The Hyprol™ Sports Drink Concept for Improved Muscle Energy

a report by
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Executive Summary

Both glucose availability and insulin concentrations in the blood determine the rate of glucose uptake and glycogen synthesis in skeletal muscles. After endurance or high-intensity exercise, athletes have used up their glycogen reserves. Glycogen is the storage form of glucose and the predominant source of energy for the active muscle. Besides rehydration, the key challenge, post-exercise, is to replenish the body's glycogen reserves as fast as possible. The intake of carbohydrates (such as sugar, glucose, malto dextrin, etc.) directly after endurance exercise increases the rate of muscle glycogen synthesis. However, an overnight rest will normally not be long enough to achieve complete recovery, as full restoration of the glycogen reserves takes longer. Fortunately, the recovery time can be reduced radically when carbohydrates are ingested in combination with Hyprol™ 4107 (a wheat protein hydrolysate rich in the amino acid glutamine) or Hyprol™ 7102 (a pea protein hydrolysate).

Hyprol™ 4107 greatly stimulates insulin excretion by the pancreas. Insulin triggers a series of events in the muscle that result in increased uptake of glucose from the blood, increased glycogen synthesis and stimulation of muscle protein synthesis. Independent clinical studies have shown that the addition of Hyprol™ 4107 to sports drinks in the recovery phase can halve the recovery time.

Overall, Hyprol™ is a valuable addition to every sport diet when consumed during and immediately after physical activity to improve personal performances. As such, Hyprol™ can be seen as a key ingredient for the next generation sports drinks.

Developments in Sports Drinks

In the last decade, much research has been undertaken to develop optimal sport nutrition products. Many of these studies focused on what happened in the body during exercise and what is required to maintain the optimal performance level of the athlete. This has led to the development of isotonic drinks that compensate mainly for the loss of water by sweat and provide extra glucose for the working muscles. These sports drinks can postpone fatigue and lengthen performance time by delaying depletion of glycogen stores in the muscles. (Glycogen is the storage form of glucose and the predominant source of energy for the muscles during intense exercise).

After endurance exercise for over an hour, the glycogen in the muscles begins to deplete and fatigue will increase. Normally, an overnight rest will not be long enough to achieve complete recovery as full restoration of glycogen reserves takes longer. To help combat this, the intake of carbohydrates directly after endurance exercise is known to increase the rate of muscle glycogen synthesis. Yet, while carbohydrates primarily stimulate insulin release, it is proteins that highly enhance this insulin release by the pancreas into the blood. Insulin triggers a series of muscle activity that results in an increased uptake of glucose from the blood, an increased glycogen synthesis and the promotion of amino acid uptake in muscle, while blunting cortisol's effect on protein breakdown. The underlying mechanism is that proteins and peptides, by enhancing the amino acid concentrations in the blood, extra-stimulate the insulin excretion by the pancreas. Therefore, the addition of proteins to a carbohydrate sports drinks is a means of increasing post-exercise glycogen resynthesis rates and a convenient way to stimulate muscle growth.

In this paper, nutrient requirements both during and after exercise are discussed, with emphasis on studies related to insulin responses and plasma amino acid levels after endurance exercise with Hyprol™ 4107, a new type of peptide material containing sports drinks as developed by Quest International – the recovery sports drink concept.

Sports Drinks During Exercise – Rehydration and Energy

Water and Carbohydrates

The primary purposes of fluids consumed during exercise are to:

(a) supply a source of carbohydrate that can

supplement the limited stores of glycogen in the muscles and liver;

b) replace sweat loss; and

(c) reduce the problems associated with dehydration.

An adequate supply of fluid during prolonged physical exercise is therefore vital to prevent heat stroke and collapse, but it also delays fatigue. However, fatigue during exercise has two main causes: depletion of the body's limited carbohydrate reserves; and dehydration. When the glycogen content of the exercising muscles is very low, it is not possible to exercise at high intensities, although low-intensity exercise is possible, with the muscles relying mainly on fat as a fuel.

Carbohydrate and fatty acids are the main fuels for the skeletal muscle to provide energy during prolonged exercise. Contrary to fat levels, the glycogen reserve in the body is limited (400–500 grams (g)). In practice, the muscle glycogen reserves are sufficient for about 45 minutes of high-intensity aerobic exercise.

