Energy Drinks: Potions of Illusion

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Energy drinks are widely consumed by adolescents as these claim to improve performance, endurance and alertness. Recent reports have shown that there are no real health benefits of these drinks. On the contrary, certain adverse effects due to energy drinks have come to the forefront, casting a big question-mark on their safety and utility. This review discusses the present status of energy drinks, their active ingredients and their safety. We conclude that energy drinks, despite having some short pleasant effects, can be harmful for the body and are best avoided.

Keywords: *Adolescents, Caffeine, Nutrition, Stimulants.*

In a competitive world – where achieving targets rules the roost – more energy is a desirable virtue. Some adolescents are naturally energetic, while others look for commercially available stamina boosters to provide instant energy. Energy drinks seem to be just the solution this group is looking for.

Energy drinks are non-alcoholic beverages containing stimulants like caffeine, herbal extracts (*guarana, ginseng, yerba mate, ginkgobiloba*), glucuronolactone, taurine, inositol, L-carnitine and B-vitamins as the main ingredients to enhance physical and mental endurance [1]. In addition, these drinks may contain carbonated water. Energy shots are a specialized form of energy drinks which contain the same amount of caffeine in a small amount of liquid, typically 60-90 mL small bottles or cans. These may be considered as concentrated energy drinks with lesser calories and lower sugar content [2]. Energy drinks/ energy shots are consumed to improve the stamina and energy levels before and during exercise, to rehydrate the body, to keep awake in demanding situations, to compensate for loss of sleep especially during examinations, or to get a kick as a mood elevator by mixing it with alcohol. Natural caffeinated beverages including coffee, cocoa, tea, and cola drinks are not regarded as energy drinks. Energy drinks should not be confused with Sports drinks that contain carbohydrates, minerals, electrolytes, and flavoring agents. These are intended to replenish water and electrolytes lost through sweating during exercise. Unlike energy drinks, sports drinks do not contain any stimulants [3].

GROWING DEMAND

Energy drinks were introduced to the world in 1949 by the name of 'Dr. Enuf' in US; these were fortified with vitamins and projected as a better alternative to sugar sodas. Subsequently, these became available in Europe and Asia in 1960s [4]. Lipovate D, an energy drink that still dominates the Japanese market, was launched in 1962. Later, several companies introduced similar drinks but none could make a mark till 1997, when 'Red Bull' was introduced by an Austrian entrepreneur [4]. This brought a boom to the industry and ever since the market for energy drinks is growing exponentially. More than 300 variants of energy drinks are available in the US market alone. India, China, and Brazil are considered as the growing markets. Red Bull was launched in India in 2003. With a 75% market share, it is presently leading the Indian market of energy drinks. The energy drink market in India was pegged at Rs 700 crore in 2013; comprising of 5% of the total soft drinks market dominated by colas, fruit juices, and flavored milk (5), compared to 8-9% in global market.

Manufacturers have now shifted their focus from athletes – the primary target for energy drinks – to teenagers and young adults. According to an estimate, about 71% of adolescents in urban centers of India consume energy drinks [6]. Despite the cost factor, youth do not mind spending money on energy drinks due to their much advertised perceived benefits on endurance, attention, and stamina.

CONSTITUENTS OF ENERGY DRINKS

The main constituent of energy drinks is caffeine. In non-

alcoholic energy drinks, caffeine content varies between 75 mg and 150 mg per can [1] compared to 80-120 mg and 60 mg in a cup (250 mL) of coffee and tea, respectively [7]. Maximum recommended intake of caffeine per day, varies from 2.5 mg/kg/day to 6 mg /kg/day in children, 100 mg/day in adolescents and up to 400 mg/day in adults [8].

Caffeine attaches to the adenosine receptor due to its similar chemical structure as that of adenosine. Due to this, the adenosine effect to promote sleep is stopped by competitive inhibition resulting in speeding up of neurons. Caffeine also improves the physical and mental performance by increasing epinephrine secretion. Once ingested, caffeine is rapidly absorbed from the gastrointestinal tract where it is demethylated to form paraxanthine (84%), theobromine (12%), and theophylline (4%). Caffeine intake leads to increased energy utilization and thereby better performance. It has also been found to enhance mood and alertness. In addition, it has been found to decrease food intake and promote lipolysis [9].

Guarana (also called guaranine, *Paulliniacupana*, and *Sapindaceae*) – another ingredient of energy drinks – is a plant extract containing large amounts of caffeine with small amounts of theobromine, theophylline, saponins, flavonoids, and tannins. The seeds contain about twice the concentration of caffeine found in coffee beans. One gram of guarana is equal to approximately 40 mg of caffeine [9]. Consumption of guarana increases energy, enhances physical performance, and promotes weight loss. These effects are largely contributed to the high caffeine content of guarana.

Ginseng (*Panax ginseng*) is a herbal supplement; root being its most important part. Athletes use ginseng for its alleged performance-enhancing attributes; however, no scientific evidence is there till date to support its performance – enhancing claims [9].

