Available online: http://journal.ipb.ac.id/index.php/jgizipangan
ISSN 1978-1059 EISSN 2407-0920
J. Gizi Pangan, March 2022, 17(1):19-26
DOI: https://doi.org/10.25182/jgp.2023.17.1.19-26

Research Article

The Effect of Sports Drink Gel Treatment from Chia Seeds (*Salvia hispanica* L.) on the VO_2 Max Capacity of Football and Futsal Players

Nur Fauzi, Mardiana
Department of Nutrition, Faculty of Sport Science, Universitas Negeri Semarang, Semarang 50229, Indonesia

Article History:
Received *07-07-2021*
Revised *22-12-2021*
Accepted *26-01-2022*
Published *25-03-2022*

Keywords:
chia seeds, football, futsal, sports drink gel, VO_2 max capacity

***Corresponding Author:**
tel: +6288226554687
email: nurfauzi@students.unnes.ac.id

ABSTRACT

The purpose of this study was to determine the effect of sports energy gel drink from chia seeds (*Salvia hispanica* L.) on the VO_2 max capacity of football and futsal players in Semarang. This is a quasi-experimental research using a crossover design on twenty-two (22) football and futsal players residing in Semarang, Indonesia. The duration of the study was five weeks, whereby 22 subjects in the control group were given 300 mL of mineral water added with butterfly pea extract as natural colorant, while another 22 subjects in the treatment group were given 300 mL of sports gel drink from chia seed 30 minutes before starting the exercise, twice a week. Data on weight, height, body fat percentage, energy and nutrient intake, and VO_2 max capacity were collected. The results showed that there was a significant increase in the player's VO_2 max capacity value after treatment with sports gel treatment (p=0.001), but there was no significant increase in the control group (p=0.314). Nutritional status, body fat percentages, physical activity, energy intakes, macro and micronutrients intake were found not to be correlated with VO_2 max capacity. It can be concluded that administration of 300 mL sports gel drink from chia seeds before training increases the player's VO_2 max capacity.

INTRODUCTION

Football and futsal are types of sports that are favored by many people, from children, teenagers, to adults (Nasution 2018; Aswad & Amir 2015). In line with the development of these two sports, training and coaching efforts are carried out to obtain good achievements at the regional, national and international levels.

Football and futsal have several things in common. This can be seen from the characteristics of both, which both use the field, several players working together to put the ball into the goal guarded by the goalkeeper. However, in futsal, the size of the ball, field and goal is smaller than in football. The game of futsal relies heavily on the high technical ability of all players. The pattern of play in futsal is dominated by foot-to-foot games, both in attacking and defending patterns, which tend to rely on short passes given the smaller field size compared to football fields (Badaru 2017).

One of the main factors that must be owned by futsal and football players is endurance. If the endurance and physical fitness of players is low, this will have an impact on the decline in player performance, especially in speed and skills in playing football (Amin *et al.* 2017). To find out the endurance of football or futsal players, it can be done by measuring the VO_2 max capacity. The high and low VO_2 max capacity of the players greatly affects the physical condition or physical fitness of the players themselves (Busyairi & Ray 2018).

Good nutritional status and balanced nutritional intake can support optimal cardiorespiratory endurance. The results of research conducted by Widiastuti et al showed that from a total of 26 athletes recruited as subjects, 22 athletes (86.4%) consumed energy according to their needs and had a VO_2 max capacity value that met the standards and the remaining four athletes (15.4%) consume less energy than they need to have a VO_2 max capacity less than standard. VO_2 max capacity is the highest amount of oxygen that can be received and utilized by individuals to produce energy (ATP) through

This is an open access article under a Creative Commons Attribution-ShareAlike 4.0 International License (https://creativecommons.org/licenses/by-sa/4.0/)

aerobic metabolism while breathing air during exercise or strenuous exercise. An individual's cardiorespiratory capacity can be determined by measuring the VO_2 max capacity (Plowman & Smith 2014).

