



Sustainable food processing: Trend and Innovations

Part 1: Trends in food acceptability



Prof. Dr. habil. agr. Dr-Ing. Dr. Iryna Smetanska
iryna.smetanska@hswt.de

Sustainable food processing



Food Quality and safety



**Trends in food acceptability by consumers:
organic, convenience and healthy food**



**Trends in food processing technologies:
minimally processed food, fermented food,
non-thermal technologies (pulsed electric fields,
high pressure, ultrasound, cold plasma)**



**Trends in biotechnological approaches:
in vitro cultures, algae and microorganisms as
sources of nutraceuticals**

Sustainable food processing

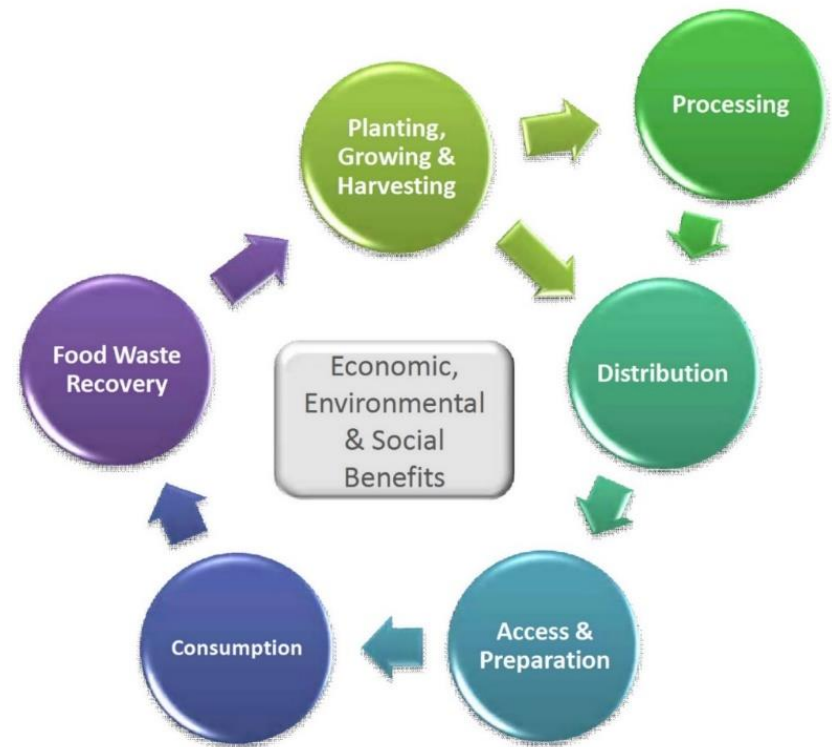


“Sustainable production and consumption is the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations.”

Symposium: Sustainable Consumption. Oslo, Norway; 19-20 January 1994

Problems:

- Paying less for more
- Food security
- Food culture
- Food quality during long-term transportation and storage
- Increasing global warming
- Food processing knowledge and skills



Trends in food processing



Industrialized countries

18-th century – primarily of plant nature, non processed

19-th century – Industrial development.

Railways – independence from local food shortages.

Prolonged shelf life – conservation (pasteurization, sterilization)

Cooking technique – gas, refrigerators, electricity.

3 meals per day

Increasing consumption of meat, sugar, fat, alcohol

Automatic production

Shelf life

Quality of the food products, healthy food

Food security

Farm-to-plate

Development

Trends in food processing



Bio-cultivation
Bio-conservation (bacterium)
Functional
Nutriceuticals, Pharmaceuticals
Pre- and Probiotics

Health

Minimally processed
Conventional

Time

Enzymes (fat decomposition, hydrolysis of starch, stimulation of digestion)
Additives (aroma and taste compounds, sweeteners)
Molecular kitchen
In vitro Culture (yeast, fungi and cell cultures)
Genetic modification (Microorganisms, Plant and Risk security)

Innovation

Consumers choice

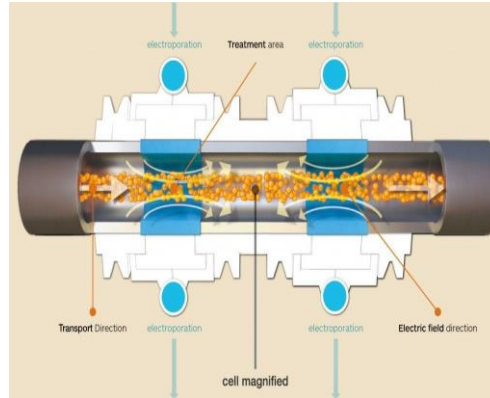


- Food with health value: Anti-ageing > Weight > Cholesterol > Blood pressure > Skin > Energy > Sugar > Memory > Bones
- Food based on natural ingredients / organic
- Traditional and regionally produced food
- Food that are produced in a socially and ethically responsible and sustainable manner

Innovative Food Processing



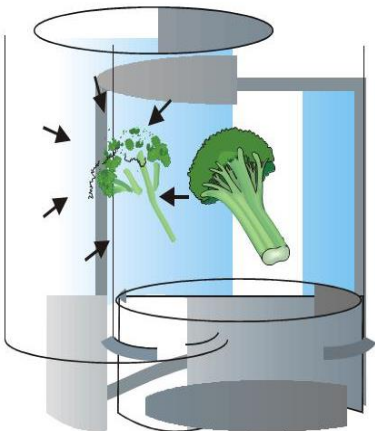
Precision Fermentation



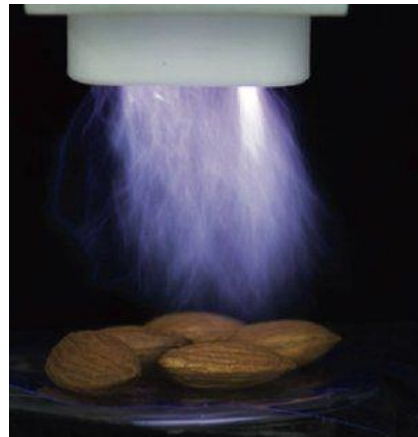
Pulsed electric fields



Ultrasound



High pressure



Cold plasma



(Nano)encapsulation

Optimal Nutrition

Factors:

- Daily energy supply
- Total energy content
- Composition

Nutrients:

- Proteins, fats, carbohydrates
- Vitamins, micronutrients, minerals
- dietary fibres

Further nutrient components:

