

What does the science say: Energy Drinks

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Introduction	2
Impetus	2
Methodology	2
Audience	2
Disclaimer	3
The Claims	3
Claim 1: Energy Drinks have significantly higher levels of caffeine than other drinks	0
Sample claims	5
What the science says	5
Summary	10
Claim 2: Energy Drinks have significantly higher levels of sugar than other drinks	0
Sample claims	11
What the science says	11
Summary	12
Claim 3: The "herbal" and otherwise mysterious ingredients in energy drinks have unknown side effects	0
Sample Claims	13
What the science says	14
Ingredients of example energy drink (Monster Lo-Carb in this case)....	15
Summary	17
Claim 4: The dangers increase when mixed with alcohol	0
Sample Claims	19
What the science says	19
Summary	20
Claim 5: Energy drinks destroy your teeth	0
Sample Claims	21
What the science says	22
Summary	23
Conclusion	24

Introduction

Impetus

I really enjoy drinking (mostly for the taste) energy drinks, especially Monster Lo-Carb. However I am often told how bad they are for me, much much worse than regular soft drinks! I have been told that not only are they absolutely filled with caffeine, but sugar. And I will also die of a heart attack if I drink them.

My goal in this was to look into into these claims, especially in terms of how energy drinks might compare with other popular soft drinks and caffeinated beverages. I knew that these drinks probably wouldn't be considered "healthy", but is it true that energy drinks represent a significantly worse health hazard than everything else we're drinking?

This is part of an ongoing series, I have previously addressed some specific [anti-vaccination claims](#)¹. They all have the dual purpose of allowing me to learn more about these topics as well as the inform others (and provide references) about them. I firmly believe that the spread of bad information is worse than no information at all. If you find anything in here that is not based on fact (or at least scientific studies), please let me know.

NOTE: I plan on addressing Diet drinks in a separate one of these, in case you have comments/questions specifically regarding diet energy drinks. Also, I will not specifically address pesticide concerns about any herbal ingredients here, as that is planned for another essay.

Methodology

As I am not a scientist or doctor, I have done no original lab-based or statistical research as part of this article. Rather I have tried to find studies which may be an intended response (or investigation into) a claim, simply a study that contradicts the claim, or even science that completely confirms the claim. I will generally just quote from the studies in those cases. Occasionally I will use Wikipedia if I don't think the particular piece of information is controversial but is rather descriptive in nature (such as describing what a chemical might be). For the controversial bits, I will always look to find the source studies.

I have done my best to accurately present the data in an objective way. If you are reading this on the internet, all sources can be reached (as of writing here in November of 2009) via clicking on the links. If you are reading this via a printout, then the citation and URL for all sources is available in the footnotes sections for later checking.

If the reader disagrees with the results, I would definitely appreciate some feedback with other (preferably peer-reviewed) evidence they have. As always, anecdotal stories are not scientific evidence and do not contribute to the debate.

Audience

I've been asked a couple of times who a document like this is meant for. Part of it is for me (basically documenting my journey of finding out about the topic). The second audience is

really for those other followers of science who may have a friend or relative making a claim about the topic (in this case energy drinks) and want some resources to be able to back up with actual numbers or studies. Or perhaps they themselves are simply unsure about whether a claim is true or not (in some cases, they might be true). The final audience are those who are convinced of the truth of what is a, I believe the science shows, false claim. To those, I hope that you are open minded enough to consider the data. In some cases, your views might even get strengthened (for instance, there's no denying that non-diet energy drinks contain as much or more sugar than other soft drinks).

And it is for those reasons that I try to have so many references and links (perhaps to the point of ridiculousness). Through that I can hopefully be able to address even minor details of claims that could come up ("yes, but did you consider... ?").

I'm also looking for ways to make this more interesting...

Disclaimer

I am not a doctor, research scientist or medically trained in any way. Nothing in this document should be construed as medical advice.

The Claims

There are a variety of claims leveled against energy drinks, which can be grouped in a variety of ways. As far as I can tell (from speaking with people and searching the Internet), the main claims are:

- They have much higher levels of caffeine than other drinks
- They have much higher levels of sugar than other drinks
- They are filled with mysterious ingredients, including the unstudied herbal ones
- When they are mixed with alcohol, chaos ensues
- They destroy your teeth

An [example](#) that encompasses most of these can be found at the "Quality Health" site²:

Caffeine content in energy drinks range between 50 and more than 500 milligrams (for a 12-ounce cola drink it's 35 milligrams, and it's about 80 to 150 milligrams for a brewed 6-ounce cup of coffee). However, energy drinks are marketed as "dietary supplements" and the Food and Drug Administration's caffeine content limit of 71 milligrams per 12-ounce can doesn't apply. As a result, consumers remain in the dark about the dangers of energy drinks, which include:

- **Dental decay.** A study published in the journal *General Dentistry* revealed that high energy drinks have the potential to erode tooth enamel more than other drinks we're usually warned about such as sodas, sports drinks and root beer.
- **Energy highs and crashes.** In a study that investigated the energy drink consumption by college students (the key target demographic for energy drinks), 29 percent reported experiencing weekly jolt and crash episodes.

- **Headaches and heart palpitations.** In the same college study, 22 percent reported having headaches, and 19 percent had heart palpitations related to drinking the energy drinks.
- **Poor perception of intoxication.** Mixing an alcoholic beverage with an energy drink may help fight fatigue, but it reduces your ability to tell that you're drunk - even more than drinking alcohol on its own, according to a study out of Brazil. This puts you at a higher risk of problems such as driving while intoxicated.
- **Higher risk of injury.** In a Wake Forest study that also investigated energy drink consumption by college students, researchers found that combining alcohol with energy drinks dramatically heightened the risk of injury and other alcohol-related problems.
- **Increased risk taking.** If you consume six or more energy drinks a month, you have a three times greater risk of smoking cigarettes, abusing prescription drugs, or engaging in a serious physical fight. You're also twice as likely to abuse alcohol and smoke marijuana compared to people who don't drink energy drinks.

