ELECTROLYTES NOT JUST FOR SPORTS!

NEW INFORMATION ON THE NEED FOR ELECTROLYTES EVEN WHEN YOU AREN'T EXERCISING.

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Electrolytes, Not Just for Sports!

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Electrolytes, Not Just for Sports! is not intended as medical advice. It is written solely for informational and educational purposes. Please consult a health professional should the need for one be indicated.

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Chapter 1: Sports drinks are not all the same.

Sports drinks are everywhere today, being consumed in the workplace, at home, and in the car as well as before, during, and after exercise. They are outperforming other beverage segments as more choices are being offered each day.[1] Several types of sports drinks are on the market: a) electrolyte replacement drinks, b) carbohydrate replacement drinks, c) combination drinks of electrolytes and carbohydrates d) alkalizing waters. While there may be a place for all within the sports arena, on closer examination, the drinks are used for completely different purposes. Electrolyte replacement drinks are designed to replace the fluids (water) and electrolytes (sodium, potassium, chromium, manganese, etc.) lost during exercise. Carbohydrate drinks are the acceptable choice for instant energy during strenuous exercise and muscle recovery afterwards. Many carbohydrate drinks may also include electrolytes. According to the American College of Sports Medicine, consuming adequate food and fluid before, during, and after exercise can help maintain blood glucose levels during exercise, maximize exercise performance, and improve recovery time. Athletes should be well hydrated before beginning exercise and should also drink enough fluid during and after exercise to balance fluid losses.[2]

Not all sports-minded people need carbohydrate drinks, but most of them need electrolyte replacement. According to the International Sports Medicine Institute, many Americans are dehydrated, even before exercise, because they don't drink enough water. In the United States, dehydration in children results in 200,000 hospitalizations and an estimated 400 deaths per year.[3] The average person normally loses between 3-6 liters from normal bowel and urinary elimination. Moisture is also lost just from breathing. Some of

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[1] Bachman, Tom, "The spurt in sports drinks." Beverage Industry, June 2000.

[2] Position of Dietitians of Canada, the American Dietetic Assn., and the American College of Sports Medicine: Nutrition and Athletic Performance. Can J Diet Pract Res 2000, winter; 61(4):176-192.

[3] Duggan, C., R. Glass, M. Santosham, "Oral rehydration therapy in children." Patient Care, April 30, 1992.

the more obvious signs of low water levels in your body include headaches and fatigue.

Sports endurance will be compromised if dehydration worsens. Heart rate increases and oxygen (and nutrient delivery to the muscles) can drop 10 percent even with mild exercise like hiking.[4] Unreplaced water losses equal 2 percent of body weight and will impact heat regulation. At 3 percent loss there is a decrease in muscle cell contraction times and when fluid losses equal 4 percent of body weight there is a 5-10 percent drop in overall performance which can last up to four hours. Lost with this fluid are electrolytes and essential minerals. Mineral replacement is essential to helping restore proper blood volume and blood sugar levels, and is necessary for enzymatic reactions that promote proper blood volume. Without them the quality of performance during long-term or explosive short-term exercise decreases.

Trying to get people to drink lots of water is not always easy. Most prefer juice or soda pop. Manufacturers have come to the rescue with many flavored and sweetened sports drinks, but are they all the same? These include unsweetened electrolyte replacement drinks, carbohydrate-electrolyte drinks, carbohydrate and protein drinks, and functional fluids (nutrients added such as vitamins or herbs). Many drinks include high-caloric sugars (glucose, fructose, maltodextrin, cereal starches) as carbohydrates. These are not recommended for dieters or diabetics and may not be beneficial in electrolyte drinks because the added sugar needs to be broken down by the digestive system thus delaying electrolyte absorption. Sports drinks that contain not only water, but also sodium and carbohydrates, do not quench thirst as quickly as water does.[5] When your body wants water, it wants it immediately, and carbohydrates may actually interfere with water absorption.

Research shows that even though the process of stomach emptying is slowed by sugar, the absorption rate in the small

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[4] Tilton, Buck, "Just Add Water; why powdered "sports" drinks belong in your pack." Backpacker, Feb. 1993, Vol. 21, No.1, p. 16.

