytes, making them ideal for endurance athletes. Fruits, cola, and chocolate were the most popular flavors.

10) **"Nitrate-rich beetroot juice offsets salivary acidity following carbohydrate ingestion before and after endurance exercise in healthy male runners"**

Burleigh et. al (2020)

Exercise-induced dehydration, high-carbohydrate diets, and transitory immune function disturbances all work together to raise the risk of oral illness in this population, according to the study. Participants drank 795 mL water, divided into three equal aliquots, during, and after 90 minutes of submaximal jogging in the negative-control condition. They were given 795 mL of carbohydrate supplementation in other trials in the same way. Blood from the veins was used taken both before and after the workout session, and saliva was taken before and after carbohydrate or water consumption for 20 minutes.

11) **"Safe and Effective Use of Nitric Oxide Based Supplements and Nutrition for Sports Performance"**

Bryan et. al (2019)

The findings suggest that sustaining nutrition supply and metabolic waste elimination through vascular NO generation is crucial for effective energy production in working muscles. Only a portion of NO's physiological impacts on energy generation and exercise performance may be due to its vasodilatory actions.

12) **"Metabolic and performance effects of raisins versus sports gel as pre-exercise feedings in cyclists"**

Kern et. al (2007)

Pre-exercise dietary carbohydrate sources with varied glycaemic indices may have distinct effects on metabolism and endurance. The purpose of this research was to investigate whether there were any differences in metabolic and cycling performance when moderate glycaemic raisins were consumed vs a commercial sports gel with a high glycaemic index. endurance-tight male (n=4) and female (n=4) cyclists took part in the study between the ages of 30 and 55 and conducted two trials in a random sequence.45 minutes before exercising on a cycle ergometer at 70%

VO2max, 1 gram of carbs per kilogram of body weight was administered to individuals in the form of raisins or sports gel.

13) "Chia seeds: can they be used as ingredients in making sports energy gel"

Lestari et. al (2021)

The goal of this research was to find the optimum for hydrocolloid making chia seed energy gel for sports. The inclusion of 0.1 percent w/w hydrocolloids was the only variable in this random-design investigation (SEG1 stands for xanthan gum, SEG2 stands for pectin, and SEG3 stands for carboxymethyl cellulose.). The pH, viscosity, total soluble solids, potassium concentration, and gross energy are all variables to consider. of a sports energy gel were then measured. Color, texture, scent, and flavor were among the sensory features studied utilizing hedonic tests on 25 participants. When various hydrocolloids were added, the pH, viscosity, total soluble solids, potassium, and energy are all factors to consider content all changed significantly.

14) "Hydration for recreational sport and physical activity"

Kenefick et. al (2012)

This article offers suggestions for determining fluid requirements and hydration levels during leisure activities. Fluid requirements are determined by sweat losses and fluctuate depending on the intensity and duration of the exercise. Dehydration has a deleterious effect on prolonged aerobic exertion, and heat exposure amplifies this effect. Fluid losses are estimated to be less than 2% of body mass when running 5–42 km at leisure speeds, therefore intensive fluid replenishment may not be essential. Competitive speeds result in increased fluid losses and demands. Although recreational activity requires little fluid, carbohydrate ingestion (sports drinks, gels, and bars) can help both high-intensity (1 h) and low-intensity, long-duration (1 h) activities.

15) "A Step Towards Personalized Sports Nutrition: Carbohydrate Intake During Exercise"

Jeukendrup et. al (2014)

Research has focused on the impact of carbs during endurance exercise, allowing for more detailed and tailored guidance on carbohydrate intake during a workout. The new recommended standards take into account the length (and intensity) of exercise, and guidance is not limited to the carbohydrate content; it also includes recommendations for carbohydrate type. A mouth rinse or tiny quantities of carbohydrates have been demonstrated to improve performance throughout 1 h of exercise in studies. A single carbohydrate supply can be oxidized at rates of up to 60 g/h, which is the recommended rate for longer activity (2–3 hours).