This article is one of the very few that actually cites their sources, which I have used as a basis to start.

Their sources (last updated 9/11/2009):

Wake Forest University Baptist Medical Center press release, "[Study Shows Energy Drink 'Cocktails' Lead to Increased Injury Risk](#)," Sept. 2007.
 Academy of General Dentistry press release, "[New Study Indicates That Popular Sports Beverages Cause More Irreversible Damage to Teeth Than Soda](#)," Feb. 2005.

Drug and Alcohol Dependence, 2009 Jan 1;99 (1-3):1-10 "Caffeinated energy drinks--a growing problem." Reissig CJ, Strain EC, Griffiths RR.

Nutrition Journal, Oct. 2007 6(35) "A Survey of Energy Drink Consumption Patterns Among College Students." Brenda M Malinauskas, Victor G Aeby, Reginald F Overton, Tracy Carpenter-Aeby and Kimberly Barber-Heidal

Alcoholism: Clinical and Experimental Research, 2006 30(4):598 - 605 "Effects of Energy Drink Ingestion on Alcohol Intoxication." Sionaldo Eduardo Ferreira, Marco Túlio de Mello, Sabine Pompéia, and Maria Lucia Oliveira de Souza-Formigoni

I was able to locate all of these and reference them within the main body of the article.

And now on to the specific claims.

Claim 1: Energy Drinks have significantly higher levels of caffeine than other drinks

Sample claims

Again from the [Quality Health article](#) mentioned above³:

Last year, scientists at Johns Hopkins University called for prominent labels to warn consumers of the possible dangers of energy drinks. "The caffeine content of energy drinks varies over a 10-fold range, with some containing the equivalent of 14 cans of Coca-Cola," says Roland Griffiths, Ph.D., a co-author of the article published in *Drug and Alcohol Dependence*. "Yet the caffeine amounts are often unlabeled and few include warnings about the potential health risks of caffeine intoxication."

From sixwise.com 's "[The 6 Top Dangers of Energy Drinks, and 5 Healthy Energy-Boosting Alternatives](#)"⁴:

1. Caffeine Intoxication

Energy drinks contain anywhere from 160 mg to 300 mg of caffeine, compared with 80 mg for a typical cup of coffee. While most adults can safely drink up to 200-300 mg of caffeine a day, many teens drink several energy drinks a day, sometimes in a short period of time.

Not surprisingly, a study by Johns Hopkins School of Medicine found that energy drinks can lead to caffeine intoxication, a condition that can cause nervousness, heart irregularities, increased blood pressure, insomnia, neurological symptoms and anxiety.

"The caffeine content of energy drinks varies over a 10-fold range, with some containing the equivalent of 14 cans of cola, yet the caffeine amounts are unlabeled and few include warnings about potential health risks of caffeine intoxication," the study's author said.

Sidebar comment: As far as I can tell, all of sixwise.com's article end with with a "solution" or "alternative" product to solve the problem listed in the article, which they conveniently link to so the person can buy it. It strikes me that all of the articles are written specifically with this in mind, but this is just my personal opinion.

What the science says

Reading those quotes you'll notice that both quote from a Johns Hopkins article, co-authored by Roland Griffiths. So it seemed like a good idea to locate this article and see what it had to say.

The article is:

Reissig, C.J., et al., Caffeinated energy drinks—A growing problem. *Drug and Alcohol Dependence* (2008), doi:[10.1016/j.drugalcdep.2008.08.001](https://doi.org/10.1016/j.drugalcdep.2008.08.001)

The only version I could find that did not require purchase was a [Google scholar cache](#) of http://www.keyetv.com/media/news/7ffc7fc1accb-5d80-4993-9e78-e985920e6762/caffeine_study.pdf, which is no

longer available. I apologize for any strange formatting. I've tried to correct bits that the Google conversion missed.

The study is a review and commentary on other studies (sort of a meta-study). For the most part, it's a review of the literature on **caffeine** in general.

With regards to caffeine levels (emphasis mine)⁵:

These drinks **vary widely in both caffeine content (ranging from 50 to 505 mg per can or bottle) and caffeine concentration (ranging from 2.5 to 171 mg per fluid ounce) (Table 1)**. For comparison, **the caffeine content of a 6 oz cup of brewed coffee varies from 77 to 150 mg (Griffiths et al., 2003)**.

This all looks to be factual information, but I would like to make some points about it. First, while they show the caffeine concentration for the energy drinks, they neglect to show it for coffee. If you do the math (77 to 150 mg for 6oz) you end up with 12.8 to 25 mg/oz. Yet, the caffeine concentrations they mention for energy drinks start as low as 2.5 mg/oz (but go up to 171, but more on that in a bit). Secondly who, outside of breakfast diner patrons who drink only a single cup, have ever consumed only 6 ounces of coffee? A Tall at Starbucks is already 12 oz.

I have reproduced a portion of the table they included in the study below (but I have added in 'brewed coffee' based on their information, though it is left out of their actual table):

	Ounces per bottle/can	Caffeine Concentration (mg/oz)	Total caffeine (mg)
Red Bull	8.3	9.6	80
Monster	16	10	160
Rockstar	16	10	160
Full Throttle	16	9	144
No Fear	16	10.9	174
Wired X505	24	21	505
Fixx	20	25	500
Coca Cola	12	2.9	34.5
Mountain Dew	12	4.5	54
Brewed Coffee	6	12.8 to 25	77 to 150

The first thing that probably strikes you is that 6 ounces (a very small cup) of coffee, can have nearly twice the caffeine as Red Bull! And it can have about equivalent to a standard 16 oz can of Monster or Rockstar, the other popular energy drinks. The actual concentration for brewed coffee is more than any standard caffeinated drink, so it seems to me slightly disingenuous and misleading to use it as an example of something with *less* caffeine.

