

Joanna FRĄCKIEWICZ, Ph.D, assistant professor
Department of Human Nutrition, Institute of Human Nutrition Sciences
Warsaw University of Life Sciences (SGGW-WULS), Poland
Katedra Żywnienia Człowieka, Instytut Nauk o Żywieniu Człowieka
Szkoła Główna Gospodarstwa Wiejskiego w Warszawie, Polska

INFLUENCE OF CONSUMPTION OF ENERGY AND ISOTONIC DRINKS ON THE HUMAN BODY®

Wpływ spożycia napojów energetyzujących i izotonicznych na organizm człowieka®

Key words: isotonic drinks, energy drinks, functional drinks, bioactive substances.

Energy and isotonic drinks are the functional drinks. The energy drinks contain bioactive substances, such as: caffeine, taurine, inositol, guarana, glucuronolactone and carnitine. These substances, and in particular the high caffeine content, reduce the feeling of fatigue with increased physical and mental effort. However, the main effect of isotonic drinks is hydration and replenishment of electrolytes, which are lost through sweat during physical exertion. In recent years, the demand for energy and isotonic drinks has increased. Although this market is still the smallest percentage in the production of non-alcoholic beverages, it attracts a lot of interest not only among consumers, but also nutrition specialists. Although these products are intended for a specific group, they are more and more often used by young people, students who do not always require the use of this type of drink in their diet. Therefore, it would be important to educate people in different age groups on the consumption of energy drinks and isotonic drinks.

Słowa kluczowe: napoje izotoniczne, napoje energetyczne, napoje funkcjonalne, substancje bioaktywne.

Napoje energetyzujące oraz izotoniczne zaliczane są do napojów funkcjonalnych. W skład napojów energetyzujących wchodzi substancje bioaktywne, tj.: kofeina, tauryna, inozytol, guarana, glukuronolakton i karnityna. Substancje te, a w szczególności duża zawartość kofeiny, wpływa na zmniejszenie uczucia zmęczenia przy wzmożonym wysiłku fizycznym oraz psychicznym. Głównym działaniem napojów izotonicznych jest nawodnienie organizmu oraz uzupełnienie elektrolitów, które tracone są wraz z potem podczas wysiłku fizycznego. W ciągu ostatnich lat zwiększa się zapotrzebowanie na napoje energetyzujące oraz izotoniczne. Pomimo iż, rynek ten wciąż stanowi najmniejszy procent w produkcji napojów bezalkoholowych, to jednak wzbudza on bardzo duże zainteresowanie nie tylko konsumentów, ale i specjalistów w zakresie żywienia. Mimo, że produkty te są przeznaczone dla specyficznej grupy, to coraz częściej sięgają po nie ludzie młodzi, studenci, którzy nie zawsze wymagają stosowania w swojej diecie tego typu napojów. Istotną byłaby edukacja żywieniowa wśród osób w różnych grupach wiekowych, dotycząca korzyści i zagrożeń wynikających ze spożycia napojów energetyzujących oraz izotonicznych.

INTRODUCTION

Energy and isotonic drinks are products classified as functional food, i.e. food that can positively affect one or more functions of the body. These drinks are intended for people with increased physical and mental activity. The purpose of energy drinks is to increase the body's efficiency. The main bioactive ingredients of energy drinks are caffeine and taurine and they are responsible for improving memory, reaction time and logical thinking efficiency. The composition of energy drinks also includes: inositol, guarana, glucuronolactone, carnitine and B vitamins [6]. Isotonic drinks are intended mainly for people with increased physical activity. The primary function of such drinks is to hydrate and restore levels of electrolytes, carbohydrates, and other nutrients. These drinks are also most

often enriched with minerals such as sodium, potassium, chloride, calcium, phosphorus and magnesium, which are excreted from the body along with sweat. These drinks may also contain amino acids, B vitamins and simple sugars [11].

In recent years, the demand for this type of drink has increased. Although this market is still the smallest percentage in the production of non-alcoholic beverages, it attracts a lot of interest among consumers and nutritionists [21]. Although these products are intended for a selected group of people, they are often used by children, adolescents and students who should not consume this type of drink or do not always require their use in their diet. Therefore, nutritional education about the benefits and risks of consumption of energy and isotonic drinks in different age groups would be important.

