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# The Changes in Hydration Status and Blood Glucose Levels of Young Football Athletes Who were Given Chia Seeds (*Salvia hispanica,* L.) Based Sports Energy Gel

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## Abstract

*An athlete's hydration status is greatly affected by the adequacy of fluids and electrolytes during a workout. This study aimed to formulate a chia seed-based sports drink and analyzed its effect on hydration status and changes in blood glucose levels in football athletes. This experimental study on 46 young football athletes from Tyrex Java Semarang club was selected using a simple random sampling method. There are P(0)=control group (given 300mL placebo); and P(1)=treatment group (given 300 mL chia seed's sport energy gel). Administering placebo and treatment are done 45 minutes before exercise. Bodyweight and blood sugar level measurements are done 30 minutes before exercise and at 120 minutes. There were significant differences in the hydration status of study subjects before and after exercise (p=0.022), but the blood glucose level was not significant (p=0.413). However, the blood glucose level appeared to differ significantly (p=0.0001) between the control and treatment groups. As for changes in hydration status (kg and %) between the control group and treatment showed no sig-nificant differences (p=0.807 and 0.771). The conclusion is that giving chia seed's sports energy drink before exercise can maintain the blood glucose levels even though it does not impact the hydration status of athletes.*

## INTRODUCTION

Athletes' sports activities, both during training and competitions, really need adequate fluid fulfillment in each period (before, during, and after). Not only does it contain adequate amounts of electrolytes, but the fluids given to athletes must also contain energy that can support the athlete's performance in each training period or competition. The importance of the content in a sports drink must be supported by selecting the right composition of food ingredients, where these food ingredients can provide adequate electrolytes, carbohydrates, and energy for athlete performance (Shirreffs, 2009; Gujar & Gala, 2014).

Chia Seeds (Salvia hispanica L) is a plant from Lamiaceae originating from Mexico and Guatemala. It has a color that varies from white, gray, brown, to black. Chia seeds have similar shapes to basil seeds (Ocimum sanctum, Linn) but have smaller seed sizes. The outer layer of

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Chia seeds contains polysaccharides (gum) which can absorb and retain water to form a capsule-like layer. A high concentration of Chia seeds in a solution can increase the viscosity to form a gel (Kusnandar et al., 2020; Prathyusha et al., 2019; Safari et al., 2016). However, Chia seeds contain high carbohydrates (26-41%), are dominated by omega-3 fatty acids, and are rich in antioxidants (myricetin, quercetin, kaempferol, caffeic acid) per 100 grams (Ayerza, 2013; Grancieri et al., 2019; Kulczy□ski et al., 2019; Prathyusha et al., 2019; Segura-Campos et al., 2014). Chia seeds also have various functional properties, especially for athletes and athletes, including increasing endurance and sustained energy, improving mental focus and concentration, stabilizing blood glucose, and also offering well-hydration (Singh, 2021). Therefore, Chia seeds can be used as a food ingredient to make sports energy gel. The addition of Chia seeds as a composition in sports drinks can increase the energy content while reducing the amount of fluid in sports drinks, where athletes are expected to consume high-calorie drinks with not too much fluid (Lestari et al., 2020). The study on rats comparing the effects of fructose (2g/rat) or lard (4g/rat) and chia seeds/extract (4g/rat) showed that there was no increase in postprandial blood sugar levels in rats in which diet was supplemented with chia seeds/extract. In addition, this study also showed results that there was a significant change in body weight in the group of rats that were given feed supplemented with chia seeds/extract compared to the group that was given fructose/lard. (Mihafu et.al., 2020).

