

# Module 2. Dietary supplementation for football

## Unit 2.1 Supplementation guidelines for football

Dietary supplements are commonly used by players in pursuit of improved performance, accelerated recovery and enhanced general health. The prevalence of dietary supplement use was reported to be 40-50 % during the 2002 and 2006 FIFA World Cups (Tscholl et al., 2008). This is consistent with studies that have reported 43-93 % of football players have taken some form of dietary supplement (Knapik et al., 2016).

The indiscriminate use of dietary supplements by players at all levels of football remains a concern due to the ever-present risk of supplement contamination with prohibited substances. The use of dietary supplementation is driven by big business, generating billions of dollars in revenue. There are a seemingly endless variety of commercially available dietary supplements, with a plethora of “claims”. Unfortunately, many of these claims are designed to appeal to footballers. For example, performance claims may include improved muscle strength, power, speed and endurance. Whereas health claims may include preventing illness and injury. The scientific studies to support many claims are often lacking.

Considering the physical demands of football and the pressures associated with professional football, elite players, coaches and sport science staff are often overwhelmed developing a practical and evidence-based dietary supplementation strategy that supports football match play and training. Without appropriate education and processes in place, a dietary supplement can often be considered a “quick fix” to resolve performance or physique management concerns.

It is important to note that there is rarely a need to supplement if the diet of the player contains a balanced variety of healthy foods. Nonetheless, there are exceptions where dietary supplements can help performance or recovery, but in either case, they should be consumed to “supplement” a healthy balanced diet, not as a replacement. The aim of Unit 1 is to provide guidelines and best practice with regard to implementing a dietary supplementation program. In Unit 2, we will discuss the most relevant dietary supplements for consideration in football that are not currently banned by the World Anti-Doping Agency (WADA). This knowledge will provide you with the foundational skills and knowledge to implement an effective dietary supplement strategy with your players.



### Key point

**Dietary supplements should be consumed to “supplement” a healthy balanced diet, not as a replacement.**

#### 2.1.1 The dietary supplement

For as long as there has been competition in sport, athletes have attempted to improve their performance by ingesting a variety of substances. These various substances have a diverse terminology including “nutritional supplements”, “nutritional ergogenics” and “ergogenic aids”.

Whilst the term ergogenic aid is popular, an ergogenic aid could refer to anything that enhances performance, for example dietary supplements, psychological strategies or biomechanical techniques (Bishop, 2010). The terms ‘nutritional supplements’ and ‘nutritional ergogenics’ should also be avoided because this phrasing may imply that there is some nutritional value to the discussed supplements, which may not be true. Therefore, for this course, the term ‘dietary supplement’ will be used.

Dietary supplements, often considered as food, are widely consumed despite limited knowledge around their safety/efficacy (Rizvi et al., 2018). Within nutrition science and legal interpretation, there is no single definition of what constitutes a dietary supplement (Maughan et al., 2018). For the purpose of this course, the definition of a dietary supplement is aligned to the International Olympic Committee's (IOC) consensus statement (Finley et al., 2013; Maughan et al., 2018):

Dietary supplement: a food, food component, nutrient or non-food compound that is purposefully ingested in addition to the habitually-consumed diet with the aim of achieving a specific health or performance benefit.

Dietary supplements come in various forms. A "dietary ingredient" may be one, or any combination, of the following substances: vitamins, minerals, herbs or other botanicals, amino acids or a dietary substance for use by people to supplement the diet by increasing the total dietary intake with a concentrate, metabolite, constituent or extract.

It is important for sports nutritionists to recognise the array of forms that dietary supplements may come in. The list below, described by the IOC consensus statement on dietary supplements and the high-performance athlete, details those potential forms of dietary supplement that the player may encounter (Maughan et al., 2018).

- Functional foods: foods enriched with additional nutrients or components outside their typical nutrient composition (e.g., mineral and vitamin fortified, as well as nutrient-enriched foods).

- Formulated foods and sports foods: products providing energy and nutrients in a more convenient form than normal foods for general nutrition support (e.g., liquid meal replacements) or for targeted use around exercise (e.g., sports drinks, gels, bars).
- Single nutrients and other components of foods or herbal products provided in isolated or concentrated forms.

Multi-ingredient products containing various combinations of those products described above that target similar outcomes.

Unfortunately, the nutrition supplement industry is not well regulated. This brings a number of risks that need to be mitigated at a club. Quality assurance is essential and decisions on supplements should always be based on a careful cost benefit analysis. Although there are thousands of supplements on the market, only a handful can be backed up by scientific evidence (Unit 2).

### **2.1.2 Prevalence of dietary supplement use**

It is clear that the use of dietary supplementation is highly prevalent in football (Tscholl et al., 2008). The extensive use of supplements in football is not surprising given players are constantly striving to achieve peak performances, not to mention the potential financial rewards should an amateur player turn professional. Dietary supplement use in football is likely to be driven by many factors. The supplement policy is likely to vary between clubs, leagues and global regions. This is because supplement use may be influenced by cultural norms as well as the level of nutrition education available to the player. Supplement use is likely to increase with the standard of play (training/performance) required by the player. Professional clubs are likely to have larger budgets to afford expertise in sports nutrition as well as the on-going purchase of specific products. Surveys suggest that supplement use increases with age and is higher in males in comparison to females (Maughan et al., 2018). Finally, dietary supplement use is not isolated to single leagues or countries, but is a worldwide phenomenon (Daher et al., 2022).

Three main reasons to justify dietary supplementation are 1) correct a diagnosed deficiency, 2) seek a direct performance advantage in competition, 3) seek an indirect performance advantage through maximizing availability to train. Beyond the three variables listed above, it is of interest for the sports nutritionist to understand other potential reasons why players may seek dietary supplementation. This will allow a degree of empathy when working with players, as well as help to identify those players that may be at greatest risk of not following appropriate guidelines. As such, table 1 suggests potential reasons and the corresponding advice.



**Table 1. Potential reasons for dietary supplementation**

<b>Potential reasons for players requesting dietary supplementation</b>	<b>Watch out/advice</b>
Diagnosed dietary deficiency	Deficiency should be clinically diagnosed
Convenient provision of energy and nutrients around an exercise session	Use trusted or reputable products/batch tested
Evidence of direct performance benefit based on physiological rationale	No clear rationale for use. Unrealistic performance/health claim/player expectation
Evidence of indirect performance benefit gained through accumulated training enhancement	No evidence. Recommendations of supplement from family or friends (non-qualified individual)
Through sponsorship/product endorsement	Mismatch between product and quality assurance. No evidence base of product benefit
Belief that opposing/superior players are using	Can lead to intentional or unintentional doping offence
Peer pressure	Players exposed to culture of supplement use
Seeking extreme weight loss or gain	Abundant on-line marketing material aimed at weight loss/gain. Ensure education program is in place



Recovery/sleep disturbance	Sleep is often disturbed following later kick off times or frequent travel. Abundance of marketed supplements aimed at sleep. Ensure education program is in place
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Source: own elaboration.

The most common supplements used in professional football are listed below, and the most relevant supplements are discussed in Unit 2.

**Table 2. Classification of potential dietary supplements and examples**

Type of supplement	Examples
Sports foods	Carbohydrate-electrolyte drinks Carbohydrate gels Sports bars and confectionery Recovery shakes Protein drinks Protein-enhanced food Liquid meal supplement



Direct performance benefits	Caffeine Creatine $\beta$ -alanine Nitrate
Indirect performance benefit Essential nutrients	Multivitamins Vitamin D Iron Calcium
Indirect performance benefit (recovery)	Tart Cherry Omega-3 fish oils

Source: own elaboration.

