Derleme/Review

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BESİNSEL ERGONEJİK DESTEKLER

NUTRITIONAL ERGOGENIC SUPPLEMENTSTHE RELATIONSHIP

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Özet

Günümüzde farklı spor dallarında rekabet arttıkça ergojenik desteklere olan ilgide artmaktadır. Birçok sporcu besinsel destekleri performansı arttırmanın yanında vücut yağ yüzdesini azaltabilmek için kullanmaktadır. Ama ergojenik desteklerin yanlış kullanımı vücuda zarar vererek spor performansının azalmasına neden olabilmektedir. Bu derleme makalede farklı türde bulunan besinsel ergojenik destekleri ve kullanım dozlarını içermektedir. Makale kreatin, glutamin, l- karnitin, koenzim Q10, hidroksi metil butirat, Kafein, Krom Pikolinat, Gliserol, arjinin, nitrik oksit, ginseng, dalı zincirli amino asit, protein tozu, sporcu içecekleri, vitamin ve mineral başlıklarını içermektedir.

Anahtar Kelimeler: Ergojenik destek, Supleman, Kreatin, Protein tozu, L-karnitin

Abstract

Nowadays, as competition in different sports branches increases, interest in ergogenic supports increases. Many athletes use nutritional supplements to reduce the percentage of body fat as well as to increase performance. However, improper use of ergogenic supplements can damage the body and cause a decrease in sports performance. This review article includes different types of nutritional ergogenic supplements and their usage doses. The article includes the titles of creatine, glutamine, l-carnitine, coenzyme Q10, hydroxy methyl butyrate, Caffeine, Chromium Picolinate, Glycerol, arginine, nitric oxide, ginseng, branched chain amino acid, protein powder, sports drinks, vitamins and minerals.

Keywords: Ergogenic support, Supplement, Creatine, Protein powder, L-carnitine

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INTRODUCTION

Athlete performance limits are constantly being challenged to be "stronger, faster and more competitive" in competitions (1). As a result of these strains, interest in ergogenic aids has increased significantly (2). The use of matters, methods and materials other than natural ability and training to increase sporting performance is called ergogenic assistance (3). Ergogenic supports, consisting of the words "ergon", which means business in Greek, and "genon", which means to produce, are grouped under five main headings: physiological, psychological, mechanical and biomechanical, pharmacological and nutritional (4). Nutritional ergogenic supplements can be defined as food sources that have a nutritional or physiological effect beyond those supported by a normal diet (5). The first known ergogenic helper was the mushroom meal for athletes to run fast in the 3rd century BC. In the chariot race, the Romans fed the horses with hydromel made from a mixture of water and honey (6). It is known that the locals in South America chew cocoa sprouts (7). Today, it has become a product that has a volume of 20 million dollars and is started to be used by every age group (8). This review article provides information about the different types of nutritional ergogenic supplements like creatine, glutamine, l-carnitine, coenzyme Q10, hydroxy methyl butyrate, caffeine, chromium picolinate, glycerol, arginine, nitric oxide, ginseng, branched chain amino acids, protein powders, sports drinks, vitamins and minerals.

Creatine

Creatine was discovered in 1832 by the french scientist Cheureul. At the beginning of the 19th century, many studies on creatine were carried out on humans and animals, and it was concluded that dietary creatine is not excreted in urine (9). Creatine, which is found as a storage in skeletal muscle and liver in mammals, is supplied by meat and meat products in diets. Creatine is synthesized in kidney, liver and pancreas from amino acids such as glycine, methionine and arginine. An average person has 120 grams of creatine storage, 95% of this creatine is stored in skeletal muscle. The average amount of creatine needed per day is 2 grams, but the amount of creatine used in cases of exercise need increases proportionally (10-18).

