Chemical constituents of foods

- ERASMUS KA220-HED - Cooperation partnerships in higher education
- Project no. 2023-1-RO01-KA220-HED-000164767
- Title: Partnership for innovation on the exchange of best practices and the design of joint collaborative initiatives at European level related to the awareness of the effects of contamination on human health
- Acronym: INNO-SAFE-LIFE

Co-funded by the European Union

Introduction – Chemical Constituents of Food

Constituents of food:

- Nutrients
- Antinutrients
- Non-nutrients
- Newly formed substances
- Contaminants
- Additives

Food is not just about nutrients. It contains beneficial and sometimes harmful chemicals. Nutrients support life functions. Antinutrients interfere with absorption. Non-nutrients may have health-promoting effects despite not providing calories. Processing and the environment can lead to new compounds, contaminants, or the need for additives. Understanding all categories helps us evaluate food's impact on health.

Nutrients – The Essential Components

Functions of nutrients:

- **Plastic** → Growth & repair (proteins, minerals).
- **Energetic** → Provide energy (carbohydrates, fats).
- **Protective** → Defend against diseases (vitamins, antioxidants).

Nutrients are divided by their main functions.

- **Plastic function:** building blocks for tissues, bones, muscles (proteins, calcium).
- **Energetic function:** supply calories for activity and body processes (carbs & fats).
- **Protective function:** vitamins and antioxidants maintain immunity and prevent cell damage.
  Each food usually provides a mix of these roles.

Antinutrients – Interfering Substances

Block nutrient absorption or action.

Examples:

- **Oxalic acid** → reduces calcium, iron absorption.
- **Avidin** → blocks biotin (vitamin B8).
- **Isothiocyanates** → reduce iodine absorption → goiter risk.

Antinutrients are naturally present in some foods. They can decrease the body's ability to use important minerals or vitamins. For example, oxalic acid in spinach binds calcium, making it unavailable. Raw egg whites have avidin, which binds biotin. Cruciferous vegetables like cabbage contain isothiocyanates, which interfere with iodine, potentially causing goiter if eaten in very high amounts.

Oxalic Acid – A Harmful Antinutrient

Formula: $H_2C_2O_4$ (oxalate).

Sources:

- Rhubarb (up to 16% weight).
- Sorrel, spinach, chard.
- Potatoes, gooseberries (Ribes grossularia).
- Toxic weeds: phytolacca, Halogeton (dangerous to cattle).

Also produced by fungi (*Aspergillus niger*).

Oxalic acid is particularly important. It forms insoluble salts with calcium and iron, leading to kidney stones or deficiency. In rhubarb leaves, oxalate levels are dangerously high, making them toxic. Even everyday foods like spinach and potatoes contain it, though in lower, tolerable amounts. Cooking can sometimes reduce oxalate levels.

Non-nutritional Substances

No direct nutritional value.

Many have **bioactive/pharmacological roles**.

Examples:

- **Fibers** → cellulose, pectin → aid digestion.
- **Methylxanthines** → caffeine → stimulant.
- **Organic sulphides** → garlic → antimicrobial.
- **Phytochemicals** → polyphenols, terpenes, alkaloids → antioxidant effects.

Non-nutrients don't provide energy or building materials, but they can benefit health. Fiber improves bowel health and reduces cholesterol. Caffeine stimulates the nervous system. Garlic contains sulphides that may reduce infections. Plant phytochemicals act as natural antioxidants, lowering chronic disease risks. These are the focus of much nutritional pharmacology research.

Phytocomplex – The Plant's Full Power

Combination of active ingredients + supportive compounds.

Contains: enzymes, resins, essential oils, tannins, flavonoids, etc.

Advantages over single molecules:

- Better absorption.
- Multiple functions.
- Synergy of effects.
- Lower toxicity.

Instead of isolating just one active ingredient, traditional medicine uses the whole plant extract, known as a phytocomplex. The different compounds work together to enhance effects. For instance, in medicinal herbs, flavonoids may help vitamins absorb better. This synergy makes plants effective while reducing side effects compared to synthetic drugs.

Factors Affecting Plant Activity

Influences on secondary plant metabolites:

- Plant species & classification.
- Environmental conditions: soil, water, light, climate.
- Food processing: drying, grinding, extraction.

Plants produce bioactive compounds depending on genetics and environment. For example, garlic grown in poor soil may have fewer sulphides. Drying methods influence potency of herbs. Grinding or extraction can either preserve or destroy delicate phytochemicals. This explains why herbal remedies vary in strength depending on source and preparation.

Bioavailability – Key to Effectiveness

Determines how well compounds act in the body.

Depends on:

- **Absorption** (intestine uptake).
- **Metabolism** (liver processing).
- **Distribution** (reaching target tissues).
- **Excretion** (removal from body).

Even if a plant is rich in active molecules, what matters is how much the body can actually use. Some compounds are poorly absorbed, broken down too fast, or excreted quickly. Combining foods (e.g., vitamin C with iron) can improve bioavailability. This is why diet combinations matter as much as nutrient content.

Contaminants & Additives

Contaminants: unwanted, harmful

- Pesticides, heavy metals, toxins, microbes.

Additives: intentionally added

- Preserve, enhance flavor/appearance.
- Examples: sweeteners, emulsifiers, colorants.

Food may contain contaminants from farming, processing, or storage — like pesticide residues or fungal toxins. On the other hand, additives are deliberately added for safety and quality. Preservatives prevent spoilage, emulsifiers improve texture, and colorants enhance appearance. While most are tested for safety, excessive use or sensitivity in some individuals remains a concern.

Summary & Takeaways

- Food contains many categories of substances.
- Nutrients → plastic, energetic, protective roles.
- Antinutrients → reduce nutrient absorption.
- Non-nutrients & phytocomplexes → often health-promoting.
- Bioavailability & processing influence effectiveness.
- Safety concerns: contaminants & excessive additives.

Food chemistry is complex. While nutrients are essential, other components like antinutrients or contaminants can reduce food's value. At the same time, bioactive non-nutrients may protect health. The way plants are grown, processed, and consumed influences their benefits. A balanced diet considers all these factors, not just calories.

INNO-SAFE-LIFE