16) "Carbohydrate-Gel Supplementation and Endurance Performance During Intermittent High-Intensity Shuttle Running"

Patterson et. al (2007)

The purpose of this study was to see how a carbohydrate gel affected performance following a period of intermittent high-intensity shuttle running. Seven male soccer players completed two workout trials separated by seven days. Five 15-minute sessions of intermittent variable-speed running were completed by the participants, interrupted with periods of walking, followed by an intermittent run until they were exhausted on each occasion. Participants took a CHO gel or a placebo (PLA) 15 minutes before exercise (0.89 mL/kg BM) and every 15 minutes afterward (0.35 mL/kg BM). Water was also ingested at a rate of 5 mL/kg BM before exercise and 2 mL/kg BM every 15 minutes during it. These findings suggest that consuming a CHO gel with water increases performance in healthy male individuals after lengthy intermittent jogging, probably by preserving blood flow.

17) "Beetroot-based gel supplementation improves handgrip strength, forearm muscle O2 saturation but not exercise tolerance and blood volume in jiu-jitsu athletes"

Oliveira et. al (2018)

Beetroot has been shown to have an ergogenic impact on trained cyclists, runners, kayakers, and swimmers' workout performance. However, it is unclear if beetroot supplementation improves jiu-jitsu athletes' workout performance. In response to handgrip isotonic exercise (HIE), the impact of supplementing with beetroot-based gel (BG) on maximum exercise time till voluntary contraction (MVC) exhaustion (ETF), a saturation of oxygen in the muscles (SmO2), blood volume (tHb), and plasma nitrate and lactate levels in the blood jiu-jitsu athletes was investigated.

18) "Comparative Study on Coconut Water, Carbohydrate Electrolyte Sports Drink, and Sodium Enriched Coconut Drink on Measures of Hydration and Physical Performance in Athletes"

Chaubey et. al (2017)

Coconut water is a rehydration fluid that contains salt, chloride, potassium, and glucose. Coconut water, a natural alternative to artificial sports drinks, has recently received attention, with preliminary research demonstrating efficacy in terms of hydration. The researchers wanted to see how coconut water, sodium-enriched coconut water, carbohydrate electrolyte sports drink, and sodium-enriched coconut drink affected athletes' hydration and performance. This is a comparison study done at the NIT in Faridabad. Purposive sampling was used to identify eight male athletes aged 18 to 30 years old. Using a systematic procedure, anthropometric and biochemical measures were taken. An electric BP machine was used to test blood pressure and heart rates.

19) "Coconut Water for Sports"

Singh et. al (2009)

The effects of fresh young coconut water on whole body rehydration over a 2-hour rehydration period after exercise-induced dehydration, as well as physiological responses and cycling endurance performance in the heat, were assessed. The patients sat in a thermoneutral setting for two hours after exercise and drank either coconut water, carbohydrate electrolyte solution, or plain water, representing 120 percent of the fluid lost in three boluses. In the second investigation, eight cyclists rode at TA percent on a cycle ergometer in a climatic chamber until volitional fatigue. Subjects consumed 3ml. kg-1 body weight of liquids every 20 minutes while cycling. All beverages were distributed at random. Throughout the rehydration period and cycle endurance performance, blood samples were obtained at rest, before, during, and after exercise at regular intervals.

3. Methodology

A research technique is a method for methodically solving a research problem. It is a science that studies how scientific research is carried out. It examines numerous steps that are commonly used by researchers in researching their research topic, as well as the reasoning behind them. Not only the research method/technique but also the approach, are required for the research. Not only does research require an understanding of how to create specific indices or how to compute the means, medium, or standard deviation, but also which methods or strategies are useful and which are not, as well as what they imply and signal and why. Why a research study was conducted, how the research problem was gathered, what method was used to acquire the data, and why a certain approach of data analysis was used has methodology relating to a research problem or study.

A method of analyzing and solving a research problem is known as a research methodology. It's a scientific discipline that describes how to conduct research scientifically. The present study's aim was to the formulation of beetroot juice and coconut water fluid-based gel to enhance sports performance.

