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Effect of locally formulated recovery drink on perfomance and muscle soreness in adolescent soccer players

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ABSTRACT

Background: Adequate post-exercise nutrition is critical for recovery and performance, especially among adolescent athletes undergoing growth and development. However, research on locally formulated and culturally relevant recovery drinks for Indonesian youth remains scarce. This study addresses that gap by testing a novel recovery drink using familiar local ingredients. **Research Objectives:** This study aimed to analyze the effects of consuming a healthy recovery drink made from low-fat milk, banana, cocoa powder, and gulo puan on muscular strength, muscular endurance, VO_2 max, and muscle soreness in adolescent soccer athletes. **Methods:** A randomized pretest-posttest control group design was conducted with 16 adolescent soccer players (aged 15-18) from Sriwijaya State Sport School, Palembang, over a 5-day intervention. Performance indicators included handgrip strength (dynamometer), vertical jump, muscular endurance (Muscular Fitness Test), VO_2 max (multistage fitness test), and muscle soreness (visual analog scale). **Finding/Results:** The results showed that the consumption of the healthy recovery drink significantly improved handgrip strength, vertical jump performance, and muscular endurance in the intervention group. The reduction in upper body muscle soreness post-exercise was also greater in the intervention group compared to the control group. **Conclusion:** The recovery drink formulated in this study has the potential to serve as an effective nutritional alternative for adolescent football athletes in the post-training recovery phase to enhance athletic performance by promoting energy replenishment and muscle regeneration. The short duration of the study and limited sample size may have restricted the ability to detect long-term effects, particularly on aerobic performance. Future research with larger samples and extended intervention period is recommended.

Keywords: Adolescent soccer athletes; nutritional intervention; performance; recovery; recovery drink

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INTRODUCTION

Sports nutrition is a key component in optimizing training, performance, injury prevention, and recovery in athletes (Bytomski, 2018). This is particularly critical for adolescent athletes who have unique nutritional needs due to daily training and competition demands, as well as the requirements for growth and development (Desbrow, 2021). Despite the importance of recovery nutrition, studies such as Briggs et al. (2015) indicate that male adolescent soccer players often experience an energy deficit. This can negatively affect long-term performance, increase injury risk, and hinder healthy development.

Athlete performance is influenced by physical fitness factors such as VO_2 max, muscular strength, and muscle endurance. Higher VO_2 max levels correlate with greater endurance during exercise (Bryantara, 2016), making it essential in sports such as soccer that demand sustained endurance. Increased muscle strength improves key sports skills like jumping, sprinting, and quick direction changes, while also lowering injury risk (Suchomel et al., 2016). Muscle endurance helps athletes sustain performance over time (Bianco et al., 2015). In addition, delayed onset muscle soreness (DOMS), can limit an athlete's ability to train effectively, making it a crucial marker of recovery quality (Chang et al., 2020; Molaeikhaletabadi et al., 2022). These variables collectively provide a comprehensive assessment of an athlete's physiological readiness and recovery, aligning with the performance demands of competitive sports.

To address recovery needs, nutritional strategies combining carbohydrates, proteins, and antioxidants are recommended. Locally available, practical, and culturally relevant post-exercise recovery beverages for adolescent athletes remain limited in Indonesia, as commercial options are often expensive, less accessible, and not tailored for local consumption, highlighting the need for affordable and effective alternatives. Several natural food sources offer potential in this regard. Milk, with its high essential amino acid content, is effective in stimulating muscle protein synthesis (James et al., 2019). Cocoa contains polyphenols, which act as antioxidants to protect against oxidative stress and reduce muscle damage during training sessions (Allgrove & Davison, 2018; Cavarretta et al., 2018). Bananas are a source of carbohydrates, potassium, and B-complex vitamins that support energy metabolism and maintain muscle function (Nieman et al., 2015).

Gulo puan is also used as one of the materials due to its potential nutritional benefits. Gulo puan, a traditional product from Bangsal Village, Pampangan Subdistrict, South Sumatra Province, is made from fresh buffalo milk and sugar (Tsuji et al., 2022; Yuliati & Hamzah, 2022). In addition to its cultural significance, it can serve as a natural alternative to refined sugar. Due to its buffalo milk content, gulo puan may also contribute protein, which is essential for muscle repair and recovery in athletes. However, despite its energy content and potential value in sports nutrition, gulo puan has rarely been explored in this context. Its high sugar content and limited commercial standardization also present challenges in achieving nutrient balance and product consistency.

