



## INFLUENCE OF ENERGY DRINKS COMPONENTS ON DIFFERENT HUMAN ORGANS AND SYSTEMS

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### Annotation:

The article presents general ideas about energy drinks, the composition of energy drinks and the effect on individual components. There is little published literature on the side effects of EN and they have recently been assigned unique reporting codes so their toxicity can be monitored. In particular, consumption of caffeinated energy drinks and their ingredients have been shown to influence mood and neurological conditions, contribute to the development of cardiovascular disorders, and cause changes in the gastrointestinal tract leading to significant metabolic effects.

**Keywords:** Energy drinks, caffeine, taurine, guarana, L-carnitine, B vitamins.

Energy drinks (energy tonics, energy) are a new brand in a series of bad habits containing alcohol, tobacco and drugs. It was in this application of law enforcement that these phenomena appeared in the life of mankind. Energy effects and effects on the human body are a consequence of deficiency. Energy drinks appeared on the market in the last quarter of the 20th century, when an Austrian entrepreneur, having





visited Asia, decided to open their industrial production. The first mass-produced energy drink was Red Bull. It quickly gained popularity among consumers, along with Coca-Cola and Pepsi, whose manufacturers immediately launched their energy drink versions, Burn and Adrenaline Rush, on the market [1]. The real world boom in power engineers began only in the mid-2000s. So, in 2006, almost 500 new brands were registered in the world, and the number of drinks began to grow. For example, in the United States for 5 years, from 2008 to 2012, the growth in sales of energy drinks was 60%, reaching a volume whose trade turnover amounted to 12.5 billion dollars a year. The first mass-produced energy drink was Red Bull. It quickly gained popularity among consumers, along with Coca-Cola and Pepsi, whose manufacturers immediately launched their energy drink versions, Burn and Adrenaline Rush, on the market [1]. The real world boom in power engineers began only in the mid-2000s. So, in 2006, almost 500 new brands were registered in the world, and the number of drinks began to grow. For example, in the United States for 5 years, from 2008 to 2012, the growth in sales of energy drinks was 60%, reaching a volume whose trade turnover amounted to 12.5 billion dollars a year. Until recently, there was no standard definition of "energy drinks" in the scientific literature. They were perceived as non-alcoholic drinks containing caffeine, vitamins and other beneficial substances designed to increase the body's performance. Power engineers progressively conquered the market, becoming part of the subculture. That is why, according to WHO (2014), the risks of heavy consumption of energy drinks among young people and their long-term effects, largely ignored by scientists and the public, may become a serious public health problem in the future [2,3]. Thanks to aggressive advertising, bright packaging, new drinks quickly became fashionable, especially among young people, and in this environment it has become customary to mix energy with alcohol. There are also alcoholic energy drinks. According to the European Food Safety Authority (EFSA) data for 2011 for 16 EU countries, about 30% of adults (over 18 years old), 68% of adolescents (from 10 to 18 years old) and 18% of children under 10 years are regular consumers of energy drinks [4,5,6]. Such a rapid spread of a new type of drink among the younger generation has raised concerns about their safety for health, both among the global scientific community and among the general public. These fears were reinforced by reports that appeared from time to time in the media about the death of teenagers, presumably after the use of energy drinks with a high concentration of caffeine, alcohol-containing, and also after mixing them with alcohol [7]. Today, the opinions of scientists and specialists are divided: some consider energy drinks to be quite harmless, similar to regular soda, while others, on the contrary, argue that energy drinks can act like drugs and cause addiction and addiction [8,9,10].





Today, marketers state an increase in the production of energy drinks [11,12,13]. Over the past 4 years, energy drinks have made a certain breakthrough in positioning: if earlier they were traditionally classified as soft drinks, now they are increasingly claiming to be allocated to a separate segment due to the fact that cocktails with a low alcohol content have joined soft drinks [14].