Organisms need energy to carry out their vital activities. This energy is met from ATP. ATP needs to be renewed rapidly in order for the activity to be carried out regularly and continuously. Energy production in the body is produced in two ways, aerobic and anaerobic. The energy system consists of ATP and

Phosphocreatine (PCr) stores. Athletes have enough ATP storage for short-term energy needs in the first 4 seconds or for a run of 50 meters. ATP used between 4-10 seconds is regenerated with PCr (Figure 1). When ATP is used, it turns into ADP and for the energy to be continuous, ADP must be converted to ATP. This cycle is carried out using phosphocreatine in the muscles in the fastest way. There is an average of 15-17 mmol PCr in 1 kg of muscle mass. When the energy needed during intense training exceeds the power of the aerobic system, the muscle needs energy production from the anaerobic system. Since PCr plays an active role in the anaerobic system, the amount of creatine in the muscles is important (13,19).

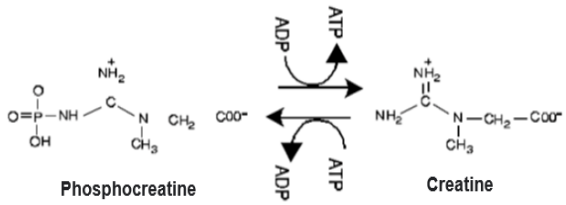

Figure 1: ATP - ADP cycle

Creatine loading is called the regular intake of creatine taken 2 weeks before the competition. It varies according to the type of sport loaded and training intensity. The most preferred method is to take 20 g / day creatine supplement for 5-6 days before training. With the use of this method, an average of 10-30% increase in the amount of storage creatine can be achieved (20).

Glutamine

L-glutamine is a member of the group of non-essential neutral amino acids. Glutamine, which 75% of which is stored in muscle tissue and the rest in other organs such as the liver, constitutes 50% of the free amino acids in the body, provides nitrogen transport between tissues, regulates acid-base balance and plays a role in many activities such as gluconeogenesis. Under normal conditions, glutamine is accepted as a non-essential amino acid in the body, but because the amount needed increases in the catabolic process, it becomes essential. Glutathione, a by-product of glutamine metabolism, protects tissue against oxidative stress (21,22). In studies, high nasal and intestinal IgA levels protect against hyperammonemia, lymphocyte apoptosis, data showing exercise-induced increase in IL-6 level and inhibition of cytokinin production (NF-KB pathway) show the effect of glutamine supplementation on immune mechanism. It has a negative effect on the blood glutamine level as the body enters the catabolic process during competitions and training. Glutamine stores are used to bring the blood glutamine level to the normal limit. If the storage glutamines cannot be regenerated, loading syndrome and fatigue develop. There is a decrease in plasma glutamine levels of athletes who participate in intense and long-term exercises such as marathon

and 30 km races. If the athlete takes glutamine supplements during intense training periods, longer-term preservation of glutamine stores is ensured and the incidence of symptoms may decrease (23,24).

Glutamine loading is called regular glutamine intake during the day. The loading process is applied in the form of 500-1000 mg of free amino acids twice a day or before exercise (20).

L-carnitine

L-carnitine was discovered in 1905 by Russian scientists Gulewitcsh and Krimberg. Studies on L-carnitine deficiency were first conducted in 1973, and supplements began to be sold commercially in 1980. Carnitine plays an important role in energy production and fat metabolism in the body. Carnitine plays an active role in the transport of fatty acids to the mitochondria. Acylcarnitine (fatty acid + L-carnitine), which is in mitochondria and is involved in energy production, is obtained from acyl-CoA (fatty acid + CoA) by means of carnitine-palmitoyl transferase I (CPT I) enzyme in mitochondria. The protein carrier carnitine, acylcarnitine translocase (CT) carries acylcarnitine to the inner membrane. Carnitine-palmitoyl transferase II (CPT II) is located in the inner mitochondrial membrane and is involved in the formation of acyl-CoA. Acyl-CoA can be metabolized through a process called beta-oxidation. Finally, propionyl CoA and acetyl CoA are obtained (Figure 2).