Liquid recovery products offer several advantages, including being more practical to consume, aiding hydration, and being easier to digest. The development of a beverage for athletes using milk, bananas, cocoa powder, and gulo puan could serve as a solution to meet nutritional needs during post-exercise recovery and enhance athletic performance in subsequent training or competitions. Therefore, this study aims to analyze the effects of a healthy beverage made from low-fat milk, bananas, cocoa powder, and gulo puan on the handgrip strength, vertical jump, muscular endurance, VO_2 max, and muscle soreness after exercise of adolescent soccer athletes.

METHOD

Time, Place, Participant

The study was conducted in October 2024 at Sriwijaya State Sports School, Palembang. This research applied pretest-posttest with a control group design. Subjects were randomly assigned to either the intervention group or the control group with simple randomization method. This study employed a single-blind method, in which the subjects were unaware of whether they received the intervention drink or the placebo. The beverages were served in opaque black cups with lids, and subjects consumed them using a straw. The minimum sample size was calculated using the Lemeshow formula for estimating the number of subjects required to compare the means of two independent populations, with an alpha level of 5% and a power of 80%, resulting in a minimum requirement of 8 participants per group. The criteria for selecting subjects included: male gender, aged 15–18, residing in a dormitory, being part of soccer sports branch, non-smokers, not consuming alcohol, not using substances that could influence muscle performance (e.g., creatine, anabolic steroids, or oral contraceptives) for at least three months prior to the study, no allergies to the composition of the healthy recovery drink, not undergoing medical treatment or consuming medications (that could affect physiological responses to training), and not experiencing illness or injury during the study period.

Procedures

Soccer athlete students at Sriwijaya State Sports High School performed routine training sessions every afternoon from Monday to Friday. Data collection for VO_2 max, muscular strength, and muscular endurance was conducted on two occasions: in the morning before the athletes' routine training on Day 1 as a pretest measurement and at the same time on Day 8 as a posttest measurement. DOMS (Delayed Onset Muscle Soreness) measurements were performed before each training session, immediately after training, and at 24 and 48 hours post-training (Molaeikhaletabadi et al., 2022). The sequence of tests began with the handgrip strength test, followed by the vertical jump, sit-up test, and VO_2 max assessment. VO_2 max was measured using the 20-meter Shuttle Run Test (20mSRT) (Léger et al., 1988). Muscular strength was assessed using a handgrip dynamometer following the procedure described by Mendez-Rebolledo et al. (2022), and a vertical jump test based on the protocol by Matsudo et al. (2015). Each test was performed three times, and the average score was recorded for analysis. Muscular endurance was measured using the Muscular Fitness Test (MFT), which consisted of sit-ups, push-ups, squats, and burpees (Ojeda et al., 2020). The Visual Analogue Scale (VAS) was used to evaluate DOMS in the upper and lower extremity muscles (Molaeikhaletabadi et al., 2022).