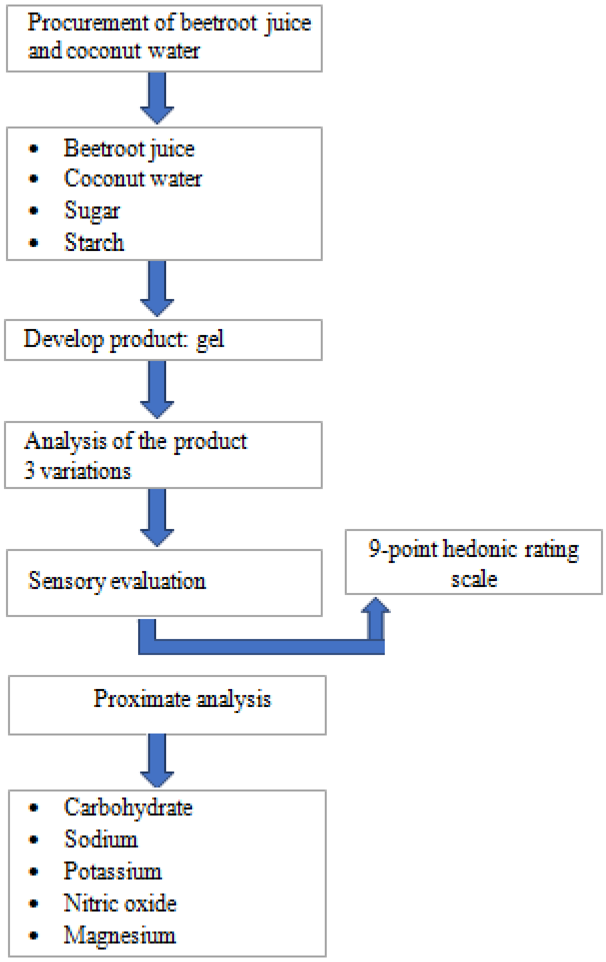
1) procurement of component
2) development of energy gel
3) analysis of energy gel

4. Methodology

Procedure

- Take corn starch and water in a beaker
- Dissolved the mixture completely
- Add coconut water, beetroot juice, and sugar
- Mix this mixture add 40°C at 5 min, stir with glass rood
- Add citric acid to the mixture
- Mixing and heating (85°C, 20min)
- Prepare for casting plasticized solution

Ingredient	Amount in percentages %
Beetroot juice	30%
Coconut water	30%
Sugar	20%
Starch	3%
Citric acid	10%
Water	22%



5. Result and Discussion

Sensory evaluation:

Table 1: All parameters against all the samples

Parameters	Sample 1 Mean ± SD	Sample 2 Mean ± SD	Sample 3 Mean ± SD
Appearance	8.13 ±1.167	7.20±0.925	8.13±0.900
Aroma	8.33±0.844	6.93±0.980	8.20±0.925
Taste	8.07±0.691	6.67±1.028	8.03±0.718
Texture	7.90±1.125	6.87±1.196	8.40±0.724
Overall acceptability	8.43±1.073	7.00±1.083	7.83±0.950

The table illustrates that the energy gel with the SAMPLE 1 was the most acceptable and also considered the best as it showed the highest mean among all the variations with the highest score for each of the attributes like appearance, aroma, taste, texture, and overall acceptability. The mean acceptability score for the appearance indicates that sample 1 with the mean score of (8.13 ± 1.167) got the highest scores in comparison with the other samples. Similarly, sample 1 means the acceptability of aroma (8.33 ± 0.844), taste (8.07 ± 0.691), and the mean acceptability score for the texture that the sample 3 (8.08 ± 0.80) got the highest scores in comparison. The comparison of other samples got the highest mean score in sample 1. Sample 1 also had the highest mean acceptability score for overall acceptability (8.43 ± 1.073).

Table 2: Appearance percentage of developed products"

S. NO	Sample 1 No. (%)	Sample 2 No. (%)	Sample 3 No. (%)	Chi-square P-<.001
Like extremely (9)	14 (46)	3 (10)	11 (36)	<.001
Like very much (8)	11 (36)	6 (20)	15 (50)	
Like moderately (7)	2 (6.70)	16 (53.30)	1 (3.3)	
Like slightly (6)	2 (6.70)	4 (13.30)	3 (10.00)	
Neither like nor dislike (5)	0 (0.00)	1 (3.30)	0 (0)	
Dislike slightly (4)	1 (3.30)	0 (0.00)	0 (0.00)	
Dislike moderately (3)	30 (100.00)	30 (100.00)	30 (100.00)	
Dislike very much (2)	0 (0)	0 (0)	0 (0)	
Dislike extremely	0 (00	0 (0)	0 (0)	

Table Illustrates the acceptability of appearance of the product developed by a 9-point hedonic rating scale. According to the result, it shows that the highest acceptability (9 like extremely) of the product energy gel concerning appearance was sample 1 (46%) incorporated with 100g of beetroot juice and coconut water as compared to other samples (2) sample (3).

