DRUGS

IN

GASTRONOMY

Alcohol, Caffeine, Chynin, Capsaicin, Nicotine,

Sugar, Poisonous delicacies

Alcohol

In everyday speech, when we talk about alcohol, we most often mean ethanol (ethyl alcohol) – chemically C2H5OH. It is an organic compound, specifically a simple alcohol, which is produced by the natural fermentation of sugars by yeast.

General characteristics:

- **Formula: C2H5OH**
- **Group:** *Hydroxyl (-OH) group attached to an ethyl chain*
- **Properties:** *Colorless liquid, flammable, characteristic odor, miscible with water*
- **Production:**

- Natural: Fermentation of sugars (e.g., from fruit, grains)
- Industrial: Hydration of ethene (reaction with water in the presence of acid)

In chemistry, there are several types of alcohols, but not all are suitable for consumption. Some are toxic or even deadly:

Name	**Formula**	**Use**	**Toxicity**
Ethanol	C_2H_5OH	Beverages, disinfection	Relatively low
Methanol	CH_3OH	Industrial	Highly toxic (even small amounts can cause blindness or death)
Propanol	C_3H_7OH	Solvents, fuels	Toxic
Butanol	C_4H_9OH	Industrial	Toxic

Alcohol Unit

An alcohol unit is a standardized way to measure the amount of pure alcohol in beverages. It helps people monitor their consumption and thus prevent health and other risks.

It is approximately the amount of alcohol that the liver of a healthy person can metabolize in one hour.

The liver begins metabolizing ethanol using enzymes:

- Alcohol dehydrogenase (ADH)
- Aldehyde dehydrogenase (ALDH)

Ethanol is converted into acetaldehyde, which is further converted into acetic acid, and then into carbon dioxide and water.

- 1 alcohol unit = 10 grams of pure ethanol
- In some countries, it is listed as 8 grams (e.g., in the UK), but in most of Europe (including the Czech Republic), it is calculated as 10 g.

Number of alcohol units in common drinks

Beverage	Amount	Volume	Approx. units
Beer (10°, 4 %)	0,5 l	20 g of alcohol	2 Units
Vine (12 %)	0,15 l	18 g	1,8 Units
Spirit (40 %)	0,04 l	16 g	1,6 Units

Recommended daily limits according to WHO:

Group	Safe limit	Risk limit
Men	max. 2 units/day	ower 4 units/day
Women	max. 1 units/day	ower 2 units/day
Pregnant, children	0 units	All alcohol is risky

Formula for calculating alcohol units:
Units = amout (ml) × % alcohol: 1000

Caffeine/Tein

Caffeine is an alkaloid – an organic compound that naturally affects the nervous system. It belongs to purine derivatives and is chemically related to adenine and guanine, the basic building blocks of DNA.

General characteristics

- ***Name:*** *Caffeine*
- ***Formula:*** $C_8H_{10}N_4O_2$
- ***Structural group:*** *Methylxanthines*
- ***Source:*** *Naturally found in coffee beans, tea leaves, cocoa beans, yerba mate, guarana, etc.*

Chemical properties

- *White crystalline powderMírně hořká chuť*
- *Highly soluble in water and fats – easily crosses the blood-brain barrier into the brain.*

Mechanism of action

- *Caffeine acts mainly as an antagonist of adenosine receptors in the brain. Adenosine is a neurotransmitter that induces fatigue and sleep.*
- *Caffeine blocks adenosine, so it has a stimulating effect - increasing alertness and reducing the feeling of fatigue.*
- *It also increases the release of dopamine, noradrenaline and adrenaline.*

Effects on the body

Organ /	***The effect of caffeine***
Brain	*increased attention, improved mood, reduced fatigue*
Heart	*slight increase in heart rate and blood pressure*
Kidneys	*diuretic effect (increases urine production)*
Digestive tract	*supporting the production of stomach acid*
Muscles	*increases energy expenditure, can improve athletic performance*

Although caffeine has stimulating effects and can be beneficial in small doses, excessive or regular use can have numerous negative health impacts (sleep disturbances, digestive issues, heart problems…).

The lethal dose of caffeine is approximately 10–12 grams of pure caffeine at once (equivalent to about 80–100 cups of coffee consumed at once).