Several studies have been conducted to examine the effect of giving sports drinks on hydration status, sports performance, and changes in blood glucose levels in athletes. The research that examined the effect of coconut water and isotonic drinks on hydration levels and changes in blood glucose levels of basketball athletes showed that there were significant differences in hydration levels and changes in blood glucose levels of athletes who were given coconut water and isotonic drinks. Another study that examined the effect of giving isotonic drinks and bananas on the blood glucose levels of tennis athletes showed that giving isotonic drinks was significantly better in maintaining blood glucose levels after exercise than giving bananas. Research comparing various types of drinking water (mineral water, isotonic drinks, and brown sugar drinks) in 45 subjects showed results that carbohydrate (isotonic) mineral drinks could maintain better hydration status than drinks containing brown sugar and mineral water (Andria, 2019; Samudera & Ashadi, 2019; Budiman & Ray, 2021) (Budiman and Ray 2019, Andria 2019, Samudera and Ashadi 2019). Therefore, researchers are interested in formulating a sports drink made from Chia seeds which will then be studied for its effect on hydration status and changes in blood glucose levels in athletes, especially young soccer athletes. This study aimed to produce a chia seed-based sports drink (Salvia hispanica, L.) and analyzed its effect on hydration status and changes in blood glucose levels in young football athletes. This study was based on previous studies which were produce chia seed-based sports drink and determine its physical characteristics also examine its effect on cardiorespiratory endurance of some athletes (Fauzi & Mardiana, 2022; Lestari et al., 2020; Lestari et al., 2021). This study combined some previous studies in order to provide better sports energy gel to fullfill energy and requirements of young athletes. This study also can use as a baseline data to explore the other effects of sports energy gel administration to young athletes performance.

## METHOD

This research was carried out during July-August 2021 located at the Dietetics and Food Processing Laboratory, Department of Public Health, Semarang State University for the production of an energy gel based on Chia seeds, and at the Manunggal Jati Sports Center, Semarang City, Central Java for the implementation of trials on the research subject.

This study used a pretest-posttest randomized experimental design, consisting of a control group (P(0)) who received a placebo in the form of mineral water and a treatment group (P(1)) who received a sports energy gel made from Chia seeds. The subjects in this study were young soccer athletes at the Tyrex Java football club Semarang, which were taken with a purposive sampling technique (n=46). The research subjects must meet the inclusion criteria, among others: 1) Age 14-19 years; 2) Registered as an athlete of the football club Tyrex Java Semarang and actively participates in training and matches; 3) No history of cardiovascular disease, metabolic syndrome (Diabetes mellitus), immune disorders or orthopedic disorders; 4) Not currently or have ever used drugs or supplements that can affect muscle work; 5) Willing to participate in a series of research through informed consent.

This research has been approved by the Health Research Ethics Commission, Universitas Negeri Semarang, with the number 381/KEPK/EC/2021.

The main ingredients used in producing sports energy gel are chia seeds (salvia hispanica, l.). The composition of the sports energy gel used in this study is a modification of the composition of the sports energy gel that has been produced previously (Amin et al., 2017; Lestari et al., 2020; Márquez cardozo et al., 2017). The ingredients were formulated into sports energy gel with the composition according to table 1.

Making sports energy gel is done by mixing all the ingredients (Chia seeds, maltodextrin, xanthan gum, and Butterfly pea juice) with young coconut water. The mixture is then stirred until homogeneous and heated over low heat until it boils (± 7 minutes).

Sports energy gel made from Chia seeds (*Salvia hispanica,* L) as a final product (Fig. 1) was given to research subjects as much as 300 mL (recommendation of minimum volume given before exercise) and given 30 minutes before exercise. Sports energy gel was given to the treatment group (P(1)) to 23 subjects. In the control group (P(0)), as many as 23 subjects were given a placebo in the form of mineral water given Butterfly pea juice (0.1% w/w) as a dye, given 30 minutes before exercise as much as 300 mL.

Figure 1. Chia Seeds Sports Energy Gel

Table 1. Composition of sports energy gel

| **Ingredients** | **Amount** |
|---|---|
| Chia seeds (*Salvia hispanica*, L) | 4 g |
| Maltodextrin | 21 g |
| Xanthan gum | 0.2% (w/w) |
| Coconut water | 300 mL |
| Butterfly pea (*Clitoria ternatea*) juice | 0.1% (w/w) |

All subjects then asessesd and measured for hydration status and blood glucose level. The determination of hydration status was carried out by measuring the bodyweight of research subjects before and after exercise (30 minutes before exercise and 120 minutes). Weighing of research subjects used digital scales brand huawei honor smart scale 2 with an accuracy of 0.1 kg. Hydration status is calculated based on the difference between body weight after exercise and weight before exercise (kg), calculateG as a percentage change in body weight (%) (Garcia-jiménez et al., 2011; Abreu et al., 2005; Carretero-krug et al., 2021).

