High5
4:1 Carbohydrate:Protein Drink Leaflet

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Once upon a time, there were only really two types of sports drinks; carbohydrate drinks for energy and endurance, and protein drinks aimed at strength athletes trying to build muscle. However, the last twenty years have seen an explosion in our understanding of sports nutrition and sports drink formulations have moved on accordingly. And for sportsmen and women seeking maximum endurance and recovery, High 5's 'Energy Source' embodies one of the most exciting developments in sports nutrition for years – carbohydrate/protein energy drinks…

Why use energy drinks?

To understand the extra advantages that carbohydrate/protein energy drinks can offer over conventional carbohydrate drinks, it's worth having a look at why you might want to use an energy drink at all. The primary purpose of an energy drink is to supply carbohydrate in a rapidly absorbable form in order to help provide fuel for your hardworking muscles during vigorous exercise.

Studies have shown that muscles can only store enough carbohydrate (in the form of glycogen) to fuel around 1_ to 2 hours of high-intensity exercise. This muscle glycogen is the 'premium grade fuel' during intense exercise; when your muscle glycogen stores start to become depleted, you'll experience a sudden and often dramatic drop in performance. Long distance runners call this sudden performance drop 'hitting the wall', while cyclists refer to it as 'the bonk'!

If you tried to replenish carbohydrate using conventional high-carbohydrate foods such as bread, pasta, potatoes etc. while on the move, you'd find it almost impossible; not only would digestion slow down the rate at which the released carbohydrate found its way to your muscles, most people also find it extremely difficult to consume solid food during vigorous exercise without suffering adverse effects such as stomach cramps, abdominal bloating etc. Energy drinks by contrast can drunk on the move without causing abdominal distress, and can therefore help prevent glycogen depletion during endurance training/events, thus extending the time to exhaustion.

What's in a conventional energy drink?

Although the exact formula varies, all energy drinks contain one or more types of soluble carbohydrates (eg maltodextrins, dextrose, fructose etc) to provide rapidly absorbed energy. The exact type and concentration of these carbohydrates is very important however; they need to be very carefully balanced to ensure that the water and carbohydrate they contain passes easily from the gastrointestinal tract into the bloodstream for transport to the muscles. The leading manufacturers such as High5 pay great attention to formulating their products so that the energy delivery is rapid, sustained and consistent, with no 'energy dips or swings' or abdominal distress!

Some energy drinks also provide added electrolyte minerals (sodium, chloride, calcium, magnesium and potassium), which can not only enhance carbohydrate uptake across the intestine (as has been shown with sodium1), but also ensure that minerals lost in sweat are replaced. This helps to reduce the risk of muscle cramping, or worse hyponatraemia (very low sodium levels), which can be very dangerous and even fatal in extreme conditions. Another benefit of adding the electrolyte mineral sodium in particular to energy drinks is that sodium helps to stimulate the urge to drink. Studies have shown that carbohydrate drinks containing 0.58g of sodium per litre are particularly effective at stimulating thirst and increasing the amount of fluid that athletes consume2 – useful if large amounts of energy drink are needed to help fuel a very long race or training session!

How do carbohydrate/protein energy drinks differ from conventional drinks?

In most respects, carbohydrate/protein energy drinks are similar to conventional carbohydrate-only drinks; they contain carbohydrate that can be easily absorbed from the intestine and transported to hard working muscles for use as fuel, and they may also contain electrolytes and other ingredients such as vitamins and minerals.

However, there is one crucial difference. As their name implies, carbohydrate/protein drinks also contain protein in addition to carbohydrate. The energy content in High5's 'Energy Source' for example is not exclusively derived from carbohydrate, but instead is supplied by a mix of 80% carbohydrate and 20% whey protein – ie 4 parts of carbohydrate to 1 part of protein. Hence the name, 4:1!

The reason why the ratio of 4 parts of carbohydrate to 1 of protein is used is that research has shown that this ratio provides muscles with all the benefits of supplying some added protein (see next section), without reducing the availability of the all-important muscle fuelling carbohydrate3-5, which extensive research has shown is vital for extended endurance performance.

This is a crucial point; yes there are plenty of carbohydrate/protein recovery drinks on the market. But these are much heavier drinks and are really designed to help muscles recover and grow after exercise.

Conventional recovery drinks generally provide around 35% or more of their calories in the form of protein and around 65% from carbohydrate. This extra protein effectively displaces some of the carbohydrate, which means that significantly less carbohydrate is available to working muscles. If you tried to use these during endurance exercise, your endurance would undoubtedly suffer, but even more importantly, the ratio and types of carbohydrates and proteins used would not make for rapid and efficient absorption from your intestinal tract. In plain English, not only would you run out of steam earlier, you'd very quickly end up with serious stomach pains and cramps as all that thick liquid swilled around your tummy with nowhere to go!

