The Changing Nature of Sports Drinks

From low-glycemic sweetener systems to functional proteins, the formulation of sports beverages is becoming ever more complex.

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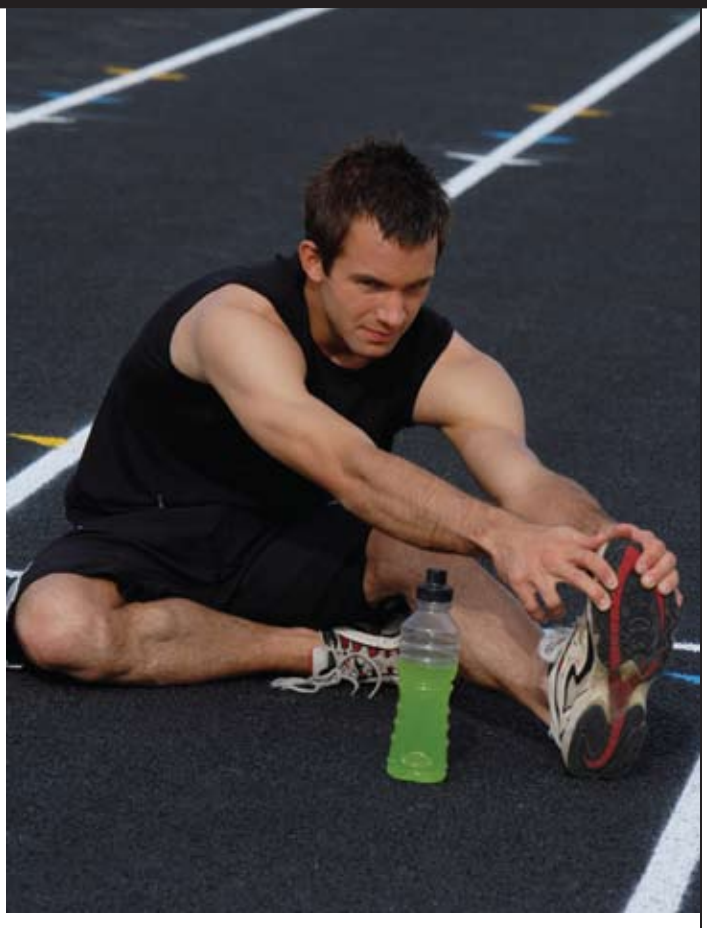


New beverage introductions in the U.S. have continued to increase in recent years. According to a report on new products published by *Food and Beverage Report*, there were a total of 3,231 in 2007, the greatest number of new product introductions in any food category[1]. According to Mintel, a consumer packaged goods monitoring service, some of the product areas with the highest growth were in the sports and meal replacement categories, which place a greater emphasis on nutrition[2]. More beverage companies are focusing their attention on adding new nutritional benefits to their new products, promoting a product's ability to enhance sports performance.

The introduction of product labeling, which highlights dietary guidelines or specific nutrient goals of a company-wide dietary program, means that these foods are typically lower in sugar, fat and calories. Often, companies are looking to dairy ingredients to add nutritional value to their products, and much of the interest is focused on protein. Beverage formulators are turning more often to whey proteins for their unique functionality and excellent nutritional properties.

Whey Protein and Muscle Recovery

Whey protein, a high-quality protein naturally found in dairy, provides the nutrition, flavor, functionality and value necessary to create great-tasting sports product formulations. Plus, whey protein has the highest biological value and protein efficiency ratio of any protein and contains all of the essential amino acids required by the body for good health.[3]

Sports beverage companies are focusing on new nutritional benefits, promoting the product's ability to enhance sports performance.

In a June 2008 study among members of IDEA® Health and Fitness Association, a worldwide organization of health and wellness professionals, 238 personal trainers and fitness-related health professionals surveyed consider whey protein to better deliver the benefits of "burning more fat while retaining muscle," "increasing lean muscle" and "enhancing physical performance" over other protein sources consumed after exercise.

There are several performance beverages on the market today using whey protein. For example, WheyUP®, a sports drink that boasts 20g of whey protein isolate in an energy formula, is targeted toward health-conscious individuals and marketed as "ideal to drink before or during your work-out to fuel your body." Accelerade® Advanced Sports Drink promotes 15g of whey protein isolate in each serving. According to the sports drink company's website, the protein in the ready-to-drink beverage, when consumed during exercise, "facilitates rehydra-

tion, minimizes the breakdown of muscle that occurs during endurance exercise and speeds up the recovery process."