One of the other important properties of L-carnitine is that it has an antioxidant effect. Carnitine helps ATP production by carrying free fatty acids to the mitochondria. In sports, carnitine theoretically increases the use of fatty acids during exercise and ensures that glycogen stores are protected for a longer period and are spent more regularly. As a result, it will be possible to postpone the feeling of fatigue in the athlete. It has been shown that carnitine supplementation can be effective in endurance sports. Carnitine supplements are administered by two methods, oral and syringe method. Intravenous carnitine is dangerous and should be done under the supervision of a doctor (9,25,26).

L-carnitine loading is a method of increasing the plasma carnitine level before the competition. Oral loading of 2-6 grams for 2-3 days is accepted as the standard method. More than 3 grams of carnitine affects the plasma carnitine level within 40-50 minutes. Intravenous application is applied as 20, 40, 60 mg / kg (26).

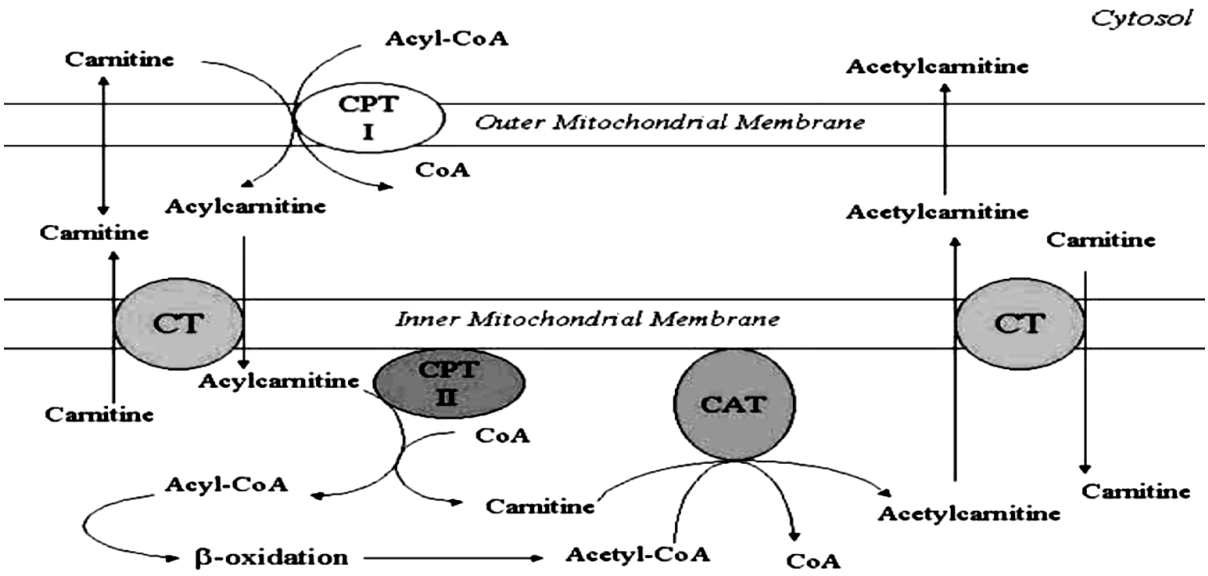

Figure 2:Ttransport of fatty acids to mitochondria

Coenzyme Q10

Coenzyme Q10, which is a fat-soluble vitamin-like compound, which is generally found in every cell, has a key role in energy production in the cell and acts as a coenzyme in enzymatic reactions. Endogenous coenzyme, one of the two varieties of coenzyme Q10, is mostly found in cardiac muscle (110 µg / g tissue), liver (60 µg / g tissue) and kidney (70 µg / g tissue), with the lowest concentration 8 µg / g, are in the lung tissues (27). Coenzyme Q10 acts as an electron carrier in the respiratory mechanism in mitochondria. Coenzyme Q10 takes part in oxidation-reduction reactions in the electron transfer chain. It transforms into hydroxyquinone by adding electrons and protons (2H ++ 2e-) to the quinone ring. In addition, ATP is formed at the end of the three-step oxidation-reduction reaction. Another important feature of coenzyme Q10 in the body is that it functions as an antioxidant. Coenzyme Q10 is the most important type of antioxidant that dissolves in fat along with vitamin E in the body. Coenzyme Q10 with or without vitamin E protects the cell against free radicals by binding to the cell membrane. Coenzyme Q10 is used for treatment in cardiac patients as it increases oxygen use and exercise performance. In sports, it has been observed that submaximal and maximal exercise increase capacity (27-30)

The usage dose is applied as 1 mg for a period of three days (20).

