

“ENERGY” DRINKS: HELP, HARM OR HYPE?

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KEY POINTS

- Many products marketed as energy drinks contain high concentrations of carbohydrate and some caffeine.
- Some energy drinks contain herbs, amino acids, protein, and other substances, usually in such small amounts that they are unlikely to have any noticeable effect on performance.
- The content of some of these products may result in inefficient absorption of fluid and nutrients from the intestine, with the possibility of gastrointestinal distress.
- Many energy drinks are quite costly and, because of their composition, are not suitable for use by athletes.
- Athletes should be educated about these products and guided towards other foods and fluids that will not pose potential risks.

INTRODUCTION

Athletes who train hard and frequently often complain about “energy drain” and fatigue. Because they are regularly reminded to consume adequate fluids and fuel to minimize early fatigue and to maximize performance and recovery, the concept of an “energy” drink—fluid and energy together in one bottle—is very appealing. Having more energy can improve one’s capacity for work, a very desirable characteristic for all and especially for active individuals. However, in addition to good hydration and sufficient food energy, an athlete needs adequate rest, frequent meals or snacks, and optimal consumption of carbohydrates to help feel energized. Moreover, there are likely to be additional elements that cause fluctuations in various neurotransmitters in the brain that can lead one to feel energized; these elements may have nothing to do with either food energy or hydration status.

Other than water, most of the products marketed as energy drinks contain carbohydrate and caffeine as their principal ingredients—the carbohydrate to provide nutrient energy and the caffeine to stimulate the central nervous system, but they may also contain a wide variety of other ingredients (Table 1). Athletes must be made aware that energy drinks are not appropriate substitutes for optimal fuel and fluid and may have no bearing at all on how energized they feel. In addition, athletes should be educated about these products. For example, some energy drinks do not contain the stated ingredients (Gurley et al., 2000), many are not cost-effective means of obtaining carbohydrate, and certain products may actually impair athletic performance.

Why are these “energy” products so appealing to athletes? For many athletes who need to juggle sports, careers, school, and personal lives,

squeezing in time for optimal eating and drinking is not a part of the athlete’s lifestyle equation. For these athletes, gulping down an energy drink may be perceived as a quick way to consume extra energy to get through the day, compensate for a perceived deficiency in vitamins, minerals, herbs, or some other nutrient, boost endurance, expedite recovery from exercise, burn fat, increase lean muscle mass, or improve brain function. Unfortunately, most of these energy drinks cannot deliver on such high expectations. This article will examine these products and the claims made for them and will provide guidelines for advising athletes about their use.

RESEARCH REVIEW

Ingredients Found in Energy Drinks

Carbohydrates

Most of the beverages sold as energy drinks contain a carbohydrate concentration of at least 18 g/8 oz and usually more than 25 g/oz (Table 1). Such high concentrations of carbohydrate—glucose, sucrose, maltodextrins, fructose, and/or galactose—will slow the rate at which fluid is absorbed from the intestine into the blood (Ryan et al., 1998) and will consequently impede rehydration during exercise. For that reason alone, energy drinks should not be ingested soon before or during physical activity when rapid replacement of sweat loss is important. In addition, when consumed too soon before or during exercise, these high concentrations of carbohydrate can cause gastrointestinal distress; beverages with a high concentration of fructose can have a laxative effect as well. Accordingly, energy beverages are not appropriate for consumption shortly before or during any exercise performance that may be compromised by a loss of body fluids in sweat or by digestive difficulties.

Likewise, energy drinks are not optimal beverages to consume during recovery from exercise in situations in which rapid rehydration is critical. A well-formulated sports drink would be preferable. Even when hydration during recovery is not a major issue, only a few energy drinks contain enough carbohydrate to provide the 50-75 g of carbohydrate recommended to be consumed within 15 to 30 minutes after exercise (American Dietetic Association, Dietitians of Canada, American College of Sports Medicine, 2000). For most other energy drinks, an athlete would need to consume many 8-oz servings of these expensive drinks to meet this guideline.