- Coloring agents, fragrances, aroma
- water

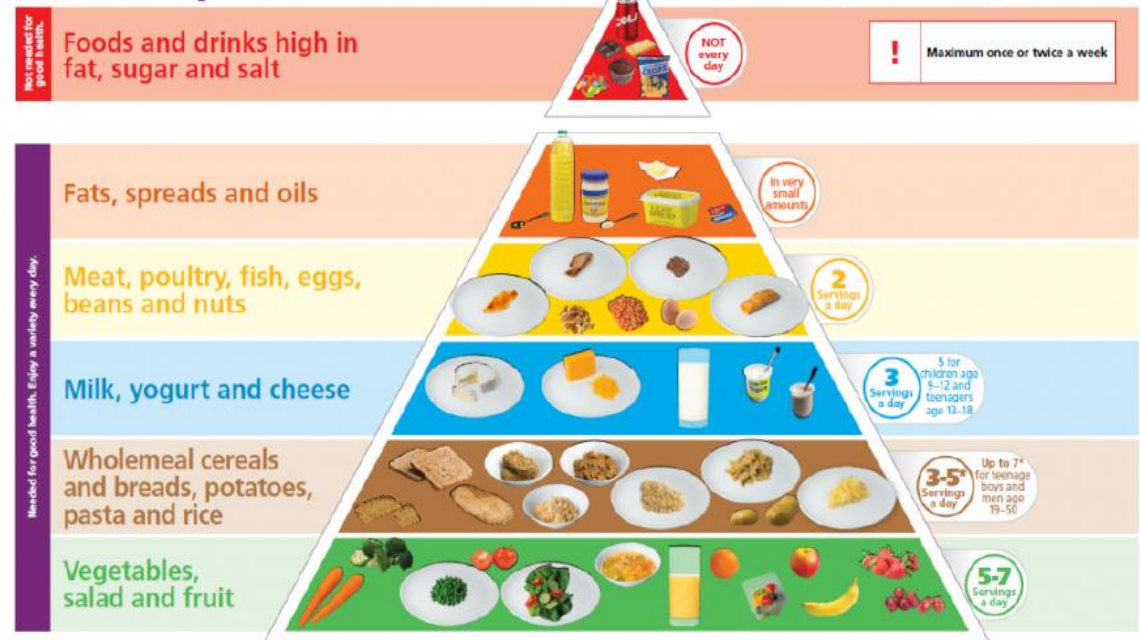
Healthy Food for Life

www.healthyireland.ie



The Food Pyramid

For adults, teenagers and children aged five and over

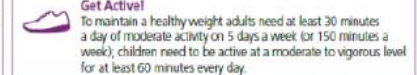
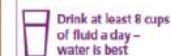


*Daily Servings Guide – wholemeal cereals and breads, potatoes, pasta and rice

Active	Child (5-12)	Teenager (13-16)	Adult (17-60)	Adult (61+)	Inactive	Teenager (13-16)	Adult (17-60)	Adult (61+)
♂	3-4	4	4-5	3-4	♂	3	3-4	3
♀	3-5	5-7	5-7	4-5	♀	4-5	4-6	4

There is no guideline for inactive children as it is essential that all children are active.

Source: Department of Health, December 2016.



Nutrient components:

- Every nutrient element play a role in the metabolic processes – a complex network of interaction between nutrient elements.

Example: Vitamin E is required for metabolic reactions of carbohydrates.

Optimal Nutrition

The basis of the health, wellness, productivity, life expectancy and life quality

developing countries

- Not sufficient food consumption
- Rapid population grow
- Low educational level

industrialized countries

- Excessive food overconsumption
- Unhealthy eating habits
- Growing prosperity
- Hypodynamic
- Lack of the food products with high nutrition values

Problems:

Digestion and absorption of the nutrients (proteins, fats, cholesterol)

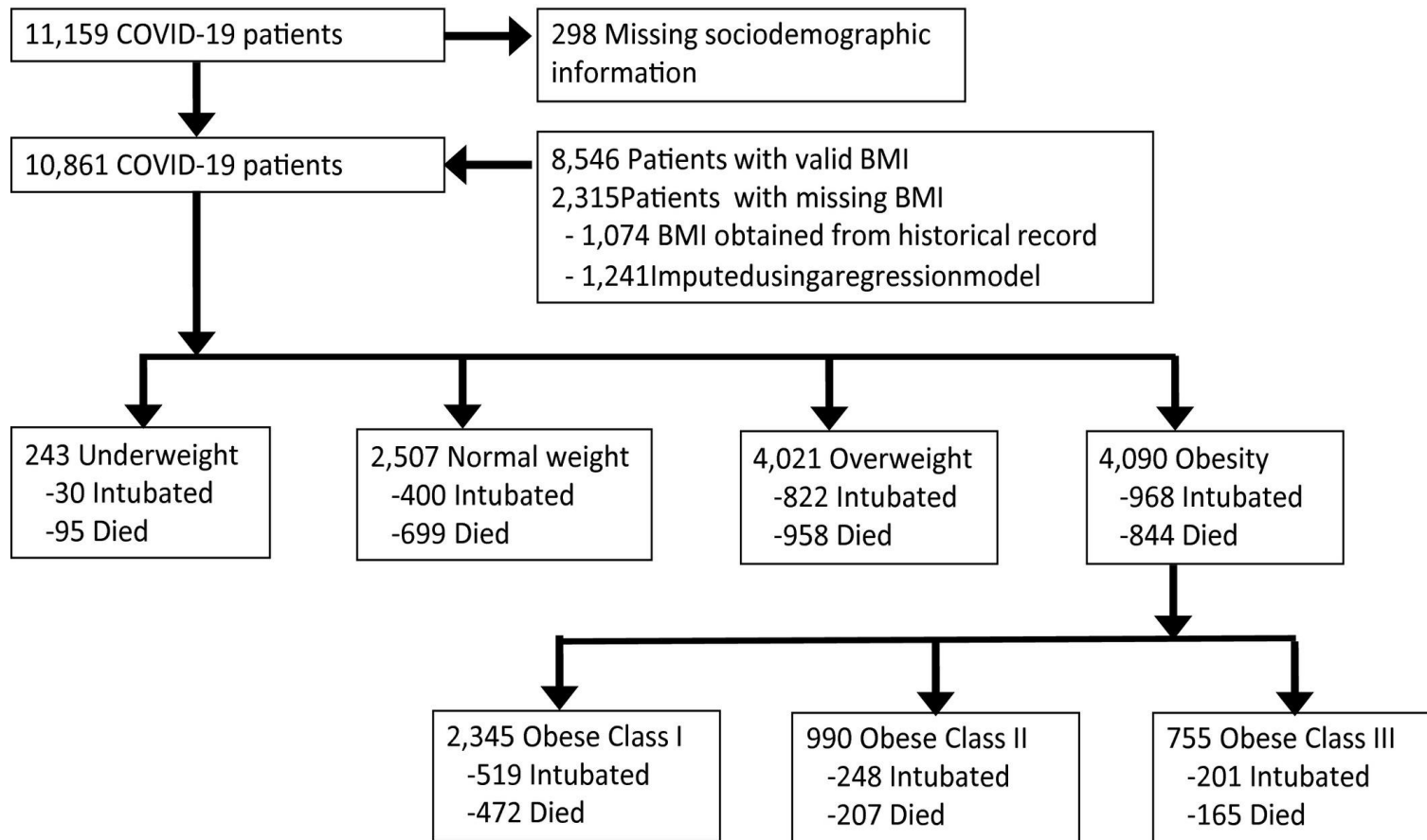
Anti-nutrient substances (alcohol, nitrates)

Nutrition mediated diseases: obesity, diabetes, heart diseases, lactose intolerance, cancer

Optimal Nutrition



BMI as a Risk Factor for Clinical Outcomes in Patients Hospitalized with COVID-19 in New York



Optimal Nutrition



Why body needs energy?