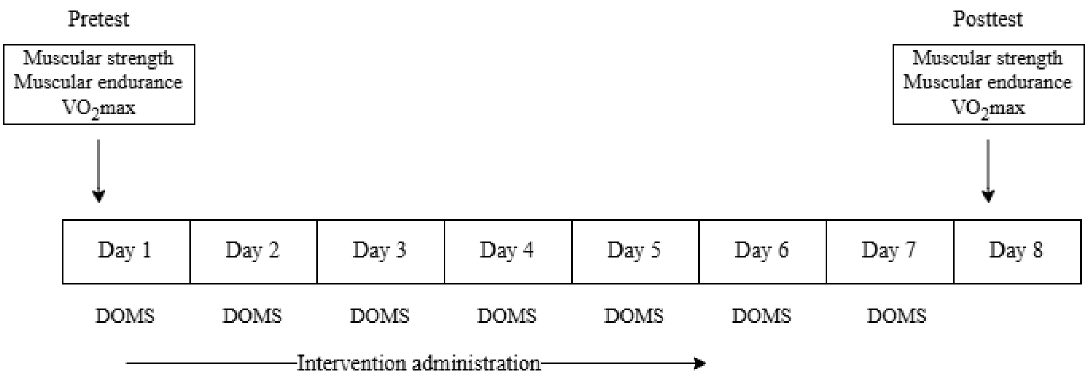

Figure 1. Schematic Data Protocol

Figure illustrates the intervention scheme, which was modified from the studies by Molaeikhaletabadi et al. (2022) and Papacosta et al. (2015). The healthy recovery drink was administered for 5 consecutive days (Day 1 to Day 5) after the athletes' routine training sessions. Subjects were instructed to consume the drink within 30 minutes to 1 hour after training. The total volume of the healthy recovery drink was designed to meet carbohydrate recovery recommendations, providing 1.0 grams of carbohydrates per kilogram of body weight (Dow et al., 2018). The treatment group received the healthy recovery drink, while the control group was given a placebo drink of the same volume. The healthy recovery drink was made using 425 ml of low-fat milk, 75 grams of *pisang raja* (a type of banana), 20 grams of cocoa powder, and 10 grams of gulo puan. The healthy recovery drink contains 330.4 kcal, 52.38 g of carbohydrates, 24.5 g of protein, and 2.54 g of fat per serving. The placebo consisted of 425 ml of low-fat milk mixed with water, 0.1% CMC (carboxymethyl cellulose), brown food coloring, chocolate flavoring, and banana flavoring. Each serving of the placebo provides 188.7 kilocalories, including 22.1 grams of carbohydrates, 13.6 grams of protein, and 5.1 grams of fat. Subjects were provided with a list of caffeine-containing food sources (e.g., coffee, tea, chocolate) and were instructed to avoid milk-based beverages during the study. Additionally, subjects were asked not to manage muscle soreness symptoms using interventions such as nutritional supplements, massage, cryotherapy, or non-steroidal anti-inflammatory drugs (NSAIDs). This research was ethically approved with protocol number 0992/HRECC.FODM/IX/2024 by Universitas Airlangga Faculty of Dental Medicine Health Research Ethical Clearance Commission.

Data Analysis

The Kolmogorov-Smirnov test was used to analyze data normality. The analysis of VO_2 max, muscular strength, and muscular endurance data was conducted using the Paired-Samples T-Test and the Independent-Samples T-Test. DOMS data were analyzed using Repeated Measures ANOVA and Independent-Samples T-Test.

RESULTS AND DISCUSSION

Table 1 shows the distribution of subjects based on their characteristics. The distribution of subject characteristics in the control and intervention groups was relatively balanced, with no significant differences observed, indicating that the subjects were homogeneous.

Table 1. Subject Distribution by Characteristics

Variables	Treatment	Control	p-value
Age (years)	15.87 ± 0.83	15.11 ± 0.33	0.155
Nutritional status (BMI)	-0.47 ± 0.55	-0.25 ± 0.97	0.575
Physical activity (MET score)	5127.76 ± 2033.36	6439.05 ± 2977.87	0.440
Energy adequacy (%)	79.62 ± 17.6	80.91 ± 24.78	0.904
Protein adequacy (%)	78.7 ± 32.75	76.58 ± 20.84	0.248
Fat adequacy (%)	124.3 ± 35.88	129.14 ± 43.93	0.808
Carbohydrate adequacy (%)	58.41 ± 14.7	61.55 ± 19.44	0.716

The results of the Independent Samples T-Test (BMI, energy adequacy, fat adequacy, carbohydrate adequacy) and the Mann-Whitney test (age, MET score, protein adequacy), *show a significant difference ($p < 0.05$)

Table 2 shows the differences in outcomes between the control and intervention groups. No significant differences were found in handgrip strength (p = 0.670), vertical jump (p = 0.436), muscular endurance (p = 0.647), and VO_2 max (p = 0.310) between the treatment and control groups. The lack of significant differences in muscular strength and endurance between the control and treatment groups may also be attributed to the fact that milk alone is already highly effective, as it contains a good combination of carbohydrates and proteins beneficial for athlete recovery. It is important to note that low-fat milk, used as the control beverage in this study, may have acted as an active placebo. The study by Born et al. (2019) showed that adolescent athletes receiving a carbohydrate-protein supplement in the form of milk had a greater increase in composite muscle strength scores compared to those receiving only carbohydrate supplements. This finding aligns with research by Upshaw et al. (2016), which showed no significant differences between milk and chocolate milk in cycling time trial performance over 20 km. The use of a more neutral placebo in future research may help clarify the distinct contributions of the added ingredients in the recovery beverage.