What extra benefits can carbohydrate/protein energy drinks offer?

In recent years, there's been extensive research into the potential benefits of carbohydrate/protein energy drinks over conventional drinks, which has centred on two main areas:

- **Performance** – do carbohydrate/protein energy drinks offer improved endurance performance over conventional carbohydrate drinks?
- **Recovery** – do carbohydrate/protein energy drinks minimise exercise-induced muscle damage and allow for better recovery following exercise?

Let's look at what the scientific evidence says about these areas.

Performance

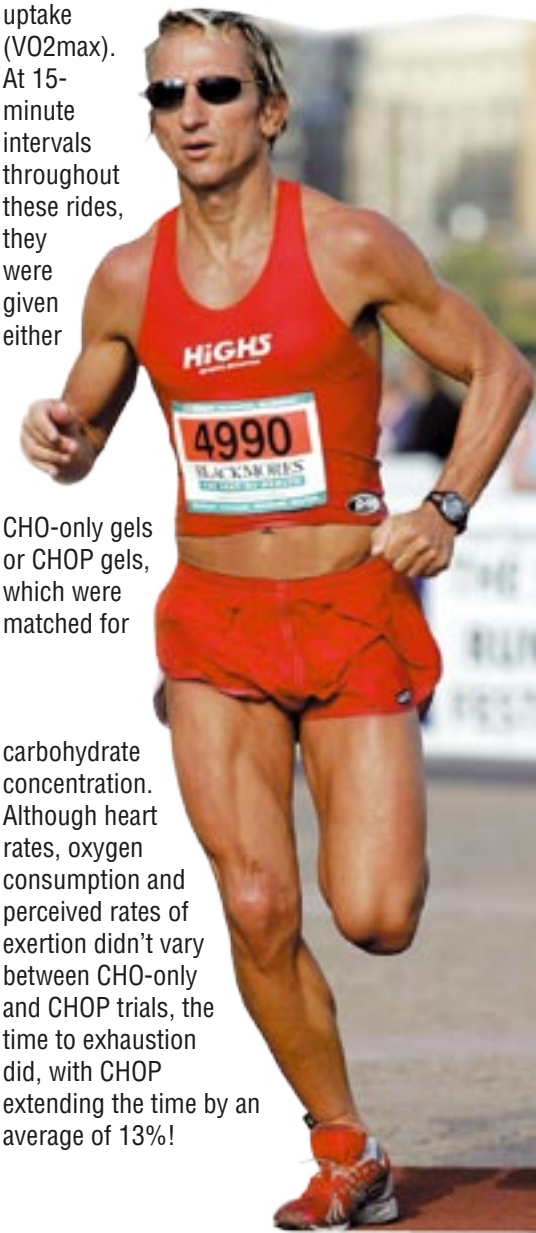
Athletes and recreational fitness enthusiasts are always looking for an edge, so any nutritional strategy that enhances performance is obviously of great interest. In the early studies on carbohydrate/protein energy drinks, researchers found that they produced greater increases in blood glucose, insulin response, and muscle glycogen storage compared to carbohydrate-only energy drinks[5-9]. All of these are conducive to improved endurance performance, and there was therefore much excitement. However, the problem with these studies was that the carbohydrate/protein energy drinks weren't calorie-matched – ie they supplied more calories in total than the carbohydrate-only drinks, which would have given the subjects taking them a distinct advantage (because more calories equals more fuel for exercise!).

Later studies also compared carbohydrate-only and carbohydrate/protein drinks that were matched for carbohydrate calories and the researchers found that subjects could exercise longer to fatigue[6,10]. However, although the carbohydrate calorie content was matched, the additional protein provided 25% greater caloric intake during exercise and recovery in the carbohydrate/protein trials. And because protein contributes up to 15% of total energy expenditure during prolonged bouts of exercise11, the protein calories in the carbohydrate–protein beverage may have accounted for the improvements.

The obvious question to ask is whether an isocaloric (ie - containing the same number of calories) carbohydrate/protein drink can enhance performance over a carbohydrate-only drink. In other words, if you take away the benefits of giving extra calories, does a carbohydrate/protein energy drink enhance performance over a straightforward carbohydrate drink? This is where things are less clear-cut.