As more and more manufacturers appear on this market and competition intensifies, manufacturers of energy drinks are striving to distinguish their products from the bulk due to taste characteristics, imparting special properties. Many manufacturers are already introducing whey, milk, and soy into these drinks to develop healthy, functional, and high-protein drinks [15]. The main target audience of energy tonics was previously considered to be young people (or rather, some of them), demonstrating a certain range of interests and style of relaxation. But recently, students, drivers, athletes, managers of trading companies, etc. have joined this group [16,17,18].

As of 2018, there are more than 500 trade names of energy drinks in the world, which differ significantly in their composition. At the same time, regardless of the specific brand, the common feature of all such drinks is the content in them of high doses of substances and compounds that have a stimulating / tonic effect. action (caffeine, guarana, taurine, ginseng, glucuronolactone, L-carnitine, B vitamins, etc.).

**Energy Drink Main Ingredients:** Caffeine is the most common psychoactive ingredient. In energy drinks, caffeine is in the form of a synthetic alkaloid, unlike tea or coffee. Caffeine, which has a mild psychostimulant effect, is the most widely used psychoactive substance in the world. It is present in soft drinks, coffee, tea, cocoa, chocolate, and a number of prescription or over-the-counter drugs. Caffeine is absorbed from the gastrointestinal tract and quickly distributed to all tissues, easily penetrating the placental barrier. The amount of caffeine in energy drinks varies widely, from 32 mg to 130 mg per 100 ml of product. However, the negative effects of caffeine are offset by the fact that coffee is usually drunk hot, for a longer time and in smaller volumes than energy drinks. In addition, coffee contains antioxidants that reduce the negative effects of caffeine on the cardiovascular and digestive systems of the body [41]. Many of the effects of caffeine can be explained by competitive antagonism at adenosine receptors. Adenosine, which is part of adenosine triphosphate (ATP) and nucleic acids, acts as a neuromodulator, affecting a number of metabolic functions in the central nervous system (CNS). Because adenosine suppresses CNS activity, adenosine receptor antagonists (such as caffeine) have a stimulant effect. The safe daily intake of caffeine varies according to Russian and Western guidelines. In Russia it is 150 mg/day, and in the West it is 400 mg/day





[19,20]. These doses are applicable to healthy young and middle-aged adults, with the exception of women during pregnancy and lactation (for whom a safe dose has not yet been established) [21]. With children, too, there are conflicting data: a reduction in their maximum allowable dose is currently being considered [22]. Experts from the Estonian branch of WHO in the journal *Frontiers in Public Health* (2014) published the results of a study according to which in Europe 1/3 of adults, every fifth child and more than 2/3 of adolescents drink energy drinks. While adults get only 8% of their caffeine intake from them, this figure is much higher in children at 43%. Therefore, scientists warn of the dangers of caffeine intoxication, which is much more pronounced in children than in adults. Moreover, 70% of young people aged 18 to 29 drink energy drinks mixed with alcohol and/or consume alcohol-containing energy drinks [23]. Caffeine can be dangerous for the elderly, especially those with cardiovascular and other chronic noncommunicable diseases [24,25]. Caffeine stimulates the processes of excitation in the cerebral cortex, increases motor activity and increases mental and physical performance, endurance. It also temporarily enhances attention, memory, reaction, while reducing the feeling of fatigue and drowsiness. Caffeine is an integral part of the diets of many athletes, as moderate doses of caffeine can improve endurance. A review of the results of "caffeine studies" shows that consumption of 3 mg of caffeine per kilogram of body weight can improve endurance by 20-50% in elite and moderately trained athletes who run or pedal at an intensity of 80-90% of  $VO_2$  max. Caffeine occupies a unique position in the sports world. In fact, a caffeine dose of 3–6 mg per 1 kg of body weight improves performance without increasing blood levels of caffeine above the International Olympic Committee (IOC) doping threshold [26]. Nevertheless, the use of caffeine is limited by the IOC - the level of its content in the urine above 12 micrograms per 1 ml is considered doping. Thus, caffeine has the potential to become a legal and safe means of increasing endurance [27]. It is likely that different mechanisms are responsible for improving performance and endurance in different sports situations. There are three main theories of the effect of caffeine on performance: 1. Stimulation of the central nervous system. Caffeine can reduce the perception of exertion by increasing the speed of transmission of nerve impulses and increasing the contraction of muscle fibers, thus making it easier to connect muscles to work. 2. Increasing the strength of muscle contractions: caffeine, acting on ion cellular transport, improves the flow of sodium and potassium to working muscles and the transfer of calcium into them [27]. 3. Caffeine can increase fat utilization and reduce carbohydrate intake. It leads to an increase in the level of adrenaline in the blood both during rest and during exercise, which as a result mobilizes free fatty acids from fatty or intramuscular triglycerides.