Table 3: Aroma percentage of developed products

S. NO	Sample 1	Sample 2	Sample 3	Chi-square p-<.001
Like extremely (9)	15 (50)	0 (0.00)	15 (50)	<.001
Like very much (8)	12 (40)	12 (40)	7 (23.30)	
Like moderately (7)	1 (3.30)	5 (16.70)	7 (23.30)	
Like slightly (6)	2 (6.70)	12 (40.00)	1 (3.30)	
Neither like nor dislike (5)	0 (0)	1 (3.30)	0 (0)	
Dislike slightly (4)	0 (0)	1 (3.30)	0 (0)	
Dislike moderately (3)	0 (0)	0 (0)	0 (0)	
Dislike very much (2)	0 (0)	0 (0)	0 (0)	
Dislike extremely	0 (0)	0 (0)	0 (0)	

Table Illustrates the acceptability of aroma of the product developed by a "9-point hedonic rating scale". According to the result, it shows highest acceptability (9 like extremely) of the product energy gel concerning appearance samples 1 & 2 (50%) incorporated with 100g of beetroot juice and coconut water as compared to other samples (2).

Table 4: Taste percentage of developed products

S. NO	Sample 1	Sample 2	Sample 3	Chi-square p-<.001
Like extremely (9)	8 (26.70)	0 (0.00)	7 (23.30)	<-<.001
Like very much (8)	16 (53.30)	8 (26.70)	18 (60.00)	
Like moderately (7)	6 (20.00)	7 (23.30)	4 (13.30)	
Like slightly (6)	0 (0.00)	13 (43.30)	1 (3.30)	
Neither like nor dislike (5)	0 (0.00)	1 (3.30)	0 (0.00)	
Dislike slightly (4)	0 (0.00)	1 (3.30)	0 (0.00)	
Dislike moderately (3)	0 (0)	0 (0)	0 (0)	
Dislike very much (2)	0 (0)	0 (0)	0 (0)	
Dislike extremely	0 (0)	0 (0)	0 (0)	

Table Illustrates the acceptability of taste of the product developed by a "9-point hedonic rating scale". According to the result, it shows highest acceptability (9 like extremely) of the product energy gel concerning appearance sample 1 (26.70%) incorporated with 100g of beetroot juice and coconut water as compared to other samples (2) sample (3).

Table 5: Texture percentage of developed products

S. NO	Sample 1	Sample 2	Sample 3	Chi-square p-<.001
Like extremely (9)	9 (30)	3 (10)	16 (53.30)	<.001
Like very much (8)	14 (46.70)	6 (20.00)	10 (33.00)	
Like moderately (7)	4 (13.30)	8 (26.70)	4 (13.30)	
Like slightly (6)	2 (6.70)	11 (36.70)	0 (0)	
Neither like nor dislike (5)	0 (0)	1 (3.30)	0 (0)	
Dislike slightly (4)	1 (3.30)	1 (3.30)	0 (0)	
Dislike moderately (3)	0 (0)	0 (0)	0 (0)	
Dislike very much (2)	0 (0)	0 (0)	0 (0)	
Dislike extremely	0 (0)	0 (0)	0 (0)	

Table Illustrates the acceptability of appearance of the product developed by a "9-point hedonic rating scale". According to the result, it shows highest acceptability (9 like extremely) of the product energy gel concerning appearance sample 3 (53.30%) incorporated with 100g of beetroot juice and coconut water as compared to other samples (1) sample (2).

