applied sciences

MDPI

*Article*

# Acute Effects of Dark Chocolate on Physical Performance in Young Elite Soccer Players: A Pilot Study

**Luca Benedetti [1,2], Federico Nigro [1,*], Marco Malaguti [1], Rocco Di Michele [1] and Cristina Angeloni [1]**

[1] Department for Life Quality Studies, University of Bologna, 40126 Bologna, Italy; luca.benedetti17@unibo.it (L.B.); marco.malaguti@unibo.it (M.M.); rocco.dimichele@unibo.it (R.D.M.); cristina.angeloni@unibo.it (C.A.)
[2] Bologna Football Club 1909, 40132 Bologna, Italy
* Correspondence: federico.nigro2@unibo.it

**Abstract:** Background: Dark chocolate is rich in polyphenols and has been linked to cardiovascular and metabolic benefits. Its potential effects on recovery, fatigue reduction, and subjective wellness in elite athletes, however, remain underexplored. This pilot study examined the acute effects of dark chocolate consumption on wellness scores, perception of effort, and GPS-based performance measures in elite soccer players during a 4-week intervention period. Methods: Twenty-two elite soccer players were assessed in two conditions—when consuming 25g/day of 85% dark chocolate (DC), or with no dietary intervention (CG). Subjective fatigue and wellness were assessed daily through validated self-report questionnaires. External loads were monitored during training and matches. Results: Athletes in the DC group reported significant reductions in muscle soreness scores and an increase in match and training physical performance (distance at very high deceleration), as compared with the CG group. Conclusions: Daily consumption of dark chocolate may reduce muscle damage and enhance physical performance in elite athletes. These findings suggest that dark chocolate could be a practical dietary strategy to support recovery and overall well-being in high-performance contexts.

**Keywords:** ergogenic supplements; elite athletes; nutraceutical; football; recovery

check for updates

Academic Editor: Wojciech Kolanowski

Received: 29 December 2024
Revised: 10 January 2025
Accepted: 17 January 2025
Published: 20 January 2025

**Citation:** Benedetti, L.; Nigro, F.; Malaguti, M.; Di Michele, R.; Angeloni, C. Acute Effects of Dark Chocolate on Physical Performance in Young Elite Soccer Players: A Pilot Study. *Appl. Sci.* **2025**, *15*, 965. https://doi.org/10.3390/app15020965



## 1. Introduction

The pursuit of nutritional strategies to enhance athletic performance has long been a source of interest for scientists and athletes alike [1]. From this perspective, nutraceuticals have recently emerged as a subject of interest. Nutraceuticals are bioactive compounds that can be found in foods or in supplements that serve as a link between nutrition and medicine, mainly aimed at 'prevention'. This syncretic neologism, coined by Dr. Stephen DeFelice in 1989, combines nutrition and pharmaceutical [2].

Nutraceuticals encompass substances such as vitamins, minerals, antioxidants, and other natural compounds, such as lycopene from tomatoes, omega-3 fatty acids from oily fish, and flavanols from dark chocolate (DC) [3]. Each of these substances has significant biological potential. Plants, herbs, and other natural products have been used as therapeutic agents since ancient times. It has been established that a considerable number of the effects attributed to plants used in traditional medicines in the past can be ascribed to nutraceutical compounds.

Among soccer players, the use of dietary supplements has become increasingly common, with most athletes including them into their routines with different purposes like enhancing performance, reducing the risk of injury, or accelerating post-exercise recovery [4,5]. The use of dietary supplements, when integrated into a context of proper nutrition, can indeed be highly effective and lead to competitive advantages for athletes. However, it is common for athletes to use supplements without a genuine understanding of both their positive and negative effects and without exploring the possibility of achieving the same benefits through diet alone [6–8]. In addition, within sports societies, there is often a lack of specialized professionals capable of adequately managing athletes' nutrition. Even when such figures are present, their attention is primarily focused on the first-team athletes, while youth teams may be neglected. For this reason, youth teams often find themselves at the mercy of unqualified individuals or ambitious parents who, hoping to foster the emergence of promising young athletes in such a competitive environment, introduce dietary supplements to improve their performance instead of improving their nutrition [9].

Moreover, in the context of youth teams, decisions are often based on anecdotal information and lack of scientific foundation. This can be extremely detrimental both because dietary supplements can have significant side effects if not taken properly, and because young athletes are not educated about proper nutrition, conveying the message that there are "shortcuts" capable of providing what they need. In this context, identifying functional foods with ergogenic effects could be an alternative and healthy strategy [10]. Functional foods provide additional health benefits beyond basic nutrition with the aim of maintaining good health and reducing the risk of disease. To be called "functional", their positive influence on one or more physiological functions must be scientifically proven.