Hydroxy methyl butyrate

Hydroxy methyl butyrate (HBM) is an active metabolite of leucine, which is in the group of essential amino acids. The effect

of HMB is on the muscle, immune system and mammary glands. HMB is synthesized in low amounts in animals. Its value in blood plasma is 1-4 mmol / L. When leucine supplementation is applied, this amount increases 5-10 times. Endogenous (protein degradation-sourced) and exogenous (diet-sourced) leucine transforms into HMB by oxidation of α-ketoisoxproate. In this oxidation process, only 5% of leucine is transformed into HMB. It is necessary to use 60 leucine in order to produce the effective dose of 3 grams of HMB. Studies have shown that HMB increases protein synthesis and reduces protein breakdown on cachectic mice. In addition, HMB increases the use of substrate for de novo cholesterol synthesis in skeletal muscle. In the muscle cell, cholesterol is important for membrane endurance and stability. The majority of HMB takes place in the structure of HMG-CoA and increases cholesterol synthesis. As a result, the strength of the muscle cell increases and its destruction decreases. It is important in sports nutrition because of these effects (24,31).

Intake of 2-3 grams per day or 38 mg / day per kilogram is recommended. Studies have shown that 3 g daily HBM supplement provides benefit (20).

Caffeine

Caffeine, which is called trimethylxanthin in the literature, is one of the most consumed active pharmacological substances in the world. Caffeine is found in 63 plant varieties in nature and the most common form of consumption is coffee. The amount of caffeine contained in plants varies (Table 1).

Caffeine helps focus and delay sleep time by stimulating the central nervous system (CNS). It is thought that metabolites such as theophylline, theobramine, and parazantine found in caffeine help vasodilation, increase urine output, trigger fat burning, and increase long-term aerobic endurance performance by delaying the discharge of glycogen stores (32). It is thought to be effective in activities and sports that involve sustained high-intensity activity lasting 1 to 60 minutes(33). It has been observed that when 5 mg / kg of caffeine supplementation per day is given to experimental animals, it causes weight loss (32,34). In addition, caffeine stimulates the sympathetic nervous system by triggering the release of serotonin in the cerebral cortex in the Central Nervous System, and decreases the activation of inhibitory neurons with adenosine receptor antagonism, eliminating the negative effects of adenosine on neurotransmission, mental vitality and pain perception. Finally, caffeine increases intracellular calcium metabolism and sodium-potassium pump activation in skeletal muscle (35). If the dosage of caffeine is not taken into consideration, it may cause side effects such as anxiety, tension, high heart rate,

gastrointestinal discomfort and insomnia (36).

Caffeine at the rate of 6-13 mg / kg (420-910 mg / 70 kg) should be consumed 0.5-1 hour before starting exercise. High doses of caffeine occur regularly with 5-6 cups of coffee. The positive benefits of the dose taken at this level are seen and can be tolerated by the body. In order to maximize the caffeine level, regular intake is required for a few weeks. The International Olympic Committee (IOC) restricted caffeine and was considered doping by exceeding the legal limit of 7 mg / kg, which is a high dose of loading, but since January 2004, caffeine has been removed from the doping list (20,37).