Table 2. The Difference in the Effect of Intervention Between the Treatment and Control Groups

Variables	Treatment Pretest Mean ± SD	Treatment Posttest Mean ± SD	Δ	Control Pretest Mean ± SD	Control Posttest Mean ± SD	Δ	p-value[1)]	Effect size (Cohen's d)
Handgrip	28.07 ± 3.14	31.58 ± 5	3.5	28.74 ± 4.25	30.66 ± 3.68	1.91	0.670	0.42
p-value[2)]	0.018*			0.037*				
Vertical jump	44.79 ± 8.03	49.83 ± 5.39	5.04	47.22 ± 5.98	52.14 ± 6.39	4.9	0.436	0.02
p-value[2)]	0.029*			0.005*				
Muscular endurance	136.75 ± 33.82	153 ± 30.42	16.25	133.88 ± 22.67	147.22 ± 20.12	13.33	0.647	0.10
p-value[2)]	0.044*			0.028*				
VO_2 max	49.43 ± 4.59	49.76 ± 3.58	0.32	46.95 ± 3.33	48.18 ± 2.58	1.23	0.310	-0.25
p-value[2)]	0.747			0.225				

The results of the 1) Independent Sample T-Test, 2) Paired Sample T-Test, *show a significant difference ($p < 0.05$)

The healthy recovery drink significantly improved handgrip strength (p = 0.018), vertical jump (p = 0.029), and muscular endurance (p = 0.044) in the treatment group. This finding is consistent with previous research that demonstrated that chocolate milk consumption can enhance muscle strength and endurance in athletes (Jayaputra & Putriningtyas, 2024; Papacosta et al., 2015; Yapici et al., 2023). Bananas, gulo puan, cocoa powder, and milk, contribute to the carbohydrate intake in the treatment group. Achieving optimal carbohydrate intake supports recovery and maximizes glycogen storage for the next training session (Amawi et al., 2024). Muscles use glucose stored as glycogen in the muscles as fuel during exertion. Carbohydrates aim to replenish muscle and liver glycogen that has been used during muscle contractions. Limited carbohydrate stores can reduce the body's ability to sustain performance, leading to muscle fatigue and poor endurance (Mahan & Raymond, 2017).

Muscle protein synthesis is a strong predictor of muscle strength improvement. This is because muscle protein synthesis is a critical factor in the muscle's adaptive response to resistance training, which results in increased muscle mass and strength (Witard et al., 2022). Dairy proteins have a high content of essential amino acids, which makes them more effective in stimulating muscle protein synthesis after exercise compared to plant-based proteins. Research shows that milk protein consumption is more effective in repairing and building muscle after physical activity (James et al., 2019; Kanda et al., 2016). Protein provides the building blocks needed to repair damaged muscle fibers, aiding in the recovery of muscle function and integrity. In addition to repairing damaged muscle fibers, protein also plays a role in muscle remodeling. This process involves not only repairing old muscle proteins but also synthesizing new, functional muscle proteins. These new proteins contribute to muscle growth, strength, and adaptation to training (Heaton et al., 2017).

There was an increase in VO_2 max in both groups, but it was not significant. VO_2 max, which reflects the maximum rate of oxygen consumption during intense exercise, is a key physiological parameter in soccer, as it correlates with endurance, recovery, and the ability to sustain repeated high-intensity efforts. The lack of significant improvement in this study may be due to the short duration of the intervention (one week) which is likely insufficient to elicit measurable cardiorespiratory adaptations. Physiologically, improvements in VO_2 max depend on both central (e.g., increased stroke volume and cardiac output) and peripheral (e.g., mitochondrial density and capillary growth) adaptations (Lundby et al., 2017). These changes typically require several weeks of consistent and progressive aerobic or high-intensity training to occur. A meta-analysis by Bacon et al. (2013) indicated that around 6 to 12 weeks of high-intensity training are required for significant improvements in VO_2 max. However, other studies have shown that chocolate milk consumption can significantly improve VO_2 max in athletes after just 6 days (Jayaputra & Putriningtyas, 2024). Future research should consider a longer duration to increase VO_2 max. The one-week duration in this study might not have been sufficient to observe significant differences.

Table 3 presents the differences in DOMS between the control and treatment groups. Both the healthy recovery drink and the placebo made from low-fat milk effectively reduced muscle soreness after exercise in each group ($p < 0.001$).