And what about the huge volumes they mention (up to 505 mg, or 14 cans of Coke)? Well,

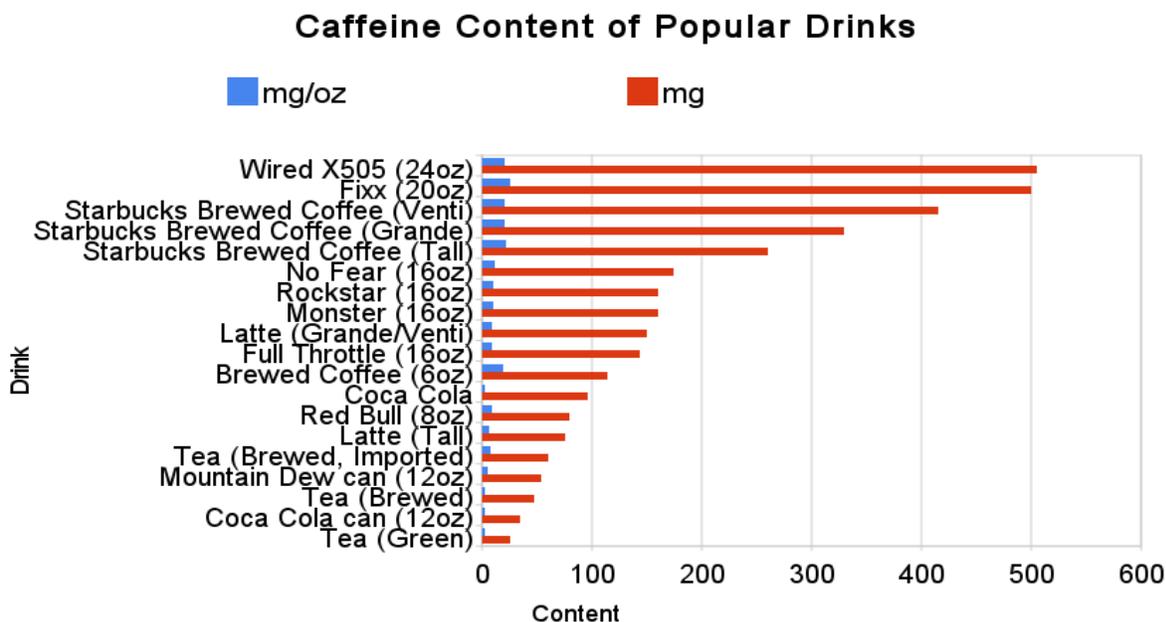
those are in drinks known as *Wired X505* and *Fixx*. Ever heard of them? Neither have I. So while nobody could actually disagree about the fact that numbers are true for them, they in no way represent the norm for energy drinks.

For more details on Starbucks (which I am using as representative of mainstream coffee shops) as well in tea (which people often bring up in caffeine conversations), I have produced portions of tables available at the [Energy Fiend](#) site. They are their "[caffeine database](#)" and "[the complete guide to Starbucks coffee](#)":

Drink	drink ounces	concentration (mg/oz)	total
Starbucks Brewed Coffee (Tall)	12	21.6	260
Starbucks Brewed Coffee (Grande)	16	20.625	330
Starbucks Brewed Coffee (Venti)	20	20.75	415
Latte (Tall)	12	6.25	75
Latte (Grande/Venti)	16/20	9.375/7.5	150
Coca Cola	33 (1 liter)	2.9	95.7
Tea (Brewed)	8	3.1	47
Tea (Green)	8	3.1	25
Tea (Brewed, Imported)	8	7.5	60

If you compare this to the previous table, you'll find that Starbucks brewed coffees (as with any brewed coffee) just blow energy drinks (except for the crazy 500 mg ones) out of the water. Espresso/latte is of approximately the same concentration and amount as standard energy drinks.

I have combined these tables and produced a chart which hopefully makes the comparison even more obvious



Continuing from the [same study](#), with regards to caffeine toxicity⁸:

Concern regarding the caffeine content of energy drinks is prompted by the potential adverse consequences of caffeine use. **One such adverse effect is caffeine intoxication, a recognized clinical syndrome included in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) and the World Health Organization's International Classification of Diseases (ICD-10)** ([American Psychiatric Association, 1994](#); [World Health Organization, 1992a,b](#)). Caffeine toxicity is defined by specific symptoms that emerge as a direct result of caffeine consumption. **Common features of caffeine intoxication include nervousness, anxiety, restlessness, insomnia, gastrointestinal upset, tremors, tachycardia, psychomotor agitation** ([American Psychiatric Association, 1994](#)) **and in rare cases, death** ([Garriott et al., 1985](#); [Kerrigan and Lindsey, 2005](#); [Mrvos et al., 1989](#)). The symptoms of caffeine intoxication can mimic those of anxiety and other mood disorders ([Greden, 1974](#)). **The consumption of energy drinks may increase the risk for caffeine overdose in caffeine abstainers as well as habitual consumers of caffeine from coffee, soft drinks, and tea.**

Basically, caffeine can make you hyper and could also have some other negative effects in some cases. So in this case energy drinks are not the culprit here any more (and in fact less in many cases) than other frequently consumed caffeinated beverages.

