



CHEMISTRY CHANGES EVERYTHING

Do Energy Drinks *really* give
you wings?

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CITIES (*Chemistry and Industry for Teachers in European Schools*) is a COMENIUS project that produces educational materials to help teachers to make their chemistry lessons more appealing by seeing the subject in the context of the chemical industry and their daily lives.

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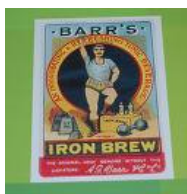
ENERGY DRINKS – WHAT ARE THEY AND DO THEY *REALLY* GIVE YOU WINGS?



Introduction

Energy drinks are soft drinks which claim to provide energy to the consumer to improve physical activity, compared to normal soft drinks. Conventional soft drinks provide refreshment, usually in a tasty form. The energy content of such drinks is measured by its so-called calorific value. The energy drinks which we will consider in this topic are designed to increase a user's physical performance and mental alertness. Other additives such as vitamins, caffeine and herbal supplements are also usually included amongst the ingredients.

When did this all begin?



The first energy drink to come on the market was produced in Scotland and sold under the name "Iron Brew" – this was as far back as 1901. The modern version is now called "Irn Bru" and its advertising slogan claims that it's "Made In Scotland, from Girders!"



TOP LEFT: One of the original "Iron Brew" labels

BOTTOM LEFT: A modern "Irn Bru" can with Russian labelling

Also in the UK, "Lucozade" hit the market in 1929. Perhaps one of the most famous brands now on sale is "Red Bull". This was first available in Austria from 1984.

Many of the large multinational beverage manufacturers have their own version of these drinks on sale across the globe. Numerous other brands have come and gone over the years, with varying degrees of sales success.

So, where's the Chemistry?

Well, largely in the cocktail of chemicals listed as ingredients! The typical list of ingredients in this type of drink may well contain some or all of the following:

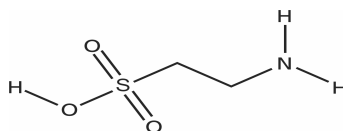
Taurine	Ginseng	Inositol
Glucuronolactone	various B vitamins	Carnitine
Caffeine	Guarana	Ginkgo
Maltodextrin	Creatine	Yerba Mate
Herbs		

PLUS, the more usual ingredients: water, sugar and carbon dioxide.

So what roles do these ingredients perform? Well, to go into real detail would take for ever, but here's a brief resumé of the effects of just a few:



Taurine (2-aminoethanesulfonic acid), C₂H₇NO₃S



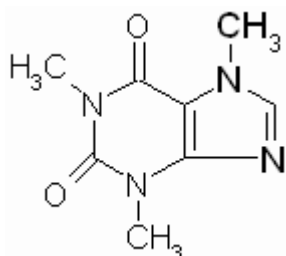
This is sometimes called an amino acid, but strictly speaking this is not correct. Amino acids must contain an amino group (-NH₂) **plus** a carboxylic acid group (-COOH). Taurine *DOES* have the amino group but *does not* have the carboxylic acid group. It does have a sulfonic acid group though, making it somewhat more acidic than if a carboxylic acid group was present. The human body produces taurine from the amino acid cysteine.

Taurine is a natural product, which is present in milk. It was first isolated from the bile of a bull in 1827. This explains the origins of its name: from taurus (latin for bull.) Nowadays, it is produced synthetically from ethane, ammonia and sodium sulfite.

It is an important antioxidant and has benefits relating to muscle contraction and has been found to reduce muscular cramps. There are conflicting claims as to its effect on the human blood pressure. It regulates the water amount in the muscle cells. This contributes to an effective protein synthesis.

Typically, an average can of energy drink could contain up to 1000mg of taurine (i.e. up to one gram.)

Caffeine $C_8H_{10}N_4O_2$



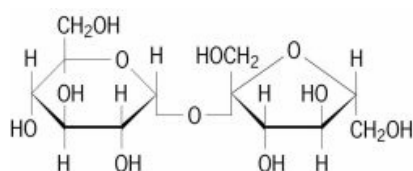
Caffeine is a bitter, white, crystalline, xanthine alkaloid which is present in a wide variety of vegetable origins, such as beans, nuts, leaves, berries etc.

The stimulant properties of caffeine have been known for many years.
 Typical content: 80mg per can (*Red Bull*)

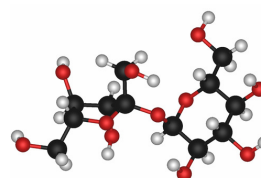
Interestingly, whilst both caffeine and taurine when taken alone have little effect on heart rate, when taken **together**, as they are in energy drinks, the stroke volume increase noticeably.