In common beverages like coffee, tea, energy drinks, and cola, caffeine content ranges between 20–80 mg per serving (one espresso, a cup of filtered coffee, a mug of tea).

Quinine

Quinine is a natural alkaloid – an organic nitrogen-containing compound – derived from the bark of the cinchona tree (Cinchona), native to South America. In the past, it was mainly known as an effective treatment for malaria.

General characteristics

- **Formula:** $C_{20}H_{24}N_2O_2$
- **Structural group**: Alkaloid (quinoline derivative)
- **Appearance:** White to slightly yellowish powder, very bitter

Occurrence of quinine in nature and in products

Natural source:

- **Bark of cinchona tree (Cinchona officinalis)** – main natural source
- The plant contains several alkaloids; quinine is the most effective

In foods:

- Tonic – contains a small amount of quinine as a natural bitter flavor.

- Legally limited content: **max. 100 mg/l**

Medical uses and effects on the body

Positive (healing) effects:

Effect	Description
Antimalarial	Blocks growth of Plasmodium parasites (cause of malaria)
Analgesic and antipyretic	Slightly reduces fever and relieves pain
Antispasmodic action	Used for nocturnal muscle cramps (e.g., in legs)
Bitter tonic	Small doses stimulate appetite and digestion

Interesting facts

- Quinine **fluoresces** – glows **blue under UV light**
- A dose above **1 gram** can cause severe side effects in some individuals (cinchonism), and doses above 2–3 g can cause **serious poisoning** or death.

Capsaicin

Capsaicin is an alkaloid and amide compound, consisting of a vanilloid aromatic part (similar to vanillin), a hydrocarbon chain with a double bond (trans configuration), and an amino group.

- **Formula:** $C_{18}H_{27}NO_3$

- **Physical properties:**
- Crystalline substance
- Insoluble in water, soluble in fats, ethanol, and organic solvents
- Stable at high temperatures (therefore spiciness remains even after cooking)

Effect on human metabolism

Mechanism of action:
Capsaicin acts as an agonist of the TRPV1 receptor, which is located on nerve endings sensitive to heat and pain.
- Activation of TRPV1 causes depolarization of neurons and transmission of pain and heat signals to the brain.
- This produces a burning sensation, even though no actual burn occurs.
- Long-term stimulation can cause receptor desensitization, which is utilized in medicine (e.g., capsaicin-containing pain relief creams).

Physiological effects:
- **Increased metabolism:** thermogenesis, higher calorie burning
- **Appetite suppression:** increased adrenaline levels and reduced food intake
- **Analgesic effects:** relief of chronic pain
- **Cardiovascular effects:** potential positive impact on blood pressure and cholesterol levels
- **Antioxidant and anti-inflammatory effects**

Occurrence of capsaicin

Capsaicin naturally occurs in plants of the genus Capsicum (e.g., bell peppers, chili peppers).

- *The highest amount is found in the placenta of the fruit, the white part that holds the seeds.*

- *Capsaicin content depends on species, variety, growing conditions, and fruit ripeness.*

- *Scoville Heat Units (SHU) indicate capsaicin concentration, e.g.:*

- ***Bell pepper (sweet):*** *0 SHU*
- ***Jalapeño:*** *2 500 – 8 000 SHU*
- ***Habanero:*** *100 000 –350 000 SHU*
- ***Carolina Reaper:*** *2 200 000 SHU*

The lethal dose of capsaicin for an adult is approximately 0.5–1 gram of pure capsaicin, equivalent to hundreds of extremely hot peppers eaten at once.

Capsaicin is generally safe in standard doses (e.g., in food), but extreme exposure or improper use can cause capsaicin poisoning or toxic reaction. The most common effects are irritation, overheating, or failure of reflex mechanisms (e.g., breathing).

Symptoms of capsaicin poisoning

Mild to moderate doses (more common):
Intense burning in the mouth and throat, nausea, vomiting, abdominal pain, diarrhea, sweating, tearing, runny nose, feeling of heat, skin redness, muscle tremors, or nervousness

Severe poisoning (rare):
Abdominal cramps, dehydration, circulatory collapse, shock, cardiac arrhythmia, shortness of breath, airway swelling, unconsciousness, in exceptional cases – heart or respiratory failure.

Nicotine

Nicotine is chemically and biologically highly interesting and simultaneously controversial.

