Frequently asked questions on Caffeine and Foods Containing Caffeine, including Energy Drinks

BfR FAQ, 23 July 2015

Foods containing caffeine have been consumed by humans for hundreds of years due to their stimulating effect on the cardiovascular and central nervous system. Energy drinks or energy shots are drinks which often contain high concentrations of caffeine. They are frequently advertised as having the ability to enhance the mental alertness and physical performance. The occurrence of possible adverse health effects such as nervousness or cardiac arrhythmias due to the consumption of products containing caffeine depends on individual sensitivity to caffeine and the extent of consumption of foods of this kind.

The BfR already pointed out possible negative health effects of the excessive consumption of energy shots and energy drinks back in 2008 and 2009. The European Food Safety Authority (EFSA) published a scientific opinion on the safety of caffeine in 2015. Due to current inquiries to the BfR, questions are answered below which were put to the Institute in connection with foods containing caffeine, in particular energy drinks.

Detailed informations on caffeine and energy drinks are available on the BfR website: http://www.bfr.bund.de/en/a-z_index/caffeine-129927.html, http://www.bfr.bund.de/en/a-z_index/energy_drinks-130012.html.

The scientific opinion of the EFSA on the safety of caffeine can be found under: http://www.efsa.europa.eu/en/efsajournal/doc/4102.pdf.

What is caffeine?

Caffeine is a natural alkaloid which has been consumed by humans for centuries mainly due to its stimulating effects. It occurs naturally in coffee beans, tea leaves and cocoa beans among other things, but it is also added artificially to numerous foods, such as bakery products, ice-cream, sweets, cola drinks and also energy drinks.

What kind of desired and undesired effects does caffeine have?

Caffeine stimulates the cardiovascular and central nervous systems, which in moderate doses enhances physical performance as well as the mental alertness.

With high intake quantities of caffeine, adverse effects can occur such as increased nervousness and excitability, sleeplessness, sweating attacks and palpitations. The occurrence of adverse effects, however, depends strongly on individual sensitivity to caffeine and the ingested dose. Over a longer period of time, excessive caffeine consumption can lead to cardiovascular problems such as high blood pressure. In pregnant women increased caffeine intake over a longer period can lead to reduced foetus growth.

How fast does the body absorb caffeine and how fast is the elimination?

After oral intake, caffeine is absorbed rapidly and completely by the body. The stimulating effects of caffeine can occur 15 to 30 minutes after consumption and last for several hours. Caffeine is metabolised and degraded in the liver and finally excreted via the kidneys.

How much caffeine is safe?

The EFSA estimated in 2015 the quantities of caffeine which are safe for the general healthy population. Accordingly, intake quantities of up to 200 milligrams (mg) as a single dose or the same quantity consumed within a short period of time (corresponding to 3 mg per kilogram

(kg) of body weight) do not give rise to concerns about adverse health effects for the general healthy population. Spread over the day, an intake of up to 400 mg caffeine is regarded as safe for healthy adults.

Regarding pregnant or lactating women habitual caffeine consumption up to 200 mg per day does not give rise to safety concerns for the foetus or breastfed infants. According to EFSA, for children and adolescents the information available is insufficient to derive a safe caffeine intake. EFSA considers that caffeine intakes of no concern derived for acute caffeine consumption by adults (3 mg per kg body weight per day) may serve as a basis to derive single doses of caffeine and daily caffeine intakes of no concern for children and adolescents.

Do the intake quantities of caffeine calculated by the EFSA that do not give rise to safety concerns apply to all persons?
No, the derived intake quantities of caffeine calculated by the EFSA apply only to the general healthy population and specific sub-groups thereof, such as children, adolescents, adults, older people, pregnant and lactating women and people performing physical exercise.

The EFSA report did not assess possible adverse effects of caffeine for persons suffering from diseases or complaints and/or persons who in combination with caffeine take drugs or medication or consume large quantities of alcohol. Therefore, the caffeine quantities regarded as safe do not apply to these groups of persons. According to the EFSA, moderate alcohol consumption (blood alcohol concentration up to 0,8 per mille) has no influence on the safety of single caffeine doses of up to 200 mg (dose regarded as safe for healthy adults).

Is there a mandatory labelling requirement for foods containing caffeine?
Drinks containing more than 150 mg of caffeine per litre must bear the following advice: *"Increased caffeine content. Not recommended for children and pregnant or lactating women"*. This note must be positioned in the same field of vision as the name of the beverage followed by a reference to the caffeine content. The exceptions to this rule are coffee and tea and/or beverages based on coffee or tea extract with the word "co*ffee"* or "*tea*" in the designation.

A comparable labelling requirement also applies to foods other than beverages to which caffeine has been added. Concerning food supplements, the caffeine content per recommended daily dosage has to be indicated.