Table 3. Difference in DOMS between the Control and Treatment Groups

Delayed Onset Muscle Soreness (DOMS)	Mean ± SD				
	Before training	Immediately after training	24 hours post-training	48 hours post-training	p-value$^{1)}$
Upper Body Muscles					
Control	5.53 ± 1.57^{a}	5.93 ± 1.46^{a}	5.05 ± 1.55^{a}	3.49 ± 1.75	< 0.001*
Treatment	3.96 ± 2.09^{a}	4.24 ± 2.35^{ab}	3.36 ± 1.73^{a}	2.08 ± 1.4	< 0.001*
p-value$^{2)}$	0.097	0.091	0.051	0.090	
Effect size (Cohen's d)	0.86	0.85	1.02	0.88	
Lower Body Muscles					
Control	5.62 ± 1.59^{ab}	5.82 ± 1.56^{ab}	4.9 ± 1.41^{a}	3.63 ± 1.55	< 0.001*
Treatment	4.68 ± 1.48^{a}	5.15 ± 1.93^{ab}	4.12 ± 1.64^{a}	2.66 ± 1.55	< 0.001*
p-value$^{2)}$	0.229	0.444	0.313	0.218	
Effect size (Cohen's d)	0.61	0.37	0.50	0.62	

The results of the 1) ANOVA Repeated Measures test, 2) Independent Sample T-Test, *show a significant difference ($p < 0.05$), Results of the ANOVA Repeated Measures test:
[a]Significantly different ($p < 0.05$) from DOMS at 48 hours post-training within the same group.
[b]Significantly different ($p < 0.05$) from DOMS at 24 hours post-training within the same group.

There were no significant differences in DOMS between the upper and lower body before exercise, immediately after exercise, 24 hours post-exercise, and 48 hours post-exercise between the control and treatment groups. However, the healthy recovery drink administered to the treatment group was more effective in reducing upper-body muscle soreness post-exercise. In the treatment group, upper-body muscle soreness significantly decreased 24 hours post-exercise, whereas in the control group, a significant reduction was only observed 48 hours post-exercise.

The analysis demonstrated consistently large effect sizes (Cohen's d = 0.85–1.02) favoring the intervention group across all time points, indicating that the healthy recovery drink substantially reduced upper body delayed onset muscle soreness (DOMS), particularly at 24 hours post-exercise (d = 1.02). Although the results were not statistically significant, the magnitude of the effect suggests a meaningful practical benefit that warrants further investigation in a larger sample. For lower body muscle soreness, moderate effect sizes were observed, particularly at 24 to 48 hours post-exercise, with greater soreness reduction in the treatment group compared to the control group, highlighting the potential of the healthy recovery drink in supporting post-exercise recovery.

Cocoa powder, one of the ingredients in the healthy recovery drink, contains polyphenols such as flavanols, which function as antioxidants to protect against oxidative stress and reduce muscle damage during athletes' training sessions (Allgrove & Davison, 2018; Cavarretta et al., 2018). Oxidative stress can cause cell and muscle tissue damage, potentially prolonging recovery time. The consumption of cocoa flavanols may help accelerate muscle recovery and alleviate symptoms that hinder athletic recovery, such as muscle soreness and the decline in muscle function, including muscle strength and endurance (Corr et al., 2021).

Intense physical exercise increases the production of reactive oxygen species (ROS), leading to an imbalance between ROS and antioxidants. A decline in antioxidant defenses results in ineffective ROS elimination, which contributes to delayed-onset muscle soreness (DOMS). DOMS caused by strenuous or prolonged exercise induces pain, inflammation, soreness, and reduced muscle function. Consequently, muscle strength progressively declines, which can be detrimental to athletic performance, particularly during the competitive season (Daud et al., 2023). Polyphenols can help mitigate ROS-induced damage and reduce muscle inflammation, thereby minimizing fatigue and enhancing athletic performance (Close et al., 2016).

Exercise-induced muscle soreness is also attributed to a series of processes following mechanical damage to muscle fibers. Milk has potential benefits in reducing the decline in functional capacity due to exercise-induced muscle damage. This also explains the observed reduction in muscle soreness in both the treatment group and the control group, which received a placebo made from low-fat milk. One of the primary mechanisms is the increase in circulating amino acid levels following the digestion of whey and casein in milk, which contributes to muscle protein repair. This process is particularly supported by leucine and other essential amino acids that facilitate an anabolic response (Kirk et al., 2017; Rankin et al., 2015).

This study has several limitations. One of the primary limitations is the relatively short duration of the intervention, which may not have been sufficient to elicit measurable physiological changes, particularly in parameters such as VO_2 max. Additionally, the small sample size may have limited the statistical power of the analysis. Furthermore, the placebo used in this study, although it was not nutritionally equivalent to the healthy recovery drink, the placebo was milk-based and may have contained certain nutrients such as carbohydrates and proteins in small amounts that could contribute to recovery processes. As a result, the placebo may have partially obscured the true effects of the intervention, thereby reducing the contrast between the intervention and control groups.