[5] Fox, Martha Capwell, "Fluid mechanics." Rodale's Fitness Swimmer, July-August, 1999.

intestine increases when slightly sweetened drinks are consumed. Tests indicate that repeated ingestion of a drink containing carbohydrates in concentrations of not more than 4-8 percent during prolonged exercise does not compromise the rate of gastric emptying.[6] Higher levels of carbohydrates could impair gastric emptying and intestinal absorption of fluids needed by the athlete. Beverage osmolality [absorption] is less important than beverage energy content in influencing gastric emptying rate at these concentrations.[7] This information relates best to absorption of a carbohydrate drink rather than a pure electrolyte drink.

For fast electrolyte replacement it is best to take pure water from a good source (filtered tap water, bottled water, spring water) and add a proper ratio of absorbable electrolyte-forming minerals. Some schools of thought advise adding a small bit of carbohydrate sweetener to hasten absorption, while others think it hampers absorption.

Sports drinks that include sodium and potassium as electrolyte-forming minerals are primarily included to replace the "salts" removed from the body by sweat during heavy exercise. Sodium, in amounts between 500-700 milligrams per liter, is recommended for prolonged exercise because it may enhance palatability and the drive to drink, therefore increasing the amount of fluid consumed.[8] Most drinks do not contain this level of sodium. Therefore, replacement may be necessary for those who are vigorously working their muscles. For people who are dehydrated from a dry environment (such as airplanes or indoor winter climates), or who exercise mildly (kayakers, hikers), lower sodium levels and a drink with a more complete electrolyte complement is recommended.

Sodium in bicarbonate form may actually help to counteract the buildup of lactic acid in the blood during *heavy* exercise. Bene-

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[6] American College of Sports Medicine. "Position Stand: Heat and cold illnesses during distance running." Med. Sci. Sports Exerc. 18:I-x, 1996.

[7] Murray, Robert, William Bartoli, John Stofan, Mary Horn, and Dennis Eddy, "A comparison of the gastric emptying characteristics of selected sports drinks." International Journal of Sport Nutrition, Sept. 1999 p. 263(12).

[8] American College of Sports Medicine. "Position Stand: Heat and cold illnesses during distance running." Med. Sci. Sports Exerc. 18:I-x, 1996.

fits to athletes include improved anaerobic performance, especially during exercise regimens that are longer and more strenuous in duration.[9] Several studies reported runners using 0.3 gm/kg of sodium bicarbonate with water over a two to three hour period when competing in 400-800 meter events, thereby improving their times by several seconds.[10] As in all supplementation, use moderation. Smaller amounts of sodium bicarbonate may be beneficial, but loading up with large quantities requires exploiting a challenging energy need and, when taken in excess, may cause diarrhea. As in carbo-loading, it must be considered on an individual basis for specific energy needs.

A major part of the sports drink market is geared towards carbohydrate drinks. Carbohydrates are the considered the principal dietary source of energy. Muscle cells store limited amounts of adenosine triphosphate (ATP), a high-energy phosphogen, and depend upon metabolic pathways to provide sufficient ATP for muscle function during activity. Power events of short duration require the rapid hydrolysis of ATP for energy, which is significantly depleted within10-20 seconds of high-intensity activity, thereby limiting its use as a source for energy.[11] In exercise of longer duration, the source of carbohydrate extraction from the energy pool may shift from the ATP muscle glycogen pool to circulating blood glucose. If blood glucose cannot be maintained, performance will decrease.[12] Fat contributes to the energy pool, but the portion of energy from fat decreases as exercise intensifies.[13] Protein also contributes to the energy pool, but probably provides less than 5 percent

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[9] Berning, Jacqueline R., Nelson Steen, Suzanne, *Nutrition for sport and exercise,* Aspen Publishers, Inc. Gaithersburg, MD, 1998.

[10] Williams, M.H., "Bicarbonate loading," Sports Sci Exchange, 1992;4(36).

[11] Conley, K., "Cellular energetics during exercise," Adv Vet Sci Comp Med. 1994; 38A:1-39.

[12] Coyle, E.F., Coggan, A.R., Hemmert, M.K., Ivy, J.L., "Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate." J. Appl. Physiol. 61:165-172, 1986.