Among the different functional foods rich in bioactive substances investigated for their potential ergogenic benefits, dark chocolate has emerged as a promising candidate [11]. The potential ergogenic effect of dark chocolate is attributable to cocoa that contains several bioactive compounds, including polyphenols (mainly (−)-epicatechin and (+)-catechin, and proanthocyanidins), methylxanthines such as theobromine and caffeine, and some psychoactive constituents such as biogenic amines (tyramine, tryptamine, and especially phenylethylamine) and the endocannabinoids anandamide and related N-acylethanolamines [12].

The concentration of bioactive compounds varies significantly between cocoa, chocolate, and different types of chocolate. Most of the health benefits of cocoa and its products are attributed to its polyphenol content, with dark chocolate containing up to five times more polyphenols than milk chocolate. These levels depend on the cocoa content, which is typically between 50% and 90% in dark chocolate, whereas white chocolate is completely devoid of these bioactive compounds, as it only contains cocoa butter [13–15]. Cocoa and dark chocolate have been associated with several physiological effects, including vasodilation, enhanced oxygen and glucose delivery, improved cognitive function, anti-inflammatory and antioxidant activity, muscle pain reduction, and mood improvement [16–19]. Importantly, the bioactive compounds in dark chocolate appear to mitigate the negative effects of inflammatory processes induced by exercise, particularly high-intensity exercise. This is achieved by reducing oxidative stress and systemic inflammation, which are key contributors to post-exercise recovery challenges [20].

Although some studies have reported inconsistent findings regarding the efficacy of cocoa flavonoids in reducing inflammatory markers, there is evidence to support potential benefits in specific contexts. For example, dark chocolate rich in flavonoids has been associated with reduced levels of inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6), likely through mechanisms involving modulation of the gut microbiota and improved endothelial function [21,22]. These effects are particularly evident when high concentrations of cocoa are consumed and in clinical populations such as individuals with obesity or diabetes [16–20,23,24].

These findings emphasize the necessity of investigating the potential effects of dark chocolate on sports performance. The bioactive compounds of dark chocolate may confer synergistic benefits, potentially enhancing recovery and reducing exercise-induced inflammation. However, the variability in bioactive compound concentrations across chocolate products and the necessity for dose-specific investigations must be considered when interpreting these results [25,26].

In contrast with earlier claims, some studies have reported no significant effects of dark chocolate consumption on IL-6 levels or leukocyte count. This suggests that dosage, duration, and population characteristics may play a critical role in determining outcomes [27]. Other investigations have explored the impact of dark chocolate on perceived muscle pain and functional recovery. However, results remain inconclusive, particularly among professional athletes and well-trained individuals [28].

To explore the possible effects of cocoa flavanols (CF), the main class of polyphenols present in cocoa, and exercise performance, Patel and Brouner conducted a study in which they measured performance using a maximum distance time sprint test, completed after 20 min of cycling. They observed that consuming 259 mg of CF daily for 14 days resulted in covering 17% longer distance than at baseline and 13% longer distance than when consuming a white chocolate control. The distance covered during Yo-Yo IRT1 increased after CF supplementation (616 mg CF for 7 days) compared to baseline, while the placebo group covered 5.8% less distance. The mechanism behind this effect could be attributed to CF's ability to decrease ROS production and attenuate fatigue. This suggests that CF may have reduced the potential oxidative stress associated with training, thus delaying fatigue [29]. Given this evidence, this pilot study aimed to evaluate the acute effects of dark chocolate consumption on wellness scores, perception of effort, and GPS-based performance measures in young elite soccer players during a 4-week intervention period. We hypothesized that well-being scores and GPS-based performance measures would improve with DC use and that perception of effort would decrease compared to the control condition.

## 2. Materials and Methods

### 2.1. Participants and Study Design

The project spanned a four-week period and involved 22 young elite athletes from the under-16 (U16) category of a professional soccer club across the 2023/2024 season (age: 15.5 ± 0.7; BMI: 21.5 ± 1.8). The players were involved, on average, five times a week, including four training sessions and one match, with each session and match lasting approximately 90 min. The players were randomly divided into two groups for the duration of the project, alternating their intake of dark chocolate each week. During the first week, one group consumed chocolate, followed by a wash-out week. In accordance with the randomized crossover design of the study, the groups were reversed in the following weeks. In accordance with previous study [22], in the experimental condition players consumed 25 g of 88% Elah–Dufour–Novi dark chocolate 40 min before each training session or match, while in the control condition they consumed no food at all. The study involved a total of 5 consumption sessions per week. Every morning, the athletes completed a wellness questionnaire about perceived recovery. At the end of each training session, they were asked about their perception of both physical and mental effort (Figure 1). The study was conducted with the approval of the bioethics committee of the University of Bologna (Prot. 0122642—8 May 2023) and informed consent for participation was obtained from the parents of all subjects involved in the study.