ENERGY DRINKS AND THEIR BIOACTIVE SUBSTANCES

Energy drinks are drinks that can be classified as functional drinks, i.e. drinks that provide other health benefits in addition to their basic nutritional functions. Mainly, it is reducing the feeling of fatigue and improving efficiency with increased work of the body, both during physical and mental effort. Quick supplementation of energy expenditure and improvement of concentration [16]. Energy drinks, due to their specific composition and the addition of bioactive substances, differ from other non-alcoholic drinks. Therefore, these drinks are intended mainly for people with increased physical activity, increased mental effort or for drivers [31]. In practice, however, it may look a bit different, because due to the spread of marketing, young people and even children more and more often reach for this type of drink.

The main ingredients of energy drinks are water and sugar, which can become a real threat to young consumers when consuming large amounts of the drink. The ingredients that make these drinks unique are biologically active substances, such as: caffeine, taurine, guarana, inositol, L-carnitine, ginseng or glucuronolactone. As an additive, you can often find B vitamins, such as: thiamine, riboflavin, niacin, pantothenic acid, vitamins B₆ and B₁₂ and minerals: potassium, sodium, calcium, magnesium, chlorine and phosphorus. There are also energy drinks with fruit or fruit and vegetables on the market [6].

Caffeine is a biologically active substance that is present in the highest amounts in energy drinks. Caffeine is a type of alkaloid from the methylxanthine group [19]. It is mainly found in coffee, tea, cocoa, but also more and more often delivered to the body in the form of energy drinks. It is very quickly absorbed from the gastrointestinal tract into the bloodstream because after 30-60 minutes from consumption, 99% of caffeine reaches its maximum concentration in the blood and with it is delivered to all tissues in the human body [17]. Caffeine can cross biological membranes, including the blood-brain barrier and the placental barrier, reaching the fetus and amniotic fluid. In adults, caffeine is almost completely metabolized by the liver. Its major initial metabolite is paraxanthine, the others are theophylline and theobromine. In the final stage of metabolism, 1- methylxanthine and 1-methyluric acid are formed. A small percentage of caffeine, only 1-5%, is excreted in urine. Caffeine metabolism depends to a large extent on the physiological state. That is why in pregnant women it is extended up to 3 times. According to recommendations issued by the European Food Safety Authority (EFSA), pregnant women should not consume more than 200 mg of caffeine per day, while in healthy adults, the safe dose for consumption is 400 mg of caffeine per day, and if caffeine is consumed within 2 hours, the dose should not exceed 200 mg [6, 21]. One normal serving of an energy drink (250 ml) provides about 80 mg of caffeine. Caffeine affects the human body in various ways. The main mechanism of action of caffeine is to block adenosine receptors, which results in increased secretion of dopamine, adrenaline and serotonin. After consuming caffeine, the central nervous system is stimulated, blood vessels dilate and blood pressure rises. As a result, it leads to the improvement of physical and mental

efficiency, improvement of concentration, logical thinking, increased creativity and reduction of the feeling of fatigue. Caffeine also has a psychostimulating effect, thanks to which it increases self-confidence and even reduces depression. Excessive consumption of caffeine, over 500 mg per day, can lead to nervousness, anxiety, tremors, palpitations, hot flushes, headache, and sleep disturbances. Excess caffeine may also lead to gastrointestinal disturbances associated with recurrent vomiting [38].

Taurine or 2-aminoethanesulfonic acid is a non-protein amino acid. It can be mainly supplied to the body from food, it is found, among others, in: crustaceans, fish, red meat, turkey, chicken. Taurine can also be synthesized endogenously from methionine and cysteine [28]. Taurine is involved in many physiological processes in the human body. It increases the metabolism of glial cells, which increases mental and physical performance and reduces nervous tension. It will contribute to better concentration and mood improvement [7]. This amino acid also has an anti-inflammatory effect, regulates blood pressure, and with a high supply, it can protect against coronary artery disease. Taurine can also help you burn fat faster during training and improve respiratory efficiency. Studies have found that a significant dose of taurine – 6 g per day increases lipid oxidation by 38% during moderate exercise [1]. Additionally, taurine influences the proper functioning of skeletal muscles during physical exertion, reducing the concentration of lactates and free fatty acids. In energy drinks, taurine is intended to reduce fatigue. This mechanism is based on inhibiting the secretion of serotonin released during training, which is responsible for the relaxation of the body. As a result, taurine allows for longer and more effective work. There is very little information available in the studies available about the negative effects of taurine on the body. In energy drinks, it is most often present in a dose of about 400 mg per 100 ml of the product.