CONCLUSION

The healthy recovery drink made from low-fat milk, bananas, cocoa powder, and gulo puan showed positive trends in improving handgrip strength, vertical jump performance, and muscular endurance within the treatment group. Although no statistically significant differences were found between the treatment and control groups, the treatment group demonstrated a more favorable trajectory in performance outcomes and a reduction in upper-body muscle soreness post-training. These findings, while promising, should be interpreted with caution due to the short duration of the intervention and the limited sample size, which may have constrained the detection of significant between-group effects. Furthermore, the milk-based placebo, although not nutritionally equivalent, may have had some recovery benefits, potentially attenuating observable differences. Future studies are recommended to implement a longer intervention period and consider using a more neutral placebo, particularly in terms of nutritional content, such as plain water, isotonic drinks, or maltodextrin solutions to more clearly isolate the effects of the recovery drink.

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CONFLICT OF INTEREST

There is no conflict of interest regarding this research.

REFERENCES

Allgrove, J. E., & Davison, G. (2018). *Chocolate/Cocoa Polyphenols and Oxidative Stress. In Polyphenols: Mechanisms of Action in Human Health and Disease (2nd Ed.)*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-813006-3.00016-7

Amawi, A., AlKasasbeh, W., Jaradat, M., Almasri, A., Alobaidi, S., Hammad, A. A., Bishtawi, T., Fataftah, B., Turk, N., Saoud, H. A., Jarrar, A., & Ghazzawi, H. (2024). Athletes' Nutritional Demands : A Narrative Review of Nutritional Requirements. *Frontiers in Nutrition*, *10*(1331854), 1–17. https://doi.org/10.3389/fnut.2023.1331854

Bacon, A. P., Carter, R. E., Ogle, E. A., & Joyner, M. J. (2013). VO_2 max Trainability and High Intensity Interval Training in Humans: A Meta-Analysis. *PLoS ONE*, *8*(9), 1–7. https://doi.org/10.1371/journal.pone.0073182

Bianco, A., Lupo, C., Alesi, M., Spina, S., Raccuglia, M., Thomas, E., Paoli, A., & Palma, A. (2015). The Sit Up Test to Exhaustion as a Test for Muscular Endurance Evaluation. *SpringerPlus*, *4*(309), 1–8. https://doi.org/10.1186/s40064-015-1023-6

Born, K. A., Dooley, E. E., Cheshire, P. A., McGill, L. E., Cosgrove, J. M., Ivy, J. L., & Bartholomew, J. B. (2019). Chocolate Milk Versus Carbohydrate Supplements in Adolescent Athletes: A Field Based Study. *Journal of the International Society of Sports Nutrition*, *16*(6), 1–8. https://doi.org/10.1186/s12970-019-0272-0

Briggs, M. A., Cockburn, E., Rumbold, P. L. S., Rae, G., Stevenson, E. J., & Russell, M. (2015). Assessment of Energy Intake and Energy Expenditure of Male Adolescent Academy-Level Soccer Players during a Competitive Week. *Nutrients*, *7*(10), 8392–8401. https://doi.org/10.3390/nu7105400

Bryantara, O. F. (2016). Faktor Yang Berhubungan dengan Kebugaran Jasmani (VO_2 Maks) Atlet Sepak Bola. *Jurnal Berkala Epidemiologi*, *4*(2), 237–249. https://doi.org/10.20473/jbe.v4i2.2016.237

Bytomski, J. R. (2018). Fueling for Performance. *Sports Health*, *10*(1), 47–53. https://doi.org/10.1177/1941738117743913

Cavarretta, E., Peruzzi, M., Vescovo, R. Del, Pilla, F. Di, Gobbi, G., Serdoz, A., Ferrara, R., Schirone, L., Sciarretta, S., Nocella, C., De Falco, E., Schiavon, S., Biondi-Zoccai, G., Frati, G., & Carnevale, R. (2018). Dark Chocolate Intake Positively Modulates Redox Status and Markers of Muscular Damage in Elite Football Athletes: A Randomized Controlled Study. *Oxidative Medicine and Cellular Longevity*, *2018*(4061901), 1–10. https://doi.org/10.1155/2018/4061901