The presence of an increased amount of free fatty acids reduces carbohydrate intake, liver glycogen breakdown and glycogen "depletion" and thus increases endurance [28].

However, there is an ethical question about the use of caffeine to improve performance in sports. The recommended dose for increased physical activity (3–6 mg/kg) is taken one hour before exercise [29]. However, even when caffeine is used in legal doses, it can be perceived as a form of doping, thus calling into question the integrity of sports performance. This is why the American College of Sports Medicine, the United States Olympic Committee, and the American Dietetic Association discourage the use of caffeine for endurance purposes [20,21].

Reducing fatigue, drowsiness, improving mental and physical performance - all this is a temporary effect of exposure to excessive doses of caffeine, it is replaced by even greater fatigue and fatigue. If you do not give the body a proper rest, but drink another cup of coffee or black tea, then you can significantly exceed the allowable dose of caffeine, since it is slowly excreted from the body [32,33]. Caffeine is completely eliminated from the body of an adult healthy person after 5-7 hours, from the body of a smoker - after 3 hours, from a pregnant woman - 18-20 hours, from a newborn - 30 hours. Caffeine has low toxicity, but in large doses and with regular use it can cause psychomotor agitation, irritability, insomnia, tachycardia, arrhythmia, increased blood pressure, nausea, and vomiting. Caffeine can damage the developing nervous system in children. The child becomes capricious, irritable, gets tired quickly, disturbed daytime and nighttime sleep. In people predisposed to cardiovascular disease, daily consumption of caffeine-containing energy drinks (both artificial and natural) can cause serious health problems: increase blood pressure, increase heart rate, and in some provoke the development of arrhythmia [24]. Caffeine is contraindicated in persons suffering from epilepsy, increased mental excitability, insomnia, uncontrolled arterial hypertension, cardiac arrhythmia and conduction disturbances, and glaucoma [35,36].

Taurine, a derivative of the amino acid cysteine, is found in most energy drinks on the market about as often as caffeine. However, it should be noted that this compound is natural for the human body, because synthesized and contained in large quantities in the muscles, liver. The human body can obtain taurine from the outside through the consumption of meat, milk and seafood. No clear negative effects have been observed from taurine use, however, there is evidence that indicates the side effects of taurine consumption in large quantities. There is also experimental evidence that suggests that taurine can reduce the negative effects of alcohol exposure [30]. Taurine is one of the main components of bile, found in small amounts in various tissues of animals