When the muscle glycogen stores become depleted, the muscles become more sensitive to cramp and the exercise can only be completed at a low-intensity level, where fat is the only energy source. Fortunately, it is possible to use exogenous glucose for energy supply during exercise and this reduces the use of muscle glycogen. The amount of glucose, including malto dextrins, which can be taken up during exercise exogenously is limited to about 60g/h. Exogenous glucose thus can provide 240kcal/h on top of the 360kcal/h obtained from fat oxidation. At higher intensities, the glycogen reserves are used to provide the extra energy. At very high intensity, more oxygen is required for the oxidation of fat and glucose than can be taken up by breathing. Glucose then is used anaerobically and converted into lactic acid. This causes the souring of the muscles and can only be undertaken for a short period. The amount of energy obtained in this way from glucose is small but the supply of energy is very fast. This allows athletes to exercise for a short time at a very high intensity – as in sprinting.

Proteins

The reasons for using protein and amino acid in sports drinks include stimulation and maintenance of muscle growth and strength and enhancement of energy utilisation (e.g., adding proteins/amino acids to a carbohydrate-containing sports drink). There are good reasons to do so in drinks used after exercise recovery, as will be explained later. Several athletes have successfully trialled (diluted) Hyprol™ 4107 recovery sports drinks during endurance exercise such as marathon running, rowing, etc. Interestingly, all these athletes found they could accelerate, even at end of the session. Furthermore, they recovered very quickly from their exhaustion and experienced no muscle pain or less pain the next day than they normally did. These real-life experiences suggest a positive influence of the Hyprol™ 4107 on performance. When speculating on the mechanism, it is possible that the peptides and amino acids in Hyprol™ 4107 enhance the water uptake from the gut and thus add positively to the rehydration in addition to the carbohydrate, as the uptake of glucose is limited to about 60g/h. Peptides and amino acids therefore stimulate extra water absorption. Furthermore, by delivering amino acids to the blood, fewer amino acids from the muscle might be used up during exercise. Although still a hypothesis, this is a promising route for further clinical testing.

Sports Drinks During Recovery – Stimulation of Glycogen Synthesis and Muscle Building

Fatigue and Recovery Time

Fatigue during prolonged or high-intensity exercise is often associated with muscle glycogen depletion. Hence, high pre-exercise muscle glycogen concentrations are essential for optimal performance during prolonged exercise. In most cases they also have lost more water than could be compensated for during physical activity. Therefore, after exercise, the athlete needs water for rehydration and glucose for restoration of the glycogen reserves. Because athletes often train twice daily for several days, and may compete on consecutive days, rapid restoration of muscle glycogen is of crucial importance to optimise recovery. Delaying the ingestion of a glucose supplement post-exercise will result in a reduced rate of muscle glycogen synthesis and thus will delay recovery. After physical exercise to exhaustion, glycogen resynthesis in muscle has a high metabolic priority.

The availability of substrate (i.e. glucose) to the muscle is the main limiting factor for glycogen resynthesis. This availability is dependent on the rate of gastric emptying and intestinal absorption of the ingested glucose, glucose output by the liver and glucose entry into the muscle. Most likely is that the rate of muscle glycogen resynthesis is limited by the rate of digestion/absorption of carbohydrate by the intestine. Directly after exercise, glycogen resynthesis in muscle has a high priority. Carbohydrate supplements taken within the first minutes result in a more rapid repletion of muscle glycogen than taking the same supplement two hours later. Timing of the provision of nutrients after exercise, therefore, is

crucial. It was further observed that the rate of muscle glycogen synthesis could be enhanced when carbohydrates ingestion is combined with proteins or, more effectively, with peptides.

Clinical Testing – Glycogen Resynthesis

Until recently, there was no clear insight into neither the type, combination or quantity of protein sources (amino acid composition) that should be taken by a carbohydrate-containing drink to maximise the *in vivo* insulin response. This aspect has been studied further at the University of Maastricht by exhaustion exercise studies with highly trained male cyclists/triathletes (24 ± 0.6 years of age).

The subjects were submitted to a glycogen depletion protocol in which they cycle in alternating workload of 90% and 50% of their maximum performance capacity until they could not maintain pedalling speed at 70% of their maximum capacity. During a recovery period of three to five hours, the athletes consume sports drinks containing carbohydrates and the wheat protein-derived Hyprol™ 4107. Several muscle biopsies were taken during the recovery period for analysis of the glycogen content and calculating the glycogen synthesis.