Beverages that are rich in carbohydrate can be useful as part of a carbohydrate-loading regimen, taking the place of bulky solid foods. When used for this purpose, energy drinks that contain enough CHO should be consumed during the first hour of recovery from exercise. For athletes who need to continue to ingest liquid CHO in anticipation of a subsequent practice or competition, a properly formulated energy drink can be consumed until about two hours before the next practice or competition. This amount of time would allow for adequate digestion and absorption of the carbohydrate before exercise begins.

In contrast to energy drinks, an effective sports drink is formulated to provide approximately 14 g (1 teaspoon) of carbohydrate in the form of sucrose, glucose, fructose (in small amounts) or maltodextrins in every 8 oz (240 ml) of beverage (Casa et al., 2000). In addition, electrolytes (sodium and potassium) help drive the desire to drink (Nose et

TABLE 1. ENERGY, CARBOHYDRATE, AND ADDITIONAL INGREDIENTS FOUND IN SELECTED ENERGY DRINKS.

Product	Energy (kcal/8 oz)	Carbohydrate (g/8 oz)	Additional Ingredients
Arizona Extreme Energy Shot ^{TMb}	124	32	Caffeine, taurine, ribose, ginseng, carnitine, guarana, inositol, vitamins
Arizona Rx Energy ^{TMb}	120	31	Caffeine, ginseng, Schizandrae, vitamins
Battery Energy Drink ^{TMb}	114	27	Caffeine, guarana
Bawls Guarana ^{TMb}	96	27	Caffeine, guarana
Dynamite Energy Drink ^{TMb}	95	25	Caffeine, taurine, inositol, vitamins
Effervescent Glutamine Recovery Drink ^{TMh}	24	0.8	Glutamine, electrolytes
Gatorade Energy Drink ^{TMk}	203	52	Vitamins
G3 Endurance ^{TMd}	90	24	Galactose, protein, chromium, green tea, ginseng, vitamins, minerals
G4 Recovery ^{TMd}	110	27	Ginseng, galactose, green tea, vitamins, protein
Hansen's Energy ^{TMb}	107	31	Taurine, ginseng, caffeine, Ginkgo biloba, guarana, vitamins
Hansen's Slimdown ^{TMc}	0	0	Pyruvate, carnitine, chromium, vitamins
Jones Whoop Ass Energy ^{TMb}	107	27	Caffeine, royal jelly, guarana, taurine, inositol, vitamins
Mad River Energy Hammer ^{TMb}	110	27	Guarana, ginseng, bee pollen
Nexcite ^{TMa}	100	21	Guarana, damiana, Schizandrae, mate, ginseng, caffeine
Oxytime+ Sports Drink ^{TMb}	80	18	"Stabilized oxygen," carnitine, aloe vera, protein
Prozone Fat-Reducing Energy Drink ^{TMg}	184	19	Protein, medium-chain triglycerides, borage oil
Pripps Amino Energy Sports Drink ^{TMi}	71	17	Protein, branched-chain amino acids, electrolytes
Pyru Force ^{TMf}	2	0.4	Caffeine, pyruvate, guarana, choline, chromium, inositol, carnitine, vitamin C
Red Bull ^{TMb}	109	27	Taurine, caffeine, inositol, vitamins
Red Devil Energy Drink ^{TMb}	80	21	Caffeine, taurine, guarana, ginseng, Ginkgo biloba, vitamins
Sobe Adrenaline Rush ^{TMb}	135	35	Caffeine, taurine, ribose, carnitine, inositol, ginseng, vitamins
Sobe Energy ^{TMb}	113	30	Caffeine, guarana, arginine, L-cysteine, yohimbe, vitamin C
Sobe Power ^{TMb}	107	28	Caffeine, taurine, creatine, proline, vitamin C
Ultrafit Liquid Endurance ^{TMc}	N.A.	N.A.	Glycerol, carnitine, chromium, vitamin B6
VAAM ^{TMj}	56	10	17 amino acids
Venom Energy Drink ^{TMb}	127	28	Caffeine, taurine, mate, bee pollen, guarana, ginseng, protein, vitamins
180 Energy Drink ^{TMb}	117	32	Guarana, vitamins