and humans, mainly in muscle. Taurine is necessary for the normal functioning of the nervous, immune and some other systems, is involved in the regulation of fat and calcium metabolism, improves cell nutrition. It is synthesized in sufficient quantities in the body (with the exception of some congenital diseases). Experiments on mice have shown that taurine can reduce muscle fatigue during prolonged exercise [28]. The effects of high doses of this substance found in energy drinks have not been studied in humans. Possessing an antioxidant effect and actively participating in metabolic processes, taurine helps to stabilize blood sugar levels, break down cholesterol, thereby preventing cardiovascular diseases [20]. In this regard, it is often included in the composition of biologically active food supplements [21,22]. The issue of taurine toxicity remains controversial, however, its multiple excess in energy drinks in combination with caffeine threatens to overexcite the central nervous system, increase metabolic processes, and reduce inhibitory processes. In case of an overdose, it can cause - abdominal pain; - exacerbation of ulcers; - gastritis; - arrhythmia; - interruptions in cardiac activity; - allergic reactions. Taurine is especially dangerous for children and adolescents, since at a dose of 3 g or more it can cause taurine-induced toxic encephalopathy [29,30]. Another common ingredient in energy drinks is guarana or guarana extract (its main active ingredient is guaranine). Guarana is a tropical plant native to Brazil and is used as a natural psychostimulant. It contains many organic substances, the main of which is caffeine, which determines the stimulating effect. In terms of its pharmacological properties, guaranine is similar to caffeine. This fact may mean that energy drinks containing both guarana and caffeine may have a dual stimulating effect. Such a dose of stimulants can enhance the negative effects of energy drinks on the human body [23]. Ginseng is a natural versatile stimulant that enhances the stimulating effect of energy drinks. In normal doses, they reduce the feeling of fatigue, increase mental and physical activity. However, their excessive use is fraught with anxiety, insomnia and a rise in blood pressure. Ginseng is a natural adaptogen, its extract has a stimulating effect on metabolism and energy, cellular activity, and oxygen uptake by cells. Carbohydrates primarily include sucrose and glucose, fructose. The first is ordinary sugar, the second is the main nutrient for the body, formed during the breakdown of starch and disaccharides (substances that enter the body with food) [29]. A 250 ml can of energy drink contains up to 35 g of sugar in the form of sucrose, glucose and fructose. Taking into account current recommendations for the daily intake of simple sugars (32 g per 2000 kcal), the amount of sugar in one can of energy drink exceeds the recommended daily intake by 2-3 times. Due to the large amount of sugar and acids contained in the composition of energy drinks, their frequent use disrupts the acid-base balance in the mouth, and also





destroys tooth enamel, contributing to the development of caries. The sugar content in energy drinks is very high, which significantly increases the load on the endocrine function of the pancreas. As a result, the risk of developing diabetes mellitus increases, especially in the case of an existing hereditary predisposition and / or against the background of overweight. Theobromine is a substance similar in structure and action to caffeine, but with about 10 times less psychostimulating effect, found in cocoa and cocoa products, such as chocolate. Glucuronolactone - D-glucourone- $\gamma$ -lactone (DGL), one of the natural metabolites of glucose in the human body, an important component of connective tissue. It does not have any "energy" properties, it somewhat improves the excretion of toxic metabolic products from the body. Found in common foods: cereals, red wine, some plant resins, where DGL can be found naturally in small amounts. Wine contains the maximum amount of glucuronolactone - up to 20 mg per 1 liter of drink. With a normal diet, any person receives glucuronolactone in sufficient quantities. Studies have also shown that DGL is rapidly absorbed, metabolized, and excreted as glucaric acid, xylitol, and L-xylulose in the urine. If the content of taurine in a drink is 1000 mg / l, glucuronolactone - 2400 mg / l, then a can of this drink with a capacity of 500 ml contains 500 and 1200 mg of these substances, respectively, which exceeds the natural daily rate by many times, and in the case of glucuronolactone - almost 1000 times. The effect of such doses, as well as the interaction with other components of drinks, has not yet been studied [29]. L-carnitine is a substance that is synthesized in the body from the amino acids lysine or methionine. Found in meat and dairy products, nuts, some fruits and vegetables. It is necessary for the normal absorption and breakdown of fats. By reducing fat content in skeletal muscles, L-carnitine reduces excess body weight. At the same time, it contributes to the economical use of glycogen and an increase in its reserves in the liver and muscles. It has a neurotrophic effect, inhibits apoptosis, limits the affected area and restores the structure of the nervous tissue. L-carnitine by reducing the level of milk and pyrovinarous acids helps to increase endurance, and also increases motor activity and increases the tolerance of physical exertion. The human body does not need an additional source of L-carnitine in view of its own production and food from food. The recommended daily dose of L-carnitine for adults is up to 300 mg, for children and adolescents from 7 to 18 years old 100-300 mg. With increased mental, physical and emotional stress, many diseases, in stressful state, during pregnancy or breastfeeding, sports, the need for L-carnitine can increase several times: when combating an excess body weight or to increase immunity-up to 1500-3000 mg. -With AIDS, diseases of the cardiovascular system, liver and kidneys, acute infections-1,500 mg. - with intensive sports - up to 1500-3000 mg. -The workers of heavy physical labor