Chang, W. D., Chang, N. J., Lin, H. Y., & Wu, J. H. (2020). Effects of Acupuncture on Delayed-Onset Muscle Soreness: A Systematic Review and Meta-Analysis. *Evidence-Based Complementary and Alternative Medicine*, *2020*(5864057), 1–11. https://doi.org/10.1155/2020/5864057

Close, G. L., Hamilton, D. L., Philp, A., Burke, L. M., & Morton, J. P. (2016). New Strategies in Sport Nutrition to Increase Exercise Performance. *Free Radical Biology and Medicine*, *98*, 144–158. https://doi.org/10.1016/j.freeradbiomed.2016.01.016

Corr, L. D., Field, A., Pufal, D., Clifford, T., Harper, L. D., & Naughton, R. J. (2021). The Effects of Cocoa Flavanols on Indices of Muscle Recovery and Exercise Performance: A Narrative Review. *BMC Sports Science, Medicine and Rehabilitation*, *13*(1), 1–16. https://doi.org/10.1186/s13102-021-00319-8

Daud, S. M. M., Sukri, N. M., Johari, M. H., Gnanou, J., & Manaf, F. A. (2023). Pure Juice Supplementation: Its Effect on Muscle Recovery and Sports Performance. *Malaysian Journal of Medical Sciences*, *30*(1), 31–48. https://doi.org/10.21315/mjms2023.30.1.4

Desbrow, B. (2021). Youth Athlete Development and Nutrition. *Sports Medicine*, *51*(s1), 3–12. https://doi.org/10.1007/s40279-021-01534-6

Dow, K., Pritchett, R., Roemer, K., & Pritchett, K. (2018). Chocolate Milk as a Post Exercise Recovery Aid in Division II Collegiate Volleyball Players. *Women in Sport & Physical Activity Journal*, *27*(1), 45–51. https://doi.org/10.1123/wspaj.2018-0012

Heaton, L. E., Davis, J. K., Rawson, E. S., Nuccio, R. P., Witard, O. C., Stein, K. W., Baar, K., Carter, J. M., & Baker, L. B. (2017). Selected In-Season Nutritional Strategies to Enhance Recovery for Team Sport Athletes: A Practical Overview. *Sports Medicine*, *47*(11), 2201–2218. https://doi.org/10.1007/s40279-017-0759-2

James, L. J., Stevenson, E. J., Rumbold, P. L. S., & Hulston, C. J. (2019). Cow's Milk as a Post-Exercise Recovery Drink: Implications for Performance and Health. *European Journal of Sport Science*, *19*(1), 40–48. https://doi.org/10.1080/17461391.2018.1534989

Jayaputra, V. M. B., & Putriningtyas, N. D. (2024). Effect of Chocolate Milk Consumption on Cardiorespiratory Endurance of Central Java BPPLOP Games Athletes. *Amerta Nutrition*, *8*(2), 295–304. https://doi.org/10.20473/amnt.v8i2.2024.295-304

Kanda, A., Nakayama, K., Sanbongi, C., Nagata, M., Ikegami, S., & Itoh, H. (2016). Effects of Whey, Caseinate, or Milk Protein Ingestion on Muscle Protein Synthesis after Exercise. *Nutrients*, *8*(6), 1–13. https://doi.org/10.3390/nu8060339

Kirk, B., Mitchell, J., Jackson, M., Amirabdollahian, F., Alizadehkhaiyat, O., & Clifford, T. (2017). A2 Milk Enhances Dynamic Muscle Function Following Repeated Sprint Exercise, A Possible Ergogenic Aid for A1-Protein Intolerant Athletes? *Nutrients*, *9*(2), 1–14. https://doi.org/10.3390/nu9020094

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The Multistage 20 Metre Shuttle Run Test for Aerobic Fitness. *Journal of Sports Sciences*, *6*(2), 93–101. https://doi.org/10.1080/02640418808729800

Lundby, C., Montero, D., & Joyner, M. (2017). Biology of VO2max: Looking Under the Physiology Lamp. *Acta Physiologica*, *220*(2), 218–228. https://doi.org/10.1111/apha.12827

Mahan, K. L., & Raymond, J. L. (2017). *Krause's Food & The Nutrition Care Process, Fourteenth Edition*. Elsevier.