Guarana (*Paullinia cupana*) is a climbing plant native to Brazil. It is a natural source of caffeine because its fruits are rich in this ingredient. Guarana has a stimulating effect, but these properties are usually attributed to 2.5 to 5% caffeine on a dry weight basis. In addition to caffeine, guarana also contains saponins and polyphenols, including tannins and catechins. In combination with caffeine, these substances give an extended stimulating effect and increase fat oxidation during physical exertion [36]. Additionally, guarana delays fatigue, improves cognitive functions and positively affects well-being [27].

Glucuronolactone is an organic chemical, an ester of glucuronic acid. In the body, it is formed in the liver as a result of glucose metabolism. It is very rare in natural food. It is more commonly found as an additive in fortified foods. Currently, no studies have been conducted on the effect of glucuronolactone on the cardiovascular system [14]. Glucuronolactone may be responsible for faster removal of harmful metabolic products from the body, increase energy, improve concentration and reduce the feeling of sleepiness. In energy drink it is present in amounts of approx. 24–240 mg per 100 ml. The NOAEL dose, i.e. the highest dose of the substance with no adverse effects, was established at the level of 1000 mg/kg body weight [14].

Inositol is an organic chemical compound often referred to as vitamin B₈, although it can be synthesized from phytic acid by a man. In food, it is found in whole grains, citrus fruits, nuts, yeast, and legumes. Inositol improves the lipid profile and participates in the metabolism of fat and cholesterol. It also exhibits anti-inflammatory and antioxidant properties [25]. Inositol acts on the nervous system, it is necessary for the stimulation and conduction of nerve stimuli. Its deficiency can lead to excitability, nervousness, and insomnia. In energy drinks, it is present in doses of about 20 mg per 100 ml and the daily requirement for this ingredient is about 1 g. According to studies, inositol in a dose from 6 to even 18 g per day does not cause any negative effects on the adult's body. In some cases, the subjects developed mild bloating or diarrhea [25].

L-carnitine is a non-protein amino acid supplied to the body in the largest amounts with food, i.e. meat, milk, fish, dairy products. It can also be synthesized in the liver and kidneys from lysine and methionine. L-carnitine plays an important role in fat metabolism as it is involved in the transport of long-chain fatty acids to the mitochondria, where they perform an energetic function. Studies also show that L-carnitine can reduce body weight and adipose tissue mass, and at a dose of 2-3 g per day, it can contribute to the improvement of fasting blood sugar [5]. Therefore, it can be found more and more often as an additive in drinks for slimming people, sports drinks and energy drinks. The excessive consumption of L-carnitine and its negative effects on health are rare [7]. In some cases, it has been observed that L-carnitine supplementation at a dose of 5 g per day and more may cause nausea, abdominal pain and diarrhea [5].

Some energy drinks contain ginseng, but it is not a bioactive substance, but a medicinal plant that contains a very large amount of biologically active substances. Ginseng comes in many varieties, which differ in their chemical composition, and thus have a different effects on the human body. The active compounds found in ginseng include ginsenosides, i.e. saponins from the group of glycosides, which have a positive effect on the functioning of the nervous, cardiovascular and immune systems, as well as have antibacterial and anticancer effects [34]. Ginseng in energy drinks is usually found in small amounts, so to achieve the desired therapeutic dose, which is usually from 100 to 400 mg per day, you should consume two portions of such a drink a day, which may contribute to other unfavorable properties [7].

RISKS RELATED TO THE CONSUMPTION OF ENERGY DRINKS

The consumption of energy drinks in Poland is becoming more and more popular. Since 2012, we can observe a systematic increase in the value of retail sales in this product group. Due to the noticeable increase in the consumption of energy drinks, they are more and more often the cause of discussion and research by scientists in the field of nutrition. This is due to the risks that may affect the health of people consuming this type of drink. Your first concern when consuming energy drinks is that sugar is one of the main ingredients in these drinks. According to research, it is the consumption of sugar-sweetened beverages that can largely contribute to weight gain, and thus to overweight and obesity.

These diseases are a serious problem of the 21st century in every age group. The consequence of high consumption of these drinks may be an increased risk of type 2 diabetes and cardiovascular disease. Another concern is the high dose of caffeine found in energy drinks. Although caffeine increases fat oxidation and may affect weight management, it is believed that caffeine in combination with sucrose increases the risk of overweight and obesity by increasing carbohydrate oxidation and inhibiting fat oxidation [15, 23, 37].