-Up 500-2000 mg. The action of higher doses of this substance has not yet been studied [12]. B vitamins are needed by a person, but the former act with food, and the second is synthesized in the body on their own. B vitamins - substances necessary for the body for many biochemical reactions; The usual diet of modern man is contained in sufficient quantities. They do not have "energy" properties, do not participate in the synthesis of ATP. With excess and/or prolonged consumption: D -ribose can lead to overexcitation and muscle pain; -artificially synthesized vitamins D6, B12, can cause disorders of the gastrointestinal tract, and vitamin C is allergies [30]; Pyridoxine (B6), if the daily dose is exceeded, can cause numbness, the appearance of a sense of compression in the limbs - the symptom of "stockings" and "gloves"; Cyanocobalamin (B12) note an increase in blood coagulation, tachycardia, pain in the heart, headache, dizziness; Ascorbic acid can cause a decrease in the permeability of capillaries and histohematological barriers, deterioration of tissue trophic, prothrombinemia, increased blood coagulation, erythrocytopenia, neutrophilic leukocytosis, damage to the glomerular apparatus of the kidneys, formation of urinary stones, metabolic disorders, including metabolism, including the metabolism of copper and zinc, impaired sleep[30]. Ginseng and guarana are natural stimulants that are useful in small doses. In drinks, these substances are mixed in various proportions. Food additives, of course, are added to energy drinks that substances are added without which the modern food industry is unthinkable: preservatives, acidity regulators, stabilizers, dyes, flavors and other unsafe food additives. They are used to increase the shelf life, improve the product, therefore, the growth of sales [31]. Energy drink contains relatively little caffeine, stimulation is achieved by its combined effect with ginseng. It is the most "soft" of all energy drinks, but this does not mean that it can be drunk more: you need to consider that one jar contains the daily norm of Taurin and ribose [32]. Currently, a scientific group of food additives and sources of food substances in nutrition (Scientific Panel on Food Additives and Nutriant Sources Added to Food) analyzed the results of experimental studies and came to the following conclusions [32]. 1. The European Scientific Committee for Nutrition (Scientific Committee on Food-ScF) with a very thorough study of the documents of the European Commission for the Study of Energy drinks and their components, including glucuronolactone, having examined the toxicokinetics of compounds in the body and its effects, concluded: "Considering the issue about the chemical nature of the components and their metabolites, and the fact that various processes are involved in their absorption, distribution, metabolism and excretion, according to the expert, do not cause any reason to expect any toxicokinetic interactions, even with high dosages of any component "[43 ]. 2. In experimental studies on rats, mutagenic,







teratogenic and oncogenic effects of high doses of both taurine and spiro lactone did not reveal. They do not affect the reproductive function of rats. Energy drink manufacturers say that their product contains natural ingredients that increase energy, attention, concentration and harmless to health. At the same time, the medical community around the world is concerned about the adverse consequences associated with use, especially excessive, “energy”, which are more often recorded [38].

## Conclusions

1. Nevertheless, it is recommended to pay special attention: - to extreme consumption of drinks; -pinence by children, since the calculations are based on the mass of the body of an adult; -The consumption of alcohol -containing and non -alcoholic energy drinks in combination with alcohol.
2. It is necessary to evaluate the entire product, and not only in the experiment on rats in which glucuronic acid can transform into ascorbic, i.e. In vitamin C, but also conduct clinical research on volunteers.

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