The full cite for the Garriott study referenced above is: Garriott, J.C., Simmons, L.M., Poklis, A., Mackell, M.A., 1985. [Five cases of fatal overdose from caffeine-containing "look-alike" drugs](#). J. Anal. Toxicol. 9, 141-143

From the abstract⁹:

Five cases of death from ingestion of "look-alike" dose forms are reported. "Look-alikes" are widely used non-prescription drugs sold as appetite suppressants or stimulants. Three of the cases had taken caffeine/ephedrine combinations, and two had taken caffeine only. All had lethal concentrations of caffeine detected in the blood (130 to 344 mg/L), and three had high ephedrine concentrations from 3.5 to 20.5 mg/L. Caffeine and ephedrine were measured in body fluids and tissues (when available) by SIM gas chromatography/mass spectrometry (GC/MS) after extraction with diethyl ether.

So in these already rare cases, 3 were because they had taken ephedrine along with the caffeine and the other two had taken lethal level doses of caffeine. In other words, they did not just have a Red Bull and die.

And finally (from the Ressig study above):

The absence of regulatory oversight has resulted in aggressive marketing of energy drinks, targeted primarily toward young males, for psychoactive, performance-enhancing and stimulant drug effects. There are increasing reports of caffeine intoxication from energy drinks, and it seems likely that problems with caffeine dependence and withdrawal will also increase.

One limitation of the present review is that the great majority of the knowledge about caffeine intoxication, withdrawal, and dependence is derived from studies of coffee consumption. However, studies that have examined these phenomena in the context of caffeine delivered via soft drinks or capsules have shown similar results (e.g. [Juliano and Griffiths, 2004](#); [Strain et al., 1994](#)).

Thus, there is no reason to suppose that delivery of caffeine via energy drinks would appreciably alter these processes.

Drinking too much caffeine can be bad, regardless of its source. My can of Monster actually contains the warning:

Consume responsibly - Limit (3) cans per day. Not recommended for children, pregnant women or people sensitive to caffeine.

Lest you think that the only thing beneficial from caffeine is the energy boost, a [WebMD article](#) has the following¹⁰:

After analyzing data on 126,000 people for as long as 18 years, **Harvard researchers calculate that compared with not partaking in America's favorite morning drink, downing one to three cups of caffeinated coffee daily can reduce diabetes risk by single digits. But having six cups or more each day slashed men's risk by 54% and women's by 30% over java avoiders.**

...

In recent decades, some 19,000 studies have been done examining coffee's impact on health. And for the most part, their results are as pleasing as a gulp of freshly brewed Breakfast Blend for the 108 million Americans who routinely enjoy this traditionally morning -- and increasingly daylong -- ritual. In practical terms, regular coffee drinkers include the majority of U.S. adults and a growing number of children.

"Overall, the research shows that coffee is far more healthful than it is harmful," says Tomas DePaulis, PhD, research scientist at Vanderbilt University's Institute for Coffee Studies, which conducts its own medical research and tracks coffee studies from around the world. "For most people, very little bad comes from drinking it, but a lot of good."

Consider this: **At least six studies indicate that people who drink coffee on a regular basis are up to 80% less likely to develop Parkinson's, with three showing the more they drink, the lower the risk. Other research shows that compared to not drinking coffee, at least two cups daily can translate to a 25% reduced risk of colon cancer, an 80% drop in liver cirrhosis risk, and nearly half the risk of gallstones.**

Summary

Energy drinks contain caffeine in varying numbers. If your goal is to get a boost of energy, they are one path to that. But coffee is actually a much "better" source of caffeine to get the extra kick. The average energy drink does contain a good amount more caffeine (4-5x) than the average soft drink (Coke, Pepsi, etc). So they are somewhere in the middle. So if the argument you are making or are hearing is that energy drinks represent "worse" caffeine levels than anything else, the argument really does not hold water.

The many thousands of Americans who start their day in a coffee shop are getting as much or more caffeine than those who start their day with an energy drink such as Red Bull or Monster. The high-caffeine (400+ mg) energy drinks do exist, but it is my view that they don't represent the mainstream assuming you can even locate them.

In terms of the the caffeine itself, there have been medical studies demonstrating that it can raise your heart rate and make you restless or anxious and in extremely rare cases of high doses, lead to death. It has also been shown to be very beneficial for helping to prevent some diseases. So partake wisely.

Claim 2: Energy Drinks have significantly higher levels of sugar than other drinks

Sample claims

Somewhat surprisingly, I found it difficult to find many popular articles addressing the sugar content in energy. One of the few that I happened to see is from the previously mentioned sixwise.com "[6 Dangers of Energy Drinks](#)" article:

Dependence

Energy drinks contain a lot of sugar (at least 7 teaspoons for each can)

So I guess suffice to say is that the claim is that energy drinks have a lot of sugar.

What the science says

There isn't much to dispute here. Non-diet energy drinks contain similar concentrations of sugar as other standard soft drinks.

I have reproduced a portion of [another table](#) from the ever-useful "Energy Fiend" site¹¹:

Drink	Ounces	Sugar Ounces	oz/g
Cherry Coke	12	42	3.50
Chocolate Milk	8	24	3.00
Clearly Canadian daily ENERGY	20	30	1.50
Club-Mate	16.9	27	1.60
Coca-Cola Blak	8	12	1.50
Coca-Cola C2	12	18	1.50
Coca-Cola caffeine free	8	27	3.38
Coca-Cola Classic	12	40.5	3.38
Cocaine Energy Drink	8.4	18	2.14
Monster	16	54	3.38
Monster Lo-Carb	16.9	7	0.41
Red Bull	8.46	27	3.19
Rockstar	16	62	3.88
Starbucks Bottled Frappucino	9.5	33	3.47
Starbucks Double Shot	6.5	17	2.62
Starbucks Grande Caffè Latte	16	20	1.25

Assuming this table is accurate, energy drinks are about average when compared to Coke or even bottled Frappucino. An individual can of Monster will have more sugar due to its higher volume, but the concentration is the side (i.e. someone having a liter bottle of Coke would actually get more caffeine than from a standard can of Monster).