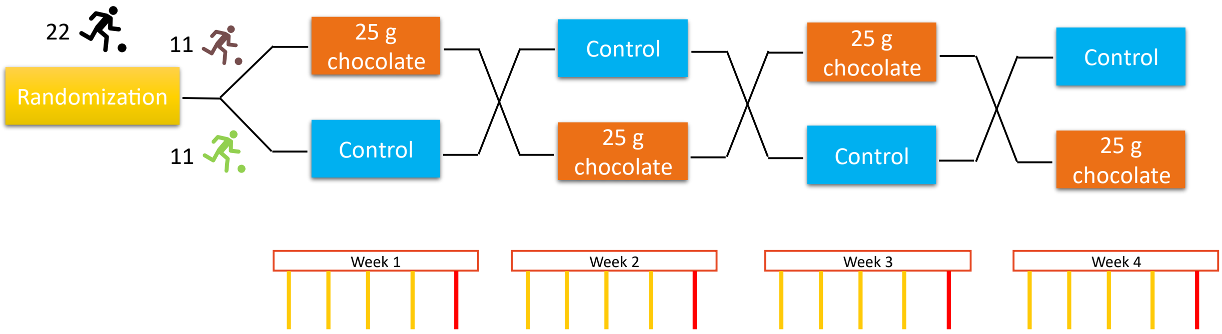


**Figure 1.** Study design. Recovery questionnaire, rating of perceived exertion, and GPS data were collected during both training and match days.

### *2.2. Recovery Questionnaire*

A questionnaire was used to evaluate the athlete's recovery status, which investigates five areas: fatigue, quality of sleep, muscle soreness, stress, and state of mind [30]. Each athlete indicated a score from 1 to 5 for each area. The questionnaire was completed by the players every morning during the entire duration of the study [31–33].

### *2.3. Rating of Perceived Exertion*

A modified version of Foster's 0–10 scale was used to determine both the physical and mental perception of effort [34]. These scales were recently created by Nigro and Marcora [35,36], who also tested their validity and reliability in athletes. Both the mental perceived exertion (M RPE) and physical perceived exertion (P RPE) were measured for the duration of the project 30 min after the end of each training session [34].

### *2.4. External Load Parameters of Training Sessions and Matches*

The following external load variables were assessed in all examined training sessions and matches, using portable 50 Hz GPS devices (K-AI, K-Sport, Montelabbate, Italy): total distance (TD), high-intensity running distance (HIR) (running speed > 4.44 m/s), number of actions at high intensity, sprinting distance (>6.95 m/s), number of sprints, distance at very high acceleration (>3 $m/s^2$), number of high acceleration sprints, distance at very high deceleration (<−3 $m/s^2$), number of decelerations, average metabolic power, and distance at very high metabolic power (>20 W/kg) [37]. For each player and session, all variables were divided by the actual training/playing time (in minutes) [34].

### *2.5. Statistical Analysis*

All data are presented as the means and standard deviations. Comparisons between conditions were performed using paired Student's *t* tests, to assess the acute effects of dark chocolate on recovery status, external load, and perception of effort. To check the normality of differences, Shapiro–Wilk tests were performed. For all tests, statistical significance was set at $p < 0.05$. The analyses were performed with the software R, version 4.3.1 (The R Foundation for Statistical Computing, Vienna, Austria).

## 3. Results

Table 1 shows the mean values for wellness scales and RPE variables assessed after training sessions. The athletes who consumed dark chocolate before training exhibited significantly lower muscle soreness than in the control condition (M = 1.485, SD = 0.446 vs. M = 1.651, SD = 0.414, respectively, $p < 0.05$). Regarding the other subjective parameters examined in association to training sessions, no statistically significant differences were observed between the group in which players consumed dark chocolate and the control group (all $p > 0.05$).

**Table 1.** Wellness, and RPE values associated with training sessions and match play in the two examined conditions. RPE P means rating of perceived physical exertion, and RPE M means rating of perceived mental exertion. TL P means physical training loads, and TL M means mental training loads. DC means dark chocolate. M means mean, and SD means standard deviation. *p* means *p* value. * $p < 0.05$.