The body needs energy and nutrients for:

- Body temperature
- Support of the bodily functions (walking, muscle activity, digestion)
- Mental activities
- Growth
- Regeneration processes (hair, fingernails, skin)
- Metabolism

Nutrients supply energy from the oxidization of Fats, Carbohydrates and Proteins.

Basic metabolism + Stress metabolism = Total energy requirement

Basic metabolism – is the energy quantity required for the sustainable function of bodily processes (temperature, heart function, breathing)

Factors: Age, Gender, Size and Weight, Hormones, Muscle/Fat ratio, Stress, Medication

Basic Metabolism – 1kcal per kg Body Weight per hour.

Stress metabolism – muscle activity (move, sport), energy requirement for growth (children, youth), digestion processes, temperature regulation (in different environments)

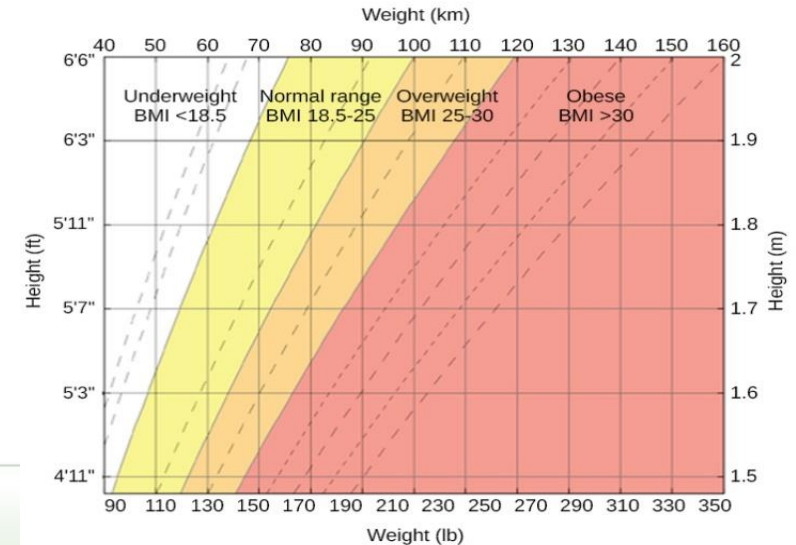
Optimal Nutrition

Body-Mass-Index

Weight : Height²

70 kg : (1,7 m x 1,7 m)= 24.2

- Underweight: <18,5
- Normal weight : 19 - 25
- Overweight (bulimia): 25,5 - 29,5
- Adiposis : ≤ 35

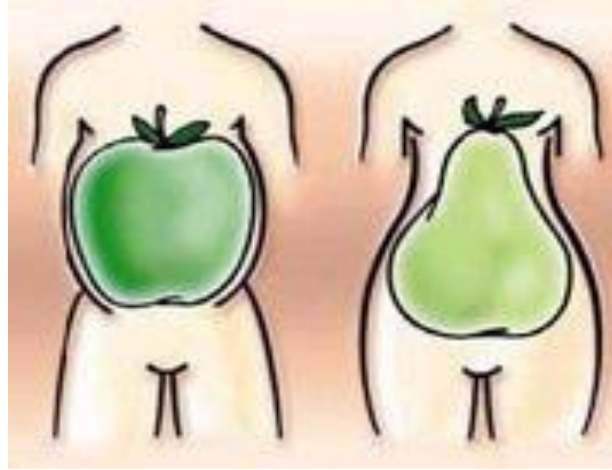


Age	Body weight (kg)		Metabolism (kcal Day ⁻¹)	
	m	w	m	w
15-19 years	67	58	1820	1460
19-25 years	74	60	1820	1390
25-51 years	74	59	1740	1340
51-65 years	72	57	1580	1270
From 65 years	68	55	1410	1170

EASY ACTIVITY	MIDDLE HARD	HARD	HARDEST
Office workers	Plumbers	Construction workers	Professional athletes
Teachers	Gardeners	Masseur	Steel workers

Optimal Nutrition

Body fat distribution



		Men	Women
Body Fat %	Healthy	10 - 20	18 – 28
	Essential	2 - 5	10 – 13
	Average range	15 - 18	22 – 25
Fat Distribution		around the abdomen (apple-shaped)	around the hips (pear-shaped)
Health Implications		Higher levels of visceral fat (abdominal fat) are associated with greater health risks: heart disease, diabetes, and metabolic disorders.	Subcutaneous fat is less risky, post-menopausal women are more prone to visceral fat accumulation, increasing health risks as they age.

Optimal Nutrition



Middle Ages



Baroque



1950th

Sophia Loren
(BMI 19,5)

1960th:
Twiggy
(BMI 18,5)



1990th

Kate Moss
(1,72 m, 53 kg,
BMI: 17)

Anorexia

Optimal Nutrition



Nutrient requirements

55-60% Carbohydrates
10-15% Proteins
30% Fats

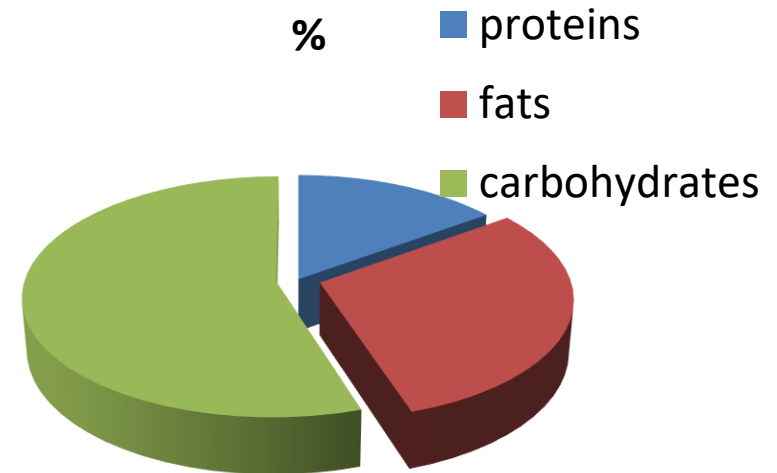
Example:

Energy requirements 2000 kcal – Nutrients distribution:

55% carbohydrates = 1100 kcal = 262 g

30% Fat = 600 kcal = 65 g

15% Protein = 300 kcal = 71 g



Balanced nutrition: proteins, fats and carbohydrates in required proportions.
Fat portion is over 30% (in DE – 40%) leads to obesity.

Carbohydrates over 55% and low fiber – problems with satiation, digestion problems and obesity.

Children and Youth have a higher energy requirements and need more protein.