Chromium picolinate

Chromium exists in nature in 2 different forms, 3-valence and 6-valence. Chromium picolinate exists under the 3-valence group roof. The 6 valence form of chromium is toxic to the human body and its use is not recommended. It contains 88% picolonoic acid and 12% chromium in chromium picolinate structure. Chromium picolinate is better absorbed in the body than other derivatives. Absorption of chromium in the intestine in the diet is trace amount and varies between 0.5-2%. Supplements can be used by athletes to increase the bioavailability of chromium picolinate. Although the exact structure of the biologically active form of chromium is not known, it is thought that it affects glucose metabolism by increasing the effect of insulin and accelerates the metabolism of fat, carbohydrate and protein. With chromium supplementation, an increase in insulin anabolic activity occurs and accordingly, amino acids are transported into the muscle, and it supports the increase of protein synthesis in the muscle. Increased insulin activity prevents food intake by suppressing the hunger center located in the hypothalamus. As a result, it helps to use the storage fats in the body (38,39).

Recommended usage amount is 50-200 mcg / day. In case of excessive use, it may cause side effects (20).

Glycerol

Hyperthermia and dehydration can occur during endurance exercises when the weather is hot. It has been observed that more than 2% fluid loss in the body may cause thermal stress, increase in heart rate, discharge in glycogen stores, increase in body internal temperature, increase in sweating rate, metabolic and nervous system damage. Accordingly, it has been observed that endurance athletes may have performance losses. The water thrown by perspiration is 30 g / min on average. With sweating, electrolytes such as sodium (Na^+), potassium (K^+) and chlorine (Cl^-), which play an important role in muscle contraction, are excreted together with water. As a result of water loss, it causes an

increase in plasma osmolality, a decrease in blood volume, and a decrease in blood flow to the muscles. Consequently, it becomes difficult to maintain cardiac output in endurance exercises (40). Glycerol is a hydroscopic substance and absorbs water in the air and shows water retaining properties. It has been observed that glycerol increases the total amount of water in the body by 250-666 ml since it is bound to water with its hydrogen bond and is distributed between the fluid spaces in proportion with the osmotic action. Also, glycerol administration has positive effects on increasing plasma osmolarity and decreasing urine volume. In addition to these, glycerol has been shown to be effective in reducing heart rate. Glycerol is accepted as a nutritional ergogenic support product because of such effects (41).

The recommended dose of glycerol should be calculated as 1-1.5 g / 25 ml water / kg lean body weight (20).

Arginine

Arginine is in the group of non-essential amino acids that can be produced in the body. It has been observed that orally taken arginine increases the release of insulin and growth hormone, thereby increasing muscle mass and decreasing fat mass. Because of these effects, arginine has become important in strength sports (42). Arginine is used as a supplement in risky surgeries due to its effects on immune functions and inflammation in the medical sector (43). Arginine has 3 important functions in sports nutrition. It affects the growth hormone. One of the important reasons why arginine is popular among athletes is its positive effect on growth hormone. In the study conducted by Bucci in 1996, it is stated that arginine has a stimulating effect for growth hormone release. It affects protein synthesis. Orally taken arginine can improve exercise performance by positively affecting protein synthesis. Arginine acts as a vasodilator and acts as a substrate during the synthesis of nitric oxide (NO), which is used in heart failure, cancer and coronary artery disease. NO synthesis is provided from arginine by a method similar to P450. Again, as arginine contributes to NO production, it can indirectly increase oxygen capacity (42,44).

Arginine loading is used as 500 mg before meals and training (20).

Nitric oxide

Nitric oxide(NO) is produced by the oxidation of L-arginine amino acid guanido nitrogen by the enzyme nitric oxide synthase (NOS) in smooth muscle, endothelial cell and many other mammalian cells. For this synthesis, adenine dinucleotidephosphate (NADPH), calmodulin, oxygen and fluvine, mononucleotide, fluvine dinucleotide, tetrahydrobiopterin cofactor are needed (45). NO plays an important role in the

dilation of vessels. NO, which acts as a vasodilator, ensures that more blood reaches other organs from the heart. It has a blood pressure lowering effect in regular aerobic training and moderate hypertension. As a result of the inhibition of NO synthesis, high blood pressure was observed in rabbits (45,46). NO has an important role in limiting platelet activation, endothelial leukocyte adhesion and regulation of myocardial contractility. Accordingly, diseases such as diabetes, hypertension and cardiovascular can be seen in NO deficiency (45). NO prevents the free radicals in the body from reacting with other radicals and causing tissue damage. In addition, one of the most important reasons for including NO in the ergogenic support class is the thought that it has a positive effect on oxygen capacity. There is a high concentration of NO in nasal posage and pharynx. During respiration with NO, there are breathing losses. The amount of loss increases with the intensity of exercise. NO has become the preferred product by athletes in order to both supplement the losses and increase the oxygen capacity (45,47,48).