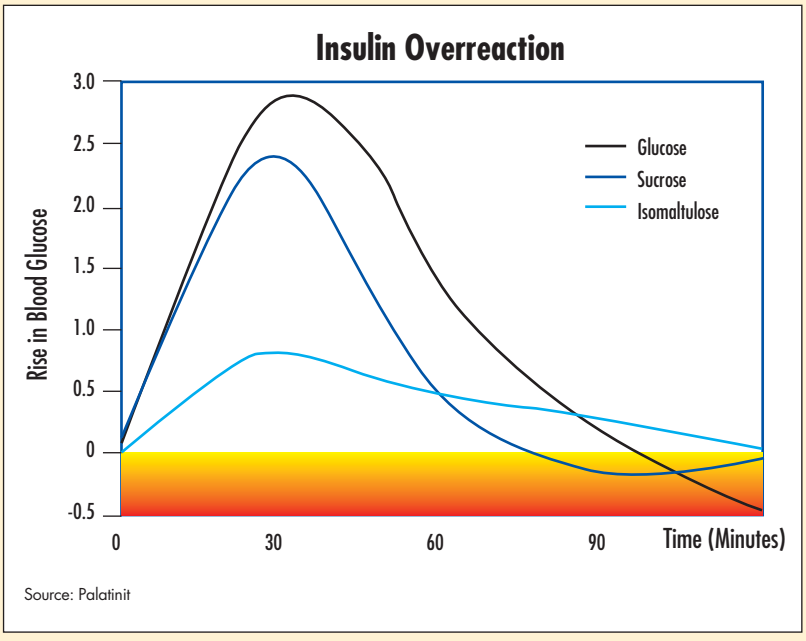
Proteins are all good, but some are more beneficial than others. The ideal sports protein should meet these criteria:

- Provide a good balance of essential and non-essential amino acids.
- Provide an abundant supply of branched-chain amino acids.
- Be low in fat and cholesterol.

Slight Sweetness and Smooth Blood Sugar Levels

Sports nutrition companies are looking at low-glycemic sugars as functional sugar systems to enhance endurance in certain products. These include newer functional sweeteners, such as isomaltulose and trehalose.

Like sucrose, isomaltulose is a disaccharide that provides 4Kcal/g and consists of glucose and fructose moieties. However, instead of a 1,2-glycosidic bond linking glucose and fructose, it has a 1,6-glycosidic link that is more resistant to enzymatic and acid hydrolysis. Thus, although isomaltulose is eventually digested, it delivers glucose to the blood at a slower, but steadier, rate, as compared to glucose or sucrose. The reduced spike in blood glucose levels means there is also a reduced blood insulin response which, in turn, means a "hypoglycemic undershoot" is less likely to occur. That is, high insulin levels may remove "too much" glucose from the blood. (See chart "Insulin Overreaction.") Isomaltulose's slow glucose delivery is thought to be particularly beneficial in sports beverages, with the goal of delivering energy over an extended period.



Source: Palatinit

According to one isomaltulose supplier, the ingredient has roughly 45% of the sweetness intensity of sucrose, a similar viscosity, is less soluble and possesses good heat and acid stability, an advantage in the formulation and processing of low-pH sports beverages.

Additionally, trehalose, also known as mycose or tremalose, has unusual properties advantageous for sports drinks. It is a disaccharide that consists of two α-glucose units linked by an α, α-1, 1-glucoside bond, which is also very resistant to acid hydrolysis. Its slight sweetness (again, roughly half that of sucrose) works well in sports drinks, and it has been claimed to help suppress the bitterness sometimes associated with peptides and amino acids.

One supplier's website notes it provides 3.6Kcal/g and reports that, when consumed before prolonged aerobic exercise, the sweetener sustains blood glucose as "effectively as glucose supplementation while producing a… consistent plasma insulin and blood glucose response before and during exercise than glucose."

For example, in one small study, when participants consumed glucose, galactose or trehalose before exercise, it was found that blood glucose concentrations 15 minutes after consumption were significantly higher when glucose was consumed, as compared to when galactose or trehalose was consumed. More than a two-fold greater increase in plasma insulin levels followed the high blood glucose levels. (Jentjens, RL and Jeukendrup, AE. 2003. Eur J Appl Physiol. 88:459-65.)