[13] Bergman, B.D., Butterfield, G.E., Wolfel, E.E., Casazza, G.A., Lopashuk, G.D., Brooks, G.A., "Evaluation of exercise and training on muscle lipid metabolism." Am.J. Physiol. 176:E106-E117, 1999.

of the energy expended although it may contribute to the maintenance of blood glucose.[14]

There is no absolute requirement for dietary carbohydrates, although the brain, red blood cells, and some cells in the kidneys use glucose as a preferred source of energy.[15] The need for carbohydrate ingestion before, during, and after exercise has been obtained from athletic performance studies.[16] Almost everyone agrees that carbohydrate feeding will improve performance in endurance events of moderate intensities over two hours.[17] In practice, athletes are instructed to drink 6-12 oz. of a carbohydrate drink immediately prior to beginning strenuous activity, and continue with additional "dosages" during the exercise (to reduce fatigue) and after (as muscle glucose replacement).[18]

Studies from sports teams show that the intake of carbohydrates is derived from both food and from sports drinks. According to the International Sports Science Association, pre-exercise, exercise, and post-exercise carbohydrate ingestion needs to include fluid and electrolyte requirements. The pre-exercise meal is ideally high in carbohydrates, low in protein, fat, and sugar, and eaten about three hours prior to exercise. This is important because it take this long for the stomach to empty and glucose to enter the bloodstream. Consuming sugar immediately before exercise can increase the risk of GI distress in the form of cramps, nausea, diarrhea, and bloating.

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[14] Phillips, S.M., Atkinson, S.A., Tarnopolsky, M.A.,MacDougall, J.D., "Gender differences in leucine kinetics and nitrogen balance in endurance athletes." J. Appl. Physiol. 75:2134-2141, 1993.

[15] Anderson, James W., M.D., J.P. Flatt, Ph.D, Peter, J. Reeds, Ph.D., "Carbohydrates," www.nutrition.org.

[16] Coyle, E.F., Hagberg, J.M., Hurley, B.F., Martin, W.H., Ehsani, A.A., Holloszy, J.O., "Carbohydrate feeding during prolonged strenuous exercise can delay fatigue." J.Appl Physiol. 1983;55:230-235.

[17] Andersen, Douglas, DC, DACBSP, CCN, DACBN, "Sports Nutrition Update – Abstracts from the American college of Sports Medicine 43rd Annual Meeting." Dynamic Chiropractic Online, 2001.

[18] Garrett, Dr. William Jr., Lohnes, John, Kirkendall, Dr. Don, Marchak, Patty, "Hydration. Fluids – Drink Types," Duke University Medical Center and Univ. North Carolina Hospital Sports Medicine Section.

During exercise if a sports beverage is taken and is too high in carbohydrate content (normally glucose or sugar), it will increase the time it takes the stomach to empty.[19] This prolongs the time for absorption.

Replacing the glycogen lost from muscles in the first two hours after exercise is the primary usage for carbohydrates during heavy exercise.[20] Glucose and sucrose are the carbohydrates of choice and considered twice as effective as fructose in restoring muscle glycogen. However, the role of adequate glycogen resources in preventing muscle cramps is speculative and still being debated.

• New information on carbohydrate replacement.

According to Dr. Zakir Ramazanov, Ph.D., who is one of the foremost biochemists and molecular biologists in the world, there is an alternative for long-term stamina. "Sports and fitness enthusiasts consider carbohydrates the best source of energy, when they actually are a relatively poor source. Glucose is considered a fast, easy source of energy. Fatty acids are the richest source of energy. The use of more energy-rich fatty acids for production is far better than relying on carbohydrates alone. Fatty acids are activated by L-carnitine before they enter into the cells, where these rich-in-energy compounds are metabolized. Liberated energy is eventually used in the product of ATP (the universal source of energy generated by the oxidation of carbohydrates, fat and proteins) and Creatine phosphate (a reservoir of high-energy phosphoryl groups that can eventually accumulate as ATP). In fact, fatty acids play a greater role in supporting the energy demands of the body during *long-term* exercise than glucose alone."[21] During times of high physical activity, energy and macronutrient needs must be met, and fat intake should be adequate to provide essential

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[19] Gastelu, Daniel,M.S., M.F.S., Hatfield, Frederick C., Ph.D. *Weight Control, Fitness, and Performance Nutrition: The Complete Guide*, ISSA, 2000.