Although some unpublished studies have shown benefits, some of these were sponsored by sports drink manufacturers, and cannot therefore be considered as reliable as independent studies published in peer-reviewed journals. If you look at the latter, the evidence for short-term performance enhancement is rather mixed:

- An American study in 2001 looked at the effects of isocaloric energy drinks of either carbohydrate-only (CHO) or carbohydrate/protein (CHOP) on the performance of 10 trained runners[12]. The runners first went on a low-carbohydrate diet and bout of running to lower muscle glycogen then were administered exactly the same amount (matched for calories) of either CHO or CHOP in a double-blind randomised fashion. After that, they were asked to run at a high- intensity to exhaustion, and their times were recorded. Not only did the CHOP beverage result in higher post-drink insulin levels (which helps to drive carbohydrate into muscle cells), it also extended the average run to exhaustion time from 446 to 541 seconds! The researchers concluded that "A CHOP drink following glycogen depleting exercise may facilitate a greater rate of muscle glycogen resynthesis than a CHO-only beverage, hasten the recovery process, and improve exercise endurance during a second bout of exercise performed on the same day."
- More positive findings for CHOP drinks on performance emerged from another US study published 4 years later[13]. In this study, carbohydrate/protein energy gels were compared with isocaloric carbohydrate-only gels, but the although the delivery system was different (gel not fluid), the principles remained the same. Thirteen cyclists (8 males and 5 women) completed two timed trials to volitional exhaustion on an electrically braked cycle ergometer at 75% of maximum oxygen uptake (VO2max). At 15-minute intervals throughout these rides, they were given either CHO-only gels or CHOP gels, which were matched for carbohydrate concentration. Although heart rates, oxygen consumption and perceived rates of exertion didn't vary between CHO-only and CHOP trials, the time to exhaustion did, with CHOP extending the time by an average of 13%!



• However, a very recent study compared the effects of CHOP vs. CHO-only drinks on 80km time trial in ten trained cyclists[14]. In particular, the researchers were unconvinced about some of the previous positive findings of CHOP drinks on endurance because these studies used a lower rate of carbohydrate ingestion than is considered optimal for endurance performance, and the performance tests (exercise time to fatigue) did not mimic the way in which athletes typically compete (ie a race in which a fixed distance or set amount of work is performed as quickly as possible). In this study, the researchers gave the cyclists 250mls of 6% CHO-only, CHO plus 2% added protein (CHOP) or a placebo (containing no CHO or CHOP) at 15-minute intervals during three separate 80km time trials, each separated by 7 days to allow full recovery. The results showed that both the CHO and CHOP drinks reduced the time to complete the time trial by 4.4% compared to placebo, but there was no extra benefit of taking CHOP compared to CHO-only. Remember too that the CHOP drink contained extra protein – ie contained more calories per 250ml portion than the CHO-only drink. The researchers concluded that "Adding 2% protein to a 6% carbohydrate drink provided no additional performance benefit during a task that closely simulated the manner in which athletes typically compete."

Maximising recovery and minimising muscle damage

Training and competition takes its toll on the body. During vigorous exercise, stored muscle glycogen (the body's premium grade fuel for exercise) is broken down and can become depleted. Meanwhile, muscle tissue is broken down, partly through mechanical impact but also because some amino acids (the building blocks of protein) locked away in muscle fibres are released and oxidised for energy, particularly during higher intensity prolonged bouts of exercise. It follows therefore that to recover from exercise, glycogen (from ingested carbohydrate) needs to be replenished and amino acids (from ingested protein) are required immediately following exercise.

It's a well-established fact that ingesting carbohydrate during endurance exercise helps to reduce the rate of glycogen depletion and so prolong performance. It seems logical therefore that if exercise also produces protein losses, that supplying small amounts of easily absorbable protein in a drink during exercise could help offset some of these losses, and minimise muscle damage (through lost protein) therefore making the recovery process more rapid. This in fact explains some of the rationale behind carbohydrate/protein energy drinks.

There's plenty of good evidence that raising blood levels of amino acids (ie by ingesting rapidly absorbed protein such as whey) as soon as possible after exercise increases the rate and extent of post-exercise muscle synthesis, thus helping to minimise muscle tissue losses and maximising gains[15-20]. This is after all what the traditional

'recovery drink' aims to achieve. However, there's also evidence that raising blood amino acid levels before and during exercise provides additional benefits:

• Research carried out over 15 years ago indicated that ingesting a light carbohydrate/protein snack 30 to 60 minutes prior to exercise is also beneficial[21,22]. In these studies it was shown that 50g of carbohydrate and 5-10g of protein fed before a training session can increase carbohydrate availability toward the end of an intense exercise bout, and also increase the availability of amino acids to muscles, thereby decreasing exercise-induced catabolism of protein.
• More recent research seems to support these early findings. US scientists investigated the effect of feeding free-form essential amino acids (EAAs) to subjects immediately before training to see how subsequence muscle metabolism was affected. EAAs are the completely unbound essential building blocks for protein; because they need no digestion, they're absorbed and find their way to muscles very rapidly indeed. Compared to a placebo solution, the researchers found that ingesting just 3 to 6 grams of EAAs prior to exercise stimulated protein synthesis[23,24]. Moreover, this stimulation increased in a dose-dependent manner until plasma EAA concentrations were doubled, and was maximised when EAAs were administered to maintain this doubled concentration over a 3-hour period. Adding carbohydrate seemed to enhance this protein synthesis, probably through the anabolic effect of insulin. More muscle synthesis indicates the body is in an anabolic state – exactly what is required for recovery!