A balanced intake of nutrients affects the appearance of an athlete at the time of competition. Consumption of energy and nutrients that are less or more than the total needs, in general, will have an unfavorable effect on the body's physiological functions (Amin *et al.* 2017). Endurance athletes need the same macronutrients as other athletes but in higher amounts to help meet energy needs during training or competition. The main difference in dietary regulation between endurance athletes and other sports athletes is in the regulation of the amount of food consumed. Higher calorie needs in endurance athletes emphasize the availability of the body's energy reserves, especially glycogen stores to be used for a long period of time such as a futsal match that lasts 2x20 minutes in normal time or even a soccer match that lasts for 2x45 minutes of normal time (Fink & Mikesky 2018).

Sports drinks consumed during exercise can help improve exercise performance because they contain important energy and electrolytes that can provide adequate amounts of fluids (Gujar & Gala 2014) Unfortunately, athletes are not able to consume or receive a lot of fluid intake in one drink, especially during exercise. On the other side, athletes really need adequate intake of energy, nutrients and electrolytes to support their performance during exercise. For this reason, athletes need to be given sports drinks that are dense of energy, nutrients and electrolytes, but with not too much fluid. This can be applied through sports drink products in the form of gel (Lestari *et al.* 2020).

The food component that can be used as a source of energy and nutrients in sports drink products is chia seeds (*Salvia hispanica* L.). Chia seeds are small grains that are oval in shape, black, grey, or brown in color, and are accompanied by white spots. In 100 g of chia seeds, there is a total of 486 kcal of energy, 16.54 g of protein, but without gluten (Safari *et al.* 2016). The fat in chia seeds is also high (30–40% of the weight of the seeds, 60% of the total fat is omega three fatty acids) (Safari *et al.* 2016). Chia seeds also contain high dietary fibre as much as 34.4 g (>30% total weight, 5–6% in the form of gum) (Reyes-Caudillo *et al.* 2008). Not only rich in nutrients, Chia seeds also contain polyphenols (such as gallic, caffeic, chlorogenic, cinnamic and ferulic acids, quercetin, kaempferol, epicatechin, rutin, apigenin and p-coumaric acid) and isoflavones (such as daidzein, glycitein, genistein and genistin) which are found in small amounts (Kulczyński *et al.* 2019).

Looking at the amount of nutritional content in chia seeds, further research needs to be done to investigate the efficacy of chia seeds sports gel oral administration on the VO_2 max capacity in football and futsal players.

METHODS

Design, location, and time

This is quasi-experimental research, using a crossover design approach. The study was conducted at Universitas Diponegoro Football field, Pleburan, and Manunggal Jati Sports Building, Semarang, Indonesia. The research was carried out from July to August 2021. The study obtained approval from the Ethics Review Committee of the Public Health Department, Universitas Negeri Semarang (163/KEPK/EC/2021).

Sampling

The sample was selected using a total sampling technique based on several criteria: the gender is male, registered as a member of the T-Rex Jawa's football and futsal club, aged 15–19 years, actively participates in training at least once a week, has no history of the cardiorespiratory disease (Upper respiratory infection, Asthma, Tuberculosis, Congestive Heart Failure and Chronic obstructive pulmonary disease), non-smoker, not injured, not taking supplements regularly, and agreeing to participate after signing the informed consent and get approval from parents and coach. Subjects are excluded from the study if sick and withdrawn from the study. Subjects were recruited using the total sampling method, where the entire population that meets the criteria would be used as the research sample (Sugiyono 2015). The total of populations that meet the criteria are 22 people, therefore the total sample size per group is 22 subjects.

Supplement preparation

The formulation to make sports energy gel in this study was based on modifications from Lestari *et al.* (2020) and Lestari *et al.* (2021)

including: 4 g of chia seeds, 5 g of maltodextrin, 0.2% xanthan gum, 300 mL of coconut water, and 0.1% butterfly pea (*Clitoria ternatea*) juice. A sports energy gel is produced by mixing chia seeds, maltodextrin and xanthan gum in to 300 mL of coconut water, all ingredients are homogenized and added butterfly pea juice to give colour, and then heated over low heat for 10 min, until its boils (Lestari *et al.* 2020). Once finished, the sports energy gel is then packaged in a 300 mL plastic pouch.