- **Formula:** $C_{10}H_{14}N_2$

- **Structure:**
Heterocyclic compound (pyridine + pyrrolidine)

- **Physical properties:**
Colorless to yellowish oily liquid, characteristic odor, soluble in water and fats

Nicotine is a natural alkaloid produced by plants of the genus Nicotiana, mainly:

- ***Nicotiana tabacum*** *(Virginia tobacco)*
- ***Nicotiana rustica*** *(common tobacco)*

Small amounts of nicotine are also present in some other Solanaceae plants, e.g.:

- ***Eggplant***
- ***Tomatoes***
- ***Potatoes***
- ***Peppers***

The amount of nicotine in these common foods is negligible and has no physiological effect.

Effect of nicotine on the human body

Mechanism of action:

- *Nicotine is an agonist of nicotinic acetylcholine receptors (nAChR) in the central and peripheral nervous system.*

- *It mimics acetylcholine – temporarily stimulating neurons – later causing receptor desensitization (tolerance).*

- *It also acts on the dopamine system – promoting dopamine release, which is crucial for the addictive effect.*

Short-term effects

CNS stimulation Improvement of attention, feeling of alertness

Increased blood pressure, increased heart rate

Increase in glucose levels Release of adrenaline

Stress relief (subjective) Paradoxically, however, it

Increases stress in the long term

Long-term effects

- Strong dependence (physical and psychological)
- Brain changes – receptor adaptation, mood changes, anxiety
- Cardiovascular risks – increased risk of heart attack and stroke
- Possible negative effects on fertility and fetal development (fetotoxic effects)
- Risk factor for type 2 diabetes

Nicotine is not directly carcinogenic, but it contributes to tobacco addiction, which contains dozens of proven carcinogenic substances (e.g., tar, benzene, nitrosamines).

Metabolism and breakdown of nicotine

Absorption:

- Rapidly absorbed through mucous membranes: oral cavity (chewing), lungs (smoking/vaping), skin (nicotine patches).
- Reaches the brain within 10–20 seconds after inhalation.

Metabolism:

- Occurs in the liver (mainly by enzyme CYP2A6)
- Converts into:

- **Kotinine** main metabolite, biologically active, longer half-life)
- **Nornikotine**, **nikotin-N-oxid**, other minor metabolites

Excretion:

- **Kidneys** – in urine (free nicotine and its metabolites)

Sugar

The topic of sugar as a drug is increasingly discussed in nutrition, neuroscience, and chemistry. Although sugar is not officially classified as a drug (e.g., legally), many of its properties and effects on the human brain and body closely resemble drugs.

What is "sugar"?

In common speech, it usually means sucrose – a disaccharide composed of:
- ***Glucose (grape sugar)***
- ***Fructose (fruit sugar)***
- *Formula: $C_{12}H_{22}O_{11}$*

Chemical nature

- *Type of compound*
  - *Carbohydrate (disaccharide)*

- *Physical form*
  - *White crystalline substance, soluble in water*

- *Hydrolysis*
  - *In the body and in acidic environment, it breaks down into glucose and fructose*

Occurrence of sugar

Natural occurrence:
- *Fruit (fructose, glucose, sucrose)*
- *Honey (glucose + fructose)*
- *Milk (lactose)*
- *Vegetables (in smaller amounts)*

Added sugar (so-called free sugars):
- *Sweets, pastries, sweetened beverages*
- *Processed foods, sauces, ketchup, cereals*
- *Most common:* ***sucrose, glucose syrup, high-fructose corn syrup (HFCS)***

Effect of sugar on the human body

Short-term effects:

• ***Rapid energy boost***
glucose quickly absorbed, raising blood sugar levels

• ***Insulin release***
pancreas responds with increased insulin production

• ***Brain stimulation***
activation of reward systems, mainly via dopamine

• ***Feeling of euphoria/well-being***
similar to some drugs (e.g., nicotine, caffeine)

Long-term effects (with excessive consumption):
• ***ZAddictive behavior*** *– strong craving for sweets, overeating*
• ***Increased risk of obesity, type 2 diabetes, insulin resistance***
• ***Increased risk of cardiovascular diseases***
• ***Tooth decay (especially in children)***
• ***Chronic inflammation*** *–sugar promotes inflammatory processes*
• ***Disruption of gut microbiome***

Sugar metabolism in the body

Absorption in the intestines:
- Glucose: directly absorbed – blood
- Fructose: absorbed and converted in the liver (partially to fat)

Usage:
- Immediate burning (energy)
- Storage as glycogen (liver, muscles)
- Excess – converted to fat (lipogenesis)

Hormonal regulation:
-Insulin: lowers blood sugar
-Glucagon: raises blood sugar (e.g., during fasting)

Sugar as a “drug” – how serious is this comparison?