[20] Applegate, Liz, "Liquid Assets," Runner's World, July 2000.

[21] Ramazanov, Dr. Zakir, Suarez, Dr. Maria del Mar Bernal, *Effective Natural Stress and Weight Management Using Rhodiola Rosea and Rhododendron Caucasicum,* Safe Goods, E. Canaan, CT, 1999.

fatty acids and fat-soluble vitamins for energy. When more fat is burned, less muscle glycogen is used. This "glycogen sparing" effect aids endurance because glycogen stores are limited, but fat stores are abundant.[22]

Our diets should provide moderate amounts of energy from fat (20-25 percent of energy).[23] Consuming adequate food and fluid before, during, and after exercise can help maintain blood glucose levels, maximize performance, and improve recovery time. Since most people's diets are fatty acid deficient, it would follow that their structure is more prone to muscle breakdown. Carbo-loading (eating lots of carbohydrates) before a sports event has been a common practice to "shore up" the muscles.

Maintaining a higher fatty-acid base will enforce the muscles without excessive carbo-loading. Dr. Ramazanov suggests supplementing your diet with an herb grown in the mountains of Russia, *Rhodiola rosea*. This herb has shown to raise the levels of fatty acids found in the blood, thereby significantly increasing muscle ATP and creatine phosphate levels. The results of tests on athletes show enhanced physical performance and increased endurance by accelerating recovery from fatigue when using Rhodiola. [24]

Beginning in the early 1930s research has been conducted on a classification of herbs known as adaptogens. These not only include Rhodiola, but Rhaponticum carthamoides, a natural anabolic steroid that has shown in athletic training situations, to burn fat into muscle up to twenty times faster. It is shown to improve nitrogen retention while increasing protein synthesis at the cellular level and is being used by athletes to improve their physical abilities. Because it contains the phyto-nutrient, ecdysterone, Rhaponti-

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[22] Berning, Jacqueline R., Nelson Steen, S., *Nutrition for sport and exercise,* Aspen Publishers, Gaithersburg, MD, 1998.

[23] "Position of Dietitians of Canada, the American Dietetic Association, the American College of Sports Medicine: Nutrition and Athletic Performance," Can J Diet Pract Res 1000, Winer; 61(4):176-192.

[24] Saratikov, A.S., Salnik,B.U., Revina, T.A., 1968, "Biochemical Characteristics of the Stimulative Action of Rodosine during prescribed Muscular Workloads. Proceedings of the Siberian Department of Academy of Sciences of the USSR," Biological Sciences, 5:108-115.

cum has shown to increase endurance and rebuild damaged muscles in addition to its ability to synthesize muscle tissue. Supplementing an electrolyte-replacement drink with Rhodiola and Rhaponticum may be a healthier alternative to sports drinks that contain dyes, sugar, or additives.

Another supplement to enhance ATP production is alpha-ketoglutarate, an intermediate of the citric acid cycle responsible for the basic energy component, ATP. Laboratory studies show in cell cultures that depletion of alpha-ketoglutarate results in loss of available cellular energy because of the decreased formation of ATP. Alpha-ketoglutarate is used as a supplement by some athletes to extend the time to energy depletion. Research is also underway on Glycerol, a 3-carbon nonintoxicating alcohol, a product of triacylglycerol (free fatty acids), which is used in the body's citric acid cycle of aerobic energy metabolism. Glycerol enhances hydration in muscles, thereby reducing fatigue and need for continued carbohydrate ingestion. In studies on athletes, it has shown to increase their total body water by nearly 2.5 percent which helped them adapt to heat during extended exercise.[25] It is the choice of the consumer to pick a product that works for them and tastes good. There is a place for carbohydrate sports drinks as a supplement to electrolyte replacement drinks, but they are not interchangeable. You may use carbohydrate drinks in addition to electrolyte replacement drinks, but at different times in relation to the intended sports activity.

[25] Robergs, R.A., et al. "Glycerol biochemistry, pharmacokinetics: clinical and practical applications." Sports Med, 1998, Sep; 26(3) 145-67.