### 2.1.3 Supplement safety

The use and availability of dietary supplement to football players has rapidly exceeded the rate at which the appropriate authorities have been able to regulate the quality of manufacture, storage and distribution (Maughan, 2013). Supplements from anywhere in the world are easily accessible to the player due to ease of internet shopping. There are significant risks associated with the use of unregulated dietary supplements, including the lack of active ingredients; the presence of harmful and toxic substances (including foreign objects); and the presence of potentially dangerous prescription-only ingredients (Maughan, 2013). It is very important, when a decision is made to use a dietary supplement, to make sure that the supplement in question is in line with the World Anti-Doping Association (WADA) code of conduct. Specifically, it should be ensured that all

supplements are free from prohibited substances. The WADA code of conduct may be downloaded free of charge and sports nutritionists working in football are advised to visit the website regularly to check for updates and amendments to the code document, which is available in five languages.

**World Anti-Doping Agency.** (2021). *World Anti-Doping Code*. <https://www.wada-ama.org/en/resources/the-code/world-anti-doping-code>

### Did you know?

**The World Anti-Doping Agency (WADA) was established in 1999. WADA acts as an independent international agency, it is equally funded by the sport movement and governments of the world. Its primary activities include scientific research, education, development of anti-doping capacities and monitoring of the World Anti-Doping Code, the document harmonizing anti-doping policies in all sports and all countries, including football.**

Unfortunately, there are examples of players who have failed doping tests because of the use of dietary supplements and of adverse serious events as a result of indiscriminate supplement use. It is, therefore, important to map out the risks and potential benefits before decisions to use supplements are made. There are quality assurance programs in place that test products and even batches of products for banned substances (for example, Informed Sport and the Köllner Liste). The primary purpose of these programs is to test manufactured products for substances on the World Anti-Doping Agency–prohibited list. Players and potentially individuals responsible for player care/nutrition may consider these programs as a “guarantee” of the quality of products. However, these sports-related programs are not complete quality assurance programs, as the presence of active ingredients is not usually verified (Maughan, 2013). Finally, it is important to consider that a limited panel of substances is tested for and that the tests will have limited sensitivity. Thus, the take home message for players and sports nutritionists is that although supplement quality assurance schemes do offer considerable protection, these schemes are not an absolute guarantee of quality (Maughan, 2013).

Sports nutritionists working in football are also advised to be cautious with regard to the use of multi-ingredient dietary supplements (Burke, 2019). Multi-ingredient dietary supplements may contain up to 30 individual substances, which are often referred to as “proprietary blends”. When proprietary blends are used in a product, it can often prevent the nutritionist from knowing what the actual ingredients are, as the company may feel the need to protect their intellectual property. As such, multi-ingredient dietary supplements may fail to disclose the full list of ingredients (Cohen et al., 2014). Furthermore, even when multi-ingredient dietary supplements contain evidence-based

ingredients, the doses provided in a recommended serving of the supplement may be sub-optimal for that ingredient (Burke, 2019).

### 2.1.4 Supplement contamination risk

Studies have been carried out since the late 1990s to determine the degree of which nutritional supplements may be contaminated with banned substances or contain ingredients not listed on the label. In 2001 and 2002, an international study gathered 634 nutritional supplements, purchased from 13 different countries. The study revealed that approximately 15 % of the nutritional supplements were contaminated with substances that would result in a failed drug test for a player (Geyer et al., 2008). Worryingly, not much seems to have changed over two decades of identifying the issue of contamination. Analytical studies have found from 14 to 50 % of samples analyzed from dietary supplement products have tested positive for anabolic agents or other prohibited substances (Jagim et al., 2023). Beside the potential health risk to the player, these results would suggest that the unregulated use/ingestion of nutritional supplements significantly increases the “risk” of players inadvertently doping.

A full list of prohibited substances can be downloaded from the WADA web page:

**World Anti-Doping Agency.** (2025). *Prohibited List 2025*. <https://www.wada-ama.org/en/resources/science-medicine/prohibited-list-documents>

Individual club or leagues may have separate doping policies. As a sports nutritionist in football, please check the regional or appropriate governing body guidelines. Players may be randomly or routinely asked to provide a urine sample, which will be analysed for markers of banned substances, for example, Nandrolone and metabolites of Nandrolone (Maughan, 2005). The players who compete under the jurisdiction of FIFA should be educated to the following regulations detailed in the 2018 FIFA anti-doping document:

- It is each player’s personal duty to ensure that no prohibited substance enters their body.
- Players are responsible for any prohibited substance or its metabolites or markers found to be present in their samples.

#### Did you know?

**Nandrolone is an anabolic steroid. Its actions are similar to that of testosterone, the male sex hormone that is involved in building muscle and associated with aggressive behaviour.**

### 2.1.5 Quality assurance programs

As stated, there are circumstances when supplementation is appropriate and as such there may be a need to source and purchase the dietary supplement of choice (Unit 2). Before a supplement is purchased, it is recommended that you understand the mechanism by which it may influence the health or performance of the player. In addition, it is important to understand the potential side-effects that the player may encounter. For example, concentrated beetroot juice ingestion may result in the player's urine colour changing to "light pink" and beta-alanine ingestion may result in a tingling sensation on the skin. If it is appropriate for the player's need, then a thorough search should be completed, including a review of the supplement and of the providing company to ensure the product meets the following criteria.

- The product is classified as GRAS (generally recognised as safe). The status of GRAS is provided to products which have been subject to pre-market review and approval by the United States food and drug administration (FDA). The product is generally recognized, among qualified experts, as having sufficient evidence to be safe under the conditions of its intended use.
- The product has been batch tested. Only use batch-tested dietary supplement products. Batch testing is a process completed by independent companies which screen the products for known banned substances. This process can either be completed at the raw ingredient stage or on the final product following the blending/mixing of ingredients. Some companies may also provide a facility certification for assurances that the manufacturing plant is free of banned substances and no risk of cross contamination. Different global regionals will have access to different batch testing companies. Such companies will provide a list on their website to either specific products or companies whose products comply with the rigor of the batch testing process. Two examples of such companies are NSF (The Public Health and Safety Organization) in the United States, and Informed Sport in Europe.

Unfortunately, the research to support the effectiveness of many dietary supplements targeted at football players is lacking. Many companies involved in the production of dietary supplements are unwilling or unmotivated to dedicate finance towards the scientific studies required to support the efficacy of their product. Paradoxically, industry (sports nutrition companies) are sometimes criticized when funding independent research. However, without this support, often the research would simply not be completed given the lack of funding devoted by central government to "performance" driven hypothesis. When evidence that has investigated the specific dietary supplement is available, it is important for the nutritionist to be aware of the strengths and limitations of research designs.

When allowed to purchase their own supplements, the risk to the players is greatly increased. Thus, a final method to safeguard the players from inadvertent doping is to

ensure that players only use those dietary supplements provided by the club. As well as adhering to the WADA guidelines, this method significantly reduces the diversity of products entering the locker rooms and allows “non-approved” supplements to be identified quickly.