^aSource: www.excitebluebottle.com
^bSource: www.bevnet.com
^cSource: www.hansens.com
^dSource: www.gpush.com
^eSource: www.ultrafit-endurance.com
^fSource: www.getbig.com
^gSource: www.prolithic.com
^hSource: www.maxperformance.com
ⁱSource: www.nutrinox.com
^jSource: www.vaam-power.com
^kSource: Package label

al, 1988; Wemple et al., 1997) and may reduce or prevent cramping during or after exercise (Bergeron, 1996).

Caffeine

Caffeine is a central nervous system stimulant, and, although the effect is temporary, it may make an athlete feel more "energized." In laboratory studies, caffeine at a dose of about 6 mg/kg body weight (e.g., 490 mg for a 180-lb person) has often proved effective at enhancing exercise performance lasting from 1-120 min (Graham, 2001). Unfortunately, such large doses of caffeine make some athletes feel light-headed, and, if ingested too far in advance of exercise, caffeine can have both laxative and diuretic effects that may impair rather than enhance performance. In addition, the dose of caffeine contained in energy drinks is not always apparent on the label but may be high enough to put the athlete at risk for failing a doping test for caffeine.

Herbs

Many energy drinks contain herbal forms of caffeine including extracts of guarana seeds, kola nuts, and Yerba mate leaves. Some people who would not ingest synthetic caffeine are apparently persuaded that herbal stimulants are somehow healthier. Because there is wide variability in the sources and processing of these herbs, it is nearly impossible to know the exact amounts of caffeine or other components of the plants that are contained in the energy drinks.

Moreover, to ensure that the consumer has at least a psychological response to energy drinks that contain herbal forms of caffeine, manufacturers often add known amounts of synthetic caffeine.

Herbs including Astragalus, Schizandrae (Sinclair, 1998) and Echinacea (Ernst, 2002) are claimed to enhance immune function and are components of some energy beverages. Supposed memory-boosting herbs like Ginkgo biloba (Ernst, 2002) and ginseng (Kennedy, 2001) are also sometimes included. Additional ingredients may include putative fat-burning substances such as Ciwujia (Cheuvront et al., 1999), hydroxycitrate (Heymsfield et al., 1998), and/or ephedra (Molnar et. al, 2000). Some drinks contain the "calming" herbs kava-kava and St. John's Wort. These ingredients are typically in small amounts, but even in larger amounts there is scant evidence that they can benefit performance.

In addition to the fact that there is little or no scientific evidence of ergogenic efficacy of these herbs, there are other concerns:

- There is little or no regulatory control of these products.
- Lack of standardization and/or purity.
- Possible mislabeling of ingredients leading to positive doping tests (Ros et al., 1999).

- Potential for serious side effects when used with prescribed medications (Izzo & Ernst, 2001).
- Potentially fatal side effects, including liver failure associated with Kava-Kava (Kraft et al., 2001) and cardiovascular dysfunction associated with ephedra (Skinner et al., 2000).
- Possible decrease in performance with large doses of herbal extracts containing caffeine and other substances that may cause dizziness and other symptoms of central nervous system dysfunction.

Pyruvate

Pyruvate, a salt of pyruvic acid, has been added to beverages and touted as a fatigue fighter as well as a fat burner. When pyruvate was administered in such large amounts that serious gastrointestinal discomfort occurred, exercise performance was shown to be improved in one study (Stanko et al., 1990). However, when pyruvate is consumed at the dosages found in commercial beverages (Morrison et al., 2000), there is no ergogenic benefit. Thus, pyruvate in tolerable amounts is an ineffective ingredient in energy drinks.