Meanwhile the measurement of blood glucose levels of research subjects was carried out before and after exercise (30 minutes before exercise and 120 minutes). Research subjects' blood glucose levels were measured using a glucose meter brand Fora® 6 Plus through capillary blood vessels. Changes in blood glucose levels of research subjects were calculated based on the difference in blood glucose levels after exercise and before exercise (Lesmana et al., 2019). The timeline of the study were explained detail in Fig.2.

All data were analyzed using SPSS 25 software for Windows. All data were analyzed descriptively and presented in tabular form. The mean analysis within groups (before and after treatment) was performed using a paired T-test with a confidence level of 95% ( =0.05). The means analysis between groups (control and treatment groups) was carried out using an independent T-test.

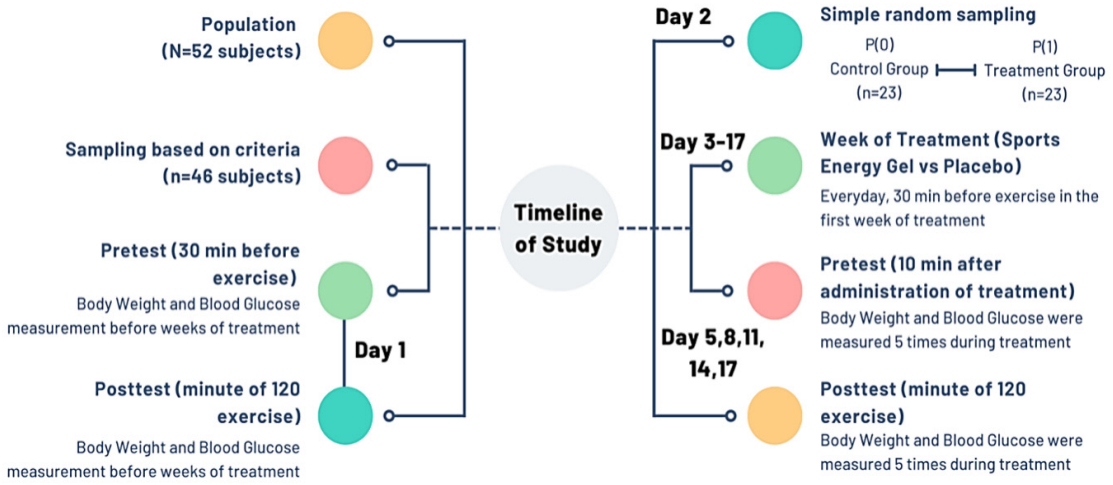


Figure 2. Timeline of Study

## RESULT AND DISCUSION

### Characteristics of Study Subjects

The subjects of this study consisted of 25 male and 21 female soccer athletes. As many as 23 subjects were in the control group (P(0)), and 23 subjects were included in the treatment group (P(1)). The research subjects were 14-19 years old (Table 2).

Giving sports energy gel to group P(1) showed a change in body weight before and after exercise. On the contrary, giving a placebo (P(0)) also showed a change in body weight in research subjects. Most of the research subjects in group P(0) showed a decrease in body weight after exercise (60.9%), whereas more than half of the research subjects in group P(1) showed an increase in body weight after exercise (52.2%).

Not only changes in body weight of research subjects, but the administration of sports energy gel in group P(1) also showed changes in blood glucose levels, where all study subjects showed increased blood glucose levels after exercise. The placebo administration in group P (0) also showed changes in glucose levels, whereas most of the study subjects in the control group showed a decrease in blood glucose levels (91.3%).

