Sports drinks (carbohydrate-electrolyte drinks)

Supplement Overview

>> Sports drinks are designed to deliver a balanced amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel during and after exercise.

>> According to various expert position stands, the compositional range which provides rapid delivery of fluid and fuel and maximises gastric tolerance and palatability is 4–8% (4–8 g/100 ml) carbohydrate and 23–69 mg/100 mL (10–30 mmol/L) sodium (American College of Sports Medicine et al. 2007).

>> Carbohydrates consumed during exercise can support or enhance performance via two different mechanisms: provision of fuel for the muscle and a mouth sensing benefit to the brain and central nervous system. Table 1 provides guidelines for carbohydrate intake during different sporting activities according to the importance of these effects.

- The type and quantity of carbohydrates provided in sports drinks varies according to the manufacturer, with factors such as taste, osmolarity (concentration of individual particles), intestinal absorption and gut tolerance being considered.
- Consuming carbohydrate before, during and/or after prolonged intensive exercise may help to protect immune function by being associated with a reduction in the detrimental changes in cytokines and immune system cells normally induced by exercise stress (Peake et al. 2017).
- Such intake may also be beneficial to bone health by reducing the effect of exercise with low carbohydrate availability on markers of bone resorption (Sale et al. 2015).

>> The electrolyte content of sports drinks, particularly sodium, helps to preserve the thirst drive. Sodium concentrations of ~ 10–25 mmol/L enhance the palatability and voluntary consumption of fluids consumed during exercise, although higher sodium/electrolyte concentrations may increase fluid retention.

>> Sodium concentrations higher than those typically provided in commercial sports drinks are generally needed to restore fluid balance and reduce urine losses when:

- Moderate to severe dehydration is present.
- Sweat losses are high (e.g. salty sweaters, prolonged exercise, athletes wearing protective clothing, in excessive hot/humid environments).

Dedicated electrolyte supplements, suited to the replacement of large electrolyte losses and commercial sports drinks with higher sodium concentrations are discussed in the *Electrolyte Replacement Supplements* fact sheet.

>> Other electrolytes (e.g. magnesium, potassium and calcium) may be included in sports drinks. Current evidence indicates that magnesium losses during exercise can be met by dietary means and it is unlikely that additional magnesium intake via sports drinks will enhance hydration goals or reduce cramping.

>> Protein or amino acids (2% or 2 g/100 ml) can be found in a small number of sports drinks.

- The case for consuming protein ***after*** exercise is strong but it can be achieved by a range of every day foods and sports foods rather than sports drinks.
- The case for consuming protein ***during*** exercise to enhance performance is contentious. A meta-analysis of the literature (11 studies) suggested a methodological bias in the current studies; benefits are seen with time to exhaustion protocols and when protein is added to sub-optimal intakes of carbohydrate. It was concluded that any ergogenic benefits may result from a generic effect of additional energy intake rather than a unique benefit of protein (Stearns et al. 2010).
- Further research is warranted, but the effects of amino acids/ protein on the flavour profile of a drink should also be considered. It is possible that protein consumed during prolonged lower- or intermittent intensity exercise may assist with protein synthesis goals; however other everyday foods or sports food sources may be consumed to achieve this.

>> The taste and temperature of sports drinks are also important factors in meeting hydration goals:

- Studies show that athletes more closely match fluid intake to sweat losses when offered flavoured sports drinks compared to water (Minehan et al. 2002, Maughan et al. 1993).
- Cool fluids are generally more palatable for athletes who are exercising in hot conditions or have become hot through the heat gain associated with high-intensity exercise; with studies showing that voluntary intake of cool drinks is increased (Burdon et al. 2012).
- Sports drinks are suitable to serve in "slushie" (ice slurry) form for use pre- and during- exercise as part of a "cooling" strategy to assist comfort and thermoregulation during activities undertaken in hot environments (Ross et al. 2013).