There is also interesting diagram of calorie and sugar content of different drinks available at <http://www.flickr.com/photos/25541021@N00/3770804689/sizes/o/>

Summary

Energy drinks have about the same sugar by volume as other soft drinks. Because most energy drinks (other than Red Bull) come in 16 oz cans, an actual can will tend to have more actual sugar than a can of Coke or Pepsi.. So if sugar is your worry, then you can have the sugar-free versions (the "dangers" of which I will address in a later article), which is the path I tend to take.

In other words, it is not true that energy drinks contain significantly more energy than other soft drinks. The effects of too much sugar are well known and I don't see any reason to go into them here.

Claim 3: The "herbal" and otherwise mysterious ingredients in energy drinks have unknown side effects

Sample Claims

From ezinearticles.com's "[The Dangers of Energy Drinks](#)" (emphasis my own)¹²:

The problem with many of these energy drinks is not what you know is in them but what you don't know or aren't familiar with. While one of the most common ingredients in energy drinks is caffeine, this is only the tip of the iceberg as far as problems go ... But what about the other common ingredients in energy drinks, the ones you probably never heard of? We are just beginning to learn of the problems associated with some of these ingredients, especially when mixed with other things, such as drugs.

To give you an example of what I am talking about, **guarana, which is a very popular ingredient in many energy drinks, is a central nervous system stimulant. What you don't know is that consuming these drinks and then mixing them with drinks containing ephedrine or diet pills can be very dangerous.**

Another popular ingredient in energy drinks is **taurine, which is actually something that we naturally get from foods that contain vitamin B6. We normally get more than enough taurine in our diet and the extra amount that we get from these energy drinks, depending on how much we consume, can become toxic in our systems.**

But even worse than what we know about the ingredients in these energy drinks that can be harmful, especially if mixed with other items, is what we don't know. **The FDA has all but admitted that many of the ingredients in most popular energy drinks have not been fully tested as to their degree of "safeness."** This is not to say that these ingredients are good or bad, simply that we don't know. When you combine these factors with what we do know, that caffeine and some ingredients in these energy drinks can be harmful, **it is almost like playing Russian Roulette with a fully loaded revolver to your head,** especially if you're like most people who consume energy drinks. It is common knowledge that most energy drink consumers are not casual users and consume large quantities of these drinks. This fact just makes the consumption of these drinks that much more dangerous.

The article is somewhat balanced, but the writer does something misleading by talking about guarana and then immediately going into caffeine dangers, which I guess is supposed to lead us to make a connection between the two.

It seems a bit unfair to bring up ephedrine and diet pills in combination of energy drinks, as they are dangerous even without mixing them with drinks. I believe they are referring to the incidents (mention in the caffeine section) of 3 people dying after having consuming a lot of diet pills mixed with caffeine. That same study mentions the 2 deaths where were reported to be exclusively from a large amount of caffeine.

And from a blog called Global Healing Center, an entry entitled "[The Health Dangers of Energy Drinks](#)"¹³:

My main concern with the use of the herbs in these drinks is their source. The mass manufacturers of energy drinks are not required by law to list whether or not the herbs they use, have been sprayed with toxic [pesticides](#), irradiated or watered with contaminated water supplies, so there is no telling what other toxins are contained in these drinks and whether or not these herbs will have a negative effect on the body."

"The bottom line concerning energy drinks is that medical professionals simply do not know the long-term effects of consuming these beverages. It is known, however, that large amounts of [sugar](#) and caffeine are harmful to our bodies. For people to utilize energy drinks during exercise or other strenuous activity compounds the problem of dehydration, and does nothing to provide the body with any necessary nutrients or fluids."

It's hard to comment on this specifically as the entire "argument" is "eh, we dunno... they might or might not be dangerous, so you should be afraid of them". We already know you shouldn't take vast quantities of caffeine and sugar. But it doesn't require energy drinks to do that, just use common sense.

What the science says

Addressing this is made somewhat more difficult by the fact that most of the actual scientific articles sounds remarkably like the claims above. Namely, the main gist is "we don't know" what the effects of guarana, etc are but express a general sense of dis-ease about them.

From the previously quoted Reissig et al study¹⁴:

The main active ingredient in energy drinks is caffeine, although other substances such as taurine, riboflavin, pyridoxine, nicotinamide, other B vitamins, and various herbal derivatives are also present ([Aranda and Morlock, 2006](#)). The acute and long-term effects resulting from excessive and chronic consumption of these additives alone and in combination with caffeine are not fully known

But a much less wish-washy conclusion can be found in the 2008 study "[Safety Issues Associated With Commercially Available Energy Drinks](#)", published in the Journal of the American Pharmacists Association, which concluded¹⁵:

Conclusion: The amounts of guarana, taurine, and ginseng found in popular energy drinks are far below the amounts expected to deliver either therapeutic benefits or adverse events. However, caffeine and sugar are present in amounts known to cause a variety of adverse health effects.

The approach I will take is to try to take each of the ingredients in turn, and see if there are any known dangers of them or what their purpose is.

Ingredients of example energy drink (Monster Lo-Carb in this case)

I have **highlighted in orange** the chemicals brought up in the "claim" section.