Chapter 2: What are electrolytes?

Electrolyte is a "medical/scientific" term for mineral salts, specifically ions. Electrolytes are the spark that keeps our body running. They are necessary for life. They are important because they are what your cells (especially nerve, heart, muscle) use to maintain voltages across their cell membranes and to carry electrical impulses (nerve impulses, muscle contractions) across themselves and to other cells. [26]

These electro-chemicals influence the body's pH — a chemical balance that determines how effectively the biological systems run. When there is a deficiency of body electricity, body functions slow down and eventually stop. Micronutrients play an important role in energy production, hemoglobin synthesis, maintenance of bone health, adequate immune function, and the protection of body tissues from oxidative damage. They are also required to help build and repair muscle tissue following exercise.

Electrolytes are formed when certain minerals come together in solution and create electrical activity providing energy for the body. When the electrolytes are dissolved, they break apart into charged particles called ions. The ions carry either a negative or positive charge. These charged particles create the electricity. If the minerals are missing, your spark will fizzle.

Electrolytes facilitate delivery of oxygen to achieve and maintain peak brain function and proper nervous system response. The constant firing of micro-electric impulses across the synapses of the brain requires a great deal of energy. Only electrolytes can supply this. If, because of electrolyte imbalance, there isn't enough oxygen available for the nerve cells to fire when needed, the brain functions less effectively. The body uses oxygen to turn nutrients into energy through the process of primary oxygenation. This simply means that electrolytes help the oxygen create a chemical reaction that ultimately allows the body to "burn" the nutrients as fuel.

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[26] University of Waterloo, Canada website:
http://sciborg.uwaterloo.ca/~cchieh/cact/c120/electrolyte.html.

In a nutshell, bio-oxidation liberates energy — which facilitates life.

The direction of health care in the future will depend on finding solutions for the ever-growing mineral deficiencies in our food and water. For those of us who take the bull by the horns, we refuse to wait! Products are available now that effectively give back to the body what is missing. Electrolyte supplementation can effectively recharge your battery and may just be an absolute necessity for future generations.

• Fish use electrolytes as propellants.

Gillian Martlew, N.D., author of *Electrolytes The Spark of Life*[27] relates a story where a man watches a fish swim in circles in a particular pool at the base of a waterfall. Round and round he swam until he finally bounded *up* the waterfall. What that fish did was create an electric charge in his body taken from the swirling waters at the base of the tumbling waterfall. With this charge he was able to challenge gravity and swim up the tumbling waters. This story lets us know how important the vortex of energy in water can be. Our ancestors used to become invigorated by drinking from rushing mountain brooks. Today most water is filtered or mineral deficient reducing its electrolyte content. In most cases, especially when exercising, we must add an electrolyte drink or supplement to our diet to recharge our *spark*!

[27] Martlew, Gillian, N.D., *Electrolytes The Spark of Life*, 1998 revised & updated, Nature's Publishing, Murdock FL.

Chapter 3: Electrolyte/mineral supplementation.

When the human body is electrolyte deficient, vital nutrients are not oxidized effectively enough. This compromises the body's ability to get the fuel it needs to run at peak performance and to fight disease. Sports enthusiasts know the value of electrolyte replacement after exercise. For example, if you sweat away 2 percent of your body weight during exercise, you reduce your electrolyte balance, and can put your heart under stress. Electrolytes must therefore be replaced. Rehydration with electrolyte sports drinks is standard procedure for athletes looking for muscle integrity after a workout. They know that dehydration severely limits performance and may contribute to heat stroke, organ damage, and possible death, if the fluids are not replaced. Electrolytes are the life-giving force lost in the dehydration process that account for the risk factor. It is essential to choose a sports drink or a supplement that provides you the basic elements — minerals that form electrolytes.