Table 6: Overall percentage of developed products

S. NO	Sample 1	Sample 2	Sample 3	Chi-square P<.001
Like extremely (9)	19 (63.30)	1 (3.30)	8 (26.70)	<.001
Like very much (8)	9 (30.00)	12 (40.00)	12 (40.00)	
Like moderately (7)	0 (0)	5 (16.70)	7 (23.30)	
Like slightly (6)	1 (3.30)	10 (33.30)	3 (10.00)	
Neither like nor dislike (5)	0 (0)	2 (6.70)	0 (0)	
Dislike slightly (4)	1 (3.30)	0 (0)	0 (0)	
Dislike moderately (3)	0 (0)	0 (0)	0 (0)	
Dislike very much (2)	0 (0)	0 (0)	0 (0)	
Dislike extremely	0 (0)	0 (0)	0 (0)	

Table Illustrates the acceptability of appearance of the product developed by a "9-point hedonic rating scale". According to the result, it shows highest acceptability (9 like extremely) of the product energy gel concerning appearance sample 1 (63.30%) incorporated with 100g of beetroot juice and coconut water as compared to other samples (2) sample (3).

Table 7: Proximate analysis

S. No.	Parameter	Test Result **as per** 100gm	**Protocol**
1	Total Energy	85.5Kcal	By Calculation
2	Protein	1.30gm	IS: 7219
3	Carbohydrate	20 gm	By Calculation
4	Sodium	148mg	Spectrophotometer
S	Potassium	27mg	AAS
6	Moisture	75.29%	Lab Method
7	Solubility	Insoluble in water	Lab Method
8	Viscosity Cst,[at]40C	6.90Cst	Lab Method
9	Nitrate Level	95.5mg	Lab Method

The table depicts the nutritive value of the beetroot gel. The results are shown per 100gm. The energy content of gel is 85.5 kcal which show low calorie. The protein estimate of gel per 100 gm is 1.3 g while the carbohydrate content is 20gm. The sodium found in 100g of gel is 148 mg. The potassium content found in the gel is 27 mg which is quite low. The nitrate level of the product is 95.5 mg which will help in increasing blood circulation.

6. Summary and Conclusion

Athletes compete and train for anywhere from 8 to 40 hours per week. For one hour of exercise at roughly 70% VO2max, a man needs about 1, 000 kcal and a woman needs about 600/700 kcal. "This amount of calorie intake is just required to maintain an energy" budget during training and competition. When beet juice is ingested, nitric oxide (NO) is created, which has several effects including enhanced blood circulation, oxygen supply, mitochondrial respiration and efficiency, and muscle contraction strengthening. Beet juice may help athletes function better by providing ergogenic benefits to cardio respiratory endurance. Beet juice can improve cardio respiratory endurance by improved productivity, which leads to improved performance over a variety of lengths, increases time to fatigue at submaximal levels, and may improve cardio-respiratory performance at hypoxic threshold intensities and peak oxygen absorption (VO2max) From the response of the participants, it was found that sample A is preferable than sample B and C. Sample A shows promising results with appearance, aroma, and taste while in the texture of samples it is shown that sample C is better than both samples. With the mean value of 8.23 in sample A in terms of appearance in comparison with sample B (7.20) and sample C (8.13), while in the case of aroma sample A shows promising results in case of aroma with a mean value of 8.33 where sample B and C shows 6.93 and 8.20 respectively. Sample A showed better taste than both samples with a mean value of 8.07 while sample B has a mean value of 6.67 and sample C showed a mean value of 8.03. Sample C shows better texture with a mean value of 8.40 whereas samples A (7.90) and B (6.87). The overall acceptability of sample A is better than both samples B and C.

References

[1] Bryan, N. S. (2019). Safe and Effective Use of Nitric Oxide–Based Supplements and Nutrition for Sports Performance. In *Nutrition and Enhanced Sports Performance* (pp.309-316). Academic Press.

[2] Burleigh, M. C., Sculthorpe, N., Henriquez, F. L., & Easton, C. (2020). Nitrate-rich beetroot juice offsets salivary acidity following carbohydrate ingestion before and after endurance exercise in healthy male runners. *PLoS One*, *15* (12), e0243755.

[3] Chaubey, A., Sharma, M., & Bhatnagar, B. (2017). Comparative Study on Coconut Water, Carbohydrate Electrolyte Sports Drink and Sodium Enriched Coconut Drink on Measures of Hydration and Physical Performance in Athletes. *IOSR Journal of Sports and Physical Education*, *4* (03), 46-51.