Ginseng

Ginseng has been used in traditional-alternative medicine for over 1700 years to strengthen the body immune system and against fatigue. Ginseng protects against cardiovascular diseases as it keeps the heart rate in balance by slowing down the time spent on effort and is among the supplements preferred among athletes due to this effect (49,50).

Branched chain amino acids

The branched chain amino acids valine, leucine and isoleucine cannot be synthesized in the body and must therefore be taken from outside. (51). While many amino acids are broken down in the liver, branched-chain amino acids(BCAA) can pass through the bloodstream directly from the liver without being metabolized. BCAA, which enters the bloodstream, is oxidized in muscle tissue and some adipose (fat) tissues. The most oxidation in the body is done in muscle tissues. BCAA is cleaved by the mitechondrial dehydrogenase enzyme and binds to keto acid dehydrogenase (BCKADH). Keto acid is used as fuel in krebs' circle to produce ATP in muscle cells. During the competition, catholic situations and urgent energy need arise in the muscles. Allene in BCAA is converted into glucose by gluconeogenesis and energy needs are met (52). Free tryptophan is the precursor of the serotonin neurotransmitter that causes sleepiness and fatigue in the brain. It is claimed that the branched chain amino acid prevents the rapid entry of free tryptophan into the brain, thus preventing central fatigue. With exercise, the amount of BCAA decreases in the body, resulting in a feeling of tiredness.

Feeling tired can be delayed with external BCAA support (37,52).

By loading 3.6-5.6 grams 2 times a day, it has a positive effect on muscle mass increase and muscle regeneration (52).

Protein powders

Protein supplements and protein-containing meals became popular in the early 90's and still maintain this popularity today. Typically, these products contain whey, casein or soy (23). Athletes in branches that provide a balanced use of aerobic and anaerobic energy systems consume more protein supplements (53).

Whey protein, one of the two types of protein found in milk, is a complete protein containing 8 essential amino acids and is reported to be superior to other proteins when compared over 4 criteria measuring protein quality (54).

Casein constitutes approximately 75-80% of the total milk protein (55). Unlike whey, casein solidifies in the stomach and thus passes through the stomach more slowly. For this reason, casein is called "slow protein" (54).

Soy is the most widely used vegetable protein source and it is reported to have an equivalent quality to other animal protein (56). Soy protein is used as an alternative for those with lactose intolerance. Soy is a complete protein containing high concentrations of BCAA, arginine, as well as glutamine, methionine (57).

Sports drinks

Fluids that contain water, carbohydrates, sodium, chlorine and potassium that help to replace the electrolyte lost through perspiration are called sports drinks (Table 2). Sports drinks are divided into three groups. First of all, hypotonic drinks contain less than 4% carbohydrates and fluids and electrolytes. It is suitable for athletes such as jokers and gymnasts who do not need carbohydrates and only need fluids. The second type is isotonic. Isotonic drinks contain 6-8% carbohydrates, fluids and electrolytes. These types of sports drinks are a good choice for many athletes. They are particularly suitable for medium and long distance running and team sports. Finally, they are hypertonic types. Hypertonic drinks contain more than 8% carbohydrates. It should be used after ultra-endurance exercises to increase muscle glycogen synthesis after exercise (58).