What are the main sources of caffeine intake?
According to an opinion prepared by EFSA, caffeine intake in Germany is mainly through coffee in adults (85 %) and mainly through chocolate in children (up to 85 %). Adolescents ingest caffeine in particular through coffee, chocolate and tea. In the years 2006 and 2007 caffeine intake through energy drinks was still negligible among adolescents in Germany (< 1 %). More recent data from other EU member states, however, show a relevant contribution of energy drinks to caffeine intake (up to 10 %). Another survey on the consumption of energy drinks commissioned by the EFSA in 2012 suggests for German adolescents too that roughly 10 % of total caffeine intake comes from energy drinks. The consumption habits in the EU member states, however, can be very different.

What are energy drinks?
Energy drinks are refreshing drinks containing in addition to caffeine one or more of the substances taurine, glucuronolactone and inositol. They are advertised as having the ability to enhance concentration and physical performance.

Energy drinks should not be confused with hypotonic or isotonic sports drinks containing carbohydrates which are intended to compensate the loss of energy, water and electrolyte resulting from physical activity.

What are energy shots?
Energy shots are similar to energy drinks in their composition, but they contain much less water and are offered in smaller portions (25 to 75 millilitres (ml)). As the concentration of caffeine in energy shots is usually considerably higher than in energy drinks, a much higher amount of caffeine can be consumed within a very short period of time. Energy shots are sold by the manufacturers as dietary supplements and may only be brought onto the market with a consumption recommendation (dose per day) for this reason. One portion per day is recommended for the products known to date.

What kind of ingredients do energy drinks contain?
The recipe of energy drinks can differ, depending on the manufacturer, but the basic substances are usually the same. Energy drinks normally contain glucuronolactone, taurine, inositol and sugar or sweeteners in addition to caffeine.

What is taurine?
Taurine occurs naturally in the human body and originates as a metabolite mainly from the amino acid cysteine. Taurine is said to play an important role in brain development as well as the stabilisation of the cell membrane. Taurine is ingested with food, in particular by fish and meat. Intake via a normal diet varies between 10 and 400 mg per day. In animal studies, intake quantities of up to 1,000 mg of taurine per kg of body weight per day showed no harmful effects.

According to EFSA, taurine in the customary energy drink concentrations (4,000 mg per litre) has no influence on the safety of single caffeine doses of up to 200 mg (dose regarded as safe for healthy adults). By consuming three conventional cans of energy drinks à 250 ml, however, as much as 240 mg of caffeine is ingested. The studies conducted to date on the matter whether additional taurine intake enhances physical and mental performance capacity are contradictory and often of poor scientific quality and therefor no clear evidence has been produced to date for this reason.

What is glucuronolactone?
Glucuronolactone is an ester of glucuronic acid which is also formed naturally in the body as a metabolite of glucose. Glucuronolactone is an important component of connective tissue which is only ingested with food in small quantities (1 to 2 mg per day). In animal studies, intake quantities of up to 1,000 mg of glucuronalactone per kg of body weight per day showed no harmful effects.

According to EFSA, glucuronalactone in the customary energy drink concentrations (2,400 mg per litre) has no influence on the safety of single caffeine doses of up to 200 mg (dose regarded as safe for healthy adults). By consuming three conventional cans of energy drinks à 250 ml, however, as much as 240 mg of caffeine is ingested. The data available to date give no indication that the customary doses of glucuronolactone in energy drinks enhance physical and mental performance capacity.

What is inositol?
Inositol (cyclohexanhexol) is a hexavalent alcohol which occurs in both plants and animals. Inositol is not essential as it can be produced from glucose in sufficient quantities in the body itself. Inositol plays an important role in signal transduction inside the cell and is involved in

formation of cell membranes. Most energy drinks contain 200 mg of inositol per litre, which means that 50 mg of inositol are ingested with one 250 ml can. On the basis of the data currently available, there are no health concerns.

How much caffeine do energy drinks contain?
Conventional energy drinks contain 320 mg of caffeine per litre. The table shows how much caffeine is ingested with other beverages containing caffeine compared to energy drinks.

Drink	Portion unit	Caffeine per portion
Filter coffee	one cup (200 ml)	90 mg
Energy drink	one can (250 ml)	80 mg
Espresso	one cup (60 ml)	80 mg
Black tea	one cup (200 ml)	45 mg
Cola drink	one can (330 ml)	35 mg
Cocoa drink	one cup (200 ml)	8 to 35 mg
Green tea	one cup (200 ml)	30 mg
Plain chocolate	half bar (50 g)	25 mg
Milk chocolate	half bar (50 g)	10 mg

All values are approximations as the caffeine content can fluctuate.
Source: modified from EFSA (2015)

How much sugar do energy drinks contain?
On average, energy drinks contain approximately 100 grams (g) of sugar per litre in the form of glucose or sucrose. One can of energy drink (250 ml) therefore contains a relatively high number of calories (25 g sugar = 100 kilocalories). Glucose and sucrose are easily converted and provide energy quickly, but only for a short time. Sugar-free energy drinks with alternative sweeteners are also available in the meantime.