Placebo is made by mixing 300 mL of boiled water with butterfly pea juice as a colourant to produce the same colour as sports energy gel from chia seeds. Then packed in a 300 mL plastic pouch.

Data collection

Anthropometric and body composition. Anthropometric measurements and body composition of subjects included weight, height, and body fat percentage. Body weight and body fat percentage were measured using Bioelectric Impedance Analysis (BIA), and height was measured using a statue meter (0.1 cm precision level).

Determination of nutritional status. Determination of nutritional status using BMI -for-age anthropometric index because the subject is adolescents aged 14–18 years. Body mass index according to age is calculated based on the results of measurements of weight and height which is then associated with age parameters. The measurement results were then categorized into underweight, normal weight, and overweight (MoH RI 2020). In addition to Body Mass Index (BMI) according to age, percent body fat was also used as an indicator for assessing the nutritional status of the subject. The results of the percent body fat measurement were then categorized into skinny, good, and acceptable body fat (Heyward & Wagner 2004).

Assessment of food intake. Food intake was obtained from interviews with subjects using multiple recall 24 hours (non-consecutive days) after treatment and cardiorespiratory endurance tests. The results of the interview were then converted into calories and grams of macronutrients and then compared with the Recommended Dietary Allowance (RDA) (MoH RI 2019) for adolescents aged 14–18 years multiplied by 100%.

The level of energy adequacy and nutrients is then categorized into three groups, namely deficit (<80% RDA), adequate (80–110% RDA) and excessive (>110% RDA) for energy, carbohydrate, fat and protein intake (Widyakarya Nasional Pangan dan Gizi 2012). And for mineral intake, it was categorized into two groups, namely deficit (<77% RDA) and adequate (≥77% RDA) (Gibson 2005).

Assessment of energy expenditure. The energy expenditure assessment was carried out by interviewing the subject's physical activity using the long form IPAQ to determine the subject's average daily METs (metabolic equivalent of task). The results were then classified into low, normal, and hard (IPAQ Research Committee 2005; WHO 2012).

Treatment and cardiorespiratory endurance test. On the first day, all subjects performed a cardiorespiratory endurance test using the Multistage Fitness Test (MFT) without any prior treatment for the pretest data. After that, the subjects will be divided into two groups, into control [p(0)] and experimental [p(1)]. The control group [p(0)] received 300 mL placebo and the experimental group [p(1)] received 300 mL sports energy gel. Treatment was given twice in 1 week following the subject's training schedule. After the treatment, subjects performed a cardiorespiratory endurance test for posttest data. After that, the subject was freed from any treatment and measurement for one week, the aim was to rest the subject and eliminate the effects of the previous treatment (washout period) (Figure 1).

After completing the washout period, all subjects performed a cardiorespiratory endurance test again for pretest data. then, the subjects were again divided into the same two groups as

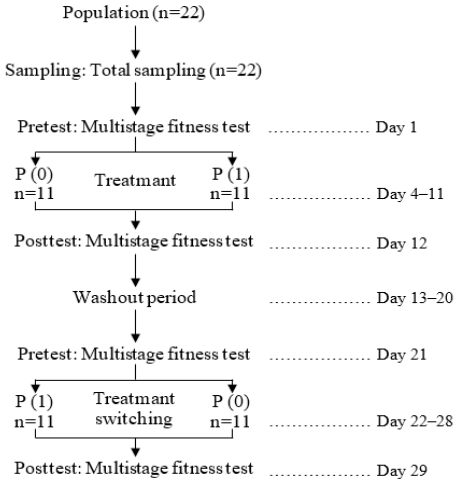

Figure 1. The stages of treatment and cardiorespiratory endurance test

before, but now the control group received 300 mL of sports energy gel [p(0)→p(1)] and the experimental group received 300 mL of placebo [p(1)→p(0)]. Treatment was given twice in 1 week following the subject's training schedule. Then, the subjects performed a cardiorespiratory endurance test again for posttest data. Therefore, the total number of subjects in the control and treatment groups was 22 subjects [p(0)=22 and p(1)=22].