- **Carbonated water** - I can't imagine that anybody has an issues with this ingredient
- **Glucose** - aka sugar. Sugar has been addressed above and isn't exactly a mystery ingredient.
- **Citric Acid** -
 - Adds an acidic/sour taste to drinks.
 - Unbuffered excessive amounts can [contribute to eroding tooth enamel](#)¹⁶.
- **Natural flavors** - Adds flavor? Not specific enough to comment.
- **Taurine**
 - Along with Zinc, helps with [retinal function](#)¹⁷.
 - Aids in bile production
 - One of the fortifying agents of [baby formula](#)¹⁸, at least [as far back as 1985](#)¹⁹.
 - Additionally it acts as a mild nervous system depressant similar to and in [conjunction with ethanol](#)²⁰ (alcohol).
 - [Approximately 2g in a 16oz can](#) [Blog link]. This is about the amount that people who take it as a supplement would use.
 - It does not seem true that it comes with foods containing B6, but rather than [B6 is required for the body to synthesize it](#)²¹ [anyvitamins.com].
 - The ["toxic" level for taurine has been set to around 1000mg/kg of body weight](#), but mainly arbitrarily as there is no strong evidence to indicate even this level would be harmful. So for a 160 pound person, that would be 72kg or 72g daily of taurine (36 16oz cans!)²².
- **Sodium Citrate** -
 - Adds a tart flavor. It can be used as an antacid (it's what you get when [Alka Seltzer](#) hits water²³).
- **Color Added** -
 - There's probably conspiracy theories about food colorings, but I'll assume for now that there is no argument about them here.
- **Panax Ginseng root extract** -
 - Also known as "Asian ginseng". Studies vary on whether or not this has any effects whatsoever, but is considered safe. It [might](#)²⁴ help [relieve chronic stress](#)²⁵.
- **caffeine** -
 - Provides energy. Addressed above.
- **sorbic acid** -
 - Used as a [preservative](#)²⁶ [Wikipedia link].
 - Occasionally people can have a mild and transient [contact reaction](#)²⁷ to it.
- **sucralose** -
 - Sweetener (since this is the diet one).
 - Commonly known as Splenda.
 - It has [no effect](#)²⁸ on blood-sugar in diabetics.
 - It does [not appear to be carcinogenic](#)²⁹ (also [here](#)³⁰).

- It was approved in 1999 after over [100 studies demonstrated its safety](#)³¹ (the linked article also addresses the common fallacy of linking the chlorination of sugar to produce sucralose with pesticides).
- There have been a report of it being a [potential migraine trigger](#)³² (this is a clinical note, not a study).
- **benzoic acid**
 - Used as a [preservative](#)³³ [Wikipedia link].
 - Found [naturally in berries](#)³⁴
 - The metabolizing of it leads to a [reduction in creatinine, glutamine, urea and uric acid](#) in the body as it is released in urine (it does not accumulate in the body)³⁵.
 - Average consumption is between [2-28 times less than the maximum](#) "tolerable" intake (safe reference as above).
- **L-carnitine**³⁶ [Wikipedia link]
 - Acts as an antioxidant.
 - Found naturally in red meats, legumes, vegetables, grains, and many others (from Wikipedia link)
 - Only [5-18% is available](#)³⁷ for use by the body following ingestion as an additive (versus 75% availability from eating the foods above).
 - When ingested, appears to have [no decrease in recovery time from intense exercise](#)³⁸.
- **niacinamide**³⁹ [Wikipedia link] (it is also known as nicotinamide)
 - Part of vitamin B group (B3)
 - Can potentially assist in [alleviating Type I diabetes](#) (and also next link), but can [become toxic at 3g/day](#)⁴⁰. *The ingredient label lists about 40mg of B3 [Blog link], well below 3g (you would have to have 150 in one day to reach this level).*
 - Not to be confused with [nicotinic acid](#).
 - Also used against inflammation and anxiety
- **acesulfame potassium**⁴¹ [Wikipedia link]
 - Another non-caloric sweetener (aka Acesulfame K)
 - See the reference for the 5th bullet on sucralose for safety studies
- **sodium chloride**
 - Standard table salt (NaCl)
- **glucuronolactone**
 - Considered one of the "active" ingredients in energy drinks (along with caffeine and taurine)
 - It's unclear to me what its exact function is, but it might be a stimulant (apparently it's part of what produces a "high" feeling with tea)
 - It's mentioned specifically in studies that [looked](#)⁴² at the [efficacy](#)⁴³ of energy drinks.
- **inositol** (most likely myo-inositol)
 - A [polyol \(6-carb alcohol\), once known as B8](#) [Wikipedia link] until it was discovered that the body is able to create it on its own
 - [Naturally occurring](#) in fruits, beans, grains and nuts, and as a result also prevalent in fruit-based drinks⁴⁴.
 - Important structure component for cells and neural pathways
 - Has been found effective for [treatment of OCD, panic attacks and depression](#)⁴⁵
- **guarana**⁴⁶ [Wikipedia link]
 - In its raw form, has about twice the caffeine per bean by percentage than coffee beans (from Wikipedia link).
 - At high enough doses, shown to provide some [improvements in cognition in humans](#)⁴⁷ (separate from the caffeine itself in the guarana plant)