| | Training | | | | | | | Match | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameters** | **Control** | | **DC** | | **t** | ***p*** | **Cohen's d** | **Control** | | **DC** | | **t** | ***p*** | **Cohen's d** |
| | **M** | **SD** | **M** | **SD** | | | | **M** | **SD** | **M** | **SD** | | | |
| Muscle Soreness | 1.651 | 0.414 | 1.485 | 0.446 | 2.352 | 0.029 * | 0.513 | 1.313 | 0.479 | 1.245 | 0.409 | 0.845 | 0.411 | 0.211 |
| Fatigue | 1.521 | 0.379 | 1.478 | 0.386 | 0.696 | 0.494 | 0.152 | 1.313 | 0.479 | 1.211 | 0.346 | 1.000 | 0.333 | 0.250 |
| Sleep quality | 1.522 | 0.496 | 1.511 | 0.416 | 0.258 | 0.799 | 0.056 | 1.333 | 0.435 | 1.275 | 0.391 | 0.740 | 0.471 | 0.185 |
| Mood Profile | 1.588 | 0.421 | 1.504 | 0.457 | 1.924 | 0.069 | 0.420 | 1.510 | 0.485 | 1.387 | 0.459 | 1.294 | 0.215 | 0.323 |
| RPE P | 3.906 | 0.483 | 3.838 | 0.686 | 0.449 | 0.658 | 0.098 | 4.155 | 1.688 | 4.686 | 1.563 | −1.283 | 0.222 | 0.343 |
| RPE M | 2.340 | 0.807 | 2.375 | 0.801 | 0.285 | 0.779 | 0.062 | 2.786 | 1.251 | 3.299 | 1.407 | −1.834 | 0.090 | 0.490 |
| TL P | 326.60 | 59.89 | 304.49 | 66.84 | 1.294 | 0.210 | 0.282 | 332.667 | 187.090 | 309.167 | 205.576 | 0.001 | 0.992 | 0.003 |
| TL M | 196.79 | 81.36 | 184.72 | 65.05 | 0.954 | 0.352 | 0.208 | 215.125 | 130.915 | 202.564 | 142.228 | 0.389 | 0.705 | 0.112 |

As presented in Table 2, players in the DC group showed higher performance in terms of distance covered at very high deceleration (M = 1.139, SD = 0.198), as compared to the control group (M = 1.234, SD = 0.286, $p < 0.05$). In regard to the other external load parameters recorded during training, no statistically significant differences were observed between the two conditions.

**Table 2.** External load variables during training sessions and match play in the examined conditions. DC means dark chocolate. M means mean, and SD means standard deviation. *p* means *p* value. * $p < 0.05$.

| | Training | | | | | | | Match | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameters** | **Control** | | **DC** | | **t** | ***p*** | **Cohen's d** | **Control** | | **DC** | | **t** | ***p*** | **Cohen's d** |
| | **M** | **SD** | **M** | **SD** | | | | **M** | **SD** | **M** | **SD** | | | |
| Metabolic power | 7.495 | 0.756 | 7.799 | 0.745 | −1.574 | 0.131 | 0.343 | 9.613 | 0.843 | 9.917 | 0.818 | 1.208 | 0.253 | 0.349 |
| High power distance per minute | 18.389 | 3.206 | 19.696 | 4.511 | −1.276 | 0.217 | 0.278 | 27.267 | 4.398 | 28.780 | 5.853 | 0.978 | 0.349 | 0.282 |
| Distance per minute | 82.331 | 8.336 | 85.430 | 8.106 | 1.481 | 0.154 | 0.323 | 105.458 | 9.159 | 108.686 | 7.771 | 1.125 | 0.284 | 0.325 |
| High speed running distance | 10.948 | 2.501 | 11.772 | 3.443 | −1.109 | 0.281 | 0.281 | 16.314 | 3.690 | 17.094 | 4.995 | 0.825 | 0.427 | 0.334 |
| Distance at very high acceleration per minute | 1.475 | 0.232 | 1.514 | 0.271 | 0.0853 | 0.404 | 0.186 | 1.569 | 0.310 | 1.636 | 0.390 | 0.374 | 0.716 | 0.397 |
| Distance at very high deceleration per minute | 1.139 | 0.198 | 0.1234 | 0.286 | 2.264 | 0.035 * | 0.494 | 1.470 | 0.264 | 1.630 | 0.439 | −2.637 | 0.023 * | 0.309 |

Table 1 shows that there were no significant differences between the two groups regarding subjective parameters measured in association with matches.

However, as observed in Table 2, when consuming the dark chocolate before the matches (M = 1.470, SD = 0.264) players exhibited greater distance covered at a higher deceleration per minute than in the control group (M = 1.630, SD = 0.439), $t(11) = 2.637$, $p < 0.05$. In regard to the other external load variables, no significant differences were observed between the two conditions (all $p > 0.05$).

## 4. Discussion

The findings of this study suggest that the acute consumption of dark chocolate can reduce the perception of muscle soreness experienced during training. This finding is consistent with previous research in the field. For instance, Cavarretta et al. [20] demonstrated that the administration of 40 g for 30 days of dark chocolate to elite soccer players resulted in a significant reduction in muscle soreness. Similarly, Garrido et al. [38] conducted a study in which the administration of a smaller amount of dark chocolate, specifically 25 g, also led to a noticeable reduction in perceived muscle soreness in elite soccer players.

Furthermore, a recent review by Gonçalves et al. [39] concluded that phenolic compounds, abundant in dark chocolate, effectively reduce muscle soreness in athletes. The ingestion of phenolic compounds appears to be beneficial, as they suppress inflammation, reduce oxidative damage, and facilitate the recovery of muscle strength and soreness. These effects collectively contribute to enhanced physical performance, endurance, and recovery in athletes.