Cardiorespiratory endurance test

The cardiorespiratory endurance test with 20-meter shuttle run (multistage fitness test), is appropriate for measuring cardiorespiratory endurance in youth (Pate *et al.* 2012). The shuttle run is advantageous when there are time constraints and when cost may be a problem, such as in schools and other educational settings (Pate *et al.* 2012). In a review article, Artero *et al.* (2011) report that test-retest reliability coefficients for this test have ranged from r=0.78 to r=0.93. Overall, the available evidence suggests that the 20-meter shuttle run has excellent validity and reliability as a measure of cardiorespiratory endurance. Procedure of multistage fitness test: a) The subject runs in a 20 meters track and if the subject arrives at the end of each lap before the "beep" sound, then the subject must wait for the "beep" to then continue running on the next lap; b) The subject must keep his running speed in accordance with the rhythm of the "beep" sound and if the subject is no longer able to follow 3 "beeps" in a row, the multistage test ends for that subject; c) The value of the multistage test results is then converted into a table for calculating VO_2 max capacity predictions.

Data analysis

Univariate analysis was used to describe all variables in the study. Bivariate analysis was used to determine the differences of VO_2 max capacity before and after the intervention in both the treatment and control groups. The bivariate analysis begins with testing the normality of the data. The normality test on each variable used the Shapiro-Wilk test because the total number of samples was less than 50 people. Results of the normality test showed that the data were not normally distributed, the next test selected was the Wilcoxon test (non-parametric test) and the Mann Whitney test (Amin *et al.* 2017; Dahlan 2014). The results of the analysis are said to be significant if the probability value is less than 5% ($p<0.05$) (Dahlan 2014).

RESULTS AND DISCUSSION

The total subjects in this study were 22 young male athletes. Some subjects are still in high school and some have completed high school education with an age range of 15–19 years. The subject's height range was 149.4–185.2 cm and the subject's weight range were 38.1–82.6 kg. The complete characteristics of the research subjects are presented in Table 1.

The nutritional status of the subjects was based on BMI-for-age; 18 subjects had normal nutritional status, one subject was underweight, and three subjects were overweight. The percentage of body fat of the subject is between 7.40–24.10 %; nine subjects were classified as skinny, eight subjects were classified as good, and five subjects were classified as acceptable. The subject's energy expenditure ranged from 674 to 1,781 kcal per day with details of 18 subjects classified as normal, and four subjects were classified as hard. The complete description of energy and nutrient intake of research subjects is presented in Table 2.

Table 1. Characteristics of subjects in control and treatment groups

Variables	Control (n=22)		Treatment (n=22)		p^*
	Mean±SD	Median	Mean±SD	Median	
Age (years)	17.1±1.2	17.0	17.1±1.1	17.0	0.941
Height (cm)	166.1±8.9	166.2	166.2±8.9	166.3	0.907
Weight (kg)	58.2±10.5	58.5	58.3±10.5	58.5	0.897
BMI-for-age (z-score)	-0.30±1.1	-0.62	-0.29±1.1	-0.62	0.916
Fat mass (%)	14.94±4.6	14.90	14.92±4.5	14.80	0.888
Energy expenditure (kcal)	950±392.7	847	946±359.3	847	0.860

*Non-parametric test: Mann-Whitney test; Significantly different at $p<0.05$; BMI: Body Mass Index; SD: Standard Deviation