The main findings were that Hyprol™ 4107 highly stimulates the insulin response on a carbohydrate load. An almost linear relationship has been found between the plasma insulin response and the blood amino acid concentration resulting from the consumed amount of Hyprol™ 4107 (see *Figure 1*). As a consequence, glycogen synthesis is also quickened in the same ratio and thus recovery time is reduced (see *Figure 2*). Time needed to restore muscle glycogen levels after intense exercise determines the time needed to recover from fatigue. In practice, this means that recovery times can be halved when consuming 30g of Hyprol™ 4107 per hour (one litre of sports drink containing 3% Hyprol™ 4107 plus 6% carbohydrates) compared with a drink containing carbohydrates only. After extreme performance, the addition of the amino acids leucine (Leu) and phenylalanine (Phe) – next to Hyprol™ – to the drink is optional for further maximising insulin response.

Muscle (Re-)Building

Endurance exercise results in a decreased protein synthesis, increased amino acid oxidation and increased conversion of amino acids to glucose especially in a state of glucose store depletion. The adaptive response to performance of strength exercise, on the other hand, results in an increased protein synthesis. Because of changes in protein metabolism, there is an increased dietary requirement for protein in both endurance and strength exercise. The increased

Figure 1: Effect of Hyprol™ 4107 Doses (with Optional Phe and Leu) in a Recovery Sports Drink on Insulin Response (Overall Picture for Person of 75kg Drinking 1L/h)

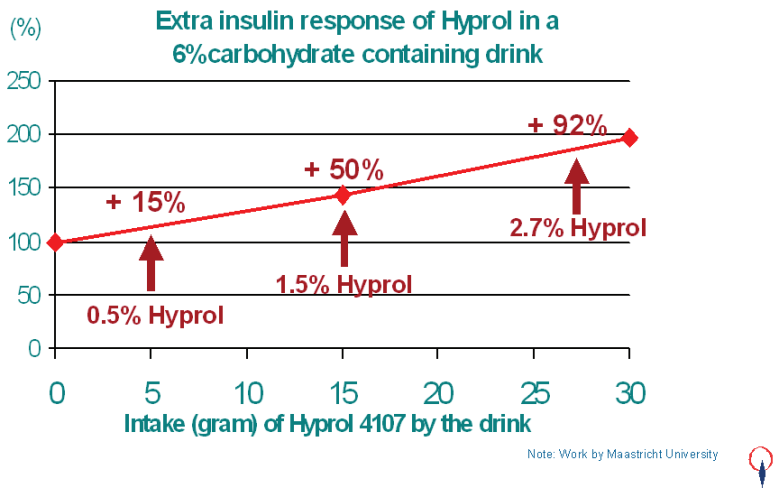
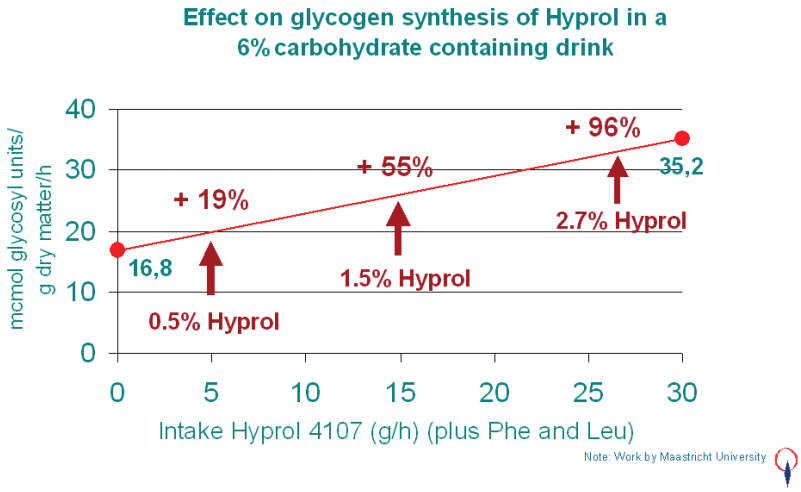