Although this study assesses the immediate effects of dark chocolate consumption, it is conceivable that the mood-enhancing effects could become more pronounced or accumulate with regular, long-term consumption due to potential physiological adaptations or sustained psychological associations. Furthermore, consuming a larger quantity of dark chocolate may further amplify these effects. Regarding the rate of perceived exertion (RPE), our findings are consistent with those reported in the literature. For example, the study by Allgrove et al. [40] found that the acute consumption of 40 g of dark chocolate by a group of physically active young individuals did not result in any significant differences in RPE compared to a control group. Similarly, in a study by Davison et al. [27], an intake of 100 g of dark chocolate by physically active subjects (four times the dosage administered in our study) also reported no statistically significant differences in RPE between the dark chocolate group and the control group.

The results of this study indicate that the consumption of chocolate, rich in flavonoids, may have an impact on athletic performance, both during training and in competition. In this case, the group that consumed dark chocolate exhibited an increase in distance covered at very high deceleration. Additionally, the very high deceleration per minute observed in this group may positively influence the muscular response to eccentric contractions. This effect can be attributed to the anti-inflammatory and antioxidant properties of flavonoids, which reduce oxidative stress and exercise-induced muscle inflammation. The flavonoids in chocolate can reduce oxidative stress by neutralizing free radicals produced during intense exercise [41]. This can help to minimize muscle damage induced by eccentric contractions. Furthermore, the anti-inflammatory properties of flavonoids can reduce the post-exercise inflammatory response, thereby improving muscle recovery and reducing delayed onset muscle soreness (DOMS).

Flavonoids enhance vascular function by stimulating the production of nitric oxide (NO), which facilitates vasodilation and improves blood flow. Improved blood flow can facilitate a greater supply of nutrients and oxygen to muscles, thereby accelerating the recovery process following eccentric contractions. Furthermore, enhanced blood flow can diminish the accumulation of toxic metabolites and accelerate the elimination of waste products, thereby facilitating enhanced muscle regeneration [42]. The potential impact of cocoa flavonoids (CF) on performance may be attributed to their antioxidant properties and the delayed fatigue induced by the neutralization of reactive oxygen species (ROS). These mechanisms may explain the increased deceleration distance observed in our study, since improved muscle recovery and pain reduction could influence motor control during physical activity.

However, it is important to note that this study did not include a placebo group, which could limit the ability to attribute the observed effects solely to dark chocolate. Without a control group receiving a placebo, it is challenging to rule out potential psychological effects or other factors that may have influenced the results. This limitation presents an opportunity for future research to explore these effects more robustly by including a placebo control and potentially varying the dosage, athlete demographics (e.g., age and sex), and duration of supplementation to understand both acute and chronic effects.

Despite this limitation, the practical implications of these findings remain relevant. The study suggests that dark chocolate, as a common and safe food item, can offer an ergogenic benefit, especially for youth athletes. This is particularly valuable for coaches and sports nutritionists working with young athletes, as it provides an alternative to traditional supplements that can be more appropriate for younger populations.

## 5. Conclusions

The present study corroborates prior findings that indicate a significant correlation between DC consumption and the recovery parameters experienced during training, particularly in relation to the perception of muscle soreness. Moreover, significant differences were observed in training and in matches over distances with very high deceleration per minute. It is recommended that sport nutritionists, sports coaches, and sports scientists consider these results when implementing measures to support sports nutrition, while simultaneously ensuring that athletes are aware of the importance of correct and healthy nutrition. Furthermore, DC is a common food and not a food supplement. In a young population of athletes, such as those considered in this study, it represents a more appropriate choice in terms of safety and education regarding a healthy lifestyle. This study was conducted on a male sports population, future research could focus on the consumption of DC both in acute and in chronic uses, with different dosage, or in the female sports population. In contrast to the present study, which primarily concentrates on performance outcomes, alternative research approaches might involve the comparison of diverse chocolate types and the incorporation of blood parameter assessments to determine inflammation and lactate levels. Nevertheless, our findings offer new perspectives on the effects of chocolate consumption on physical performance. We suggest that chocolate could influence not only endurance and energy but also motor control during sporting activity. The utilization of a common, widely appreciated, food with ergogenic effects represents a winning strategy, particularly among adolescents. During this critical period of physical and cognitive development, the use of supplements might convey a distorted message regarding proper nutrition. Moreover, the use of supplements may be perceived negatively by parents, who are often concerned about the safety and long-term implications of such interventions.