Table 2. Characteristics of Study Subjects.

| Characteristics[1] | Mean ± SD | Min | Max | P-Value |
|---|---|---|---|---|
| Ages (years) | 16.47±1.486 | 14.00 | 16.00 | |
| Body Weight (baseline) (kg) | | | | |
| P (0) | 53.48±11,549 | 37.40 | 80.70 | |
| P (1) | 55.64±9.347 | 42.60 | 76.00 | 0.022* |
| Body Weight (after treatment) (kg) | | | | |
| P (0) | 53.17 ± 11.443 | 37.40 | 80.20 | |
| P (1) | 55.37±9.418 | 42.90 | 76.20 | |
| Blood Glucose Level (baseline) (mg/dL) | 101.65 ± 9,893 | 76.00 | 120.00 | |
| P (0) | 93.74 ± 8.935 | 80.00 | 110.00 | |
| P (1) | | | | 0.413 |
| Blood Glucose Level (after treatment) (mg/dL) | 87.74 ± 9.771 | 68.00 | 100.00 | |
| P (0) | 104.09 ± 7.342 | 92.00 | 116.00 | |
| P (1) | | | | |

[1]The values are expressed as means ± SD (n=46); P(0)= control group; P(1)= treatment group
Different tests of a mean of the treatments using paired T-Test, significant at 0.05
Significance is shown by notation *
Treatment: 300mL of Chia Seeds based Sports Energy Gel given 30 minutes before exercise

**The Effects of Chia Seeds Sports Energy Gel on Athlete's Hydration Status**

Based on the results of the analysis using paired t-test, it is known that the bodyweight of the research subjects before and after treatment showed significant differences in the control group (P(0)) and the treatment group (P(1)) (p=0.0001 and 0.0001).

Table 3. Body Weight and Blood Glucose Level Changes After Exercise

| Δ[1] | Mean ± SD | P-Value |
|---|---|---|
| Body Weight (kg) | | |
| P(0) | 0.56 ± 0.515 | 0.807 |
| P(1) | 0.60 ± 0.775 | |
| Body Weight (%) | | |
| P(0) | 1.01 ± 0.948 | 0.771 |
| P(1) | 1.13 ± 1.569 | |
| Blood Glucose Level (mg/dL) | | |
| P(0) | -13.91 ± 8.723 | 0.0001* |
| P(1) | 10.35 ± 7.414 | |

[1]The values are expressed as means ± SD (n=46); P(0)= control group; P(1)= treatment group
Δ = the difference of before and after exercise values
Different tests of a mean between-group using Independent T-Test, significant at 0.05
Significance is shown by notation *
Treatment: 300mL of Chia Seeds based Sports Energy Gel given 30 minutes before exercise

Based on the results of the analysis of the difference between the initial data and the final data, the bodyweight of the research subjects showed that there was no significant difference between the control and treatment groups (p=0.807), although there was a significant difference in body weight before and after exercise (p=0.022). It shows that pre-exercise treatment (the administration of Chia seeds-based sports energy gel) has not changed the bodyweight of research subjects during exercise (Table 2 and 3). The results of this study are in line with previous research on rats given isotonic drinks and physical exercise, which showed that the provision of sports drinks and physical exercise on rats did not show any changes in plasma parameters, including changes in rats' body weight. A study also compares coconut water, supplement drinks (containing sodium, calcium, magnesium, and potassium), and water to rowing athletes, showing that subjects given coconut water can provide better weight recovery than those given water. However, the body weight changes of subjects given coconut water showed a higher value than the control group Dwita et al., 2015; Abreu et al., 2005).

Several previous studies have shown that not all players are adequately hydrated before and after training. A study of 40 soccer players who underwent 90 minutes of training showed that 35% were well-hydrated, and more than half of the players were hypo-hydration before training, and their hydration status worsened after training. This condition shows that players who start training with a good hydration status are not necessarily well hydrated after training. Players can achieve good hydration status by consuming adequate fluids before, during, and after training (Belval et al., 2019; Cheuvront & Kenefick, 2014; Coyle, 2004; Ozoli□ a et al., 2013).

The recommended fluid intake for adolescents aged 14-18 years is 3.3 liters/day. Meanwhile, athletes must consume more fluids than non-athletes because their physical activity is higher than non-athletes. The American College of Sports Medicine (ACSM), the National Athletic Trainers Association (NATA), and the American Dietetic Association (ADA) recommend that athletes drink 2.4–3.4 liters of fluid before, during, and after a game. During training, the average fluid consumption of young soccer athletes aged 14-18 years is 1.12-1.7 liters. However, during training or matches, young soccer athletes lose 2-3 liters of sweat. It is shown that the consumption of these fluids has not been able to replace the fluids lost through sweat during training or competition. Insufficient fluid consumption will increase the risk of dehydration in athletes (Armstrong, 2007; Maughan et al., 2005).