## **2.1.6 Dietary supplement considerations**

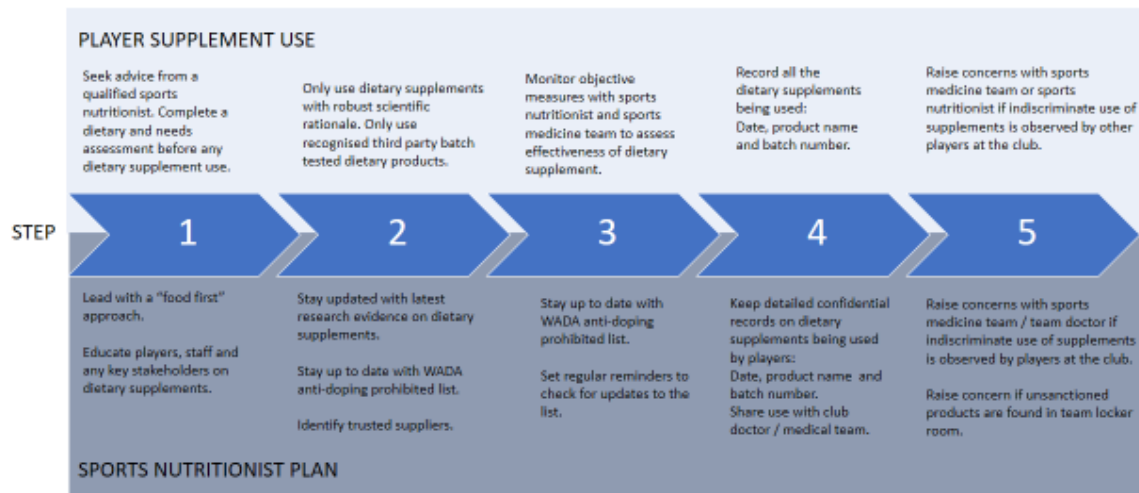
In professional football, the stakes are high for the player (as well as the coach, staff and all stakeholders invested in the player/team performance). In general, professional players are considered role-models for peers and youth players. Professional players are also rewarded financially by participation in the modern game (wages, endorsement). Therefore, the use of dietary supplements should be carefully considered prior to use, with the overarching risk/benefit trade-off. The strategic use of dietary supplementation should meet the specific sports nutrition objectives of the individual player. Players should always be encouraged to adopt a healthy balanced diet using “food first” prior to considering dietary supplements (Unit 2).

Just because a supplement has been shown to improve performance, it does not necessarily mean that the player has to use it. The personal preferences of the player must be respected. Players may have individual tolerances to certain supplements, and the willingness to adopt a new “dietary supplement” may be strongly dictated by previous experiences. The budget of the club and player is also a consideration. Quality, batch tested products are affordable; however, costs may accumulate if players are requested to ingest supplements over the season. If players cannot meet the financial requirements, but have become “reliant” on specific strategies, then they may be tempted to source cheaper non-regulated alternatives.

If introducing a dietary supplement program to a player or club, it is important to consider the practicalities of the intake regime. If the appropriate loading phase cannot be achieved or if the ingestion plan required for the dietary supplement (for whatever reason) interferes with training, the coach’s plans or match day preparation, then it should not be considered. Finally, if using dietary supplements, it is advised to educate and inform all support staff, coaches and physical trainers on why a supplement has been recommended. This strategy allows all “touch-points” for the player to understand what the goal of the strategy is, and that it is a powerful mechanism for the delivery and adherence of a dietary supplement regime.



**Figure 1. Key steps for player adherence to dietary supplement use and guidelines for the sports nutritionist to consider**



Source: own elaboration.

## Summary

- A dietary supplement is a food, food component, nutrient or non-food compound that is purposefully ingested in addition to the habitually-consumed diet with the aim of achieving a specific health or performance benefit.
- Dietary supplements may contain ingredients not listed on the label or substances that may result in a failed drugs test for the player.
- Before use of dietary supplements, players should seek guidance from a qualified sports nutritionist, dietician or medical professional.
- Players should be educated that they are responsible for all dietary supplements that enter their body.
- Appropriate dietary supplementation may have a positive impact on a player's health and performance.
- If choosing to use dietary supplements, players should ingest products that are GRAS or batch tested to minimize risk of inadvertent doping.

## Unit 2.2 Dietary supplements for consideration in football

The philosophy of a “food first” approach for sports nutritionists in football is encouraged. Nutrient provision should come from whole foods and beverages rather than from isolated food components or dietary supplements. However, there are numerous reasons why a food only approach may not always be optimal for footballers (Close et al., 2022):

1. some nutrients are difficult to obtain in sufficient quantities in the diet, or may require excessive energy intake or consumption of other nutrients;
2. some nutrients are abundant only in foods athletes do not eat/like;
3. the nutrient content of some foods with established ergogenic benefits is highly variable;
4. concentrated doses of some nutrients are required to correct deficiencies or promote immune tolerance;
5. some foods may be difficult to consume immediately before, during or immediately after exercise;
6. batch tested supplements could help where there are concerns about food hygiene or contamination.

Under these circumstances, it is reasonable for the player and sports nutritionist to consider ingesting dietary supplements on the condition that steps to minimize risk are in place (Unit 1). Thus, the practical approach should be “food first, but not always food only” (Close et al., 2022).

The main reason to use a dietary supplement program in football is to improve player performance. To achieve this, the dietary supplement must have an indirect or direct impact on the performance of the player. The dietary supplements which have an indirect effect on player performance are those concerned with the player’s health (allowing the player to accumulate training hours) and recovery (enhanced adaptation). Whereas, other dietary supplements may be ingested acutely to directly impact on the completion of match-specific activities. With respect to the objective of dietary supplementation, the sports nutritionist should work closely with the sports science department to track relevant key performance indicators. Although match metrics should be considered, we have discussed the many impacting factors on player match performance (Course 1). Therefore, where possible controlled and standardized performance tests during training are recommended.

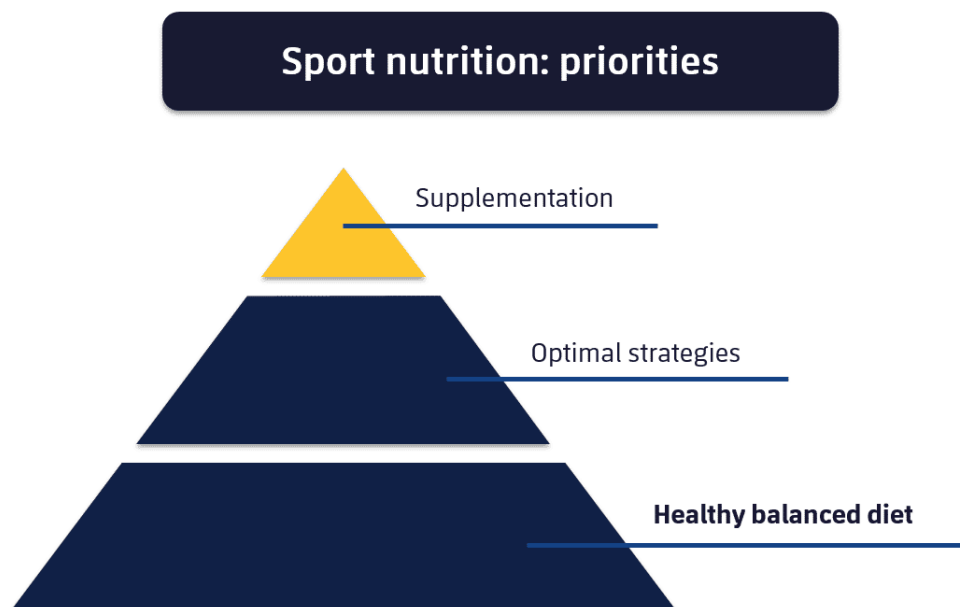


This unit will focus on dietary supplements that are supported by a moderate to high level of evidence and which may be considered for football performance. However, it is also important to understand emerging dietary supplements, on which you may be questioned. To this end, the aim is to provide you with the foundational evidence for dietary supplement use followed by advice for practical application.