Protein and Amino Acids

Protein is used as a fuel for exercise, but in negligible amounts, so adding protein to a beverage containing adequate energy from carbohydrate will provide no performance advantage for an athlete. It is also unlikely that adding protein to a carbohydrate-rich beverage will have any demonstrable effect on the synthesis of muscle glycogen during recovery compared to ingesting equivalent calories of carbohydrate alone (Carrithers et al., 2000; van Loon et al., 2000). Moreover, adding protein to a sports drink may adversely affect the taste and mouth feel of the product.

Some beverage ingredients include individual amino acids such as glutamine, arginine, taurine, and/or branched-chain amino acids, i.e., leucine, isoleucine, and valine. It has been speculated that glutamine supplementation would boost the immune system to decrease the likelihood of overtraining in endurance athletes and might increase the storage of glycogen in muscles during recovery from exercise. However, a glutamine drink had no effect on immune responses to exercise (Krzykowski et al., 2001), and adding glutamine to a carbohydrate-rich beverage did not enhance muscle glycogen synthesis during recovery when compared to carbohydrate alone (van Hall et al. (2000).

Arginine supplementation also does not appear to benefit glycogen replenishment following exercise when compared to carbohydrate alone (Yaspelkis & Ivy, 1999).

Taurine reportedly improves the contractility of the heart in cardiac patients and can serve as an antioxidant, but thus far there seems to be no published evidence that taurine supplementation positively affects exercise performance.

Branched-chain amino acids (BCAA) can reduce the synthesis of serotonin by the brain. Because serotonin is associated with early fatigue, it has been proposed that administration of BCAA during exercise might delay fatigue and improve performance. But adding BCAA to a carbohydrate-containing beverage does not prevent fatigue during exercise any better than the carbohydrate drink itself (Van Hall et al., 1995).

Creatine and Carnitine

The amounts of creatine added to most energy drinks is too small (e.g., 11.2 mg/8 oz) to be of any benefit to performance unless the athlete were to drink about 178 servings of the beverage, and this would have to be repeated daily for five days to comply with the typical creatine-loading regimen of 20 g/day for five days.

Carnitine is involved in fatty acid metabolism, and it has been claimed that carnitine supplementation can delay fatigue by stimulating greater use of fat as a fuel for exercise. These claims have not been supported by the best research studies (Brass, 2000).

Medium-Chain Triglycerides

Visual and taste appeal aside, fat takes longer to empty from the gut than either carbohydrate or protein and thus would not provide a quick energy source for the body before or during exercise. Medium-chain triglycerides (MCTs) are quite rapidly metabolized and have been added to some energy drinks to delay fatigue by having the body use MCTs as a fuel, thereby sparing glycogen. Unfortunately, the MCTs can cause severe gastrointestinal distress, do not spare glycogen (Jeukendrup et al., 1996), and do not improve performance (Jeukendrup et al., 1998).

Vitamins and Minerals

Athletes who consume a reasonably normal diet are not apt to be vitamin deficient, and their exercise performance will not be improved if they use vitamin supplements (Clarkson, 1991). Similarly, other than the necessity to replace sodium lost in sweat to minimize dehydration, there is little evidence that mineral supplements affect performance. If an athlete wants to be on the “safe side,” a multivitamin-mineral supplement will be a far less costly and more effective alternative to a fortified beverage. However, adding appropriate amounts of the vitamins involved in carbohydrate metabolism (e.g., 10-30% of the Recommended Daily Allowance of certain B vitamins), at least assures that athletes will not be ingesting carbohydrate calories devoid of the micronutrients normally associated with carbohydrate-rich foods.