Matsudo, V. K. R., Matsudo, S. M., de Rezende, L. F. M., & Raso, V. (2015). Handgrip Strength as a Predictor of Physical Fitness in Children and Adolescents. *Revista Brasileira de Cineantropometria e Desempenho Humano*, *17*(1), 1–10. https://doi.org/10.5007/1980-0037.2015v17n1p1

Mendez-Rebolledo, G., Ruiz-Gutierrez, A., Salas-Villar, S., Guzman-Muñoz, E., Sazo-Rodriguez, S., & Urbina-Santibáñez, E. (2022). Isometric Strength Of Upper Limb Muscles In Youth Using Hand-Held And Hand-Grip Dynamometry. *Journal of Exercise Rehabilitation*, *18*(3), 203–213. https://doi.org/10.12965/jer.2244198.099

Molaeikhaletabadi, M., Bagheri, R., Hemmatinafar, M., Nemati, J., Wong, A., Nordvall, M., Namazifard, M., & Suzuki, K. (2022). Short-Term Effects of Low-Fat Chocolate Milk on Delayed Onset Muscle Soreness and Performance in Players on a Women's University Badminton Team. *International Journal of Environmental Research and Public Health*, *19*(6), 4–8. https://doi.org/10.3390/ijerph19063677

Nieman, D. C., Gillitt, N. D., Sha, W., Meaney, M. P., John, C., Pappan, K. L., & Kinchen, J. M. (2015). Metabolomics-Based Analysis of Banana and Pear Ingestion on Exercise Performance and Recovery. *Journal of Proteome Research*, *14*(12), 5367–5377. https://doi.org/10.1021/acs.jproteome.5b00909

Ojeda, Á. H., Maliqueo, S. G., & Barahona-Fuentes, G. (2020). Validity and Reliability of the Muscular Fitness Test to Evaluate Body Strength-Resistance. *Apunts Sports Medicine*, *55*(208), 128–136. https://doi.org/10.1016/j.apunsm.2020.08.002

Papacosta, E., Nassis, G. P., & Gleeson, M. (2015). Effects of Acute Postexercise Chocolate Milk Consumption during Intensive Judo Training on the Recovery of Salivary Hormones, Salivary Siga, Mood State, Muscle Soreness, and Judo-Related Performance. *Applied Physiology, Nutrition and Metabolism*, *40*(11), 1116–1122. https://doi.org/10.1139/apnm-2015-0243

Rankin, P., Stevenson, E., & Cockburn, E. (2015). The Effect of Milk on the Attenuation of Exercise-Induced Muscle Damage in Males and Females. *European Journal of Applied Physiology*, *115*(6), 1245–1261. https://doi.org/10.1007/s00421-015-3121-0

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The Importance of Muscular Strength in Athletic Performance. *Sports Medicine*, *46*(10), 1419–1449. https://doi.org/10.1007/s40279-016-0486-0

Tsuji, T., Febriany, D. S., Widiastuti, I., & Yazid, M. (2022). Uses of Domestic Water Buffalo Milk in South Sumatra, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *995*(1). https://doi.org/10.1088/1755-1315/995/1/012018

Upshaw, A. U., Wong, T. S., Bandegan, A., & Lemon, P. W. R. (2016). Cycling Time Trial Performance 4 Hours after Glycogen-Lowering Exercise is Similarly Enhanced by Recovery Nondairy Chocolate Beverages Versus Chocolate Milk. *International Journal of Sport Nutrition and Exercise Metabolism*, *26*(1), 65–70. https://doi.org/10.1123/ijsnem.2015-0056

Witard, O. C., Bannock, L., & Tipton, K. D. (2022). Making Sense of Muscle Protein Synthesis: A Focus on Muscle Growth during Resistance Training. *International Journal of Sport Nutrition and Exercise Metabolism*, *32*(1), 49–61. https://doi.org/10.1123/ijsnem.2021-0139

Yapici, H., Gülü, M., Yagin, F. H., Ugurlu, D., Comertpay, E., Eroglu, O., Kocoğlu, M., Aldhahi, M. I., Karayigit, R., & Badri AL-Mhanna, S. (2023). The Effect of 8-Weeks of Combined Resistance Training and Chocolate Milk Consumption on Maximal Strength, Muscle Thickness, Peak Power and Lean Mass, Untrained, University-Aged Males. *Frontiers in Physiology*, *14*(March), 1–11. https://doi.org/10.3389/fphys.2023.1148494

Yuliati, K., & Hamzah, B. (2022). *The Traditional Local Product Gulo Puan in Chocolate Bar Making*. *International Journal of Science and Research (IJSR)*, *11*(2), 1-3. https://doi.org/10.21275/SR22205162931