**Author Contributions:** Conceptualization, L.B., M.M., R.D.M. and C.A.; Data curation, L.B., F.N., R.D.M. and C.A.; Formal analysis, F.N. and R.D.M.; Investigation, L.B., F.N. and C.A.; Methodology, L.B., F.N., M.M., R.D.M. and C.A.; Project administration, L.B.; Software, F.N. and R.D.M.; Supervision, M.M., R.D.M. and Cristina Angeloni; Validation, F.N. and R.D.M.; Visualization, L.B. and F.N.; Writing—original draft, L.B., F.N., M.M., R.D.M. and C.A.; Writing—review and editing, L.B., F.N., M.M., R.D.M. and C.A. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Alma Mater Studiorum University of Bologna (protocol code 0122642—8 May 2023).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** We would like to thank the strength and conditioning staff of the U16 Bologna Football Club 1909 (2023–2024), and all the players who voluntarily participated in this study.

**Conflicts of Interest:** Author Luca Benedetti was employed by the company Bologna Football Club 1909. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## References

1. Holway, F.E.; Spriet, L.L. Dietary Protein for Athletes: From Requirements to Optimum Adaptation. In *Food, Nutrition and Sports Performance III*; Routledge: London, UK, 2013; pp. 37–46. ISBN 9781315873268.
2. Angelo, D.; Tafuri, S. Nutraceutical: Their Role in Improving Sports Performance. *Sport Sci.* **2020**, *13*, 7–12.
3. Rajasekaran, A.; Sivagnanam, G.; Xavier, R. Nutraceuticals as Therapeutic Agents: A Review. *Res. J. Pharm. Technol.* **2008**, *1*, 328–340.
4. Aguinaga-Ontoso, I.; Guillen-Aguinaga, S.; Guillen-Aguinaga, L.; Alas-Brun, R.; Guillen-Grima, F. Effects of Nutrition Interventions on Athletic Performance in Soccer Players: A Systematic Review. *Life* **2023**, *13*, 1271. [CrossRef]
5. Abreu, R.; Oliveira, C.B.; Costa, J.A.; Brito, J.; Teixeira, V.H. Effects of Dietary Supplements on Athletic Performance in Elite Soccer Players: A Systematic Review. *J. Int. Soc. Sports Nutr.* **2023**, *20*, 2236060. [CrossRef] [PubMed]
6. Jovanov, P.; Đorđić, V.; Obradović, B.; Barak, O.; Pezo, L.; Marić, A.; Sakač, M. Prevalence, Knowledge and Attitudes towards Using Sports Supplements among Young Athletes. *J. Int. Soc. Sports Nutr.* **2019**, *16*, 27. [CrossRef]
7. Giraldi, G.; Unim, B.; Masala, D.; Miccoli, S.; La Torre, G. Knowledge, Attitudes and Behaviours on Doping and Supplements in Young Football Players in Italy. *Public Health* **2015**, *129*, 1007–1009. [CrossRef] [PubMed]
8. Finamore, A.; Benvenuti, L.; De Santis, A.; Cinti, S.; Rossi, L. Sportsmen's Attitude towards Dietary Supplements and Nutrition Knowledge: An Investigation in Selected Roman Area Gyms. *Nutrients* **2022**, *14*, 945. [CrossRef] [PubMed]
9. Meyer, F.; O'Connor, H.; Shirreffs, S.M. International Association of Athletics Federations Nutrition for the Young Athlete. *J. Sports Sci.* **2007**, *25* (Suppl. S1), S73–S82. [CrossRef]
10. James, R.; Naughton, D.P.; Petróczi, A. Promoting Functional Foods as Acceptable Alternatives to Doping: Potential for Information-Based Social Marketing Approach. *J. Int. Soc. Sports Nutr.* **2010**, *7*, 37. [CrossRef] [PubMed]