Oxygen

Beverages that include dissolved oxygen claim that the extra oxygen accelerates aerobic metabolism and results in lower levels of lactic acid and improved performance. Given that the arterial blood is essentially fully saturated with oxygen and that any “extra” oxygen consumed in a drink would immediately be exhaled, it is not surprising that there is no scientific support of the ergogenic claims for “super oxygenated” beverages.

Hornet’s Saliva

VAAM™ (Vespa Amino Acid Mixture) is a product derived from 17 amino acids found in the saliva of baby hornets. Two studies of VAAM that used swimming mice as an experimental model are described on the manufacturer’s website but have not been published in recognized scientific journals. This research purportedly demonstrated an increase in endurance and decreased lactic acid levels in the mice, but in rodents, swimming endurance is not a good criterion for ergogenicity. There is apparently no published research on VAAM using human subjects, nor is there any good reason to think that some special group of amino acids would have any beneficial effect in human athletes.

PRACTICAL APPLICATIONS

Being optimally “energized” requires a suitable level of physical activity, adequate sleep, effective fueling and hydration strategies, and probably other unknown factors that affect neurochemicals in the brain. An energy drink alone will never make up for all of these elements. When it comes to choosing any food or beverage product, athletes must be skeptical consumers and ask questions before buying. Here are some guidelines:

- Label reading is necessary!
- Athletes using medications should avoid any product that contains herbs.
- If there is no Nutrition Facts or Supplement Facts panel, athletes should not buy the product.
- Athletes need to know if the ingredients are legal and safe.
- Athletes should examine the Nutrition Facts panel for the total carbohydrate content as well as calories.
- Avoid the product if the evidence for claims is non-existent, incomplete, or unsubstantiated!
- If it sounds too good to be true, chances are that it probably is!

SUMMARY

Athletes will always be attracted to products that claim to have performance-enhancing effects. Energy drinks are not adequate substitutes for the time, training, rest, recovery, and fueling required for sports. Athletes must take the responsibility for what goes into their bodies, which includes being informed as well as cautious about dietary supplements. Educating athletes about these products is critical for their health, safety, and sport performance.

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WHAT YOU NEED TO KNOW ABOUT “ENERGY DRINKS”

Energy is the capacity to do work, including synthesizing proteins, fats, and carbohydrates, producing nerve stimuli and muscle contractions, and performing sports. Biochemical energy is derived from food and is optimized when athletes get adequate rest and sleep and when they engage in effective training programs. The feeling of being “energized” also requires the correct balance of neurochemicals in the brain; this, too, requires the appropriate amounts of food, fluids, rest and sleep, and physical activity, plus other psychological factors about which we know little.

Eating an optimal amount of calories and being well hydrated are certainly critical components of athletic success. Energy drinks can supply energy and fluid, and they may have a role to play in carbohydrate loading during recovery from exercise. But energy drinks typically are not optimally formulated to work best to improve strength, speed, stamina, and other requirements for sport performance when consumed shortly before or during exercise. Here are some of the concerns experts have with energy drinks:

- Doses of ingredients are often not standardized, so it is impossible to know if you are getting too little or too much of a particular ingredient.
- Some supplements do not contain the ingredients stated on the package; some contain banned ingredients not stated.
- Some products may have side effects that detract from performance.
- Energy drinks are a costly way to acquire carbohydrate and fluid.

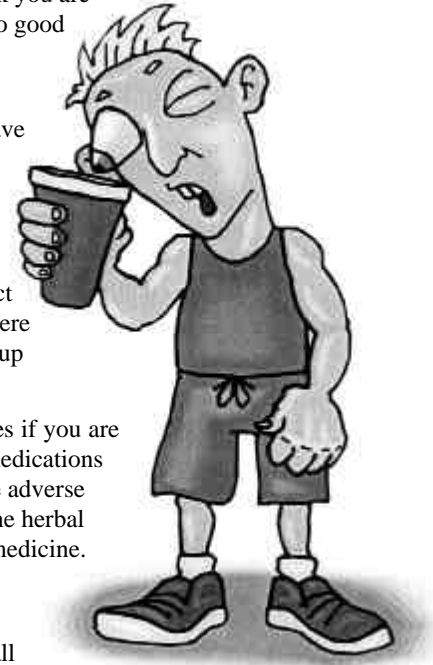
The table on back lists some of the ingredients added to energy drinks with claims and facts.