Table 2. Average energy and nutrient intakes in control and treatment groups

Food Intake	Control (n=22)		Treatment (n=22)		p^*
	Mean±SD	Median	Mean±SD	Median	
Energy (kcal)	1309.83±237.54	1203.00	1281.4±185.28	1189.30	0.814
Protein (g)	48.29±14.03	45.95	47.66±12.04	46.55	0.888
Fat (g)	38.44±17.16	38.70	34.75±14.24	29.20	0.526
Carbohydrate (g)	188.87±41.72	190.55	190.66±33.64	192.05	0.991
Sodium (mg)	342.49±314.98	182.40	171.80±127.74	162.50	0.178
Calcium (mg)	158.51±78.26	134.00	132.53±35.76	131.65	0.439
Potassium (mg)	897.42±350.88	868.70	837.90±259.84	820.55	0.589
Magnesium (mg)	163.23±46.73	162.85	219.32±309.73	156.55	0.851

*Non-parametric test: Mann-Whitney test; Significantly different at p<0.05; SD: Standard Deviation

The results of the analysis showed that most of the energy and macronutrient intakes of the subjects were classified as deficits. and the mineral intake of sodium, calcium, potassium and magnesium are mostly also classified as deficit. The results of the bivariate analysis to determine the difference in the subject's VO_2 max capacity value are presented in Table 3.

The end line results showed that the group who received the treatment of 300 mL chia seed drink had a higher average in VO_2 max capacity value (42.17±6.32 mL/kg/minute) than the control group receiving 300 mL placebo (38.11±6.37 mL/kg/minute). There was an increase in VO2 max capacity value of 1.97 mL/kg/minute in subjects who received the sports energy drink from chia seeds. It was equal to five times the rate at the 8th level on the Multistage Test (about 30 seconds). This value is very meaningful when applied in football and futsal matches, for example when all players with the same cardiorespiratory endurance ability are already in a state of ability threshold (fatigue), one of the players has a VO_2 max capacity greater than 1.97 mL/kg/minute, then the player still has the additional ability to run for another 30 seconds.

The results of this study are in line with the research of Illian *et al.* (2011) which showed that a mixture of chia seeds and a 6% carbohydrate sports drink supported a 10 km running performance (after running at a moderate intensity for one hour) to the same level as an isocaloric volume of the 6% carbohydrate sports beverage alone. Another study also found that ingesting 7 kcal kg-1 of chia seed oil 30 minutes before running at 70% VO_2 max capacity led to a 3.4-fold increase in plasma Alpha-Linolenic Acid (ALA) levels (Nieman *et al.* 2015). The addition of chia seeds (Figure 2) as a component in sports drinks can increase energy content while lowering the amount of fluid in sports drinks, as athletes are expected to consume high-calorie drinks with few fluids (Lestari *et al.* 2021). Athletes who perform high-intensity endurance exercises are restricted from consuming excessive fluids during exercise, since they can cause discomfort to the digestive system (Shirreffs 2009; Lestari *et al.* 2020).

The nutritional status of subjects based on BMI-for-age is not related to VO_2 max capacity (p=0.669). The results are similar to the research conducted by Widyastari and Setiowati (2015) which showed that there was no significant effect between nutritional status and VO_2 max capacity. Research conducted by Amin *et al.* (2017) also showed the same results that there was no significant relationship between nutritional status and VO_2 max capacity of soccer athletes. Body fat percentage is also an important factor that can support the physical condition and performance of the players in addition to nutritional status. The higher the proportion of body fat and the

Source: Vecteezy (2018)

Figure 2. Chia seed (*Salvia hispanica* L.)

Table 3. VO_2 max capacity values in control and treatment groups

Groups	Control		Treatment		p^*
	Mean±SD	Median	Mean±SD	Median	
Pretest	37.69±7.26	37.01	40.20±6.46	38.48	0.038*
Posttest	38.11±6.37	35.84	42.17±6.32	40.87	
Δ VO_2 max capacity	0.41±2.79	1.29	1.97±2.07	2.72	0.023**

*Non-parametric test: Wilcoxon test; **Non-parametric test: Mann-Whitney test; Significantly different at p<0.05; SD: Standard Deviation

increase in the endomorphy of the body shape of a player or athlete, the acceleration of a person's movement will decrease. Physical movement in sports is closely related to skills related to fitness or fitness related to skills (Saputra *et al.* 2019). The results of statistical analysis shows that the proportion of body fat is not significantly related to the subject's VO_2 max capacity (p=0.528). This is similar to the results of research conducted by Amin *et al.* (2017) which showed that there was no significant effect between body fat percentage and VO_2 max capacity of soccer athletes (p=0.43). However, this result is different from the research of Dewi *et al.* 2015 which explains that the proportion of body fat is significantly correlated with VO_2 max capacity (p<0.001).