11. Samanta, S.; Sarkar, T.; Chakraborty, R.; Rebezov, M.; Shariati, M.A.; Thiruvengadam, M.; Rengasamy, K.R.R. Dark Chocolate: An Overview of Its Biological Activity, Processing, and Fortification Approaches. *Curr. Res. Food Sci.* **2022**, *5*, 1916–1943. [CrossRef] [PubMed]
12. Massaro, M.; Scoditti, E.; Carluccio, M.A.; Kaltsatou, A.; Cicchella, A. Effect of Cocoa Products and Its Polyphenolic Constituents on Exercise Performance and Exercise-Induced Muscle Damage and Inflammation: A Review of Clinical Trials. *Nutrients* **2019**, *11*, 1471. [CrossRef] [PubMed]
13. da Silva Medeiros, N.; Koslowsky Marder, R.; Farias Wohlenberg, M.; Funchal, C.; Dani, C. Total Phenolic Content and Antioxidant Activity of Different Types of Chocolate, Milk, Semisweet, Dark, and Soy, in Cerebral Cortex, Hippocampus, and Cerebellum of Wistar Rats. *Biochem. Res. Int.* **2015**, *2015*, 294659. [CrossRef]
14. Halib, H.; Ismail, A.; Mohd Yusof, B.-N.; Osakabe, N.; Mat Daud, Z.A. Effects of Cocoa Polyphenols and Dark Chocolate on Obese Adults: A Scoping Review. *Nutrients* **2020**, *12*, 3695. [CrossRef] [PubMed]
15. Cruz, J.F.M.; Leite, P.B.; Soares, S.E.; Bispo, E.d.S. Bioactive Compounds in Different Cocoa (*Theobroma Cacao*, L) Cultivars during Fermentation. *Food Sci. Technol.* **2015**, *35*, 279–284. [CrossRef]
16. Corr, L.D.; Field, A.; Pufal, D.; Clifford, T.; Harper, L.D.; Naughton, R.J. The Effects of Cocoa Flavanols on Indices of Muscle Recovery and Exercise Performance: A Narrative Review. *BMC Sports Sci. Med. Rehabil.* **2021**, *13*, 90. [CrossRef] [PubMed]
17. Presler, K.M.; Webster, M.J. Dark Chocolate Supplementation Elevates Resting Energy Expenditure in Exercise Trained Females. *Int. J. Exerc. Sci.* **2021**, *14*, 250–259. [CrossRef] [PubMed]
18. Sebastiá-Rico, J.; Martínez-Sanz, J.M.; Sanchis-Chordà, J.; Alonso-Calvar, M.; López-Mateu, P.; Romero-García, D.; Soriano, J.M. Supplement Consumption by Elite Soccer Players: Differences by Competitive Level, Playing Position, and Sex. *Healthcare* **2024**, *12*, 496. [CrossRef]
19. Theunissen, S.; Schumacker, J.; Guerrero, F.; Tillmans, F.; Boutros, A.; Lambrechts, K.; Mazur, A.; Pieri, M.; Germonpré, P.; Balestra, C. Dark Chocolate Reduces Endothelial Dysfunction after Successive Breath-Hold Dives in Cool Water. *Eur. J. Appl. Physiol.* **2013**, *113*, 2967–2975. [CrossRef]
20. Cavarretta, E.; Peruzzi, M.; Del Vescovo, R.; Di Pilla, F.; Gobbi, G.; Serdoz, A.; Ferrara, R.; Schirone, L.; Sciarretta, S.; Nocella, C.; et al. Dark Chocolate Intake Positively Modulates Redox Status and Markers of Muscular Damage in Elite Football Athletes: A Randomized Controlled Study. *Oxid. Med. Cell. Longev.* **2018**, *2018*, 4061901. [CrossRef]
21. Shin, J.-H.; Kim, C.-S.; Cha, J.; Kim, S.; Lee, S.; Chae, S.; Chun, W.Y.; Shin, D.-M. Consumption of 85% Cocoa Dark Chocolate Improves Mood in Association with Gut Microbial Changes in Healthy Adults: A Randomized Controlled Trial. *J. Nutr. Biochem.* **2022**, *99*, 108854. [CrossRef] [PubMed]