### 2.2.1 Nutrition priorities

Players should always be encouraged to adopt a healthy balanced diet using a “food first” approach prior to considering dietary supplements. Thus, when discussing the use of dietary supplements, it is assumed that the key components of the player’s diet are already optimized. As a guide, first, players should be eating a variety of different (predominantly whole) foods to meet their daily energy needs (healthy balanced diet). Second, guidelines with regard to the timing and quantity of macronutrient (protein, carbohydrate, fats) ingestion to support performance and recovery are being followed (optimal strategies). Once these two building blocks are in place, dietary supplementation may be considered (figure 2).

Figure 2. Nutritional priorities



Source: own elaboration.

### 2.2.2 Dietary supplementation: indirect impact



There are periods of the season when the physical demands of football are intensified, such as pre-season or periods of fixture congestion (2-3 matches per week). A dietary supplement program that assists the player to maintain training intensity, maximise their adaptation, speed recovery, reduce muscle soreness and avoid illness has obvious benefits to the player's performance. Below are those dietary supplements that may indirectly benefit player performance.

### **Essential nutrients**

The essential micronutrients were discussed in Module 1. On the occasion when players are accurately diagnosed with a specific nutrient deficiency, the first response should be to address with dietary modifications. However, there may be specific situations where dietary supplementation may provide a prompt and effective response. The most common micronutrients requiring a dietary supplement are iron, calcium and vitamin D (table 3). Correction of these micronutrients may maintain health and maximise performance gains from training. As recommended in Unit 1, the appropriate steps to ensure quality assurance of the nutrient product should be followed. If supplementation is commenced, it should be accompanied by a routine monitoring system to evaluate the impact of the supplementation program and for a duration required to restore the player's desired nutrient status (Maughan et al., 2018).

It is important to note that players engaged in frequent travel, disturbed eating patterns, or on body fat loss programs may benefit from a broad spectrum, low dose multivitamin and mineral dietary supplement (Maughan et al., 2018). Furthermore, although not necessarily required, due to the prevalence in football probiotics are also included. These recommendations should be assessed on an individual player by player basis and will be covered in detail in later modules.



**Table 3. Dietary supplements and guidance for use**

<b>Dietary supplement</b>	<b>Examples</b>	<b>Use</b>	<b>Dose</b>	<b>Concerns</b>
<b>Essential nutrients</b>	Multi-vitamin-mineral  Iron  Vitamin D  Calcium	Prevent or treat deficiency to help maintain health and performance	To meet RDA  See Module 1	Inappropriate use or when taken with lack of monitoring or supervision can lead to health problems
<b>Probiotics</b>	Lactobacillus or Bifidobacterium species	Probiotics stimulate some aspects of immunity and may reduce infection incidence in players	Minimum dose of 10 <sup>10</sup> live bacteria per day	Expensive option that may not always be needed. Difficult to determine individual needs

Source: own elaboration.

### **Tart cherry**

Both sweet and sour cherries contain high levels of antioxidants including melatonin, carotenoids, hydroxycinnamates and several flavonoid groups including anthocyanins, as well as the flavonol quercetin (McCune et al., 2011). Although mechanisms are currently unknown, reports have suggested that both tart Montmorency and sweet cherries reduce inflammation (Kelley et al., 2006; Howatson et al., 2010), oxidative stress, muscle



soreness, and improved recovery of muscle (Connolly et al., 2006; Howatson et al., 2010; Kuehl et al., 2010; Bowtell et al., 2011). In football, where eccentric muscle actions and multiple repeated short bouts of high-intensity exercise are common, mechanical stress is high, resulting in primary muscle damage. This damage is followed by a secondary inflammatory phase as part of the repair process during which the muscle is sore and function is impaired (Howatson and van Someren, 2008). Cherry juice is believed to act mainly during this second phase, reducing inflammation, soreness and better maintaining muscle function.

Connolly et al. (2006) was the first to investigate the application of cherry juice supplementation in a damaging exercise model. The supplementation consisted of freshly prepared tart Montmorency cherry juice mixed with apple juice in a proprietary ratio, with each serving containing ~ 50–60 tart cherries. In a single blind crossover design, participants were supplemented 4 days before exercise, on the day of exercise, and 4 days after exercise, consuming two 237-ml servings per day (am/pm). In the 96 h following eccentrically biased contractions of the elbow flexors, maximal isometric strength loss was attenuated with the tart Montmorency cherry juice blend vs. placebo (4 % vs. 22 %); consequently, recovery was accelerated with the cherry juice blend. Furthermore, more recent research supported these findings using a similar study design with a damaging bout of knee extensor exercise. Bowtell et al. (2011) reported faster recovery of isokinetic knee extensor force when supplementing with a tart Montmorency cherry juice concentrate versus isoenergetic placebo. Creatine kinase (CK) showed a trend to be raised in the placebo trial when compared to cherries, although this did not reach statistical significance. Recent review articles and meta-analyses have concluded that, on balance, there are a number of positive effects of consuming cherry juice before and after damaging exercise (Bell et al., 2014; Nedelec et al., 2015).

### **Practical recommendation**

Tart cherry supplementation may be particularly relevant during busy periods of the competitive season (2–3 matches per week). The recommended delivery system is a tart cherry concentrate, which can be ingested to achieve an equivalent of approximately 100 tart cherries every day. The cherry concentrate can be added to protein shakes, added to breakfast meals or snacks during the day (yoghurt). Tart cherry intake should be considered when recovery is a priority, but not during periods when physiological adaptation is the objective (as the attenuation of the inflammatory response may impair adaptation). However, it is important to note that these recommendations are based on studies relevant to football, and no benefits from tart cherry juice supplementation are yet observed in the recovery of elite soccer players. Therefore, research is needed to understand the optimal dose of tart cherry and the duration of use is needed (Abreu et al., 2023).

### **Cannabidiol (CBD)**



Cannabidiol was removed from the WADA prohibited list in 2018 and has emerged as a dietary supplement targeting football players. This is because the claims attached to using cannabidiol include promoting sleep, recovery and anxiety. Cannabidiol is the non-intoxicating constituent of the cannabis plant with potential therapeutic effects (White, 2019). Nevertheless, the use of cannabidiol currently represents a risk to players due to the possibility of prohibited cannabinoids being present in quantities sufficient to produce a positive doping test. Furthermore, as a sports nutritionist in a team, you should be aware of any countries that prohibit the use of cannabidiol, in which it is considered illegal. To date the available research is yet to establish the efficacy of its use, safety profile, risk of inadvertent doping, as well as a therapeutic dose. Therefore, despite potential, it is too early to make recommendations for football players (Burr et al., 2021).

### **2.2.3 Dietary supplementation: direct impact**

A player's individual performance is under constant scrutiny from their manager, coaches, teammates and fans. For success, the individual player must outperform their peers in order to be selected in the starting line-up, and then outperform their opponents to win matches. There are many factors that contribute to successful football performance. From a nutrition perspective, the most researched and potent nutrient, which may benefit football performance, is carbohydrate. The benefits of carbohydrate have been extensively covered in previous courses and modules. Thus, this unit will discuss those other dietary supplements, which may result in marginal gains in physical and technical performance of the player. These dietary supplements include caffeine, creatine (in the form of creatine monohydrate), nitrate, and  $\beta$ -alanine.