The Hunzas' of Pakistan, and the Vilcabambas tribe of Ecuador, live extraordinarily long, healthy lives. This is attributed to the fact that their home is in a mountainous area and their drinking sources contain highly mineralized and electrically charged water. The moose that appeared in the opening credits of the popular television show, Northern Exposure, died before his time. They attributed his death to a mineral deficiency because he was fed "civilized" food and given mineral deficient water. Mineral depleted soils are yielding mineral depleted food.[28]

Approximately four percent of the human body mass is composed of 21 macro and trace minerals that are essential for life. When mineral levels are insufficient to meet the demands of the body under emotional, physiological, and psychological stresses such as during physical activity, the result will most likely be a substandard level of performance. For athletes or weekend exercisers, this increases the risk of serious injury and reduces the recovery rate after strenuous work or exercise. Most of us are not

[28] *Variations in Mineral Content of Vegetables,* Acres, USA, March 1977.

ingesting sufficient amounts of minerals because our food and water is mineral deficient. To compound problems, athletes often induce low body weights by maintaining restrictive diets which do not contain the variety of foods needed for ingesting a wide range of minerals. Certain foods or drinks can actually create mineral deficiency. For example, drinks (carbonated) containing high levels of phosphorus cause the phosphorus to bind with calcium and move it out of the body. Calcium loss also increases following the consumption of white sugar, salt, or caffeine. Therefore, carbonated drinks used for rehydration, containing these ingredients, should be avoided.

• ***Is more better?***

Sports drinks and supplement manufacturers who claim their electrolyte-forming trace minerals facilitate proper rehydration may be only partially correct. Trace minerals work in combination to provide the proper environment for electrolyte formation and maximum absorption. According Dr. Gerald Olarsch, N.D., too *few* trace-minerals in a drink are unable to form the proper electrolyte balance to enter the cell and maximize rehydration. Only certain minerals will form electrolytes. For example, iron won't form electrolytes, but drinking electrolytes creates an electromagnetic energy in the body that will pull iron out from food and out of the blood into the cells.[29]

• ***Key minerals for supplementation:***

•**Boron**. Essential for plants, boron is a catalytic trace element that is suspected to play a role in the prevention and treatment of osteoporosis as it aids in the retention of calcium and magnesium in the bones. Studies indicate that boron improves the production of antibodies that help fight infection and markedly decreases peak secretion of insulin from the pancreas. The way in which boron acts in

[29] Yarrow, David, *Fire in the Water*, Nature's Publishing, Ltd., 1999.

the body is not known, but a deficiency has proven to cause abnormal bone formation.

•**Calcium**. This is the most common mineral in the body. Adequate intakes of this mineral are an important determinant of bone health and risk of fracture. Calcium also carries an electric charge during an action potential across membranes and acts as an intracellular regulator and as a cofactor of enzymes and regulatory proteins.[30] Dietary recommendations set by the 1997 National Academy of Science Panel on Calcium and Related Nutrients are 1300 mg/day for children 9-18 years of age, 100 mg/day for those 19-50, and 1200 mg/day for those over 51. The most recent research shows that a proper balance of 1:1 should be maintained with magnesium for homeostasis in the body.[31] The form of calcium supplementation should be specified. For example, calcium carbonate is common blackboard chalk and cannot be adequately absorbed by the body. A better choice would be calcium citrate or calcium aspartate.[32]

•**Chloride**. As a natural salt of the mineral chlorine, chloride works with sodium and potassium to help in maintaining proper pH balance, healthy nerve and muscle function. It also contributes to digestion and waste elimination. Chloride should not be confused with the chemical chlorine used in water treatment. This chemical, when combined with waste in the digestive tract converts to trihalomethanes, a potential carcinogen. A diet of unprocessed foods provides more than enough dietary chloride.

•**Chromium**. Chromium is an essential nutrient required for normal sugar and fat metabolism. As an aid to glucose metabolism, chromium is essential to the regulation of blood sugar and fat metabolism. It protects against cardiovascular disease, diabetes, high cholesterol, and helps decrease body weight. Supplementation is

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[30] Matkovic, Viliir, M.D., Ph.D., Connie Weaver, Ph.D., "Calcium," American Society for Nutritional Sciences, www.nutrition.org.

[31] Peiper, Howard, *Naturopathic Secrets for Building Better Bones*, Nature's Publishing Group, 2001.

[32] Martlew, Gillian, N.D., *Electrolytes The Spark of Life*, 1998 revised & updated, Nature's Publishing, Murdock FL.

essential if you eat white flour, milk and sugar as those foods steal chromium from the body and excrete it unused.