Yerba mate, obtained from *Ilex paraguariensis* is known for its anti-inflammatory, anti-diabetic, and anti-oxidative properties. It is a central nervous system stimulant due to its high caffeine concentration (78 mg in 1 cup of yerba mate tea) [9].

L-carnitine, D-glucuronolactone, taurine, and inositol are other ingredients of energy drinks. Data remain insufficient regarding their safe use and claims to increase endurance [6,9,10]. Certain other ingredients like milk thistle, ginkgo, acai berry, L-theanine and creatine have bioactive properties for which they are sometimes added to energy drinks [9].

POTENTIAL ADVERSE EFFECTS

When consumed in moderation, most energy drinks are considered safe. Over-consumption is fraught with potential adverse effects attributed to the high caffeine content.

Caffeine tolerance varies between individuals, though most people would develop toxic symptoms in doses of 200 mg (1 mg = 4 ppm). Some of the energy drinks may contain caffeine as high as 300-500 mg per can [1]. ***Table* I** shows the caffeine content of commonly available energy drinks in the Indian market. Symptoms of caffeine intoxication include palpitations, anxiety, insomnia, nausea, vomiting, restlessness, and tremors [1]. The risk increases if multiple drinks are consumed in a short period of time. A cocktail of energy drinks when mixed with alcohol decreases the awareness of the amount of intoxication, leading to a higher risk of alcohol-related injuries [11]. The combination might also increase the risk of arrhythmia if there is an underlying heart disease. Teens are shown to mix their energy drinks with alcohol [12]. This can be potentially dangerous cocktail as the drinkers will be unaware of the amount of alcohol they have actually consumed. Caffeine content of beverages consumed by adolescents has also been linked to high blood pressure [13].

Caffeine, taken in large amounts over an extended period of time, leads to caffeinism characterized by nervousness, increased risk of addiction, irritability, anxiety, tremulousness, muscle twitching, insomnia, headache, respiratory alkalosis, and palpitations [1]. The Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) recognizes four caffeine-induced psychiatric disorders: caffeine intoxication, caffeine-induced anxiety disorder, caffeine-induced sleep disorder, and caffeine-related disorder. Studies in adult twins have shown a significant positive association between major depression, generalized anxiety disorder, panic disorder, antisocial personality disorder, alcohol

TABLE I CAFFEINE CONTENT OF COMMERCIALLY AVAILABLE ENERGY DRINKS IN THE INDIAN MARKET

Brand	*Amount (mL)*	*Cost (Rs)*	*Caffeine content declared by manufacturer (ppm)*	*Caffeine content as tested by CSE (ppm)*
Red Bull	250	95	320 (80 mg/250 mL)	310.08
Tzinga	250	25	300 (75 mg/250 mL)	258.37
Triple X	250	75	100	117.14
Cloud 9	250	85	Not given	142.25
Burn	300	75	320	291.73

Source: CSE (Centre for Science and Environment).

dependence, and cannabis and cocaine abuse/ dependence; with lifetime caffeine intake, caffeine toxicity, and caffeine dependence [14]. Another demerit of caffeine is its ability to foster dependence. Genetic factors have also been found to play some role in caffeine intoxication, dependence, and withdrawal [14].

Ginseng has been associated with adverse effects like hypotension, edema, palpitations, tachycardia, cerebral arteritis, insomnia, mania, and cholestatic hepatitis but they are not noted at levels found in energy drinks. Studies are insufficient to prove its safety [15].

Most energy drinks contain a lot of sugar or artificial sweeteners to mask the bitterness of caffeine. The sugar content in energy drinks ranges from 21 g to 34 g per 8 oz. Sugars in energy drinks may be in the form of sucrose, glucose, or high fructose corn syrup. Their intake poses a risk for obesity and diabetes in children.

Most sports and energy drinks have citric acid, which lowers their pH in the acidic range (pH 3-4). A pH this low is associated with enamel demineralization and dental problems.

ENERGY DRINKS FOR CHILDREN WITH SPECIAL MEDICAL CONDITIONS

- Energy drinks if taken by children being treated for attention deficit hyperactivity disorder, can be very harmful as they are already taking stimulant medications [16].
- Patients of ion channelopathies and hypertrophic cardiomyopathy should not take energy drinks because of the risk of hypertension, syncope, arrhythmias, and sudden death due to unwanted stimulant effect of caffeine [17]. In August 2008, a study conducted by the Cardiovascular Research Centre at the Royal Adelaide Hospital in Australia assessed the cardiovascular status of 30 young adults one hour before and after the intake of a popular energy drink and found that it could increase the risk of stroke and heart attack [1].
- High amounts of caffeine help to counter caloric-restriction–associated fatigue, and suppress appetite, and thus have often been taken by patients of anorexia nervosa. But as these patients have a propensity for cardiac morbidity/mortality and electrolyte disorders, intake of high-caffeine energy drinks can trigger cardiac dysrhythmias and intracardiac conduction abnormalities [18].
- Other high-risk groups include adolescents with obesity, hemodynamic compromise, diabetics and individuals with pre-existing cardiovascular, metabolic, hepatorenal, and neurologic disease, those who are taking medications that may be affected by high glycemic load foods, caffeine, and/or other stimulants, and adolescents in rapid growth phase [12].
- Caffeine also acts as a diuretic; therefore, energy drinks should be avoided during exercise as fluid losses from sweating coupled with diuresis can lead to dehydration.