Similarities to addictive substances:

- **Stimulation of dopamine system** in the brain (reward center)
- **Tolerance effect** – higher doses needed over time for the same effect
- **Withdrawal symptoms** – irritability, fatigue, cravings upon cessation
- **Compulsive behavior** – strong craving even without physical hunger

In animal experiments (especially rats), sugar has been shown to be as addictive as cocaine or nicotine – some animals even **preferred sugar over cocaine.**

Differences from drugs:

- Does not alter consciousness or psyche like alcohol, THC, or opiates
- **No acute toxic effect**
- Socially accepted and **legally allowed**


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Poisonous Delicacies

The topic of poisonous delicacies is fascinating but somewhat morbid – it concerns foods that can be lethally toxic, yet are sought after (or precisely because of that) as gourmet specialties. In these cases, everything depends on precise preparation, which prevents or neutralizes the poison.

Fugu (Japanese Fish – Pufferfish)

- *Fugu is a fish from the family Tetraodontidae (pufferfish).*
- *It contains an extremely potent toxin, tetrodotoxin – especially in the liver, ovaries, and skin.*

Danger:

- ***Tetrodotoxin is a neurotoxin – it blocks sodium channels – causing muscle paralysis – death by asphyxiation.***
- *Lethal dose for humans: ~1–2 mg*
- *No known antidote (toxin neutralizer)*

Preparation:

- ***Requires a licensed chef***
- ***Organs containing the toxin must be carefully removed and disposed of***
- *In Japan, the sale of liver is completely prohibited*

King Scallop (shellfish) – especially clams with paralytic toxin

- *MMarine clams, oysters, and other bivalves can accumulate saxitoxin produced by cyanobacteria and algae (e.g., during red tides).*

Danger:

- ***Saxitoxin causes paralytic shellfish poisoning (PSP).***
- *Poisoning can lead to death within a few hours.*
- ***The toxin is not destroyed by heat.***

Prevention:

- *Official monitoring of toxin presence in harvesting areas.*
- *Consumption only from verified regions and seasons.*

Casu marzu (Italian “live cheese”) – Sardinia

• *Sheep cheese into which cheese fly (Piophila casei) eggs are deliberately laid.*
• *During fermentation, the larvae “digest” the cheese – producing a creamy texture and strong aroma.*

Danger:
• *If the larvae are not killed before consumption, they can survive the digestive tract – causing myiasis (intestinal infestation).*
• ***Risk of infections and allergic reactions.***
• *Banned in the EU, but still offered unofficially in Sardinia.*

Preparation:
• *Traditional method: the cheese is allowed to “live”, and larvae are sometimes removed just before consumption.*
• *Some consumers eat it with live larvae.*

Hákarl – fermented shark from Iceland.

• *Meat of the Greenland shark (Somniosus microcephalus), which contains toxic compounds: urea and trimethylamine oxide (TMAO).*

Danger:

• *Unfermented meat is toxic to humans.*

• *Causes nausea, vomiting, and neurological problems.*

Preparation:
• *Traditional fermentation: the meat is buried in the ground for several weeks and then dried.*
• *The smell is extreme (ammonia, urea), but the toxins are broken down during fermentation.*

Fermented herring (Surströmming, Sweden)

• *Herring fermented in brine*

Danger:

• *If not properly fermented, there is a risk of botulism (Clostridium botulinum).*
• *Extreme pressure in cans can cause explosions.*
• *The odor (hydrogen sulfide, ammonia) is very strong.*

Preparation:

• *Herrings are stored in barrels with salty brine in spring and left to ferment naturally.*
• *The fermentation process occurs due to enzymes and bacteria naturally present in the fish flesh.*
• *After several months, the herrings are transferred to cans, where the fermentation process continues.*