- Not shown to [have any toxic effects](#)⁴⁸
- [seed extract](#) (presumably grapefruit) [Wikipedia link]
 - Possibly has [some anti-oxidant properties](#)⁴⁹
 - Helps [suppress colon cancer](#)⁵⁰
- [pyridoxine hydrochloride](#)⁵¹ [Wikipedia link]
 - A version of vitamin B6 (about 4mg in 16oz can)
 - Helps promote red blood cell production
 - Most comes from milk and meat products
 - Most beneficial at levels between 101 and 150 mg, but at *chronic* daily levels starting at 200mg (50 cans) [but really around 1000 mg](#) (250 cans) can cause temporary sensory and nerve damage⁵².
 - So to directly address the original claim... yes this can be "toxic" but only in very very large doses.
 - There was a study that claimed doses of 10mg could be dangerous, but this study has been discredited
- [riboflavin](#)⁵³ [Wikipedia link]
 - A version of vitamin B2 (about 4mg in 16oz can)
 - Common in milk, cheese, leafy green vegetables, liver, kidneys, soybeans, yeast, almonds
 - Not very fat soluble, so not toxic via ingestion (unabsorbed amounts over 20mg or so come out as bright yellow urine)
- [maltodextrin](#)⁵⁴ [Wikipedia link]
 - Provides some slight sweetness
 - Derived from starch (to get glucose chains)
 - Even in cases where it is made from wheat, the [processing removes all of the gluten](#)⁵⁵.
- [cyanocobalamin](#)⁵⁶ [Wikipedia link]
 - One of the most common versions of vitamin B12
 - about [12 micrograms](#) in a 16 oz can.
 - Apparently B12 can [help with folate levels in anemia](#)⁵⁷.

So that's that... it does not appear that any of these would represent some shocking health hazard based on the science. Some of them in very large levels could prove toxic, but the same can be said of anything including water. In the cases of things like guarana and taurine, the study above found that most likely the levels (regardless of the potential benefits of the chemical itself) in energy drinks are not high enough to have any noticeable effect.

There was an additional claim about pesticides in the herbal ingredients or them being watered with toxic water. This is one of those that is difficult to address because it is simply thrown out there as a "what if!?" hypothetical. So on that note I will leave it for a later essay devoted to pesticides (kind of a cop out I suppose, but I think it would take quite a bit more time to find any evidence either way).

Summary

Hard to say here. I did not find anything in the research about the ingredients that would lead me to believe they are dangerous (especially in the levels in an energy drink). In fact, most are more beneficial than I was aware of. And this is without actually attempting to specifically look for benefits of the ingredients or energy drinks in general. It does seem true that the "long term" effects of the full complement of ingredients has not been done, but I don't know that it is seen as being warranted by the scientific community. Red Bull was introduced in Austria in the late 80s, so that could be the place to look.

For the cases where the original claim said that some of the herbal and amino acid ingredients could become toxic, the levels are significantly higher than a person could reasonably consume in a day via energy drinks. For taurine specifically, it is a damn crucial chemical!

Claim 4: The dangers increase when mixed with alcohol

Sample Claims

From the [sixwise article mentioned](#) previously:

Heart Failure

Energy drinks are commonly used as mixers for alcoholic drinks in bars and nightclubs, and there are now new pre-mixed alcoholic energy drinks on the market.

The dangerous combination of mixing energy drinks, a stimulant, with alcohol, a depressant, has proven deadly. "It is scary to think that these energy drinks are being used as a mixer with vodka and whiskey," said David Pearson, a researcher in the Human Performance Laboratory at Ball State University. "You are just overloading the body with heavy stimulants and heavy depressants." The resulting mix can lead to cardiopulmonary and cardiovascular failure.

What the science says

Also again from the [Reissig article mentioned above](#) in the section on caffeine, but this time relating to alcohol consumption:

There is an association between the heavy use of caffeine and the heavy use of alcohol ([Istvan and Matarazzo, 1984](#); [Kozlowski et al., 1993](#)), and the ingestion of energy drinks in combination with alcohol is becoming increasingly popular ([O'Brien et al. 2008](#); [Oteri et al., 2007](#)), with 24% of a large stratified sample of college students reporting such consumption within the past 30 days ([O'Brien et al., 2008](#)). In the previously mentioned survey of 496 college students, 27% reported mixing alcohol and energy drinks in the past month. Of those that mixed energy drinks and alcohol, 49% used more than three energy drinks per occasion when doing so ([Malinauskas et al., 2007](#)). In a survey of 1253 college students, energy drink users were disproportionately male and consumed alcohol more frequently than non-energy drink users ([Arria et al., 2008](#))

And from a 2006 study "[Effects of Energy Drink Ingestion on Alcohol Intoxication](#)" which looked to see if energy drinks actually had any effect on the intoxication (versus perception of intoxication)⁵⁸:

Conclusions: Even though the subjective perceptions of some symptoms of alcohol intoxication were less intense after the combined ingestion of the alcohol plus energy drink, these effects were not detected in objective measures of motor coordination and visual reaction time, as well as on the breath alcohol concentration.

And from the discussion section (emphasis my own):

Riesselmann et al. (1996) suggested that users of alcohol plus energy drinks might have their judgment affected by the reduced subjective sensation of intoxication, thus increasing the probability of their becoming involved in accidents after the combined ingestion of these drinks. Besides, the increase in the alcohol palatability reported by many users of energy drinks **could lead youth toward a higher consumption of alcoholic beverages**

The Riesselmann study referenced above appears to be of [single case study](#) of a DUI in Germany
From the abstract (PubMed translation of the original German)⁵⁹:

In the case discussed here-both the 20-year-old car driver and his passenger suffered not inconsiderable injuries-an alcohol concentration of 1.2 per mille was found at the time a blood sample was taken. Furthermore, a caffeine content of 1.5 micrograms/ml was noted. A value also reached after drinking a cup of filter coffee. In contrast, values of 2 to 10 micrograms/ml are reached when caffeine is used for therapeutic purposes. Values of more than 15 micrograms/ml are considered toxic. The measured caffeine content was thus fully insignificant. The same also applies to the "active ingredients" (taurine, glucuronolactone) contained in the beverage "Red Bull". Another assumption that, namely, the effect of alcohol can be offset by such beverages could lead to a situation in which young people incorrectly assess their ability to drive after imbibing alcohol and fitness drinks.