WHERE WE STAND?

Considering the potential adverse effects, energy drinks have been banned in some countries like Denmark, Uruguay and Turkey. Energy drinks with caffeine more than 320 ppm are banned in Australia [19]. European countries have stipulated that energy drinks with caffeine more than 150 ppm should be labeled as having 'high caffeine content'.

In the first year of the launch of a leading energy drink, there was a tussle between the manufacturers and government agencies on labeling of the product. The central food laboratory continued to label it as carbonated beverage (maximum allowable caffeine content – 200 ppm, now lowered to 145 ppm). The manufacturers maintained it as proprietary product (caffeine content – 320 ppm), and claimed it to be safe. The maximum limit of caffeine of 200 ppm in carbonated beverages was reduced to maximum level of 145 ppm on recommendations by Central Committee on Food Standards (India) and notified vide notification GSR 431(E) dated 19.06.2009. Food Safety and Standards Authority of India (FSSAI) then constituted an expert group on energy drinks and made certain observations (***Box* I**) [1].

Center for Science and Environment (CSE), a Delhi-based NGO, tested 8 brands of energy drinks and showed that caffeine levels were exceeding 145 ppm in 6 of them [20]. FSSAI constituted an expert group, followed by a risk assessment study commissioned by National Institute of Nutrition (NIN), Hyderabad. On the basis of NIN report, FSSAI has now recommended a limit of 320 ppm of caffeine in energy drinks. In June 2012, FSSAI announced the mandatory use of statutory safety warnings and that all energy drinks should be renamed as "caffeinated beverages." Following this, the energy drinks now boldly write "contains caffeine". Further, they mention clearly "Not recommended for children, pregnant or lactating women and persons sensitive to caffeine. Use not more than 2 cans a day." FSSAI has

BOX I FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA OBSERVATIONS ON ENERGY DRINKS

- Caffeine is not an additive but a chemical with addictive property. Caffeine up to 200 ppm is added as a flavoring agent but above 200 ppm it is a functional ingredient. The functionality of caffeine at 320 ppm needs to be ascertained along with justification for fixing a cut-off limit at 320 ppm.
- Energy drink is a beverage which is fortified with vitamins and there is no case for encouraging its consumption. The name 'energy drinks' is a misnomer as it gives the impression that this should be taken to get energy.
- The vegetarian and non-vegetarian symbol should also be given on the label of energy drinks as per the source of ingredients added.
- Standards for energy drinks, both carbonated and non-carbonated need to be laid down to enable better regulation of the product. These may be termed as 'caffeinated drinks'.
- There is a need to limit consumption of energy drinks by a person per day taking into account total caffeine content from all ingredients and items in the diet.
- Alternatively, instead of laying down separate standards for carbonated energy drinks, standards for carbonated beverages per se can be amended to include other ingredients like taurine, glucuronolactone, etc. which are found in energy drinks.
- There is also a need to get the market data of availability of energy drinks in India and analyze samples as a basis for fixation of standards according to Indian requirements.

also proposed that such products be packed in only 250 mL containers. However, consumers need to keep in mind that there are other sources of caffeine intake like coffee, tea, chocolate products, and carbonated drinks. ***Table* II** depicts the caffeine content of commonly consumed beverages. As of now, this caffeine cap of 320 ppm for energy drinks does not take into account the total caffeine content from other beverages. There is no sample study in India to determine the caffeine intake of the population as such. Also the justification for propagating the use of energy drinks for a source of vitamins, minerals, and amino acids is not acceptable as these can be easily obtained from a normal healthy diet.

TABLE II CAFFEINE CONTENT OF COMMON FAST-MOVING CONSUMER GOODS

Products	*Caffeine content/250 mL*
Tea	60 mg
Coffee	80-120 mg
Carbonated beverages	25-40 mg
Dark chocolate (100 g)	43 mg
Hershey's syrup (2 tbsp/39 g)	5 mg

CONCLUSIONS

Intake of energy drinks prior to physical activities may be undertaken while keeping their possible deleterious effects in mind. Their use during physical activity is not recommended. Sports drinks (non-caffeinated) are designed to be taken during physical activity and should be preferred. Energy drinks claim to have stimulant effects; these may be pleasant at times. However, intake of these drinks can be harmful. Considering this fact and the growing popularity of these drinks, one should be cautious before and during intake of energy drinks. More awareness needs to be created in the younger generation regarding their appropriate intake. Further research should be done to assess the benefits and ill-effects of various ingredients present in these drinks. Indian Academy of Pediatrics should lead a campaign to educate parents and pediatricians about the risk of caffeinated drinks.

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