BOTTOM LINE

Athletes need to be well rested, well fueled, and well hydrated for optimal energy and performance. Supplemental beverages should have a beneficial, not negative effect on the body. Examine energy drinks carefully and think before you buy, keeping the following points in mind:

- Is there anything about your present eating, hydrating, or lifestyle patterns that you should improve before trying a costly energy drink?

- Does the energy drink you are considering sound too good to be true? If so, it probably is.
- Does the beverage have a Nutrition Facts or Supplement Facts Panel? If not, avoid it.
- What does the product claim to do, and is there any research to back up those claims?
- Avoid herbal additives if you are taking prescription medications because there may be adverse interactions among the herbal chemicals and your medicine.
- Avoid products containing ephedra, yohimbe, and mate, all of which are unsafe.



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INGREDIENTS OF ENERGY DRINKS

INGREDIENT	CLAIMS	FACTS
Royal jelly/bee pollen	Improved exercise performance	No effect on performance; dangerous for those allergic to bee stings
Glucose, sucrose, fructose, galactose	Carbohydrate is the preferred fuel source; enhanced performance	Carbohydrate supplements often improve performance. Carbohydrate-rich drinks can be effective for carbohydrate loading up to 2 hours before exercise. If consumed shortly before or during exercise, carbohydrate amounts in energy drinks are usually too much or too little; drinks containing only galactose or fructose can cause digestive problems
Pyruvate	Enhance aerobic metabolism; delay fatigue; decrease body fat	Amount needed is far in excess of what current products provide; larger quantities cause GI distress
Branched-chain amino acids (BCAAs)	Decrease brain serotonin; delay fatigue; expedite recovery	No effect on athletic performance when compared to carbohydrate; may cause digestive distress
Glutamine	Boost immune system; increase glycogen storage	No effect on an athlete's immune system or on performance
Arginine	Improve muscle glycogen stores	No benefit; can cause digestive distress
Creatine	Delay fatigue in high-intensity exercise	Insufficient amount in energy drinks to be effective
Carnitine	Delay fatigue, burn body fat	No effect on athletic performance
Taurine	Serves as antioxidant; enhances cardiac function	No effect on athletic performance
Medium-chain triglycerides (MCTs)	Spare glycogen; enhance endurance	No effect on athletic performance; causes digestive distress
Vitamins and minerals	Essential for normal body functions	Amounts in energy drinks range from trace to megadoses; no effect on athletic performance
Oxygen dissolved in beverage	Increased aerobic metabolism; decreased lactic acid; improved endurance	No effect on metabolism or athletic performance in typical athletes, who have no deficiency of vitamins
Caffeine	Stimulates brain function and metabolism; Improves performance	May improve athletic performance; may stimulate urine production and contribute to dehydration if ingested before exercise; may cause nervousness; laxative effect
Guarana extract; Kola nut extract; Yerba mate extract ("natural" caffeine sources)	Similar to caffeine	Similar to caffeine; often unknown quantities of active ingredients; could lead to anti-doping violation if too much caffeine
"Fat burners" such as Ciwujia, hydroxycitrate, ephedra	Stimulate metabolism and brain function; reduce fat	Little or no evidence of athletic performance effect; ephedra can cause cardiovascular dysfunction and death in sensitive individuals
Kava-kava and St. John's Wort	Calm the nervous system	No athletic performance effect; kava-kava associated with liver failure
Amino acids from hornet's saliva	Increase endurance	No evidence of effect on athletic performance in humans

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