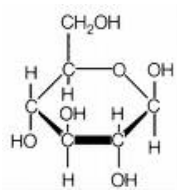
Optimal nutrition: carbohydrates



Monosaccharides

1

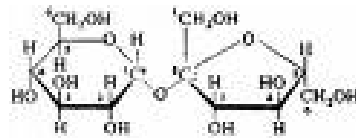
Glucose



Disaccharides

2

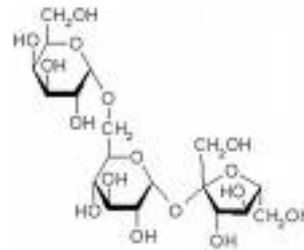
Saccharose



Oligosaccharides

3-8

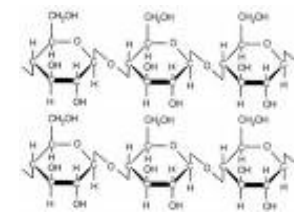
Oligosaccharide



Polysaccharide

ab 9

Cellulose



Glucose + Fructose

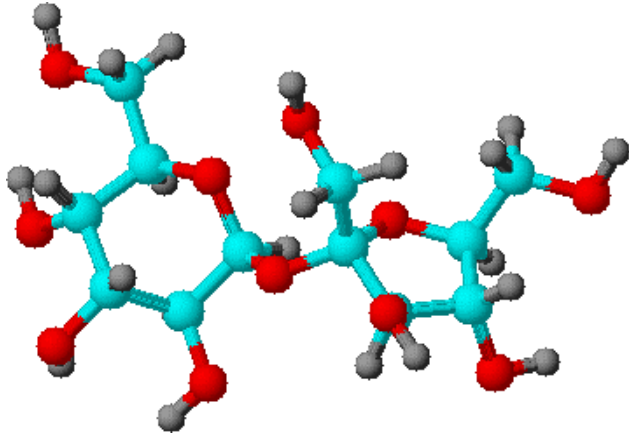
Galactose + Glucose + Fructose

(Glucose)_n



29/JUN/2022

Optimal nutrition: carbohydrates



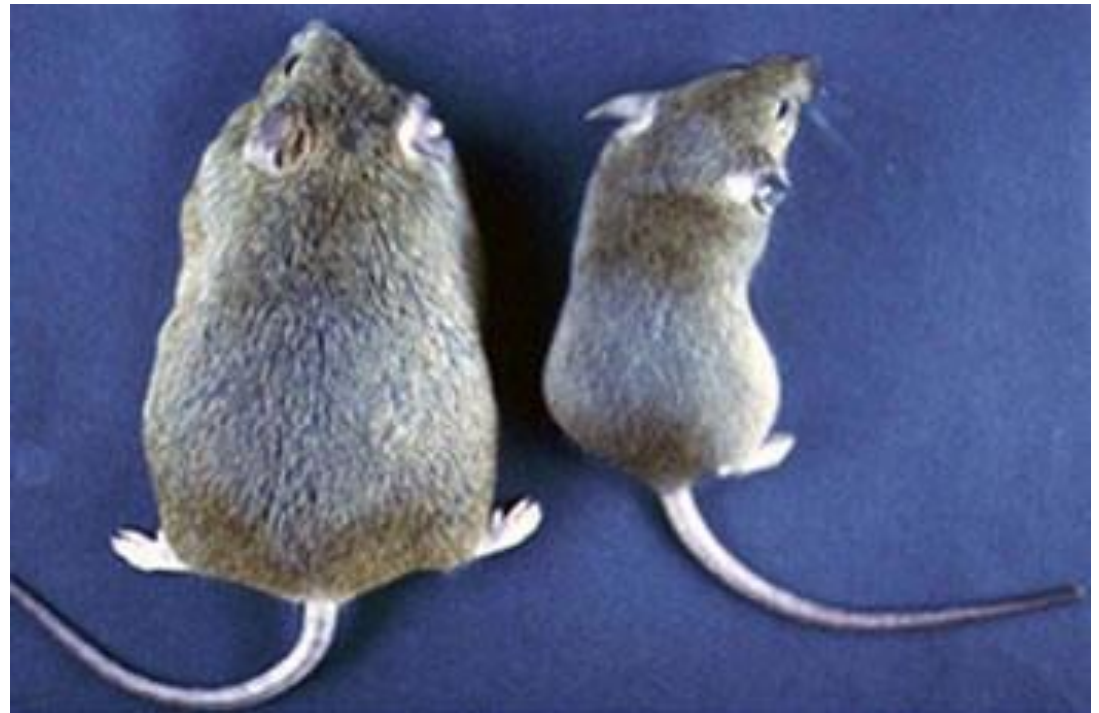
Composition: Glucose : Fructose: Saccharose

Glucose /Fructose-free products

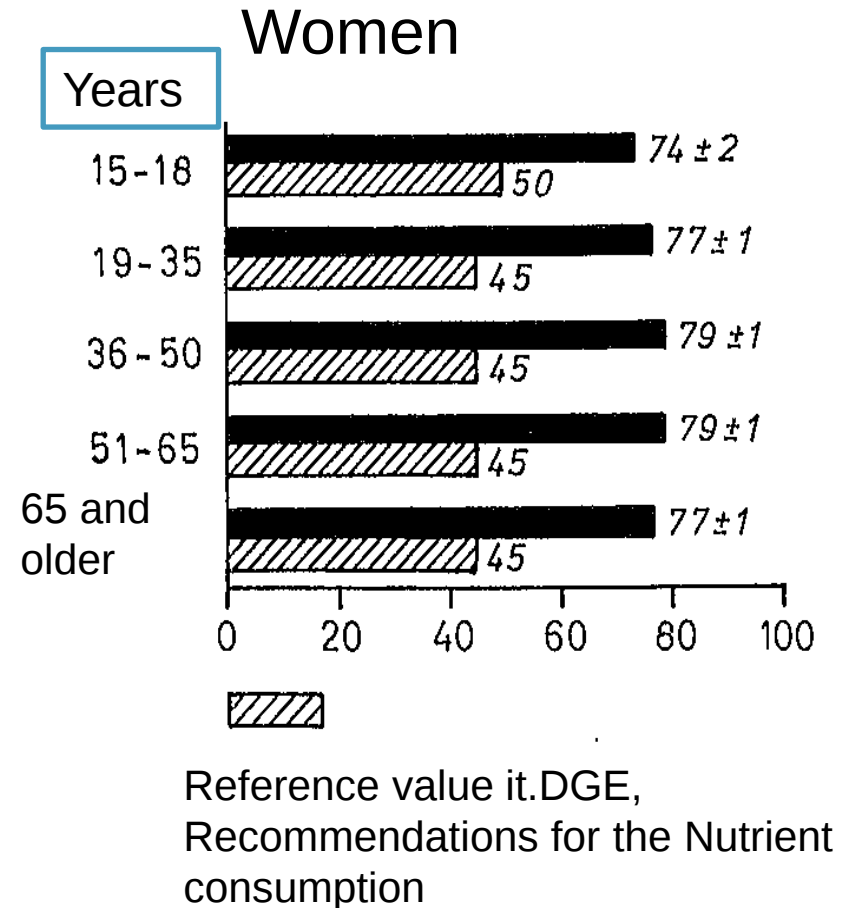
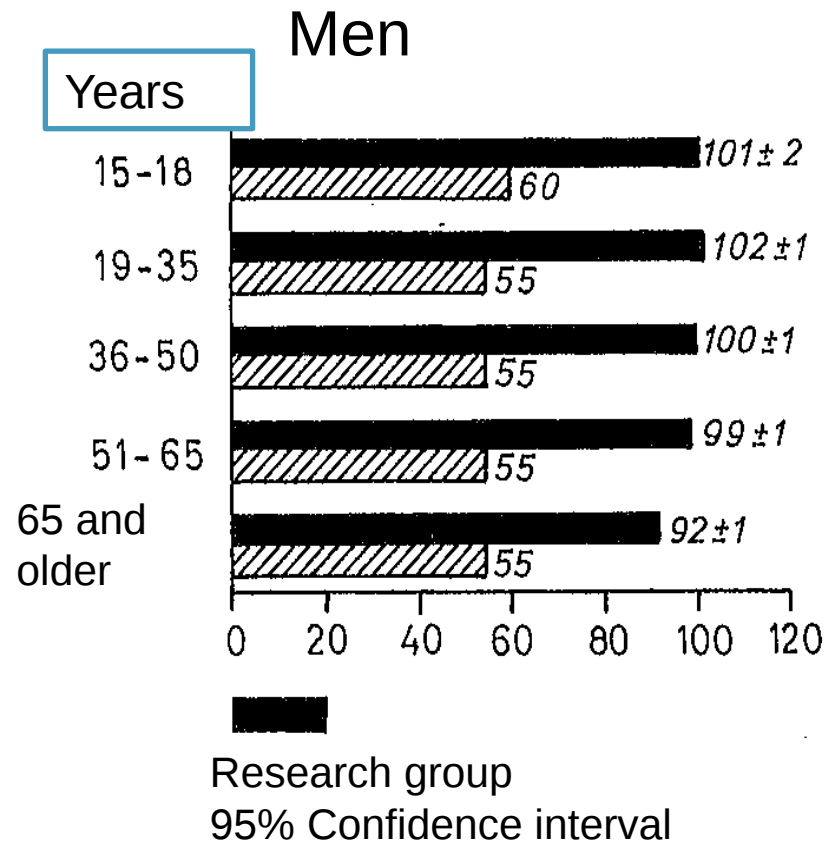
Hidden Sugar