22. Mancin, L.; Rollo, I.; Golzato, D.; Segata, N.; Petri, C.; Pengue, L.; Vergani, L.; Cassone, N.; Corsini, A.; Mota, J.F.; et al. Short-Term Cocoa Supplementation Influences Microbiota Composition and Serum Markers of Lipid Metabolism in Elite Male Soccer Players. *Int. J. Sport Nutr. Exerc. Metab.* **2024**, *34*, 349–361. [CrossRef]
23. Babar, A.; Bujold, E.; Leblanc, V.; Lavoie-Lebel, É.; Paquette, J.; Bazinet, L.; Lemieux, S.; Marc, I.; Abdous, B.; Dodin, S. Changes in Endothelial Function, Arterial Stiffness and Blood Pressure in Pregnant Women after Consumption of High-Flavanol and High-Theobromine Chocolate: A Double Blind Randomized Clinical Trial. *Hypertens. Pregnancy* **2018**, *37*, 68–80. [CrossRef] [PubMed]
24. González-Garrido, J.A.; García-Sánchez, J.R.; López-Victorio, C.J.; Escobar-Ramírez, A.; Olivares-Corichi, I.M. Cocoa: A Functional Food That Decreases Insulin Resistance and Oxidative Damage in Young Adults with Class II Obesity. *Nutr. Res. Pract.* **2023**, *17*, 228–240. [CrossRef] [PubMed]
25. Jaramillo Flores, M.E. Cocoa Flavanols: Natural Agents with Attenuating Effects on Metabolic Syndrome Risk Factors. *Nutrients* **2019**, *11*, 751. [CrossRef] [PubMed]
26. Tušek, K.; Valinger, D.; Jurina, T.; Sokač Cvetnić, T.; Gajdoš Kljusurić, J.; Benković, M. Bioactives in Cocoa: Novel Findings, Health Benefits, and Extraction Techniques. *Separations* **2024**, *11*, 128. [CrossRef]
27. Davison, G.; Callister, R.; Williamson, G.; Cooper, K.A.; Gleeson, M. The Effect of Acute Pre-Exercise Dark Chocolate Consumption on Plasma Antioxidant Status, Oxidative Stress and Immunoendocrine Responses to Prolonged Exercise. *Eur. J. Nutr.* **2012**, *51*, 69–79. [CrossRef]
28. Decroix, L.; Soares, D.D.; Meeusen, R.; Heyman, E.; Tonoli, C. Cocoa Flavanol Supplementation and Exercise: A Systematic Review. *Sports Med.* **2018**, *48*, 867–892. [CrossRef] [PubMed]
29. Patel, R.K.; Brouner, J.; Spendiff, O. Dark Chocolate Supplementation Reduces the Oxygen Cost of Moderate Intensity Cycling. *J. Int. Soc. Sports Nutr.* **2015**, *12*, 47. [CrossRef]
30. Perri, E.; Simonelli, C.; Rossi, A.; Trecroci, A.; Alberti, G.; Iaia, F.M. Relationship Between Wellness Index and Internal Training Load in Soccer: Application of a Machine Learning Model. *Int. J. Sports Physiol. Perform.* **2021**, *16*, 695–703. [CrossRef]
31. Sawczuk, T.; Jones, B.; Scantlebury, S.; Till, K. The Influence of Training Load, Exposure to Match Play and Sleep Duration on Daily Wellbeing Measures in Youth Athletes. *J. Sports Sci.* **2018**, *36*, 2431–2437. [CrossRef] [PubMed]
32. Hooper, S.L.; Mackinnon, L.T. Monitoring Overtraining in Athletes. Recommendations. *Sports Med.* **1995**, *20*, 321–327. [CrossRef] [PubMed]
33. Jeffries, A.C.; Wallace, L.; Coutts, A.J.; McLaren, S.J.; McCall, A.; Impellizzeri, F.M. Athlete-Reported Outcome Measures for Monitoring Training Responses: A Systematic Review of Risk of Bias and Measurement Property Quality According to the COSMIN Guidelines. *Int. J. Sports Physiol. Perform.* **2020**, *2020*, 1203–1215. [CrossRef] [PubMed]
34. Foster, C.; Florhaug, J.A.; Franklin, J.; Gottschall, L.; Hrovatin, L.A.; Parker, S.; Doleshal, P.; Dodge, C. A New Approach to Monitoring Exercise Training. *J. Strength Cond. Res.* **2001**, *15*, 109–115. [CrossRef] [PubMed]
35. Nigro, F.; Marcora, S.M. Criterion Validity of a New Rpe Scale to Assess the Psychological Load of Physical Training. 2023. Available online: https://cris.unibo.it/handle/11585/960821 (accessed on 23 February 2024).
36. Nigro, F.; Marcora, S. Others Validity of Two New Rpe-Scales to Assess Physical and Psychological Load of Training and Competition. In Proceedings of the XIV Congresso Nazionale SISMeS, Napoli, Italy, 3 November 2023; p. 22.
37. Izzo, R.; Palma, A.; Cejudo, A.; Cruciani, A.; Giovannelli, M.; Vardei, H.C. Validation of the New Technology Sensor Fusion K-50 Based on Data Integration Detected by GPS 50 Hz and Inertial Sensors. *J. Phys. Educ. Sport* **2022**, *22*, 555–561.
38. González-Garrido, J.A.; García-Sánchez, J.R.; Garrido-Llanos, S.; Olivares-Corichi, I.M. An Association of Cocoa Consumption with Improved Physical Fitness and Decreased Muscle Damage and Oxidative Stress in Athletes. *J. Sports Med. Phys. Fit.* **2017**, *57*, 441–447. [CrossRef] [PubMed]
39. Gonçalves, A.C.; Gaspar, D.; Flores-Félix, J.D.; Falcão, A.; Alves, G.; Silva, L.R. Effects of Functional Phenolics Dietary Supplementation on Athletes' Performance and Recovery: A Review. *Int. J. Mol. Sci.* **2022**, *23*, 4652. [CrossRef] [PubMed]
40. Allgrove, J.; Farrell, E.; Gleeson, M.; Williamson, G.; Cooper, K. Regular Dark Chocolate Consumption's Reduction of Oxidative Stress and Increase of Free-Fatty-Acid Mobilization in Response to Prolonged Cycling. *Int. J. Sport Nutr. Exerc. Metab.* **2011**, *21*, 113–123. [CrossRef]
41. Peake, J.; Nosaka, K.; Suzuki, K. Characterization of Inflammatory Responses to Eccentric Exercise in Humans. *Exerc. Immunol. Rev.* **2005**, *11*, 64–85. [PubMed]
42. Bondonno, C.P.; Croft, K.D.; Ward, N.; Considine, M.J.; Hodgson, J.M. Dietary Flavonoids and Nitrate: Effects on Nitric Oxide and Vascular Function. *Nutr. Rev.* **2015**, *73*, 216–235. [CrossRef] [PubMed]