#### **Caffeine**

Caffeine use is prevalent in elite football (Sebastiá-Rico et al., 2024). Caffeine is unique because it is found in various socially accepted beverages and foods (e.g. tea, coffee, cola, chocolate, etc.). In addition, caffeine is one of the most widely investigated and research-proven of all dietary ergogenic aids. Caffeine has been consistently shown to improve both cognitive and physical performance across a range of endurance sports including running, cycling, rowing and swimming (Burke, 2008; Guest et al., 2021).

“Numerous data suggest that caffeine also improves the physical and technical elements of performance that are inherent to football match play. For example, caffeine can enhance repeated sprint and jump performance (Gant et al., 2010), reactive agility (Duvnjak-Zaknich et al., 2011) and passing accuracy (Foskett et al., 2009) during intermittent-type exercise protocols. The ergogenic effects of caffeine are typically achieved with ingestion of 2-6 mg/kg body mass (BM) (Burke et al., 2013). Given that plasma caffeine levels peak approximately 45-60 min after ingestion (Graham and Spriet, 1995), it is recommended that players consume caffeinated drinks, capsules or gels (depending preference) within the warm-up period prior to kick-off.



Although the precise ergogenic mechanisms are still considered elusive, most researchers agree that the ability of caffeine to modulate the central nervous system (CNS) is the predominant mechanism (Meeusen, 2014). Indeed, caffeine is readily transported across the blood-brain barrier and can act as an adenosine antagonist, thereby opposing the action of adenosine. As such, caffeine can increase concentrations of important neurotransmitters such as dopamine (Fredholm, 1995), the result of which manifests itself as increased motivation (Maridakis et al., 2009) and motor drive (Davis et al., 2003). In addition to its effect on the CNS, data suggest that caffeine may also exert its ergogenic influences during high-intensity intermittent exercise through mechanisms related to maintaining muscle excitability. Indeed, Mohr et al., (2011) observed improved performance of the Yo-Yo Intermittent Recovery Test 2... following caffeine supplementation that was associated with reduced muscle interstitial accumulation of potassium (K<sup>+</sup>) during intense intermittent exercise. The latter observation is consistent with the notion that extra-cellular accumulation of K<sup>+</sup> is a contributing cause of fatigue during very high-intensity exercise” (Morton, 2014, <https://lc.cx/LfA7hh>).

Several studies simulated the exercise pattern of a football match and studied the effects of caffeine. For example, Del Coso et al. (2012) reported total distance covered at speeds above 13 km/h during the game and the total number of sprints during the match were improved following the consumption of a caffeine containing drink versus a non-caffeine containing drink (Del Coso et al., 2012).

The influence of caffeine ingestion has also been investigated on football specific tasks. In one study the effect of adding a moderate dose of caffeine to a carbohydrate solution during prolonged football activity was investigated (Gant et al., 2010). It was concluded that the addition of caffeine to the carbohydrate-electrolyte solution improved sprinting performance, countermovement jumping, and the subjective experiences of players. Caffeine appeared to offset the fatigue-induced decline in certain components of performance. Similarly, Foskett et al. (2009) reported that caffeine ingestion before simulated football activity improved players' passing accuracy and jump performance without any detrimental effects on other performance parameters (Foskett et al., 2009). Studies by the same research group found similar effects in female football players (Ali et al., 2016a; Ali et al., 2016b).

In contrast to competition days, when specialised caffeinated sports products are typically consumed, players may achieve ergogenic effects on training days by consuming caffeine in the form of coffee with their breakfast meal prior to training. Anecdotal reports suggest coffee is commonly ingested by players pre-exercise to improve energy levels, mood, and perceived improved exercise performance. Indeed, coffee ingestion is appropriate given that drinking coffee before exercise induces similar performance benefits to that of non-fluid based caffeine ingestion (Hodgson et al., 2013).

### **Did you know?**



**The two most common species of coffee used for global coffee production are *coffea arabica* (arabica coffee) and *coffea canephora* (robusta coffee).**

Caffeine may also be delivered in a chewing gum format. This approach may speed the rate of caffeine delivery to the blood as caffeine can be absorbed through the vascular system in the mouth (Kamimori et al., 2002). Caffeine is then also absorbed in the intestine as the player swallows the caffeine containing saliva. This knowledge is important for the sports nutritionist, due to its associated benefit of chewing caffeinated gum (200 mg) on football specific physical performance (Ranchordas et al., 2018). For example, a caffeinated gum (typically 100-200 mg/piece) may be provided as a preparatory strategy for players who need to enter the field of play as a planned substitution or at short notice (Yildirim et al., 2023).

Given that substantial literature supporting caffeine ingestion for football performance, caffeine may be considered for use by players. However, it is recommended that players first experiment with caffeine ingestion during training sessions. This is because caffeine can potentially result in a number of adverse side-effects that may limit its use in some situations or by sensitive individuals. For example, chewing caffeine gum (200 mg for 5 min) after 90 minutes of a simulated football match improves reaction time in the extra time period. However, chewing the gum was also associated with a reduction in the players composure. Clearly, there is a trade off to consider and consideration must be given as to the impact that any reductions in composure could have on the execution of a penalty kick, should the match reach that stage (Field et al., 2024).

Other potential negative side-effects to consider include insomnia, headache, gastrointestinal irritation and a stimulation of diuresis (Maughan et al., 2011). "Indeed, not all individuals display performance enhancements after acute caffeine ingestion, and large doses (i.e. especially > 6 mg/kg BM) may often induce negative symptoms such as increased heart rate, irritability, tremor, confusion, reduced concentration and shortness of breath (Graham and Spriet, 1995)" (Morton, 2014, <https://lc.cx/LfA7hh>). None of these effects would be beneficial for skill-based performance. "Furthermore, consuming high doses of caffeine prior to or during evening kick offs can also be problematic given that sleep quality can be negatively affected (Drake et al., 2013)" (Morton, 2014, <https://lc.cx/LfA7hh>).

### **Practical recommendation**

Players should experiment with caffeine in training to find an appropriate dose and form of delivery. Players should gradually increase their caffeine intake to achieve 3 mg/kg (range 1-5 mg/kg) to gain potential benefits of ingestion. Caffeine should be ingested between 30 and 60 minutes before a match. The half life (duration which caffeine remains high in the circulation) of caffeine is between 3 and 5 hours after ingestion. Therefore, this knowledge may help manipulate caffeine intake to various kick-off times, as not to impact



sleep. If a caffeine gum is used as a method of caffeine delivery, then players should use this immediately after the warm up. Players should not exercise whilst chewing the caffeine gum which should be removed from the mouth before kick-off. The method to deliver caffeine can be modified depending on the player's personal preferences.

## **Creatine**

Creatine is a widely researched dietary supplement with strong supporting evidence for use in football (Antonio et al., 2021). Creatine can be generated endogenously by the body or provided exogenously by dietary sources. In the player's body, creatine is synthesized in the liver and kidneys from the amino acids arginine and glycine. The largest store of creatine in the body is skeletal muscle (Wyss and Kaddurah-Daouk, 2000). In skeletal muscle approximately 60-70 % is stored as a phosphorylated form known as phosphocreatine (PCr).

The main dietary sources of creatine are fish and red meat. As an example, approximately 5 g of creatine is contained in 1 kg of fresh beef steak. Dietary supplementation with creatine monohydrate for sport has traditionally been associated with strength and power athletes, such as weightlifters and sprinters, given the role of PCr hydrolysis in regenerating ATP during the initial seconds of maximal activity (Course 1).