Sweeteners:

natural and synthetic



Optimal nutrition: proteins



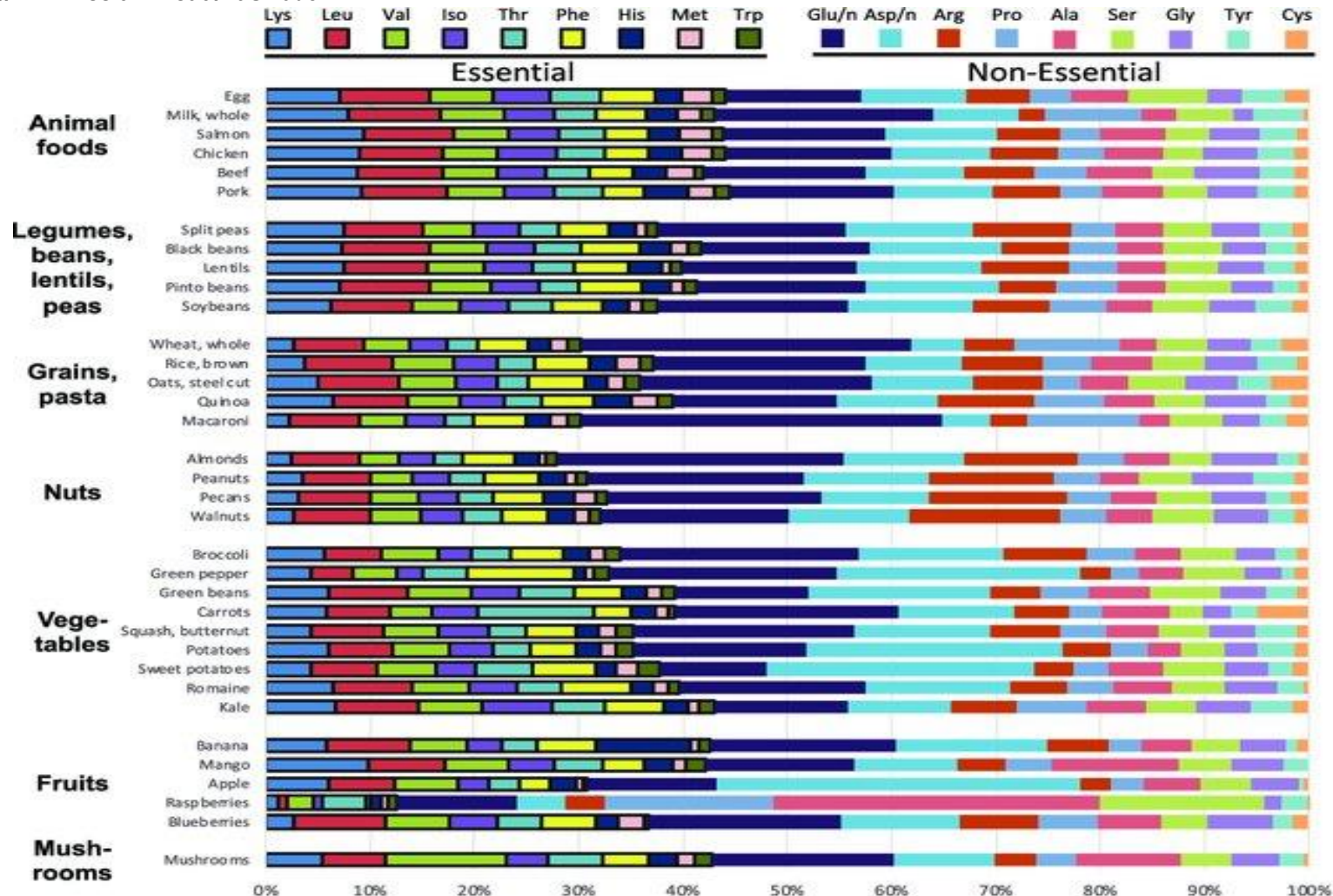
Comparison of protein consumption (g/Day) with respective reference value.