How do energy drinks take effect?
Due to the caffeine content, energy drinks have a stimulating, pick-me up effect. In addition to the caffeine, the large quantities of sugar they contain also result in a brief boost in performance. This additional energy intake does not occur with sugar-free products, however.

Are energy drinks harmful to human health?
Unwanted effects of energy drinks are presumably caused mainly by the caffeine. If ingested in high quantities, caffeine can cause increased nervousness and excitability, sleeplessness, outbreaks of sweating and palpitations. Over a longer period of time, excessive caffeine consumption can lead to cardiovascular problems, such as increased blood pressure.

No health impairments are to be expected with moderate consumption of energy drinks under observation of the directions for use. 80 mg of caffeine are ingested through the consumption of one conventional energy drink à 250 ml with a caffeine content of 320 mg per litre. This caffeine quantity is regarded as safe for healthy adults and is the equivalent of roughly one cup of coffee.

If three cans of energy drinks (equivalent to 240 mg caffeine) are consumed within a short period of time, however, the single caffeine dose of 200 mg which is regarded as safe for healthy adults is exceeded. Health risks can therefore result if these drinks are consumed in larger quantities so that high levels of caffeine are ingested within a short period of time. With a high consumption of energy drinks, in particular the simultaneous consumption of larger

quantities of alcohol and/or extensive physical activity can have additional negative effects on the cardiovascular system. According to EFSA, moderate alcohol consumption (blood alcohol concentration of up to 0,8 per mille) has no influence on the safety of single caffeine doses of up to 200 mg (dose regarded as safe for healthy adults).

What quantities of energy drinks are consumed?
The “Event-Related Survey of High Consumers of Energy Drinks“ conducted by the BfR in 2013 shows that visitors to clubs as well as music and sports events to some extend consume considerable amounts of energy drinks. On average, the high consumers drank approx. 1 litre of energy drinks either straight or mixed with alcoholic beverages when dancing in clubs. In 5 % of these cases, more than 2.75 litres were consumed. (http://www.bfr.bund.de/cm/350/anlassbezogene-befragung-von-hochverzehrern-von-energy-drinks.pdf)

A survey commissioned by the EFSA in 2012 on the consumption of energy drinks in 16 EU countries showed that roughly 16 % of the adolescents and 6 % of the adults questioned drink three and more cans of energy drink at a single session. Assuming that these were conventional cans, the single caffeine dose that is regarded as safe – 200 mg for healthy adults – is exceeded. The consumption habits in the EU member states, however, can be very different.

Who should avoid energy drinks?
Increased caffeine doses can result in special health risks for several groups of persons. These include children, pregnant and lactating women and persons who are sensitive to caffeine (e.g. people with cardiovascular diseases). These population groups should avoid the consumption of energy drinks.

Can energy drinks be drunk along with alcohol?
According to EFSA, moderate alcohol consumption (blood alcohol concentration of up to 0,8 per mille) has no influence on the safety of single caffeine doses of up to 200 mg (dose regarded as safe for healthy adults). By consuming three conventional cans of energy drinks à 250 ml, however, 240 mg of caffeine have already been ingested.

In the view of the BfR, health risks can arise if energy drinks are consumed in larger quantities, especially in combination with larger quantities of alcohol. In the past, severe health impairments such as cardiac arrhythmias, in parts with fatal outcome, have been described in some case reports, often in combination with the simultaneous consumption of alcohol. However, no causality has yet been proven.

Are energy drinks suitable for enhancing sporting performance?
Energy drinks should not be confused with sports drinks, which provide above all liquid and energy in the form of water and carbohydrates. They are either hypotonic or isotonic, i.e. they have lower or identical concentrations of dissolved particles compared to blood which allow the liquid to be absorbed quickly by the body. Many sports drinks also contain caffeine as it can increase endurance performance in sports.

In general, energy drinks have a relatively high sugar concentration. This means that they provide a lot of energy for a short space of time, but the high sugar content can delay the liquid adsorption via the digestive tract. As the feeling of thirst increases with physical efforts, there is also the risk of energy drinks being consumed in larger quantities, thus resulting in high caffeine intakes. It is then possible that the effects on the cardiovascular system caused by the physical activity can be negatively intensified by the high caffeine intake.

Moderate caffeine intake in combination with physical activity is unproblematic to health. Accordingly, EFSA stated that single doses of up to 200 mg of caffeine do not give rise to concerns about adverse health effects to healthy adults, even if consumed less than two hours before intense physical exercise.

Are there any maximum legal limits for the ingredients of energy drinks?
National maximum legal limits have been in force in Germany since June 2013 for the following four ingredients:

- Caffeine: 320 mg per litre
- Taurine: 4,000 mg per litre
- Inositol: 200 mg per litre
- Glucuronolactone: 2,400 mg per litre

The exact quantity of added caffeine must be declared by the manufacturer on the packaging (label) of energy drinks. In other EU countries, different rules may apply.