Sugar (sucrose, saccharose, table sugar etc) $C_{12}H_{22}O_{11}$

Sugar is a white, crystalline powder with an appealing, sweet taste. It is a disaccharide, which occurs naturally in numerous plants, most commonly as cane sugar and sugar beet. The molecule consists of two monosaccharide fragments: glucose and fructose; indeed, hydrolysis of sucrose yields these two monosaccharides.



or



Sucrose has a relatively high calorific value, 4kCal per gram (17kJ per gram). This is its purpose in energy drinks. Unfortunately, as it is a disaccharide, it releases its energy relatively slowly. The body has to wait for the sucrose to be hydrolyzed before the energy can be accessed. For this reason, some drinks manufacturers are turning to the use of high fructose corn syrup or simply glucose.

A typical sugar content in energy drinks is between 10.5-13.0 grams per 100mL, which is similar to many other carbonated drinks like *Coca-Cola* or *Fanta*, but some can be as high as 27 grams per 100mL, such as *Hype*.

Sugar-free versions of many of these drinks are also now available, although there must be some doubt as to whether these can truly claim to provide energy, in the same way as their sugar-based predecessors!

So you want to try something out?

Try the taste of various energy drinks. See which you like best. Try them after exercise. Compare the taurine, caffeine and sugar contents of each – you'll be surprised at what you find! This information is readily available on the web.

To make your own energy drink, have a look at:

http://hubpages.com/hub/Manufacture_your_own_energy_drink

How are these drinks made?

The actual details are a closely-guarded secret, but most manufacturers will probably follow a similar procedure. This is likely to be to rely on the overseas manufacturer to provide water, to a specified composition and then to mix in concentrate supplied from the home company. Bottling/canning and distribution will be left to the individual country-based manufacturer. More details on this are given in the article on "Coca-Cola" elsewhere in this module. For convenience, this is duplicated below, on the basis of "Coca-Cola" manufacture:

Now that Coca-Cola is sold worldwide, it is essential that the bulk is reduced for ease of transport. Consequently, the water, sugar and carbon dioxide are added in the county of production. The remainder of the ingredients are shipped abroad by the Coca-Cola Company as a syrup concentrate, which is blended with the remaining ingredients before bottling or canning. This also helps to protect the composition of the "secret ingredient".

Steps must be taken to ensure that the water is always of the same composition to that specified by the Coca-Cola Company. If this was not done, the finished article would be different, depending on where it was produced. This could include filtration, sterilization of the water by chlorine and/or ozone, addition of certain minerals, such as magnesium sulfate, potassium chloride etc. and deodorizing.

What are the benefits/risks?

Apart from the obvious refreshing qualities these drinks possess, they also rehydrate athletes – i.e. they help to replace vital liquid which is lost as perspiration during strenuous physical exercise. This is not simply a matter of taking in water. It is also important to take in minerals, to replace those lost on the release of perspiration. For this reason, many energy drinks are *isotonic* – they help to maintain the right electrolytic balance of the bloodstream. Without this, there is a risk of the body's natural osmotic processes being disturbed.

There are many other benefits, such as energy replacement – hence the name '*energy drink*'. They improve mental awareness and can temporarily stave-off the need for sleep. They also help to calm the mental recovery process of the athlete during the recovery period.

Many sportsmen optimize their performance with the aid of taurine. Weightlifters for example use taurine to alleviate their muscle fatigue. Taurine also regulates the water amount in the muscle cells. This contributes an effective protein synthesis. Marathon runners use taurine to increase the stroke volume of their heart.

Many adverse effects have been reported by users, although possibly insufficient to show causal links. Some of these include: arrhythmia, upset stomach, increased need to urinate, sleeplessness, increased irritability. Drinks with high energy content usually contain high levels of sugar (or sugar derivatives). This alone can lead to obesity, tooth decay or even certain forms of diabetes.

It has also been suggested that the combination of energy drinks with alcohol has detrimental effects.

There are many web-based articles on benefits and risks (see later.)

Whilst there are many beneficial effects of taking energy drinks, it is certainly safe to say that they do not actually *give you wings*. Drinking too many in a short space of time, or in combination with alcohol or other caffeine/taurine-containing products, may give one a feeling of well-being. This has been likened to a heightened sense of euphoria – possibly *creating the illusion* of feeling as though one is flying!

More medical research would be welcomed in this particular area.

Future developments

New flavours,

New formulations/ingredients to decrease dependency

New formulations/ingredients to increase speed of recovery

Improved packaging for ease of carriage during sporting activity

Interested by what you've read?

You can find much more information at:

<http://www.sentientdevelopments.com/2009/02/improve-your-performance-with-energy.html>

http://en.wikipedia.org/wiki/Energy_drink

http://altmedicine.about.com/od/completeazindex/a/energy_drinks.htm

<http://www.brianmac.co.uk/drinks.htm>

<http://www.redbull.co.uk/#page=ProductPage>

<http://www.lucozade.com/sport/default.aspx>

<http://www.gatorade.com/#/products>

<http://www.hypeenergy.com/>

<http://www.energyfiend.com/sugar-in-drinks>

<http://en.wikipedia.org/wiki/Caffeine>

<http://en.wikipedia.org/wiki/Taurine>