Optimal Nutrition: proteins

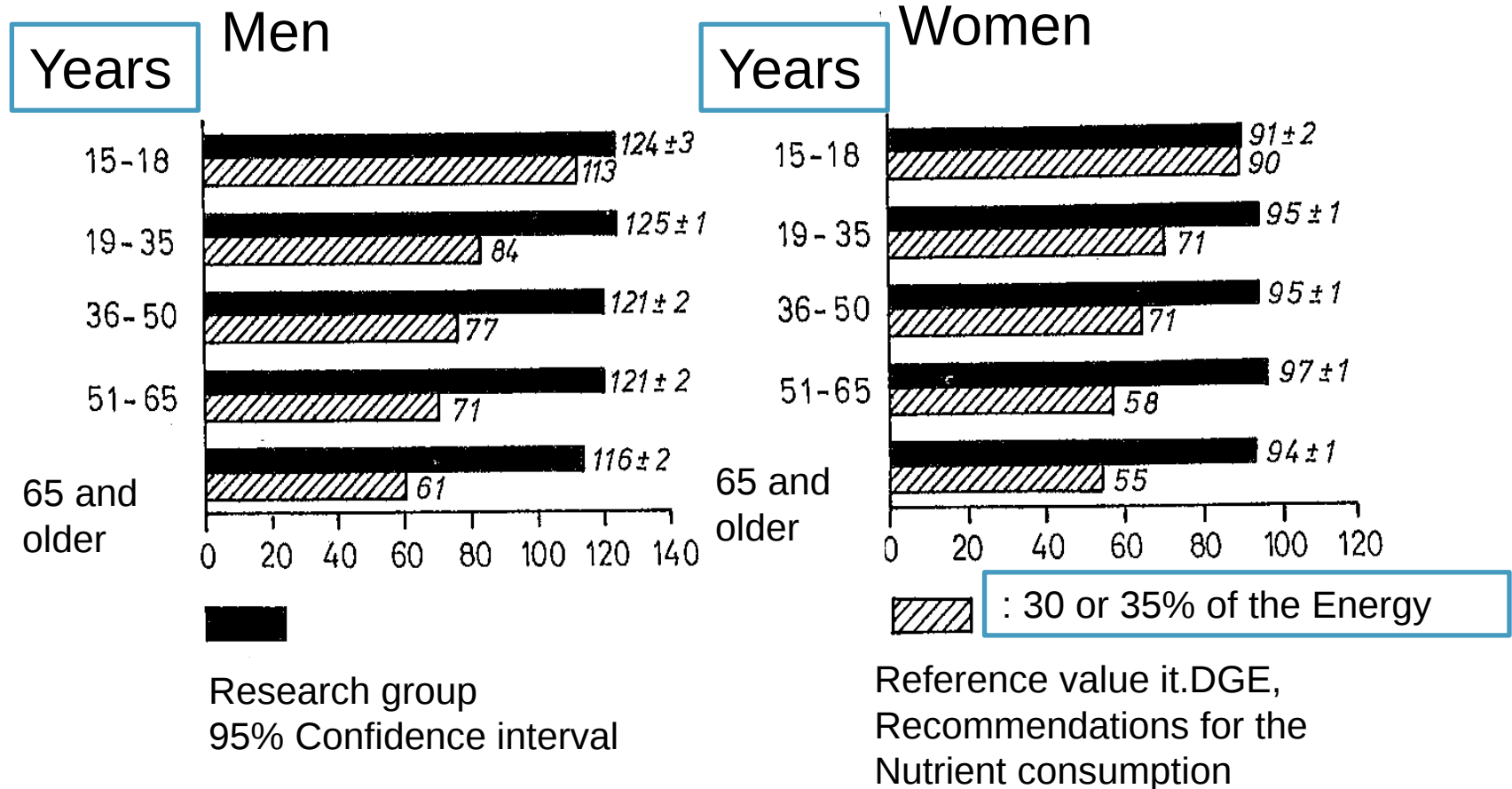


Proportions of amino acids in selected foods across food groups. Amino acids are grouped as essential or nonessential

<http://www.ncc.umn.edu/ndsr-dat>



Optimal Nutrition: fat

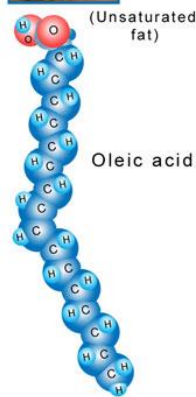
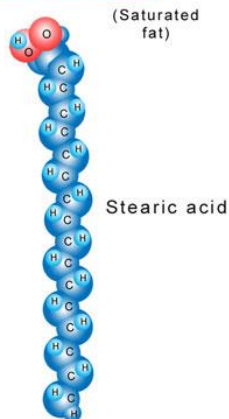


Comparison of daily Fat consumption (g/Day) with recommended reference value.

Optimal Nutrition: fatty acids

Saturated and unsaturated
 ω -3- and ω -6
10 saturated : 10 mono-: 80
polyunsaturated

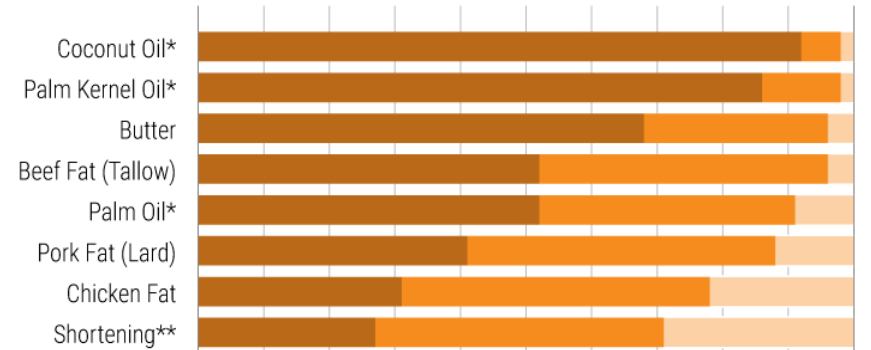
Trans-fats
9 kcal/g



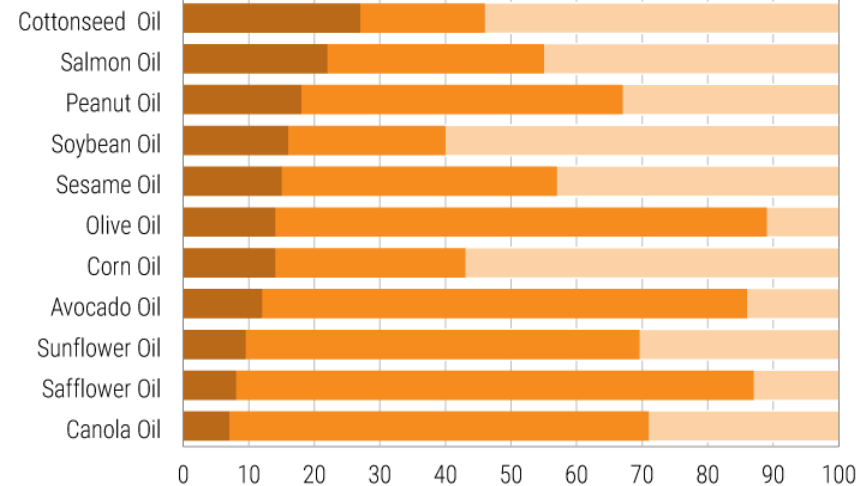
■ Saturated Fatty Acids | ■ Monounsaturated Fatty Acids | ■ Polyunsaturated Fatty Acids



Solid Fats



Oils



Fatty Acid Composition (Percent of Total)

<https://openoregon.pressbooks.pub/nutritionscience/chapter/5c-fatty-acid-types-food-sources/>