Another risk related to the presence of caffeine in energy drinks is the possibility of consumption of these products by children under 16 years of age. Caffeine can have a very strong effect on a child's body. It can cause severe abdominal pain, nausea, nervousness, agitation, insomnia and, in large amounts, even dehydration in this age group. Pregnant women are also more exposed to caffeine, so 200 mg of caffeine per day is considered a safe dose. For a healthy person, this is 400 mg per day. Caffeine crosses the placental barrier and can obstruct blood flow to the placenta and inhibit nutrient transport to the fetus. This may contribute to the birth of a child with lower birth weight, premature birth and even miscarriage [20, 22].

The effect of energy drinks on the work of the cardiovascular system may also be disturbing. Drinks with a high caffeine content are not recommended for people with cardiovascular disease. Some studies show that consuming more caffeine may contribute to the aggravation of cardiovascular diseases, as they may contribute to an increase in blood pressure and may increase the risk of myocardial infarction [2, 9, 10, 18, 24].

The greatest amounts of energy drinks are consumed by young people aged 19-25 and are often mixed with alcohol. Often, such mixtures are consumed at social gatherings. This combination can lead to serious health effects. Energy drinks, through their stimulating effects, have the opposite effect on the body from alcohol, reducing its sedative effects, confusing and producing the confusing feeling of being sober. This leads to even greater consumption of alcohol, causing an increased risk of intoxication. People who consume this type of mixture have a three times higher probability of alcohol intoxication and four times higher risk of driving a motor vehicle, which results from an incorrect assessment of sobriety [3, 12, 35].

ISOTONIC DRINKS – DEFINITION AND INGREDIENTS

Isotonic drinks are intended mainly for people with increased physical activity. They play an important role in hydrating the body and supplying lost electrolytes, carbohydrates and other nutrients that are excreted during increased activity. Their effective hydration results from adequate osmolality. According to the European Union regulations, drinks with an osmolality of 300 mOsm/kg \pm 10% are isotonic drinks. Due to osmolality, we also distinguish hypotonic drinks – with lower osmolality (<270 mOsm/kg) and hypertonic drinks with higher osmolality (> 330 mOsm/kg) [26, 32]. Osmolality is the number of moles of osmotically active substances dissolved in 1 kg of the solvent. These compounds lower the chemical potential of water. Osmolality is a measure of the osmotic pressure that results from the passage of water through

a semipermeable membrane when there is a substance on one side that is impermeable to the membrane, i.e. an osmotically active substance, and pure water on the other. If two solutions have the same osmotic pressure, we call them isotonic solutions. This is the case with the human body and isotonic drinks, because the osmotic blood pressure in adults is 275 to 295 mOsm/g on average, which is the osmotic pressure of an isotonic drink. This contributes to shortening the time of fluid absorption in the body and restoring the water and electrolyte balance. The osmolality of a drink depends on the minerals it contains and the type of carbohydrates [32].

Isotonic drinks mainly consist of water, carbohydrates, and electrolytes. The essential mineral is sodium. It is believed that only sodium is an essential mineral in the prescription of isotonic drinks, as sodium deficiency leads to rapid dehydration of the body. Through sweating, other minerals such as potassium, calcium, magnesium, chloride and phosphate are also lost, but not in such large amounts as sodium. The above-mentioned ingredients are also added to isotonic drinks [30, 33]. During physical exertion, sodium contributes to the maintenance of optimal body temperature, enabling proper thermoregulation. Supports the absorption of water, carbohydrates and other electrolytes. Sodium in isotonic drinks is usually present in amounts from 400 to 1100 mg/l, but amounts above 460 mg/l and even 600 mg/l are considered appropriate. With very strong dehydration of the body and high intensity of physical exertion, the effective concentration is 1150 mg of sodium per liter of drink. Carbohydrates in isotonic drinks are usually about 6 g in 100 ml of drink and are usually glucose, maltodextrin, fructose and sucrose. You can also often find drinks sweetened with aspartame and acesulfame K. Isotonic drinks are often enriched with B vitamins [4, 13, 26, 32].