The 1.2 per mill, would correspond to .12 per cent, certainly over the legal limit but not ridiculously so.

So the general idea here is that if you consume some number of energy drinks with alcohol, you will feel less impaired than you actually are and so might either consume more alcohol or otherwise make dangerous decisions (DUI).

I suspect the majority of energy drink consumption is not in combination with alcohol and that generally the alcohol will be in larger volumes than in this test. But that is purely my own conjecture.

Summary

This seems to be scientifically valid concern (though to what extent it is not clear). If you are going to consume energy drinks with alcohol, be aware that your subjective experience of "being drunk" may be affected. Granted, once you have reached a certain point in your alcohol consumption that ability to judge will go out the window anyhow. I think the danger is more going to be at those borderline (~.10%) cases where the person is not ridiculously drunk but is in the range of DUI.

Claim 5: Energy drinks destroy your teeth

Sample Claims

From the "[Quality Health](#)" article referenced above:

- **Dental decay.** A study published in the journal General Dentistry revealed that high energy drinks have the potential to erode tooth enamel more than other drinks we're usually warned about such as sodas, sports drinks and root beer.

And from the "[Yale-New Haven Children Hospital](#)" general info site⁶⁰:

According to the study cited in General Dentistry, the Academy of General Dentistry's clinical, peer-reviewed journal, enamel damage caused by non-cola and sports beverages was 3 to 11 times greater than cola-based drinks.

"A study by the University of Maryland revealed that regular long-term use of these beverages may cause irreversible damage to dental enamel – the thin, outer layer that helps preserve the tooth's structure and prevent decay."

Lead author Dr. Anthony von Fraunhofer, professor of biomaterials science at the University of Maryland Dental School, exposed tooth enamel from cavity-free molars and premolars to a variety of popular sports beverages including energy drinks, fitness water and sports drinks and cola and non-cola beverages – such as bottled lemonade and canned iced tea. The tooth enamel was steeped in the drinks for a total of 14 days, and weighed every 24 to 48 hours. The solution's acidity was checked, and solutions were changed daily. The exposure time was intended to simulate the effects of normal beverage consumption over about 13 years.

While all the drinks produced some enamel damage, von Fraunhofer found **the most wear occurred, in descending order, from lemonade, energy drinks, sports drinks, fitness water (often with citrus flavors), ice tea and cola**. Von Fraunhofer said most cola drinks contain acids, but energy and sport drinks also contain other organic acids that can speed up damage to the enamel.

To be balanced, they also include a response to that study:

"The study from Maryland uses an experimental approach that takes the tooth out of the mouth and uses a non-real-world situation to see if beverages have an impact on tooth weight," said Craig Horswill, senior research fellow at the Gatorade Sports Science Institute. He pointed to another study, published in the European journal Caries Research in 2002, that found no relationship between sports-drink consumption and dental erosion in more than 300 athletes.

What the science says

The study being referenced is:

von Fraunhofer JA, Rogers MM. [Effects of sports drinks and other beverages on dental enamel](#). Gen Dent. 2005 Jan-Feb;53(1):28-31. PubMed PMID: 15779219.

From the actual study summary⁶¹:

Enamel dissolution occurred in all of the tested beverages, with far greater attack occurring in flavored and energy (sports) drinks than previously noted for water and cola drinks. No correlation was found between enamel dissolution and beverage pH. Non-cola drinks, commercial lemonades, and energy/sports drinks showed the most aggressive dissolution effect on dental enamel. Reduced residence times of beverages in the mouth by salivary clearance or rinsing would appear to be beneficial.

I found it interesting that actually lemonade was the worst of the bunch. The response above should also be noted (taking into account that the guy is from the "Gatorade Sports Science Institute") that in the real-world, your teeth are not bathed continuously in the drink for 14 days days (this type of study is known as an "in vitro" study), and that at least one other study has actually found no relationship in the world world with tooth decay by sports drinks.

Additionally, from a [study published by the American Journal of Dentistry](#)⁶²:

Furthermore, although there is much in vitro evidence that acidic drinks such as wine, fruit juices and carbonated soft drinks have erosive potential and there are relationships between consumption of these drinks and erosion, only one study has reported an association between sports drinks and dental erosion. Other factors such as drinking habit and salivary production may be more important determinants of dental erosion.

Basically, this one in vitro study has found a dental erosion correlation, but when looking at actual people there isn't much there.

Summary

This one seems somewhat inconclusive. Basically, studies testing direct bathing of teeth in energy and sports drinks show tooth decay. Evaluations of actual do not appear to relate equivalent amounts of decay due to other factors. So, swallow regularly I suppose.

Conclusion

As part of my research, I was not looking to prove that energy drinks were "good" for you, only that they were not as bad as some people claim. The look into the ingredients did have the side effect of definitely making want to continue drinking them (even if the quantities of the ingredients might not be enough to offer their claimed benefit). In any case, it seems unfair to say that they are *any worse* than the beverages (coffee, soda, etc) consumed by the same people making the claim the energy drinks represent something akin to a narcotic. And depending on which axis their claim is about (i.e. caffeine levels, sugar, acidity, etc), energy drinks are actually *better/lower* than commonly consumed drinks that are considered more mainstream, such as a coffee from Starbucks or a Coke. Unless all you drink is water...

In a sense, even the naysayers have been swayed by the marketing ("it gives you wings!") into believing that energy drinks are full of mysterious substances wreaking havoc on the body. The claims don't appear to me to hold much water and in some cases are exactly the opposite as claimed. I'm going to continue to drink my much-loved Monster Lo-Carb with knowledge that soft drinks in general are not the best thing in the world, but that energy drinks are really no worse.

The reader can decide if they agree with my conclusions.

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