[4] Chaubey, A., Sharma, M., & Bhatnagar, B. (2017). Comparative Study on Coconut Water, Carbohydrate Electrolyte Sports Drink and Sodium Enriched Coconut Drink on Measures of Hydration and Physical Performance in Athletes. *IOSR Journal of Sports and Physical Education*, *4* (03), 46-51.

[5] de Oliveira, G. V., do Nascimento, L. A. D., Volino-Souza, M., do Couto Vellozo, O., &Alvares, T. S. (2020). A single oral dose of beetroot-based gel does not improve muscle oxygenation parameters but speeds up handgrip isometric strength recovery in recreational combat sports athletes. *Biology of sSport 37* (1), 93.

[6] de Oliveira, G. V., Nascimento, L. A. D. D., Volino-Souza, M., Mesquita, J. D. S., &Alvares, T. S. (2018). Beetroot-based gel supplementation improves handgrip strength and forearm muscle O2 saturation but not exercise tolerance and blood volume in jiu-jitsu athletes. *Applied Physiology, Nutrition, and Metabolism*, *43* (9), 920-927.

[7] Domínguez, R., Cuenca, E., Maté-Muñoz, J. L., García-Fernández, P., Serra-Paya, N., Estevan, M. C. L.,. . . &Garnacho-Castaño, M. V. (2017). Effects of beetroot juice supplementation on cardiorespiratory endurance in athletes. A systematic review. *Nutrients*, *9* (1), 43.

[8] Jeukendrup, A. (2014). A step towards personalized sports nutrition: carbohydrate intake during exercise. *Sports Medicine*, *44* (1), 25-33.

[9] Kenefick, R. W., &Cheuvront, S. N. (2012). Hydration for recreational sport and physical activity. *Nutrition reviews*, *70* (suppl_2), S137-S142.

[10] Kern, M., Heslin, C. J., & Rezende, R. S. (2007). Metabolic and performance effects of raisins versus sports gel as pre-exercise feedings in cyclists. *The Journal of Strength & Conditioning Research*, *21* (4), 1204-1207.

[11] Lestari, Y. N., Farida, E., Amin, N., Afridah, W., Fitriyah, F. K., &Sunanto, S. (2021). Chia Seeds (Salvia hispanica L.): Can They Be Used as Ingredients in Making Sports Energy Gel?. *Gels*, *7* (4), 267.

[12] Olsson, H., Al-Saadi, J., Oehler, D., Pergolizzi Jr, J., & Magnusson, P. (2019). Physiological effects of beetroot in athletes and patients. *Cureus*, *11* (12).

[13] Patterson, S. D., & Gray, S. C. (2007). Carbohydrate-gel supplementation and endurance performance during intermittent high-intensity shuttle running. *International Journal of Sports Nutrition and Exercise Metabolism*, *17* (5), 445-455.

[14] Singh, R. (2010). Coconut water for sports. In *Proceedings National Coconut Conference 2009: Opportunities for a Sunrise Industry*. Malaysian Agricultural Research and Development Institute.

[15] Stander, Z., Luis, L., van Reenen, M., Howatson, G., Keane, K. M., Clifford, T.,. . . & Loots, D. T. (2021). Beetroot juice—a suitable post-marathon metabolic recovery supplement?. *Journal of the International Society of Sports Nutrition*, *18* (1), 72.

[16] Suksaard, C., Masashi, M., Kuenpetch, K., &Nokkaew, N. (2022, March). Consumer behavior of energy gel in male runners. In *International Conference of Sports Science-AESA* (Vol.6, No.1, pp.11-11).

[17] Tanaka, Y., Fukao, K., & Miyamoto, Y. (2000). Fracture energy of gels. *The European Physical Journal E*, *3* (4), 395-401.

[18] Tarnopolsky, M. A., Gibala, M., Jeukendrup, A. E., & Phillips, S. M. (2005). Nutritional needs of elite

endurance athletes. Part I: Carbohydrate and fluid requirements. *European Journal of Sport Science*, *5* (1), 3-14.

[19] Vasconcellos, J., Henrique Silvestre, D., dos Santos Baião, D., Werneck-de-Castro, J. P., Silveira Alvares, T., &Paschoalin, V. M. F. (2017). A single dose of beetroot gel rich in nitrate does not improve performance but lowers blood glucose in physically active individuals. *Journal of Nutrition and Metabolism*, *20*