"In the context of football, creatine monohydrate (creatine) supplementation is also of particular interest given that PCr stores exhibit significant declines during match play (Krustrup et al., 2006). Accordingly, creatine supplementation improves repeated sprint performance during both short duration (Casey et al., 1996) and prolonged intermittent exercise protocols (Mujika et al., 2000), likely due to increased resting muscle PCr stores as well as improved rates of PCr resynthesis in the recovery periods between successive sprints (Casey et al., 1996)" (Morton, 2014, <https://lc.cx/LfA7hh>). Sprint performance improvements following creatine supplementation (compared to a placebo) are in the range of 1-4 %. In addition to improving repeated sprint performance, players may also wish to consume creatine in context of other football specific nutrition objectives such as augmenting training-induced improvements in muscle mass, strength and power (Branch, 2003).

Harris and colleagues (1992, cited in Morton, 2014) completed the first study to show that dietary creatine supplementation (using a loading protocol of 20 g/d for 5 days) increased (+ 20 %) both total creatine and PCr stores in skeletal muscle. "As such, the conventional creatine dosing strategy is to undertake a loading protocol (usually involving 4 x 5 g doses/d for 5-7 days) followed by a daily maintenance dose of 3-5 g/d (Hultman et al., 1996). However, given that player adherence to such a protocol may be limited, it is noteworthy that daily consumption of a lower dose over a longer period (i.e., 3 g/d for 30 days) will eventually augment muscle creatine to a similar level as that observed with classical loading protocols (Hultman et al., 1996)" (Morton, 2014, <https://lc.cx/LfA7hh>).



If creatine supplementation is stopped, players should expect muscle creatine stores to return to basal levels within 5-8 weeks. To facilitate creatine storage, it is recommended that creatine is ingested post-exercise and in combination with carbohydrate and/or protein feeding, given that contraction and elevated insulin are known to increase muscle creatine uptake (Robinson et al., 1999). In practical terms, “this means ensuring creatine provision before and after training periods in conjunction with sports nutrition products containing carbohydrate (and/or protein) or with whole food provision such as breakfast, lunch and dinner. Prior loading with creatine may also enhance post-exercise muscle glycogen resynthesis rates (Robinson et al., 1999)” (Morton, 2014, <https://lc.cx/LfA7hh>).

In a survey of 70 elite football players, 60 % reported supplementing their diet with creatine monohydrate (Sebastiá-Rico et al., 2024). It is important to note that not every player will respond similarly to creatine supplementation in terms of both augmentation of muscle creatine stores and subsequent improvements in performance (Antonio et al., 2021). “The magnitude of elevation of muscle creatine to a given dose of creatine supplementation is highly variable and appears to be largely determined on the initial level of muscle creatine concentration prior to supplementation, the latter likely determined by habitual diet (Hultman et al., 1996). To this end, players with lower muscle creatine stores are likely to experience greater increases in total muscle creatine during supplementation compared with those players who already exhibit high concentrations of muscle creatine. Accordingly, creatine-induced improvements in intermittent exercise performance are greater in those individuals who exhibited larger increases in muscle (especially type II fibres) creatine and PCr (Casey et al., 1996)” (Morton, 2014, <https://lc.cx/LfA7hh>).

The creatine supplementation loading regime may induce a 1.0-1.5 kg gain in body mass, an effect that has been reported to be greater in men compared with women (Mihic et al., 2000, cited in Morton, 2014). Such increases are confined to fat free mass and are likely due to an increase in intra-cellular water accumulation. For this reason, not all players may choose to supplement with creatine given the perception that they feel heavier and slower, an effect that may be especially relevant for those who cover the greatest distances during a match, such as the central and wide midfielders. Additionally, creatine supplementation is also often perceived to have negative health effects in terms of liver and kidney function (Morton, 2014). It is noteworthy, however, that prospective studies demonstrate no adverse health effects in healthy individuals who were long-term creatine users (Kim et al., 2011, Forbes et al., 2022).

In general, the available evidence supports a beneficial effect of creatine monohydrate supplementation on short term high intensity and repeated sprint exercise. Creatine has several key roles within skeletal muscle as a temporal energy buffer, energy carrier and maintaining ATP/ADP ratios (Greenhaff, 2001). “Given that it takes weeks for creatine stores to return towards basal levels upon the cessation of supplementation (hence



ergogenic effects should still occur), it may be prudent for players to “cycle” creatine supplementation at specific stages of the season (e.g. pre-season, congested fixture schedules) or training goals (e.g., strength/hypertrophy goals)” (Morton, 2014, <https://lc.cx/IrhL4m>).

### **Practical recommendation**

The loading phase for creatine supplementation may be short (5 x 20 g per day) or gradual 3 g/day for 30 days. Thus, players should develop individual strategies and dosing protocols, and they should be monitored regarding potential side effects and body mass changes. Creatine supplementation may be taken continuously or periodized over a competitive season. As an example, creatine supplementation may be targeted during pre-season, and maintained during the season, and then stopped during the off-season. Ideally, supplementation should be mapped against key performance indicators. For example, an independent repeated sprint test or yo-yo tests. Finally, the powder form of creatine monohydrate is recommended, as it is the most researched and other forms (liquid) unlikely to contain or deliver appropriate quantities of creatine.

### **β-alanine**

In skeletal muscle cells, the single amino acids β-alanine and L-histidine combine to form the dipeptide β-alanyl-L-histidine. The dipeptide β-alanyl-L-histidine is more commonly known as carnosine. Carnosine is of particular relevance for high-intensity exercise performance given that it can act as an intracellular buffer to hydrogen ions (H<sup>+</sup>) (e.g. 10-60 mmol/kg d.w) (Hobson et al., 2012, cited in Morton, 2014). Given the repeated sprint nature of football match play, muscle pH declines to levels that may impair the capacity to generate ATP through glycolytic metabolism (Krustrup et al., 2006, cited in Morton, 2014). As such, a dietary supplementation practice for football players is to consume β-alanine supplements. This is because β-alanine availability is the rate-limiting determinant of carnosine synthesis (Morton, 2014).

Daily β-alanine supplementation has been consistently shown to elevate skeletal muscle carnosine concentration by approximately 50 % in both type I and II human skeletal muscle fibres (Harris and Sale 2012). “Furthermore, in recent meta-analyses, Hobson et al. (2012) concluded likely ergogenic effects of β-alanine supplementation during high-intensity sports lasting from 1-6 min, such as track and field events, cycling, rowing and swimming” (Morton, 2014, <https://lc.cx/IrhL4m>).

“Unfortunately, investigations evaluating the effects of β-alanine supplementation during high-intensity intermittent exercise protocols that are applicable to football are both limited and conflicting. For example, Saunders and colleagues observed no beneficial effect of four weeks of β-alanine supplementation (6.4 g/d) on sprint performance during the field-based LIST (Saunders et al., 2012a). In contrast, the same researchers later



observed improved performance during the Yo-Yo Intermittent Recovery Test Level 2 following 12 weeks of daily supplementation with 3.2 g of  $\beta$ -alanine (Saunders et al., 2012b). Unfortunately, neither studies measured changes in muscle carnosine stores following supplementation, though it is possible that the enhanced effect observed in the latter study was due to the longer period of supplementation. This hypothesis is relevant given that the duration of  $\beta$ -alanine supplementation will determine the increases in muscle carnosine concentration (Hill et al., 2007).