Table 1: Guidelines for carbohydrate intake during sporting activities (taken from Burke et al. 2010)

Type of sport/ Exercise	Duration	Carbohydrate Target	Comments
Brief exercise	<45 min	Not needed	
Sustained high intensity exercise	45-75 min	Small amounts including mouth rinse (swilling in mouth)	>>A range of drinks, gels and sports products can provide easily consumed carbohydrate. >>The main benefit from carbohydrate use in these events comes from interaction with the brain and CNS. To achieve optimal benefit, the athlete may need to organise their event nutrition strategy to allow frequent "mouth sensing" with a significant duration of mouth contact (e.g. 10 s).
Endurance exercise including "stop and start" sports	1-2.5 h	30 – 60 g/h	>>Opportunities to consume foods and drinks vary according to the rules and nature of each sport. >> A range of everyday dietary choices and specialised sports products ranging from liquid to solid may be useful. >>The athlete should practice to find a refuelling plan that suits individual goals including hydration needs and gut comfort. >>The benefits of carbohydrate intake strategies in these events are likely to be achieved both in the muscle (fuel) and CNS (perception of effort).
Ultra-endurance events	>2.5-3 h	Up to 90 g/h	>>As above >>Higher intakes of carbohydrate are associated with better performance. >> Products providing multiple transportable carbohydrates (glucose: fructose mixtures) will achieve high rates of oxidation of carbohydrate consumed during exercise. >>The benefits of carbohydrate intake in these events are likely to be achieved both in the muscle (fuel) and CNS (perception of effort).

Products and protocols

>>Commercially available sports drinks come in both ready-to-drink and powdered forms in a wide range of flavours which vary according to their carbohydrate (CHO) and electrolyte content as well as the addition of other ingredients.

>>Typical sodium concentrations range from ~20-40 mmol/L (~46-92 mg/100 ml), however some drinks are much lower (<10 mmol) in sodium:

- Higher sodium concentrations will decrease urine losses, increase fluid absorption/retention and improve hydration status/
- Lower sodium concentrations increase palatability and therefor usually volume consumed/

>> Typical carbohydrate concentrations range from 6-8% (6-8g /100 ml), however some drinks may vary from 4-10% carbohydrate and several low energy/"sugar free" varieties also exist:

- Higher carbohydrate concentrations will increase fuel provision during exercise, but can also increase the risk of gastrointestinal comfort.
- Certain varieties may contain ~20% carbohydrate; suited for situations when carbohydrate intake without simultaneous intake of large fluid volumes is desired (e.g. for pre-event fuelling or to take advantage of carbohydrate 'mouth sensing').
- Low energy/'sugar free' varieties may be useful when electrolyte replacement is desired without carbohydrate intake (e.g. protocols to "train low" or when attempting to decrease energy intake).

Situations for Use in Sport

>>Sports drinks provide a convenient option for simultaneously addressing fuel, fluid and electrolyte needs before, during and after exercise.

>>Use before exercise: may be part of the pre-exercise meal or consumed immediately before exercise to enhance fluid and fuel status.

- Pre-exercise "slushies" may be part of pre-cooling strategies for exercise in hot environments.

>>Use after exercise: may be part of post-exercise recovery snacks and meals to assist with rehydration.

- Can also contribute to refuelling goals but other foods/sports products should be considered to address total recovery needs.

>> Use during exercise: major role for sports drinks to promote hydration and refuelling during exercise.

- Hydration: promotes voluntary drinking and fluid retention to assist the athlete to achieve a fluid intake plan that keeps the fluid deficit incurred during exercise to an acceptable level. Opportunities to drink fluids during sporting vary according to the rules and practical features of the sport (Garth and Burke 2012).
- Fuelling: supplies easily consumed carbohydrates to provide an additional fuel source for the muscle according to the requirements of each sporting activity. Performance benefits have been clearly demonstrated in a range of sporting events as a result of this strategy (Phillips et al. 2011; Stellingwerff and Cox 2014). See Table 1 for recommendations.
- Mouth sensing: the exposure of receptors in the mouth/oral cavity to carbohydrate creates a favourable response in the brain and central nervous system (CNS), decreasing the perception of effort and pacing strategies (Burke and Maughan 2015).