•**Cobalt**. As the key mineral in the vitamin B_{12} molecule, it is essential for proper nerve function and red blood cell formation.

•**Copper**. Copper is influential upon human health because it is a part of the body's enzymes, proteins that help biochemical reactions occur in all cells. Copper is required for the absorption and utilization of iron and the regeneration of blood. Copper and zinc together are crucial to the formation of collagen, connective tissues, and the protein fibers found in bone, cartilage, ligaments, dental tissues, and skin. Deficiency symptoms are similar to iron deficiency anemia, cardiac abnormalities, and elevated levels of serum cholesterol. Evidence exists that copper helps ease rheumatoid arthritis and other inflammatory diseases. Copper is utilized by most cells through enzymes involved in energy production, strengthening of connective tissue, and in brain neurotransmitters.

•**Germanium**. As a metallic trace mineral it is know to improve cellular oxygenation. It also fights pain, assists in immune system operation, acts as an antioxidant, and improves stamina and endurance. Germanium acts as a carrier of oxygen to the cells.

•**Iodine**. This is a nonmetallic element that is converted to iodide in the gut and absorbed through the digestive tract. The thyroid gland needs this mineral to support metabolism, nerve and muscle function, physical and mental development. Deficiencies can lead to reduced brain function, growth stunting, apathy, impaired movement, speech, or hearing. Since soybeans, peanuts, cabbage, and turnips can block utilization of iodine, supplementation may be necessary in people who eat these foods.

•**Magnesium**. Not only does magnesium facilitate 300 fundamental enzymatic reactions, it also functions in the activation of amino acids and plays a key role in nerve transmissions and immune system operation. Numerous ATP-dependent reactions use magnesium as a cofactor.[33] This essential mineral enjoys a reciprocal relationship with calcium. In our muscles, calcium stimulates muscle

[33] Berning, Jacqueline R., Nelson Steen, S., *Nutrition for sport and exercise,* Aspen Publishers, Gaithersburg, MD, 1998.

fibers to tense up and contract whereas magnesium encourages the muscle fibers to loosen up and relax. Stored in the bones (60%) and muscles (40%), magnesium is called upon during exercise. Since bones do not release magnesium easily, the muscles are the target. The result may be cramps, irritability, or twitching. Supplemental calcium and magnesium in a 1:1 ratio are important to guard against this attack on our muscles.[34]

•**Manganese**. An essential element concentrated primarily in the bone, liver, pancreas, and brain. Manganese factors into cholesterol metabolism, normal skeletal growth and development. Manganese is responsible for transmitting nerve impulses to the muscles and for metabolism and RDA and DNA production. It is an important cofactor in the key enzymes of glucose metabolism. Lack of manganese has also been implicated in aggravating bone loss and porosity.

•**Molybdenum**. This is a component of a number of enzymes, including sulfite oxidase (deficiencies can cause metabolic disorders resulting in death at early age). It is required for nitrogen metabolism. It is essential in working with vitamin B_2 in the conversion of food to energy and is necessary for iron utilization. The Estimated Safe and Adequate Dietary Intakes of molybdenum in micrograms for adults are 75-250. Molybdenum deficiency is very rare, but is linked to an increased allergic reaction to sulfite food additives (such as additives to wine).

•**Potassium**. Potassium performs countless vital functions in the body supporting the nervous system, aiding in digestion, and providing the electrolyte charge to the cells. Most of the total body potassium is found in muscle tissue. Because of its link with the metabolizing, oxygen-consuming part of the body, a decline in total body potassium is usually interpreted as a loss of muscle mass. This is not necessarily the case, but muscle mass loss is the result of a catabolic protein wasting condition which reduces the total cell

[34] Peiper, Howard, *Naturopathic Secrets for Building Better Bones*, Nature's Publishing Group, 2001.

mass of the body.[35] Excess stress during exercise without proper nutrient components can facilitate this wasting condition. Low potassium in certain cases can lead to death.

•**Phosphorus**. As a key component of DNA, RNA, bones, and teeth, phosphorus plays an important role in energy metabolism of the cells affecting carbohydrates, fatty acids, and proteins. It is essential for bone formation and maintenance and stimulates muscle contraction. Deficiencies can appear as a general weakness, loss of appetite, bone pain, and susceptibility to fractures. Excesses in the bloodstream may promote calcium loss.