Functional food

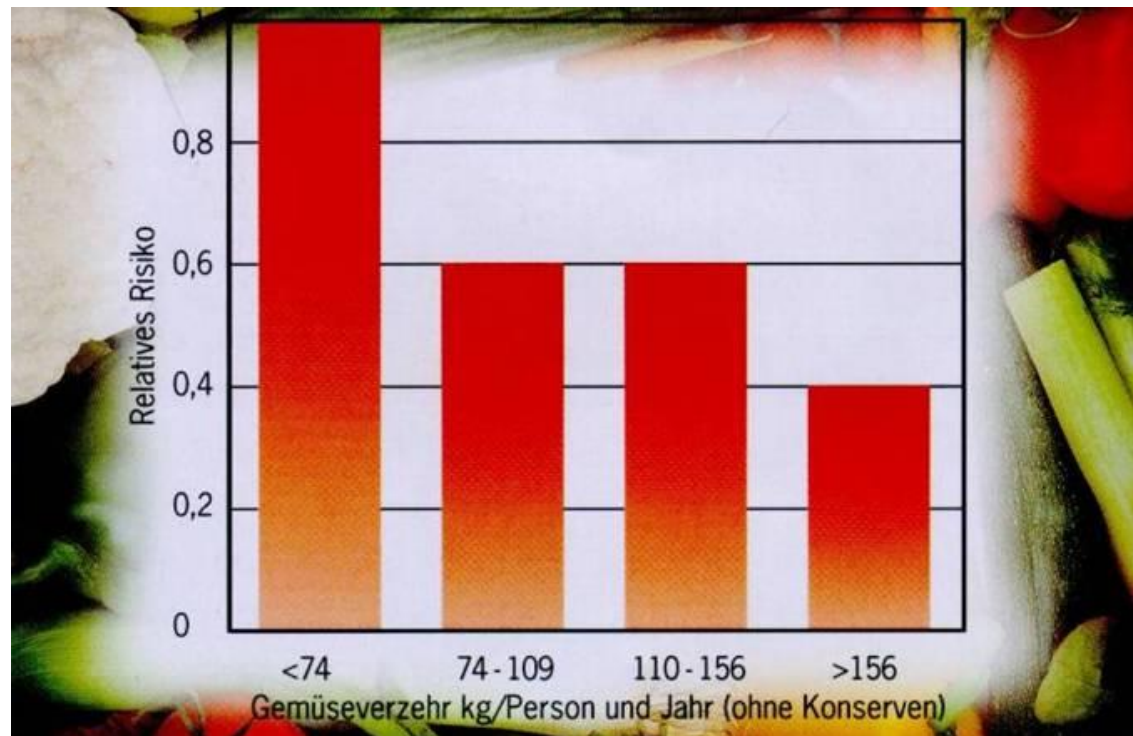


Reasons why the functional foods attract consumers:

- **Consumer wants to prevent diseases;**
- **Medical treatment is expensive;**
- **Consumers are getting aware of the connection “-Health-Nutrition”;**
- **The population of the industrialized countries is getting older;**
- **Consumers want to protect themselves against negative environmental factors;**
- **The scientific proof of activity is growing.**

Functional food

Decrease of stomach cancer in dependence of vegetable consumption



<200g/d >450g/d

Wie-Cheng You et al. Cancer Research 48, 1988

Functional foods



Attractive for consumers:

- Help to prevent illnesses
 - Cost of medicine
 - Ageing population
 - Evidence of their effectiveness is mounting
- Japan has the largest percentage of over 65's in the world
 - Western Europe has the oldest population in the world – 60% over 30
 - India has the youngest population with 50% under 25
 - Highest birth rates are in Africa and the Middle East
 - The middle-age working population is accumulating wealth



Life expectancy in 2015 according to the German Federal Statistical Office:

Women: 81.9 years

Men: 76.5

Forecast for 2050:

Women: 103.7 years

Men: 100.2 years

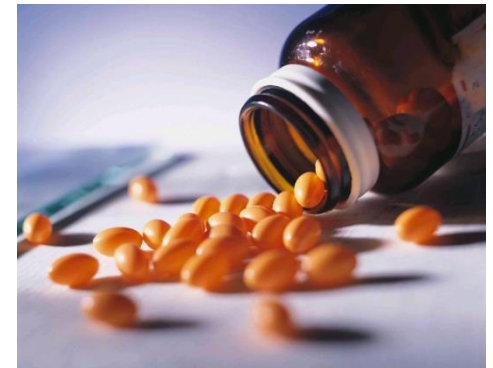
Modern food



Functional Foods – Foods (no tablets) take on functions in the body regarding health statute, mental health and reduction of disease contraction.

Nutraceuticals – prevention or treatment of diseases supports medical treatment. Can be in form of tablets, pills, powder etc.

Pharmaceuticals – Medical food - medicinal product of plant origin (as dried plant material or extract) must be taken according to the recommendation of medical personnel.



Modern food



APONEO
Mehr als Apotheke

Suchbegriff oder PZN



PRODUKTE AKTIONEN & ANGEBOTE MARKEN RATGEBER BONUSPROGRAMM

Startseite > Produkte > Sulforaphan Vegetarisch Kapseln

Sulforaphan Vegetarisch Kapseln

-17%³



Geben Sie die erste Bewertung ab!

Superschnell

Darreichungsform: Kapseln
Packungsgröße: 120 St
PZN: 02848668
Anbieter/Hersteller: Hirundo Products
Grundpreis: 77,89€/100g
UVP¹: 59,95 €

- ✓ Schützt Zellen vor oxidativem Stress
- ✓ Hilft normaler Funktion des Immunsystems
- ✓ Mit Vitamin C und Selen

→ ↺ 🏠 https://de.vwr.com/store/catalog/product.jsp?catalog_number=CAYM10496-50

Produkte

Themengebiet ▾

Services ▾

PRODUKT

Angebot hinzufügen

Zur Einkauf

Beschreibung	Katalognummer	Verpackungseinheit	Preis
Sulforaphane 1 * 50 mg	CAYM10496-50	1 * 50 mg	300,00 €

Modern food



Stevia Getrocknet Lose Blätter - 100% BIO Certified Premium Qualität 500 G

Marke: BlendNature



73 Sternebewertungen

Amazon's Choice

für "stevia blätter bio"

Preis: 21,40 € exkl. USt

25,90 € (51,80 € / kg) inkl. USt

Typ	Bezeichnung	VE	Katalognummer	Planlieferzeit	Listenpreis
Certified reference material	Total Phenolics	2 ml	QC1134-2ML	Unbestätigte Lieferzeit: 3 Tage	45,90 €

Hersteller-Artikelnummer: QC1134-2ML

Functional foods: Colonic food



High-Fiber Foods:

Fruits, Vegetables, Whole Grains, Legumes

Probiotic-Rich Foods:

Jogurt, Kefir, Sauerkraut and Kimchi, Tempeh and Miso, Pickles

Prebiotic Foods:

Garlic and Onions, Asparagus, Bananas, Chicory Root

Hydrating Foods and Fluids:

Water-Rich Fruits, Soups, Water

Healthy Fats:

Olive Oil, Avocados, Nuts and Seeds

Detoxifying Foods:

Lemon, Ginger, Aloe Vera

Low-Processed, Low-Sugar Foods:

Foods Rich in Omega-3 Fatty Acids:

Fatty fish, Flaxseeds and chia seeds

Functional food: choice of food



Functional foods

No standard legal definition

Increase in well-being and prevention of diseases: Food with additional health-promoting properties (e.g. strengthening of the immune system)

However, complete curing of illnesses should not be promised!