>> Exercise delivery of carbohydrate consumed during exercise to the muscle is largely influenced by the rate at which it can be absorbed in the small intestine. Typically, ingesting glucose based carbohydrates (e.g. sucrose, glucose polymers, maltodextrin) at rates in excess of ~ 60 g/h during exercise does not lead to additional performance benefits. In fact, because intestinal glucose transporters (called SGLT1) are saturated at this level, excessive carbohydrate intake can cause gut discomfort/problems that impair performance.

- The gut can be 'trained' by consuming carbohydrates during exercise to maximise the number and activity of the SCGT1 transporters, thus enhancing glucose uptake and reducing gut symptoms (Costa et al. 2017; Miall et al. 2017). In addition, some newer sports drinks and sports foods contain 'multiple transportable carbohydrates' - a blend of carbohydrates such as glucose and fructose which are absorbed via different transporter molecules in the intestine to overcome the usual bottleneck on a single transport system.
- Studies have shown that when carbohydrates are consumed at high rates (> 60 g/h) during exercise to meet new guidelines for prolonged strenuous events, drinks containing multiple transportable carbohydrates are more effective than glucose-based products in maintaining gut comfort, promoting muscle carbohydrate oxidation and enhancing performance (see Jeukendrup 2010).

>> The composition of sports drinks provides a generic balance between fluid and carbohydrate needs across a range of sports. The relationship between fluid and fuel needs may vary according to the environment, the athlete's nutritional preparation and the demands of the exercise.

- If fluid needs are greater than carbohydrate needs: sports drinks with lower carbohydrate content or diluted sports drinks may be used.
- If carbohydrate needs are greater than fluid needs: sports drinks with higher carbohydrate content may be used or supplemented with sports gel/ sport bar/ sport confectionery.

Concerns Associated with Supplement Use

>>Sports drinks are not needed at every training session. In fact, the optimal training program may include the periodisation of workouts in which there is "low carbohydrate availability" (i.e. the session is undertaken with low muscle glycogen stores and/or after an overnight fast). This strategy may increase some of the important adaptive responses to exercise. Therefore, on some occasions, an athlete may deliberately choose not to consume a sports drink during the session or during the first part of a session (Bartlett et al. 2015).

>> Athletes need to consider their physique goals and total nutritional goals when deciding whether to consume sports drinks. In the case of athletes who have short- or long-term restrictions on dietary energy intake, overuse of energy-dense fluids such as sports drinks may create problems with energy balance and overall nutrient density of the diet.

>> Sports drinks should be mixed according to the manufacturer's directions or as advised by a Sports Dietitian to ensure that fluid and carbohydrate intake goals are met and gastrointestinal tolerance is optimised.

>> Some athletes report that sports drinks cause gut discomfort or make them feel unwell. While some athletes may not tolerate sports drinks well, the following strategies can help to minimise problems.

- Dehydration increases the risk of gastrointestinal problems during exercise and is often the cause of such complaints. Practicing fluid intake strategies during training can assist in preventing dehydration as well as helping to overcome problems such as dislike of the taste, mouth-feel of the drink and gastrointestinal discomfort.
- 'Gut training' – deliberately consuming a gradually increasing volume and concentration of sports drink during workouts - can allow the gut to develop better capacity to absorb carbohydrate and feel comfortable.
- The use of sports drinks with multiple transportable carbohydrates may assist in maximising gastrointestinal comfort, particularly when carbohydrate is consumed at high rates of intake (> 60 g/h).