THE MARKET OF ENERGY AND ISOTONIC DRINKS

The consumption of energy drinks in Poland is becoming more and more popular. Since 2012, we can observe a systematic increase in the value of retail sales of energy drinks, amounting to approximately PLN 1.15 billion. In 2015, Poles spent almost PLN 1.3 billion on energy drinks. The average Pole drank more than 3 liters of energy drinks per year and spent an average of EUR 8 on them. Compared to other European residents, energy drinks are most often consumed by the British. On average, the average UK resident bought over 8 liters of energy drinks in 2015 and spent almost € 31 on them. Poles buy energy drinks most often at discounters (65%), supermarkets (55%) and hypermarkets (51%). However, sales at gas stations are of great importance for the Polish market of energy drinks, as many as 28% of Poles declare that they buy energy drinks there [8, 29].

The sports drinks market is not as big as that of energy drinks. Often these two markets are combined as functional drinks of which around 80% of sales are energy drinks and around 20% are isotonic drinks. However, the value of the sports drinks market continues to grow. This is due to changes in human behavior and an increase in awareness of a healthy lifestyle and physical activity. People more and more often decide to play sports, use the gym or fitness, which makes

them choose isotonic drinks to replenish fluids and electrolytes during physical activity. In 2015, the Polish isotonic drinks market amounted to PLN 203 million, it is 2.6% of the European market and it ranks 9th among all European Union countries. The countries in which this market is the largest and accounts for almost 80% of the entire European Union market are: Spain, Germany, Great Britain and Italy. Among the above-mentioned countries, Spaniards consumed the most isotonic drinks in Europe in 2015 and on average 5.5 liters of isotonic drinks per person. The second place was taken by Great Britain and Germany, with 2.2 liters per person. On average, a Pole consumed 0.9 liters of an isotonic drink in 2015 [26, 29].

In Poland, the sports drinks market is dominated by 3 brands and they account for approximately 87% of the entire market in Poland. More and more often, we can find isotonic drinks produced by supermarkets under their own brand names, which are available only in a selected chain of supermarkets or shops. These drinks are usually cheaper and therefore more accessible to a larger number of consumers. Available isotonic drinks come in a variety of flavors and colors, with various vitamin and fruit additives. Beverages without added sugar are becoming more and more popular. Marketing of isotonic drinks aimed at people interested in sports may also contribute to the increase in sales because more and more often on bottles and in advertisements we can see the image of leading Polish sportsmen achieving success in their disciplines [26, 29].

CONCLUSIONS

Energy and isotonic drinks are functional drinks. Energy drinks contain bioactive substances such as caffeine, taurine, inositol, guarana, glucuronolactone and carnitine. These substances, and in particular the high caffeine content, reduce the feeling of fatigue with increased physical and mental effort. The main effect of sports drinks is to hydrate and replenish electrolytes, which are lost through sweat during exercise. In recent years, the demand for energy and isotonic drinks has increased. Although this market still accounts for the smallest percentage in the production of non-alcoholic beverages, it is of great interest to consumers and nutritionists.

Although these products are intended for a specific group, they are more and more often used by children, adolescents or students who should not consume this type of drink or do not always require it in their diet. Therefore, it would be important to educate people of different age groups about the consumption of energy drinks and isotonic drinks, which would also indicate the benefits and risks of their consumption.

PODSUMOWANIE

Z analizy dostępnych publikacji naukowych – krajowych i zagranicznych wynika, że napoje energetyzujące i izotonizujące to napoje funkcjonalne. Napoje energetyczne zawierają substancje bioaktywne, takie jak: kofeina, tauryna, inozytol, guarana, glukuronolakton i karnityna. Substancje te, a w szczególności wysoka zawartość kofeiny, zmniejszają uczucie zmęczenia przy wzmożonym wysiłku fizycznym i umysłowym. Natomiast głównym celem spożywania napojów izotonizujących jest nawodnienie i uzupełnienie elektrolitów, które są tracone z organizmu wraz z potem podczas

aktywności fizycznej. W ostatnich latach wzrosło zapotrzebowanie na napoje energetyczne i izotoniczne. Choć rynek ten wciąż stanowi najmniejszy procent w produkcji napojów bezalkoholowych, to cieszy się dużym zainteresowaniem zarówno konsumentów, jak też specjalistów z dziedziny żywienia. Produkty te przeznaczone są dla konkretnej grupy osób, jednak coraz częściej sięgają po nie dzieci, młodzież lub

studenci, którzy nie powinni spożywać tego rodzaju napojów lub też nie zawsze wymagają stosowania ich w swojej diecie. Istotną byłaby więc edukacja żywieniowa wśród osób w różnych grupach wiekowych, która dotyczyłaby korzyści i zagrożeń wynikających ze spożycia napojów energetyzujących oraz izotonicznych.

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