•**Selenium**. Shown to have a role in the detoxification of heavy metals, such as mercury, selenium plays a role in the production of antibodies in the immune system and may help prevent cancer and other degenerative diseases. Selenium protects cell membranes, cell nuclei and chromosomes from environmental damage. Preliminary studies suggest that it may have an anticancer effect on humans. Toxic levels of selenium can cause hair loss, nail problems, accelerated tooth decay and swelling of the fingers.

•**Silicon**. Shown to be necessary for normal growth and bone formation in animals, silicon has not been shown to be an essential element in human health. Growing evidence suggests it may have anti-aging properties because deficiencies of silicon apparently play a role in tissue degeneration.

•**Sodium**. Sodium acts together with potassium to maintain proper body water distribution and blood pressure, therefore being a primary ingredient necessary for rehydration. It is also important in maintaining the proper pH balance and to facilitate the transmission of nerve impulses. People with pronounced losses of sodium through heavy perspiration or diarrhea may experience decreased blood volume and a fall in blood pressure that could result in shock. Excessive amounts of sodium can lead to cardiac failure and liver disease. The Estimated Minimum Requirement of Health Persons from the National Academy of Sciences for adults is 500 milligrams per day.

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[35] Kehayias, Joseph J., Ph.D., Pierson, Richard N. Jr., M.D., American Society for Nutritional Sciences, 2001, www.nutrition.org.

•**Zinc**. No one can hope to be healthy without zinc. It is vital to the function of 90 enzymes that regulate dozens of bodily processes. It supports the immune system and fights infection, assists in chelating heavy metals from the body, improves vision, sexual potency and enhances the senses. Zinc also aids in cell respiration, bone development and growth, wound healing, and the regulation of heart rate and blood pressure. Together with copper is crucial to the formation of connective tissues and the protein fibers found in bone, cartilage, ligaments, dental tissues and skin. The average American diet is low in zinc; therefore zinc rich foods should be included in our menus.

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Chapter 4: Sports drinks: A comparison.

The sports drink market includes a flurry of bottled drinks, mixes, and electrolyte supplements. The marketing goals appear to be focused on rehydration and increased sports performance. While most companies producing the products seem to embrace the value of electrolytes, they may not have delivered the proper complement of ingredients for maximum electrolyte formation and absorption. Certain preservatives, artificial flavors and colored dyes, aspartame and sugar may add to the visual or taste appeal of the drink, but may not be user-friendly to the body.

In addition to its usefulness after exercise to replenish glycogen stores, sugar (fructose, dextrose, glucose, high fructose corn syrup, maltodextrin) is usually added as a carbohydrate to boost energy levels. While this may stimulate the body momentarily, minutes later the glycemic roller coaster sets in with associated compromise in body function. Muscle-testing (Kinesiology), used by chiropractors and natural medicine practitioners, reveals that sugar actually diffuses the body's ability to maintain muscle strength; therefore, it does not seem wise to use it when periods of strength are required. Sugar also creates cravings that generate a desire for more sweet drinks. In high quantities it also has been linked to diabetes. As blood glucose levels increase, people with diabetes are more at risk for heart disease.[36] Besides sugared drinks, there are other ways to get carbohydrates, such as energy bars, and complex carbohydrates found in apples, grapes, or peanuts. Furthermore, studies show that it may be the complex carbohydrates that support strength and endurance, rather than simple carbohydrates.[37]

For any sports workout we recommend pure electrolyte drinks with the proper complement of minerals. If you need a boost for short term energy or glycogen replacement, you may want to

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[36] "Univ. Cambridge, U.K. study," British Med Jnl,vol. 322;15-18, Jan. 26, 2001.

[37] Martlew, Gillian, N.D., "*Electrolytes, The Spark of Life"*, 1998 revised & updated, Nature's Publishing, Murdock FL. $12.95 To order (800)-950-1929.

choose a drink containing less than 8 percent carbohydrates or take an ATP booster like rhodiola. As a general rule, the higher the carbohydrate content, the slower the absorption rate of electrolytes and nutrients.