It's clear then that giving small amounts of protein before and during exercise has benefits, so you'd expect the research on the benefits of carbohydrate/protein energy drinks on recovery to be favourable and indeed it is:

• A study in 2004 by Dutch scientists compared the effects of feeding CHOP (0.7g of carbohydrate + 0.25g of protein per kilo of body weight per hour) drinks with CHO-only (just 0.7g of carbohydrate per kilo per hour) drinks at 30-minute intervals to eight athletes performing an ultra-marathon (2.5 hours of cycling, 1 hour of running, and 2.5 hours of cycling)[25]. In particular they were keen to measure the protein balance during exercise – ie whether the athletes were losing muscle mass (a sign of muscle damage), or retaining it. When they looked at the rate of amino acid breakdown during exercise, they found that protein balance when taking the CHO-only drink was negative. However, with the CHOP drink, it was significantly less negative, and in some cases actually positive – ie some athletes managed to gain muscle mass even after a 6-hour ultra-marathon!
• Another study also found similar results in fifteen cyclists who rode a cycle ergometer at 75% VO2max to exhaustion, followed 12-15 hours later by a second ride to exhaustion at 85% VO2max[26]. The cyclists consumed either 1.8mls per kilo of body weight of randomly assigned CHO-only drink or CHOP drink every 15 minutes of exercise, and 10mls per kilo

immediately following exercise. As well as cycling performance, the researchers measured peak post-exercise plasma CPK levels (a marker used to indicate the amount of muscle damage) and found that they were 83% lower following the CHOP trial compared to CHO-only trial! They also found that in the first ride at 75% VO2max, subjects rode 29% longer when consuming the CHOP beverage compared to the CHO beverage, and in the second ride at 85% VO2max, subjects performed 40% longer when consuming the CHOP beverage. However, an important caveat here is that the CHO-only drink contained 20 less calories than the CHOP drink, which makes drawing firm conclusions tricky.

• More evidence for the benefits of CHOP drinks, in particular their ability to limit muscle damage during exercise, emerged from a study by the same US scientists the following year[27]. They compared the effects of CHO-only vs. CHOP drinks administered every 15 minutes to fourteen competitive cyclists, who rode a cycle ergometer at 75% of VO2max until exhaustion. Fifteen hours later, the subjects had blood samples taken to assess plasma CPK levels and then performed a second ride to exhaustion at 85% of VO2max. Post-exercise CPK levels were significantly lower following the CHOP trial compared to the CHO-only trial, with nine of the cyclists showing very large declines in CPK. Interestingly, when the researchers looked at the times to exhaustion in these nine cyclists, they found that they were able to cycle significantly longer to exhaustion after the CHOP drinks compared to CHO-only drinks, indicating not only less muscle damage, but superior recovery too!

• Further confirmation of the damage prevention effect that CHOP drinks can offer over CHO-only drinks came from another study by the same group last year[28]. Using a very similar format to the previous two studies described above (except that the first and second rides were carried out at 70% and 80% of VO2max respectively), they found that compared to CHO-only, CHOP drinks reduced the levels of two different markers of muscle damage (CPK and LDH), and reduced reported levels of post-exercise muscle soreness. In this study, the drinks were calorie matched; while there was no improvement in the time to exhaustion of the second ride, it does indicate that the protective effects of CHOP drinks are in fact due to the added protein rather than just extra calories.

How can you benefit from using Energy Source?

The weight of evidence in favour of using CHOP drinks over CHO-only drinks is fairly persuasive. For starters, CHOP drinks provide all the performance advantages of CHO-only drinks, and a number of studies have reported that they may even enhance performance over CHO-only drinks. However, it needs to be remembered that a calorie for calorie basis, the evidence that CHOP drinks are superior to CHO-only drinks is rather less conclusive.

What is not in doubt however is that CHOP drinks do reduce the amount of exercise-induced muscle damage and muscle tissue loss, and therefore can make proper and complete recovery more rapid. For endurance athletes, this is extremely important; once endurance training volumes creep up, muscle tissue breakdown increases, which in the longer term can reduce power and strength, and leave athletes vulnerable to injury. If you've fought hard to develop power and strength in the gym, or with specific drills, the last thing you want is to be losing it every time you train! This is where Energy Source can offer a real advantage when taken regularly during and after training; by supplying your muscles with a low but significant concentration of amino acids (from whey protein) in a pleasant and easily absorbed drink, muscles can be simultaneously fuelled while muscle tissue is conserved. The result is more rapid post-workout recovery and a greater retention of lean muscle tissue, power and strength – definitely an advantage for those with naturally slim and wiry builds, or in fact anybody who wants optimum performance and recovery all in one tasty drink!

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