Vitamins and minerals

There is no need to take vitamins and minerals in addition to the normal diet for athletes who are fed properly. However, some vitamins and minerals may be deficient in eating habits where high-calorie, purified products, called western-style diets, are predominant. Numerous studies today report that people are getting insufficient levels of calcium, magnesium, iron, zinc, and possibly copper and manganese. The desire to lose weight,

vegetarian eating habits, dietary habits that focus on certain types of foods or contain less certain types of foods constitute risky groups. Weight athletes, athletes who travel frequently, athletes who cannot regulate their diets according to training density, intensity and type are the athlete groups at risk (37).

For this reason, supplements of vitamins and minerals are of great importance for athletes (Table 3).

CONCLUSION

Today, studies on the effect of ergogenic support products on performance are insufficient and incomplete to prove the positive effect except for a few products. The studies showing that it affects sports performance positively are explained theoretically with the physiological effect mechanism. However, in recent surveys, it is noteworthy that the interest in ergogenic supplements and the rapid increase in the rate of use, as well as the gradual decrease in the age of use. When using nutritional supplements, athletes should pay attention to the approval of national and international institutions. In addition, it should be explained to the athletes that it should not be used without consulting experts in sports nutrition.

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Table 1. Caffeine Amounts of Some Food İngredients

Foodstuff	**Caffeine amount (mg)**
Filter Coffee (8 Oz)	85
Crystal (Instant) Coffee (8 Oz)	75
Decaffeinated Coffee (8 Oz)	3
Espresso (1 Oz)	40
Brewed Tea (8 Oz)	28
Crystal (Instant) Tea (8 Oz)	25
Ice Tea (8 Oz)	24
Some Types of Soda (8 Oz)	6
Hot Cocoa (8 Oz)	5
Milk Chocolate Drink (8 Oz)	6
Milk Chocolate (1 Oz)	20

Table 2. Contents of sports drinks

Product	Carbohydrate g / L	Carbohydrate %	Protein g/L	Sodium mmol / L	Potassium mg / L	Other Components
Gatorade	60	6	0	21	230	
Gatorade Endurance	62,4	6	0	36	150	
Accelerade	60	6	15	21	66	Calcium, Iron, Vitamin
Powerade Isotonic	76	7,6	0	12	141	
Powerade Energy Edge	75	7,5	0	22	141	100 mg Caffeine
Powerade Recovery	73	7,3	17	13	140	
Staminade	72	7,2	0	12	160	Magnesium
PB Sports Electrolyte Drink	68	6,8	0	20	180	
Mizone Rapid	39	3,9	0	10	0	Vitamin B, Vitamin C
Powerbar Endurance Formula	70	7	0	33	x	
Powerade No Sugar	0,1	x	0,5	23	230	

Table 3. Recommended daily doses in vitamins and minerals preparations

Substance	Daily Amount (including diet)	Recommended Optimum Amount in Multi Vitamin Mineral Product
Selenium	**70 µg**	**100–200 µg**
Zinc	**15 mg**	**15–25 mg**
Calcium	**1.000 mg**	**800–1.000 mg**
Chromium	**120 mg**	**120–200 µg**
Copper	**2 mg**	**1–3 mg**
Folate	**400 µg**	**400 µg**
Iodine	**150 µg**	**150 µg**
Iron	**18 mg**	**People who are not diagnosed with or at risk of iron deficiency should not take supplemental iron.**
Magnesium	**400 mg**	**250–400 mg**
Manganese	**2 mg**	**2–5 mg**
Molybdenum	**75 µg**	**75 µg**
Niacin	**20 mg**	**20 mg**
Biotin	**300 µg**	**300 µg**
Folate	**400 µg**	**400 µg**
Pantothenic acid	**10 mg**	**10 mg**
Riboflavin	**1,7 mg**	**1,7 mg**
Thiamine	**1,5 mg**	**1,5 mg**
Vitamin A	**5.000 IU**	**5.000 IU (natural beta-carotene)**
Vitamin B6	**2 mg**	**10 mg**
Vitamin B12	**6 µg**	**50 µg**
Vitamin C	**60 mg**	**100–200 mg**
Vitamin D	**400 IU**	**400 IU**
Vitamin E	**30 IU**	**100–400 IU**
Vitamin K	**80 µg**	**80 µg**