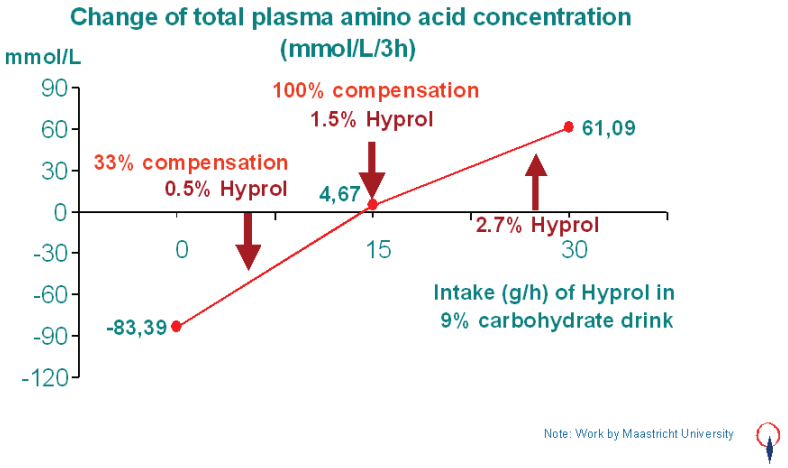
Figure 2. Effect of Hyprol™ 4107 (plus Phe and Leu) in a Recovery Sports Drink on Glycongen Synthesis (Overall Picture for Person of 75kg Drinking 1L/h)



uptake of amino acids by the muscle results in a lowering of the plasma amino acids concentrations during recovery from exercise. At this stage the intake of proteins is crucial to change degradation into net muscle protein synthesis. Insulin directly stimulates muscle protein synthesis by stimulating the amino acid uptake by the muscle and, to at least some extent, decreases protein breakdown. The stimulatory effect of amino acids directly after exercise is greater than the effect of amino acids on muscle protein synthesis when at rest. Timing is also important here.

Consumption of a Hyprol™ 4107-containing sports drink after exercise can compensate for the plasma amino acid lowering in our clinical tests as described. About 15g Hyprol™ 4107 consumed per hour can compensate for the plasma amino acids lowering after exercise to exhaustion (see *Figure 3*). Further pilot studies clearly show the positive effect of Hyprol™ 4107 on muscle increase and strength gain.

Figure 3. Effect of Hyprol™ 4107 in a Recovery Sports Drink on Plasma Amino Acid Concentration (Overall Picture for Person of 75kg Drinking 1L/h)



Note: Work by Maastricht University

The Need for Glutamine by Endurance Athletes

A significant decrease of plasma glutamine levels is observed during the recovery from prolonged high-intensity exercise. One hour after running a marathon, the plasma glutamine level might decrease by approximately 20%. So, physical exercise puts a great strain on the reserves of conditional essential amino acid glutamine and does not stop when the workout is over. Muscles will respond by manufacturing new glutamine from other amino acids, especially from the branched-chain essential amino acids (BCAAs), e.g., leucine, phenylalanine and valine. There must therefore be enough glutamine available to fill the gap between depletion and supply.

Besides its aid in muscle protein synthesis, glutamine is also essential for many important homeostatic functions and for the optimal functioning of a number of tissues in the body, particularly the immune system, energy requirements of the gut and the regulation of the glutathione reduced/oxidised ratio.

A high incidence of infections is seen in athletes undergoing intense, prolonged training or participating in endurance races. Those athletes easily catch a cold or influenza. This enhanced susceptibility to infection is probably related to the decreased plasma level of the amino acid glutamine seen in these athletes. Interestingly, athletes who took glutamine supplements show fewer infections.

The wheat protein-derived Hyprol™ 4107 is a good dietary source for glutamine as its amino acid composition consists for 30% out of glutamine. Consumption of a sports formulation with glutamine-containing peptides can prevent the decrease in plasma glutamine and can enhance immune functions.

In Conclusion

Hyprol™ 4107 is an important ingredient for the next-generation sports and energy drinks. Hyprol™ included in a sports formulation (ready-to-drink, powder-based or other delivery forms) can improve personal performances when consumed during and immediately after physical activity. After exercise, during the recovery period, adding Hyprol™ 4107 to the carbohydrate-containing sport drink highly stimulates the insulin response. This results in a faster recovery because of the enhanced glycogen synthesis and muscle protein rebuilding. This allows sportsmen and sportswomen to recover overnight from sporting activity and be ready the next day for a top performance again. During physical exercise, water and carbohydrates are important ingredients for a sports drink to prevent dehydration and fatigues. Hyprol™ 4107 can improve these parameters. Further clinical studies are in place to substantiate these functionalities more. The glutamine-rich Hyprol™ 4107 also stimulates muscle gain, which is important during training practices. ■

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