Apart from nutritional status (BMI-for -age) and body fat percentage, this study also analyzed the subject's physical activity factors. The description of the subject's physical activity during the study was mostly classified as normal or moderate, namely 18 subjects and the activities of four other subjects were classified as heavy. The results of statistical analysis shows that physical activity has no significant effect on the subject's VO_2 max capacity (p=0.586).

Factor analysis of the subject's food intake showed that there was no significant effect between energy, protein, fat and carbohydrate intake with VO_2 max capacity of subjects with p-values of energy 0.356, protein 0.132, fat 0.942 and carbohydrates 0.597 (p>0.05). This result is in line with research Safitri & Dieny (2015); Setiawan (2016); Amin *et al.* (2017) which showed that the intake of energy, protein, fat and carbohydrates did not have a significant effect on the VO_2 max capacity of football athletes. In addition to energy and nutrients such as protein, fat and carbohydrates, the intake of minerals such as magnesium, calcium, sodium and potassium is also a confounding variable in this study. The magnesium intake of subjects in the control group, there were 16 subjects included in the deficit category, five subjects classified as adequate, and one subject classified as excessive, and in the treatment group there were 18 subjects included in the deficit category, three subjects classified as adequate, and one subject classified as excess. Likewise with sodium, calcium, and potassium intake, where all subjects in both the control and treatment groups were included in the deficit category.

In addition to energy intake and macronutrients, this study also analyzed the subject's mineral intake during the study. Based on the results of this study, it is known that there is no significant effect between intake of sodium, calcium, potassium, and magnesium, with the subject's VO_2 max capacity with p-values respectively 0.396 sodium, 0.780 calcium, 0.126 potassium, and 0.141 magnesium (p>0.05). This is similar to the research conducted by Amin *et al.* (2017) which showed that the intake of sodium, calcium, potassium and magnesium did not have a significant effect on the VO_2 max capacity of football athletes.

This study showed that increase in physical endurance is mostly resulted from the increase in energy intake from the chia seed drink, thus did not reflect balanced energy and nutrients intake as main requirements for determining the level of work productivity (MoH RI 2011). The portrayal of imbalance nutrient intake in this study can be caused by the 24-hours food recall results during the VO_2 max capacity test were not consecutive thus insufficient to meet their needs. In addition, the body's ability to use oxygen optimally can be determined by factors other than food intake (Setiawan 2016).

Treatment is not given for one full week, but is only given two times a week following the subject's training schedule due to the Covid-19 pandemic. And analysis of food intake only for energy, macronutrients and several types of minerals without analyzing vitamin intake became limitations in this study. Recommendations for

future research are expected to provide treatment not only two times a week and for a longer time span, so that the effects of sports energy gel on athlete performance can be more optimal.

CONCLUSION

Provision of 300 mL of sports energy drink from chia seed to futsal and football players before exercise can increase the VO_2 max capacity value by 1.97±2.07 mL/kg/minute. This increase in the value of VO_2 max capacity in the treatment group (1.97±2.07 mL/kg/min) was significantly higher than the increase in the control group (0.41±2.79 mL/kg/min) ($p<0.05$). It can be concluded that consumption of sports energy drinks from chia seeds before exercise for endurance athletes such as futsal and football players can provide additional energy needed during exercise.

ACKNOWLEDGEMENT

The authors would like to thank the Nutrition Studies Program, Department of Public Health, Faculty of Sports Science, State University of Semarang and the T-Rex Jawa Semarang football and futsal club for their contributions to this research.

DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

REFERENCES

Amin N, Susanto H, Rahfiludin MZ. 2017. Pengaruh penambahan maltodekstrin dalam minuman elektrolit terhadap daya tahan jantung-paru atlet sepak bola. Gizi Indonesia 40(2):79–88. https://doi.org/10.36457/gizindo.v40i2.241

Artero EG, Espana-Romero V, Castro-Pinero J, Ortega FB, Suni J, Castilo-Garzon MJ, Ruiz JR. 2011. Reliability of field-based fitness tests in youth. Int J Sports Med 32(03):159–169. https://doi.org/10.1055/s-0030-1268488

Aswadi AN, Amir N, Karimuddin. 2015. Penelitian tentang perkembangan cabang olahraga futsal di kota Banda Aceh tahun 2007–2012. Pendidikan Jasmani, Kesehatan dan Rekreasi 1(1):38–44.

Badaru B. 2017. Latihan Taktik BEYB Bermain Futsal Modern. 1st Ed. Bekasi (ID): Cakrawala Cendekia.

Busyairi B, Ray HRD. 2018. Perbandingan metode interval training and continuous run terhadap peningkatan VO2max. Jurnal Terapan Ilmu Keolahragaan 3(1):76–81. https://doi.org/10.17509/jtikor.v3i1.10128

Dahlan MS. 2014. Statistik Untuk Kedokteran dan Kesehatan Deskriptif, Bivariat dan Multivariat. Dilengkapi Aplikasi Menggunakan SPSS. 6th ed. Jatinagor (ID): Salemba Medika.

Dewi M, Kustiyah L, Kuswari M. 2015. Percent fat mass and body mass index as cardiorespiratory fitness predictors in young adults. J Gizi Pangan 10(3). https://doi.org/10.25182/jgp.2015.10.3.%25p

Fink HH, Mikesky AE. 2017. Practical Aplications in Sport Nutrition. 5th edit. Massachusetts (USA): Jones & Bartlett Learning.

Gibson RS. 2005. Principles of Nutritional Assessment. 2nd Ed. New York (USA): Oxford University Press.

Gujar MVV, Gala MBV. 2014. Product development, biochemical and organoleptic analysis of a sports drink. IOSR J Sports Phys Educ 1:1–5. https://doi.org/10.9790/6737-0140105

Heyward V, Wagner D. 2004. Applied Body Composition Assessment. 2nd Edition. Illinois (USA): Human Kinetics.

Illian TG, Casey JC, Bishop PA. 2011. Omega 3 chia seed loading as a means of carbohydrate loading. J Strength Cond Res 25(1):61–65. https://doi.org/10.1519/JSC.0b013e3181fef85c

IPAQ Research Committee. 2005. Guidelines for data processing and analysis of the international physical activity questionnaire (IPAQ)-short and long Forms. http://www.ipaq. ki. se/scoring. pdf [Accessed 18th September 2021]

[MoH RI] Ministry of Health Republic of Indonesia. 2011. Pedoman Pemenuhan Kecukupan Gizi Pekerja selama Bekerja. Jakarta (ID): Direktur Jenderal Bina Kesehatan Masyarakat.

[MoH RI] Ministry of Health Republic of Indonesia. 2019. Permenkes No. 28 Tahun 2019 Angka Kecukupan Gizi yang Dianjurkan. Dirjen Peraturan Perundan-

Undangan Kemenhum Ham RI. Jakarta (ID): MoH RI.

[MoH RI] Ministry of Health Republic of Indonesia. 2020. Permenkes RI No. 2 Tahun 2020 tentang Standar Antropometri Anak. Jakarta (ID): MoH RI.

Kulczyński B, Kobus-Cisowska J, Taczanowski M, Kmiecik D, Gramza-Michałowska A. 2019. The chemical composition and nutritional value of chia seeds—Current state of knowledge. Nutrients 11(6):1242. https://doi.org/10.3390/nu11061242

Lestari YN, Farida E, Fauzi N, Fikri F. 2020. Analysis of Physicochemical and Sensory Quality of Chia Seeds Sport Energy Gel (*Salvia hispanica* L.) During Storage. In Prceedings of the 5th International Seminar of Public Health and Education, ISPHE 2020, 22nd July 2020. Semarang (ID): Universitas Negeri Semarang.