A negative side effect of  $\beta$ -alanine supplementation when administered in single doses  $>10$  mg/kg BM (especially when in solution or as gelatin capsules) is a flushing of the skin and a tingly sensation (Harris et al., 2006), a phenomenon known as paraesthesia. To reduce such symptoms, sustained release formulations have been developed that allow two 800 mg doses to be ingested simultaneously without any symptoms (Decombaz et al., 2012). Although the optimal dosing and delivery strategy of  $\beta$ -alanine supplementation is not currently known, it is noteworthy that a significant linear relationship exists between total  $\beta$ -alanine intake (within the range of 1.6 - 6.4 g/d) and both relative and absolute increases in muscle carnosine (Stellingwerff et al., 2012a). To this end, Stellingwerff and colleagues (2012b) observed that four weeks of supplementation with 3.2 g of  $\beta$ -alanine daily induced 2-fold greater increases in muscle carnosine stores compared with 1.6 g daily. Moreover, these researchers also observed that subsequent daily doses of 1.6 g/d continued to induce further increases despite already high carnosine stores following the four weeks of higher dose  $\beta$ -alanine supplementation" (Morton, 2014, <https://lc.cx/IrhL4m>).

Following 6 weeks of 3.2 g  $\beta$ -alanine/d a further daily maintenance dose of 1.2 g/d was required to maintain muscle carnosine content elevated at 30-50 % above baseline values (Stegen et al., 2014). When  $\beta$ -alanine supplementation is stopped players may expect muscle carnosine stores to return towards basal levels within 10-20 weeks (Baguet et al., 2009). On the basis of the aforementioned studies, it is recommended that when muscle carnosine stores are required to be elevated quickly (perhaps during important stages of competition such as intense fixture schedules), loading with larger doses (e.g. 3-6 g daily for 3-4 weeks) may be initially beneficial followed by daily maintenance doses  $>1.2$  g. To minimize symptoms of paraesthesia, players may benefit from consuming slow-release formulas in a number of doses spread evenly throughout the day. Finally, it has been shown that carnosine loading via  $\beta$ -alanine supplementation is more pronounced in athletes (i.e. trained muscle) in comparison to untrained individuals (Bex et al., 2014). Thus, it is reasonable to assume a similar response in football players engaged in routine training or match play.

### **Practical recommendation**



There is limited evidence for the use of beta-alanine for football players. Reassuringly, this may account for the low reported use in elite players (Sebastiá-Rico et al., 2024). Therefore, a clear justification for use should be established before adding to a player's diet. Should players use  $\beta$ -alanine they are advised to ingest 3-6 g daily for 3-4 weeks; this may be followed by daily maintenance dose of 1.2 g/day. The concentration of muscle carnosine will remain elevated for 4 to 8 weeks following the cessation of intake. There does not appear to be a benefit of one off or acute intake strategies. Although Beta-alanine can be used continuously, it is recommended to periodise supplementation. For example, supplementation may be targeted during periods of the year to support performance rather than continuous use. In addition, because of the prolonged "wash-out" period following supplementation, ingestion may stop approximately 3 weeks before the end of the season. The use of a slow release form of beta alanine may alleviate some of the known side effects.

### **Dietary nitrates**

Dietary inorganic nitrate supplementation may be considered for football players. This is because there is considerable research detailing the effects of nitric oxide on a variety of physiological functions. Specifically, nitric oxide has well-documented roles in regulating blood flow, muscle glucose uptake and the contractile properties of skeletal muscle (Jones, 2014; Jones, 2016).

"The traditional pathway of endogenous nitric oxide production is recognized as that of L-arginine oxidation, facilitated by the enzyme nitric oxide synthase. However, it is now known that dietary ingestion of inorganic nitrate can also be metabolized to nitrite and subsequently, nitric oxide, thereby complementing that produced from the L-arginine pathway (Hord et al., 2011). Identification of this biochemical pathway has led to studies evaluating the effects of inorganic nitrate ingestion on exercise performance.

Nitrates in the diet are especially prevalent in green leafy vegetables such as beetroot, lettuce and spinach. The exact content of nitrates in these foods will vary considerably depending on soil conditions and time of year. To provide a standardised intake of nitrate, researchers have used doses of beetroot juice (0.5 L is equivalent to approximately 5 mmol nitrate) to elevate nitrite availability (Jones, 2016). Using both chronic (ranging from 3-15 days of 0.5 L beetroot juice per day) or acute ingestion 2.5 h before exercise, it was demonstrated that nitrate ingestion reduces blood pressure, lowers oxygen consumption for a given workload or velocity during steady-state exercise, as well as improving exercise capacity during short-duration high-intensity cycling or running (Bailey et al., 2009; Vanhatalo et al., 2010; Lansley et al., 2011a). These initial studies were later supported by experiments demonstrating that acute (Lansley et al., 2011b) and chronic beetroot juice ingestion (Cermak et al., 2012) in trained but sub-elite athletes also improved cycling time trial performance in distances ranging from 4 km to 16.1 km (i.e., approximately 5-30 min of exercise). It is noteworthy, however, that the performance-

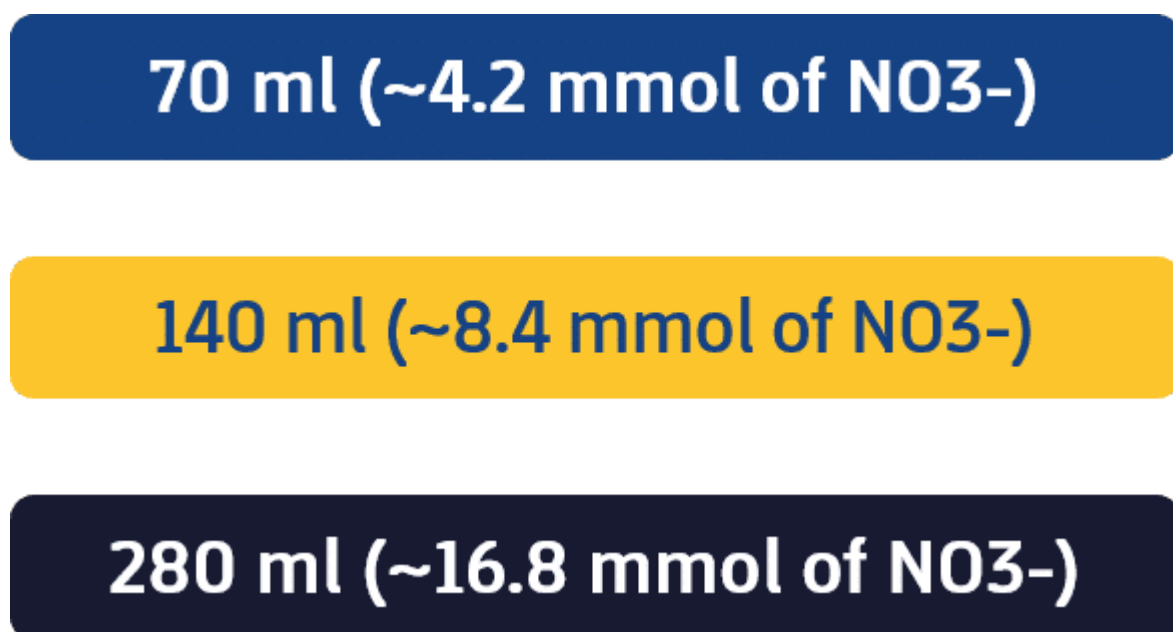


enhancing effects of nitrate are not readily apparent in elite endurance athletes (Wilkerson et al., 2012). Although the exact reason for these findings are yet to be established, it may be due to a combination of underpinning differences in the physiology of elite versus sub-elite athletes. Specifically, a trained athlete may be less sensitive to additional nitric oxide availability e.g. higher nitric oxide synthase activity, plasma nitrite values, greater muscle capillarization, higher type I fibres (Jones, 2014)" (Morton, 2014, <https://lc.cx/IrhL4m>).