The regulation of fluid intake for athletes during sports is critical because it can minimize the occurrence of dehydration. A dehydrated athlete will not carry out training or competitions properly to affect the athlete's performance and achievement. During exercise, the body needs fluids and carbohydrates, which can be obtained from drinks containing carbohydrates and elect-

rolytes such as fruit juices, vegetable juices, milk, and sports drinks. Based on several studies conducted on soccer athletes regarding the provision of sports drinks, it was found that giving sports drinks was able to improve the performance of athletes. In addition to functioning as a substitute for fluid loss in the body, sports drinks can also supply glucose and replace electrolytes lost during exercise or competition. Research on the effect of giving sports drinks and water on several functional variables for soccer players during aerobic work with progressive intensity using a treadmill, recording heart rate, blood pressure, and blood electrolytes (Na + K +) before and after running, show a significant difference between water drinks and sports drinks. It is also in line with research on giving sports drinks on performance and skill tests in soccer athletes aged 15-18 years. Giving a sports drink affects the treatment group's 60-meter sprint, 4-meter dribbling, jump, and Harvard step test results. The results of this study indicate that the consumption of sports drinks can affect the performance and skills of athletes. The results show a significant difference between water drinks and sports drinks (Shalesh et al., 2014; Orrù et al., 2018; Silva et al., 2019).

**The Effects on Chia Seed Sports Energy Gel on Athlete's Blood Glucose Level**

As for the results of the paired T-test for variable blood glucose levels, it is known that there is a significant difference between blood sugar levels before and after treatment in both the control group (P(0)) and the treatment group (P(1)) (p =0.002 and 0.002).

Based on the analysis results using independent T-tests, it was obtained that the administration of sports energy gel made from chia seeds showed a significant increase in blood glucose levels (p = 0.0001). The control group given the placebo also showed a significant reduction in blood glucose levels (p=0.0001). It shows that the treatment in the form of sports energy gel made from chia seeds before exercise can impact increasing blood glucose levels of study subjects during exercise (Table 2 and 3). Based on the study conducted to Japanese student athletes who given glucose before exercise showed rapid increase in blood glucose during exercise and the rebound hypoglycemia didn't happen (Koma & Terasawa, 2020). The decrease of blood glucose during the onset of exercise was a common. It is due to the increase of GLUT-4 mRNA muscle as soon as exercise end. The exercise can induce the muscle to be more sensitive to insuline, so that more glucose can utilize into muscle and will have an impact on decreasing blood glucose level after exercise (Kamal et al., 2020). Therefore, it is assumed that the ingestion of glucose or the other source of carbohydrate exactly 30 min before exercise can prevent the decrease of blood glucose level during exercise, but the contrary the blood glucose level can increase significantly.

The results differed from a study conducted on 20 cyclists who showed that administering carbohydrate gel and isotonic drink showed no significant difference between before and after exercise. However, carbohydrate gel can affect improving performance and providing enough energy during exercise (Suna & Türkay, 2020).

Some studies say that physical exercise can increase blood glucose levels due to a decrease in insulin levels in the blood. Research conducted on cyclists shows that exercise can increase blood glucose levels and lower insulin levels after exercise. Other studies conducted on aerobic athletes showed that insulin levels decreased significantly after the exercise. Research examining the relationship of intensive interval training to blood parameters showed a significant increase in blood sugar levels before and after intensive exercise (Shalesh et al., 2014; Kurdak et al., 2010; Maughan et al., 2005). Giving a sports drink with a simple liquid and carbohydrate content appropriate during exercise and matches can help maintain blood glucose and muscle glycogen levels so that energy availability is maintained and muscle fatigue can be delayed.

## CONCLUSION

Based on the study results, it can be concluded that the administration of sports energy gel made from chia seeds can maintain blood glucose levels during exercise. In contrast, the hydration levels of the study subjects did not change significantly due to the ad-ministration of sports energy gels made from chia seeds.

The results of this study can be used as a study material for further research in de-veloping energy drink formulations for sports with carbohydrate and mineral composition that is suitable for each exercise periodization. In addition, further research examines the effect of energy drinks for sports on athlete performance parameters.

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