Additionally, trehalose is an antioxidant. This function is not only sought in sports beverages, but has been researched for its abilities to hinder omega-3 fatty acid degradation. (Higashiyama, T. 2002. Pure Appl Chem. 74(7):1263-1269. 2002.)

It should be remembered, however, that low-glycemic ingredients are not always the most appropriate. The use of high-glycemic ingredients—such as glucose/dextrose, sucrose, maltodextrin—to help spike glucose blood levels can be positive. Athletes generally are advised to consume such beverages during and immediately following an athletic event for recovery. (See www.PreparedFoods.com and type in "High Glycemic Goals," with quotations, for an article providing more details.) Mintel International's GNPD provides a number of examples of products taking this tactic. For example, Recovery Drink, launched November 2008 under the Codeblue brand, "features a mixture of benefits as hydration, antioxidants, anti-inflammatory, detoxification and electrolytes." The sweetener system includes prickly pear, agave nectar and sugar.

—*Prepared Foods* Editors

Concepts presented in this sidebar were suggested by Pete Maletto, president and senior food scientist, PTM Food Consulting, Long Branch, N.J. With over 20 years of experience in beverage, dietary supplement and food development, the company has developed many innovative products for top sports nutrition companies. For more information, call 888-736-6339; ptmfood@mac.com; www.foodconsultant.biz.

Whey has an excess of essential amino acids, making up 60% of whey's total protein content. As a result, there are no limiting essential amino acids in whey proteins to detract from protein quality, as is the case with some vegetable proteins.

Recent research has shown that adding just 10g of whey protein to an isotonic drink following resistance exercise can stimulate the building of lean muscle and muscle recovery, according to a research team from the Department of Kinesiology at McMaster University in Hamilton, Ontario, Canada. In a study using eight resistance-trained athletes, McMaster's Exercise Metabolism Research Group found that participants who ingested a carbohydrate drink containing 10g of whey protein with 21g of fructose following resistance exercise saw a rise in muscle protein synthesis.

Because of its high solubility, whey protein has the unique ability to remain clear at the low pH range of 2.8-3.5 found in high-acid beverages, such as isotonics. Due to its clarity and solubility, formulators can pack more protein into a beverage drink than with soy protein, which is not as soluble as whey protein at levels below pH 3.9.

Explaining the Behavior of Whey Proteins

The unique functionality of whey proteins is linked to their chemical makeup and conformation. Whey proteins represent a combination of different proteins with unique functions. They are very ordered and globular in structure, with a high level of sulfur amino acids. Like other proteins, they are charged molecules, and the overall net positive or negative charge changes with the pH of the solution. Most beverages are in the 3-7 pH range, so it is helpful to understand the behavior of whey proteins in this range. At a pH of 3.0-3.5, whey proteins have a very high net positive charge[4]. This net positive charge creates an environment where there is strong repulsion between molecules of the protein. This repulsion translates into a decreased ability of the proteins to interact, even with heating.

Whey proteins exhibit some of their best heat stability in this pH range because of the repulsive forces present. It also means that formulators can fortify a drink with the most protein possible in that pH range (greater than 2g protein/30mL liquid or 6.7% protein) and still obtain good heat stability. As pH increases above 3.5, whey proteins will start to decrease in their net positive charge, until they reach the pH range of their isoelectric points (pH of 5.0-5.5), at which point they will have a balance of positive and negative charges or no charge.

Like other proteins, the isoelectric point of whey proteins is the point of lowest heat stability because of the great potential for protein interaction, due to attractive forces between molecules. Once the pH increases close to 7, whey protein molecules will be more negatively charged. However, they will not be at their highest net negative charge until they reach pH 10.

Protein Punches

Although whey proteins are commonly found in sports beverages, other sources of protein occasionally appear as well. For example, Mintel International's GNPD shows that Advanced Food Products's XRTD30 Xtreme Thirty Gram Protein Drink was introduced with milk protein concentrate and soy protein isolate. The product label explains, "Protein helps to support the immune system and helps to build and maintain muscle. Therefore, it is an essential nutrient for those individuals who partake in weight lifting on a regular basis." Similarily, EAS's EAS Advant Edge was introduced with an ingredient legend first listing soy protein isolate and then whey protein concentrate. Overall, the product provides 17g protein per 330ml serving. Internationally, other proteins are called into service. In Spain, in 2006, Huevos Maryper launched Ovogym Clara Plus, an "egg white drink enriched with tryptophan and vitamins B6 and C aimed at sportsmen and women," with the claim that it is "absorbed to the maximum capacity." In the Netherlands, in 2008, Mintel's database notes that DSM Food Specialties introduced into the retail market Next Generation Sports Drink, with casein hydrolysate (from milk).