Whether this applies to "elite" versus "sub-elite" footballers is yet to be established.

The mechanisms underpinning the reduced oxygen cost of exercise and improved exercise capacity/performance are currently thought to involve improved muscle efficiency and energy metabolism (Jones, 2014). For example, Bailey and colleagues observed that reduced oxygen uptake during exercise (following six days of 0.5 L beetroot juice ingestion per day) was associated with reduced PCr degradation and accumulation of ADP and Pi, thus implying a reduced ATP cost of contraction for a given power output (Bailey et al., 2010). Larsen et al. (2011) suggested that mitochondrial efficiency might be improved in human skeletal muscle following three days of sodium nitrate ingestion (0.1 mmol/kg BM). Haider and Folland (2014) observed that seven days of nitrate loading in the form of concentrated beetroot juice (9.7 mmol/d) also improved *in vivo* contractile properties of human skeletal muscle, as evidenced by improved excitation-coupling at low frequencies of stimulation as well as explosive force produced by supra-maximal stimulation.

**Figure 3. Volume of concentrated beetroot juice and the associated nitrate content**



Source: own elaboration.

The optimal loading dose to facilitate the ergogenic effects of nitrate is not well established, especially in relation to whether acute (i.e. 2.5 h before exercise) or chronic (i.e. several days) loading protocols are required. Nevertheless, in the acute context, Wylie and colleagues (2013) observed that the improved exercise tolerance (relative to placebo) was not different when 8.4 or 16.8 mmol of nitrate was ingested 2.5 h before exercise, but that both were more efficacious than 4.2 mmol (Wylie et al., 2016). However, the reduction in oxygen cost during exercise was associated with the higher dose of nitrate ingestion (Wylie et al., 2013). Such data suggest that the inability to detect physiological effects of nitrate in acute scenarios (especially with elite athletes) may be overcome by using higher pre-exercise dosing strategies and/or longer duration dosing protocols (>3 days).

### **Did you know?**

**Peak increases in plasma nitrite concentrations occur 2-4 h post ingestion. 140 ml has been reported to be beneficial for intense exercise, with no further benefit at 280 ml. Therefore, dietary nitrate supplementation can be added to the pre-match meal occasion.**

Although initial studies were performed during high intensity continuous exercise, more recently, studies have begun to investigate the potential effects of beetroot juice in high intensity intermittent exercise. Using a more aggressive loading dose of concentrated beetroot juice (approximately 30 mmol in a 36 h period), Wylie et al. (2013) observed significant improvements in the distance ran on the Yo-Yo Intermittent Recovery Test Level 1 when compared with placebo condition. Improved performance may have been due to maintained muscle membrane excitability given that plasma K<sup>+</sup> was lower during exercise following beetroot juice supplementation. The same research group reported that a similar loading dose spread over a longer duration (6.4 mmol for 5 days) also enhances maximal sprint and high-intensity intermittent running performance in competitive team sport players (Thompson et al., 2016). In football specific studies, beetroot juice ingestion 3 days prior to, on the day of a simulated match (LIST) and 3 days after exercise reduced post exercise perceived muscle soreness and maintained jump performance in comparison to placebo (Daab et al., 2021). Indeed, the ingestion regime of drinking two 150 mL shots of beetroot juice (~8 mmol/L nitrate) for seven days was also found to attenuate markers of neuromuscular fatigue induced by the same simulated football match (Daab et al., 2024).

### **Practical considerations**

Players are recommended to ingest dietary nitrate for 3-7 days prior to a match. Typically, this is achieved by ingesting a concentrated beetroot shot with morning and evening meals. The acute ingestion of nitrate (5-8 mmol) with the pre-match meal, 3 h before kick-off, may also be of benefit to the player. As with all dietary supplement recommendations, players should practice loading and acute strategies in training first. To date, the forms of



delivery of concentrated dietary nitrate (typically beetroot) is not an appealing flavor for the player. Players should also be made aware that the potential side effect of concentrated beetroot juice ingestion is a change in urine color, specifically, urine may have “pink” tones. Despite being completely harmless, players may worry if not informed of this change. In addition, it is important to note that the change in urine color may make self-monitoring of hydration status difficult for the player (assessed by urine color). Finally, to promote the potential beneficial effects of nitrate supplementation, players are also advised to avoid antibacterial mouthwash and chewing gum, as these products diminish the conversion of nitrate to nitrite (Jones 2014; Jones, 2016).

## **2.2.4 Supplement considerations**

Table 4 lists the dietary supplements to be considered in specific situations in football using evidence-based protocols. The dietary supplements should be used in individualized protocols under the direction and monitoring of an appropriate sports nutrition/medicine/science practitioner. While there may be a general evidence base for these products, additional research may often be required to fine-tune protocols for individualized player and event-specific (training/match) use. Quality assurance programs are in place for sports nutrition products, suppliers to the sports nutrition industry, and supplement manufacturing facilities. These programs will help make sure that supplements are safe to take and reduce the risk of the product containing banned substances (Backhouse, 2023).

**Table 4. Summary of the dietary supplements to be considered in specific situations in football using evidence-based protocols**

<b>Indirect: player health</b>	<b>Supplement</b>
<p>Medical supplement are used to treat clinical issues, including diagnosed nutrient deficiencies.</p> <p>Requires individual dispensing and supervision by appropriate sports dietician / medical professional.</p>	Iron
	Multivitamin / mineral
	Vitamin D
<b>Player recovery</b>	
<p>Food polyphenols – food chemicals which have purported bioactivity, including antioxidant and anti-inflammatory activity. May be consumed in food form or as a concentrate.</p>	Tart cherry juice
<b>Direct: performance</b>	
<p>Performance supplements are used solely to contribute to optimal performance.</p> <p>Should be used in individualised protocols under the direction of an appropriate sports medicine / science practitioner.</p> <p>While there may be a general evidence base for these products, additional research may often be required to fine-tune protocols for individualised and event-specific use.</p>	Caffeine
	Creatine
	B-alanine
	Dietary nitrate

Source: own elaboration.

Very few dietary supplements have been tested using football-specific tests simulating match-play. In general, dietary supplements recommendations are based on those studies, which have reported a dietary supplement to be effective at improving specific



exercise performance. In addition, most participants used in these studies have been recreational players or even non-footballers. Thus, the evidence that professional footballers will benefit from these supplements is therefore limited.

Although many dietary supplements can be used continuously, from experience, it is recommended to periodize/cycle their use. This is because the adherence to dietary supplement programs is likely to be improved when adopting a “targeted” approach. During periods of the off-season, players may benefit from psychologically “switching off” from football, and this may include additional nutrition strategies.

Finally, although not discussed in this module, the potential placebo effect on player’s performance by using dietary supplements should not be underestimated (Clark et al., 2000). Strategically, introducing appropriate supplementation also provides players a “belief effect” which can provide the “boost” required at targeted periods of the season, such as periods of fixture congestion or finals.

## Summary

- The daily diet, lifestyle and training of the player should be optimized before dietary supplementation is considered.
- Dietary supplements may indirectly benefit performance by maintaining the player’s health and subsequent availability to train, as well as availability for selection.
- Dietary supplements may directly benefit performance by improving physical or skill capabilities over the duration of training and matches.
- Key “indirect” dietary supplements include micronutrients, probiotics and tart cherries.
- Key “direct” dietary supplements include caffeine, creatine and dietary nitrate.
- Potential dietary supplementation should be delivered with respect to quality assurance programs (Unit 1), the risk/benefit trade-off, and the needs and preferences of the individual player.

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