>> Sports drinks, like other carbohydrate-containing fluids such as soft drinks and fruit juices, have been shown to contribute to dental erosion. To help reduce the potential impact of sports drinks on dental health, athletes should:

- Minimise the contact time the sports drink has with their teeth. The sports drink should not be held or swished in the mouth, and a straw or squeezy bottle can also minimise contact time with the teeth by directing fluids towards the back of the mouth.
- Where practical, consume dairy products or chew sugar free gum immediately after consumption of the sports drink.
- Avoid brushing teeth for at least 30 minutes after consuming sports drink to allow tooth enamel to re-harden.

>> Individuals with fructose malabsorption or FODMAP intolerance should be aware of the fructose content of sports drinks containing multiple transportable carbohydrates.

References

American College of Sports Medicine, Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS.American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc. 2007; 39(2):377-90.

Bartlett JD, Hawley JA, Morton JP. Carbohydrate availability and exercise training adaptation: too much of a good thing? Eur J Sport Sci. 2015;15(1):3-12.

Burdon CA, Johnson NA, Chapman PG, O'Connor HT. Influence of beverage temperature on palatability and fluid ingestion during endurance exercise: a systematic review. Int J Sport Nutr Exerc Metab. 2012; 22(3):199-21

Burke LM, Hawley JA, Wong SH, Jeukendrup AE. Carbohydrates for training and competition. J Sports Sci. 2011; 8:1-11.

Burke LM, Maughan RJ. The Governor has a sweet tooth - mouth sensing of nutrients to enhance sports performance. Eur J Sport Sci. 2015;15(1):29-40

Costa RJS, Miall A, Khoo A, Rauch C, Snipe R, Camões-Costa V, Gibson P. Gut-training: the impact of two weeks repetitive gut-challenge during exercise on gastrointestinal status, glucose availability, fuel kinetics, and running performance. Appl Physiol Nutr Metab. 2017;42(5):547-557.

Garth AK1, Burke LM. What do athletes drink during competitive sporting activities? Sports Med. 2013; 43(7):539-64.

Jeukendrup AE. Carbohydrate and exercise performance: the role of multiple transportable carbohydrates. Curr Opin Clin Nutr Metab Care 2010; 13(4): 452-457.

Maughan RJ and Leiper JB. Post-exercise rehydration in man: effects of voluntary intake of four different beverages. Med Sci Sports Exerc 1993; 25:34-35.

Miall A, Khoo A, Rauch C, Snipe RMJ, Camões-Costa VL, Gibson PR, Costa RJS. Two weeks of repetitive gut-challenge reduce exercise-associated gastrointestinal symptoms and malabsorption. Scand J Med Sci Sports. 2017 May 16. doi: 10.1111/sms.12912

Minehan MR, Riley MD and Burke LM. Effect of flavor and awareness of kilojoule content of drinks on preference and fluid balance in team sports. Int J Sport Nutr Exerc Metab 2002; 12(1): 81-92.

Phillips SM, Sproule J, Turner AP. Carbohydrate ingestion during team games exercise: current knowledge and areas for future investigation. Sports Med. 2011;41(7):559-85.

Ross M, Abbiss C, Laursen P, Martin D, and Burke LM. Precooling methods and their effects on athletic performance: a systematic review and practical applications. Sports Med 2013 43:207-225

Sale C, Varley I, Jones TW, James RM, Tang JC, Fraser WD, Greeves JP. Effect of carbohydrate feeding on the bone metabolic response to running. J Appl Physiol. 2015;119(7): 824-30.

Stearns RL, Emmanuel H, Volek JS, Casa DJ. Effects of ingesting protein in combination with carbohydrate during exercise on endurance performance: a systematic review with meta-analysis. J Strength Cond Res. 2010; 24(8):2192-202.

Stellingwerff T, Cox GR. Systematic review: Carbohydrate supplementation on exercise performance or capacity of varying durations. Appl Physiol Nutr Metab. 2014;39(9):998-1011