Lestari YN, Amin N, Afridah W, Fitriyah FK, Sunanto S. 2021. Chia seeds (*Salvia hispanica* L.): Can they be used as ingredients in making sports energy gel?. Gels 7(4):267. https://doi.org/10.3390/gels7040267

Nasution A. 2018. Survei teknik dasar berman sepak bola pada siswa SMKT Somba Opu Kabupaten Gowa, Ilmu Keolahrgaan 1(1):1–10.

Nieman DC, Gillitt ND, Meaney MP, Dew DA. 2015. No positive influence of ingesting chia seed oil on human running performance. Nutrients 7(5):3666–3676. https://doi.org/10.3390/nu7053666

Pate R, Oria M, Pillsbury L. 2012 Health-related Fitness Measures for Youth: Cardiorespiratory Endurance. In Fitness Measures and Health Outcomes in Youth. Washington, DC (USA): The National Academies Press.

Plowman SA, Smith DL. 2014. Exercise Physiology for Health, Fitness, and Performance. 4th Ed. Baltimore (USA): Lippincott Williams & Wilkins

Reyes-Caudillo E, Tecante A, Valdivia-López MA. 2008. Dietary fibre content and antioxidant activity of phenolic compounds present in Mexican chia (*Salvia hispanica* L.) seeds'. Food Chemistry 107(2):656–663. https://doi.org/10.1016/j.foodchem.2007.08.062

Safari A, Kusnandar F, Syamsir E. 2016. Biji chia: Karakteristik gum dan potensi kesehatannya chia seeds. Jurnal Pangan 25(2):137–146. https://doi.org/10.33964/jp.v25i2.329

Safitri I, Dieny FF. 2015. Pengaruh sari umbi bit (*Beta vulagaris*) terhadap VO2max atlet sepak bola. Journal of Nutrition College 4(2):202–210. https://doi.org/10.14710/jnc.v4i2.10066

Saputra RPS, Tursilowati S, Larasati MD, Sunarto S. 2019. Hubungan asupan lemak, persen lemak tubuh, somatotype dengan kelincahan atlet sepakbola diklat Salatiga training centre (STC). Jurnal Riset Gizi 7(1):21–27. https://doi.org/10.31983/jrg.v7i1.4360

Setiawan MI, Widyastuti N. 2016. Pengaruh pemberian jus semangka kuning (*Citrulus lanatus*) terhadap konsumsi oksigen maksimal (VO2max) pada atlet sepak bola. Journal of Nutrition College 5(2):64–70. https://doi.org/10.14710/jnc.v5i2.16361

Shirreffs SM. 2009. Hydration in sport and exercise: Water, sports drinks and other drinks. Nutrition Bulletin 34(4):374–379. https://doi.org/10.1111/j.1467-3010.2009.01790.x

Sugiyono. 2015. Metode Penelitian Kuantitatif, Kualitatif, dan R&B. Bandung (ID): Alfabeta.

Vecteezy. 2018. Close up of chia seeds. https://www.vecteezy.com/photo/1231541-closeup-of-chia-seeds [Accessed 21st November 2021].

[WHO] World Health Organization. 2012. Global Physical Activity Questionnaire (GPAQ) Analysis Guide. Geneva (CH): WHO.

[WNPG] Widyakarya Nasional Pangan dan Gizi. 2012. Pemantapan Ketahanan Pangan dan Perbaikan Gizi Berbasis Kemandiriran dan Kearifan Lokal. Jakarta (ID): Lembaga Ilmu Pengetahuan Indonesia.

Widyastari H, Setiowati A. 2015 Pengaruh status gizi, tingkat konsumsi energi dan protein terhadap VO2 maks. Media Ilmu Keolahragaan Indonesia 5(2):46–50. https://doi.org/10.15294/miki.v5i2.7893