— *Prepared Foods* Editors

PHOTO COURTESY MINTEL'S GNPD

It is also important to note that whey proteins have the unique ability to be soluble over the entire pH range, from pH 2-11.

Looking for Clarity

Beverages can have a range of clarity, from cloudy (smoothies) to clear (flavored waters). Turbidity usually refers to a drink's cloudiness or clarity. Using a nephelometer is one way to measure turbidity. Water typically is used as a standard and has a value of 0 nephelometric turbidity units (NTU). If a protein-enhanced flavored water is the target, then a WPI is the best ingredient. The addition of 2.5% WPI (5g protein/235mL serving) in the pH range of 3.0-3.5 will provide good clarity.

Fat is the main component of whey ingredients that contribute to cloudiness at low pH, so choosing an ingredient that is very low in fat is best for protein-enhanced water. If clarity is not a goal, such as formulating for a smoothie-type product, then the pH range would be increased to 3.5-4.5. The decrease in net positive charge creates an environment where there are more attractive forces between the whey proteins, making the beverage appear cloudier. Meal replacement beverages are typically around pH 7. Whey proteins can still achieve good solubility and heat stability in these pH ranges, but may require the help of added processing steps and ingredients.

Formulation Tips

Though it is relatively easy to formulate ready-to-drink beverages with whey protein ingredients, there are methods to optimize the performance of the protein. Some processes are discussed in the USDEC monograph titled "U.S. Whey Proteins in Ready-to-Drink Beverages," available at www.usdec.org/files/Publications/BEVERAGESwebversion8-16-06.pdf. All of the methods are designed to maximize the heat stability and shelf stability of the proteins.

One of the most critical steps in processing ready-to-drink beverages with whey protein is the pre-hydration of the protein. In most beverage plants, dried ingredients are typically added to water with high-speed mixers, such as a liquefier or tri-blender, to quickly dissolve the powders. Whey proteins will dissolve quickly, but they also will foam readily with this high shear[5]. It is important to also allow some time for the whey proteins to hydrate, once they are dissolved. The warmer the water used, the faster the hydration time, so it is recommended that the temperature of the water be less than 54˚C. Some 20 minutes is adequate time for hydration of the protein prior to heat processing[6]. Drinks in the acid pH range are processed using hot/fill conditions (i.e., 91˚C for 30 seconds).

When formulating in the pH range of 3.0-3.5, good hydration will help ensure good heat stability and better clarity, if using a WPI. At a pH range of 3.5-4.5, good hydration will not be enough to ensure good heat stability, and food additives will be needed. Whey protein stability will benefit from the addition of a high-methoxy pectin combined with homogenization prior to heat treatment. The homogenization step will ensure good interaction of the pectin and the whey protein.

If formulating a drink at neutral pH, the whey protein will need additional protection, because Ultra High Temperature (UHT) or retort heat treatment conditions will be used to ensure adequate food safety and shelflife. In these drinks, phosphate buffers and stabilizers, combined with homogenization prior to heat treatment, are important. UHT and retort drinks also would benefit from the use of hydrolyzed whey proteins for added heat stability.

Like other proteins, the isoelectric point of whey proteins is the point of lowest heat stability; this is because of the great potential for protein interaction, due to attractive forces between molecules.

A chalky or grainy mouthfeel is common in protein drinks that are not formulated for good heat stability. Syneresis, or the formation of a water layer at the top of the drink, is another possible defect that usually is the result of too much foaming prior to heat processing.

Whey proteins can be formulated into a variety of sports and performance beverages. Using these tips and working closely with a whey protein supplier will ensure the best performance in product applications. pf

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For the latest information on dairy and dairy ingredient-related research and information, visit www.innovatewithdairy.com. For assistance formulating products with whey proteins or other dairy ingredients, contact techsupport@innovatewithdairy.com.

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