Most common additives: Vitamins, minerals, bacterial cultures, unsaturated fatty acids

Regulations:

- *Laying down the general principles and requirements of food law*
- *Responsibilities of food companies*
- *Declaration obligation*
- *Traceability*

Responsibilities of food companies: The main legal responsibility with regards to the safety of a food lies with the food company that has produced it.

Safe food: The safety of a food product must be guaranteed at all stages during the food production and marketing process - from the producer to the consumer. Safe food from field to table

Functional food: Regulations



UNITED STATES

Regulatory Body **FDA (Food and Drug Administration)**: safety and labeling of functional foods.

Health claims must be supported by scientific evidence.

Categories of health claims:

1. **Authorized health claims:** Calcium may reduce the risk of osteoporosis
2. **Qualified health claims:** Some evidence suggests...
3. **Structure/function claims:** Calcium supports strong bones

GRAS (Generally Recognized As Safe)

Dietary Supplements

Consumer knowledge of health claims about selected functional foods in the USA

For the active ingredients	Effect on	Percentage of those surveyed with knowledge:
Cranberries	Urinary tract infections	56% of women
Lycopene	Prostate cancer	54% of men and women
DHA (omega 3)	Osteoporosis	With US citizens knowledge is - lowest amongst over 75-year-olds - highest amongst young US citizens
Antioxidants	Cancer	- 39% of citizens with a high school diploma - 60% of citizens with a university degree
Soy	Heart disease	- 55% of older US citizens - 35% of US citizens aged between 35 and 54

Functional food: Regulations



EUROPEAN UNION

Regulatory Body **EFSA (European Food Safety Authority)**: Responsible for food safety, including functional foods and health claims.

EU Nutrition and Health Claims Regulation (NHCR):

1. **Nutrition claims**: “high in fiber”, “source of vitamin D”
2. **Health claims**: “reduces cholesterol”

Novel Foods: If a functional ingredient is classified as a novel food, it must undergo a safety assessment before being approved for the market.

Functional food: Regulations



EU: Health Claims

EU Health Claims Regulation (EC No. 1924/2006) came into force on 20/12/2006, Revised on 01/07/2007

The EFSA (European Food Safety Authority) is responsible

Content:

Use of health-related claims on products and in advertising

Applies to functional foods and food supplements

The EFSA lists

Nutrition Claims

- e.g. “Low fat” = <3g fat / 100g;
<1.5ml / 100ml
- e.g. “Sugar-free” = <0.5g sugar / 100
mg or 100 ml

List is available

Health Claims

- e.g. “Promotes digestion”, “Reduces
cholesterol levels”
- Are carefully checked

List not yet created

Functional foods

1995 to 1998 - FUFOSE (Functional Food Science in Europe)

Functional foods should:

1. Be available in conventional form and possess sensory characteristics such as appearance, colour, texture, consistency and taste.
2. Possess nutrients that provide physiological benefits in addition to the necessary nutrient requirements. These additives should not reach the same concentrations as in medical products.
3. Have a functional benefit that can be scientifically proven, proven to be safe during a long-term study, be health promoting and adapted to the target group.
4. Allow consumers to enjoy these functional benefits after ingesting just a normal amount of food.
5. Contain functional nutrients that occur naturally or that are added to the food.

Novel Food

Novel foods can only be put on the market if they

- Do not present a risk for consumers
- Do not deceive consumers
- Do not differ from the traditional products they are intended to replace in such a way that their normal consumption would result in nutritional deficiencies for consumers
- Labelling

Novel food (and food ingredients): Not used for human consumption in the European Union before the 15th of May 1997

Regulation (EC) No. 258/97 of 27th of January 1997 consists of 15 articles that cover the areas of: uses, placing on the market, labelling

Novel food products

- Noni juice (Morinda Inc)
- Argan oil (Oleador)
- Omega 3 fatty acids from algae oil
- Cereal bran (Du Pont): Fat substitute and fibre (UK03/1999), application withdrawn*

Novel Food: Noni juice



- Noni (*Morinda citrifolia*)

Class: Rosopsida

Subclass: Rosidae

Genus: *Morinda*

Variety: Noni tree

**“Noni juice” – authorised novel food
from 5th of June 2003 (2003/246/EC) Brussels for Morinda Inc.**

- Xeronine is an alkaloid that was discovered by Ralph Heinicke when he was investigating bromelain from pineapple fruit.
- 2002, German Federal Institute for Risk Assessment (BfR): Xeronine is completely unknown in biochemical and medical literature.
- 2008: Structural formula of xeronine
- Smell: cheesy, sweaty smell, often other flavours are added (e.g. raspberry flavour).



Novel Food: Noni juice

Medicinal effects

- Lowers blood pressure
- Helps to regulate sleep, temperature and mood together with the hormones melatonin and serotonin
- Increases the body's energy levels
- Acts as an antihistamine and anti-inflammatory
- Relieves pain
- Has anti-bacterial properties that can protect against damage to the digestive system and heart
- Prevents the emergence of preliminary stages of cancer and cancerous growths
- Stories of patients with terminal cancer being healed

The EU Commission Scientific Committee on Food has determined that special health effects of noni juice have "not been scientifically proven"

Novel Food: Nano



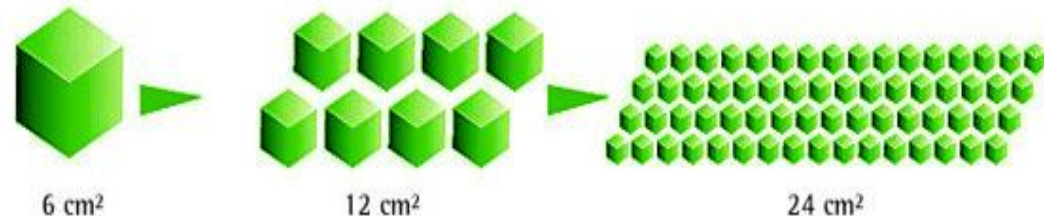
“Nano” (comes from the Greek word for dwarf)

“All technologies that control the behaviour of materials at an atomic and molecular level and / or fundamentally rearrange and shape them” (Norio Taniguchi, 1974)

Size of individual atoms: 1-100 nanometres (billionth of a metre: 10^{-9}m)

The tiniest particles of matter that can determine the characteristics of a product

- Taste
- Colour
- Viscosity
- Chemical reactivity, greater biological activity, catalytic behaviour



→ *The cause of this is the greatly increased surface area of nano materials but with the same total volume*

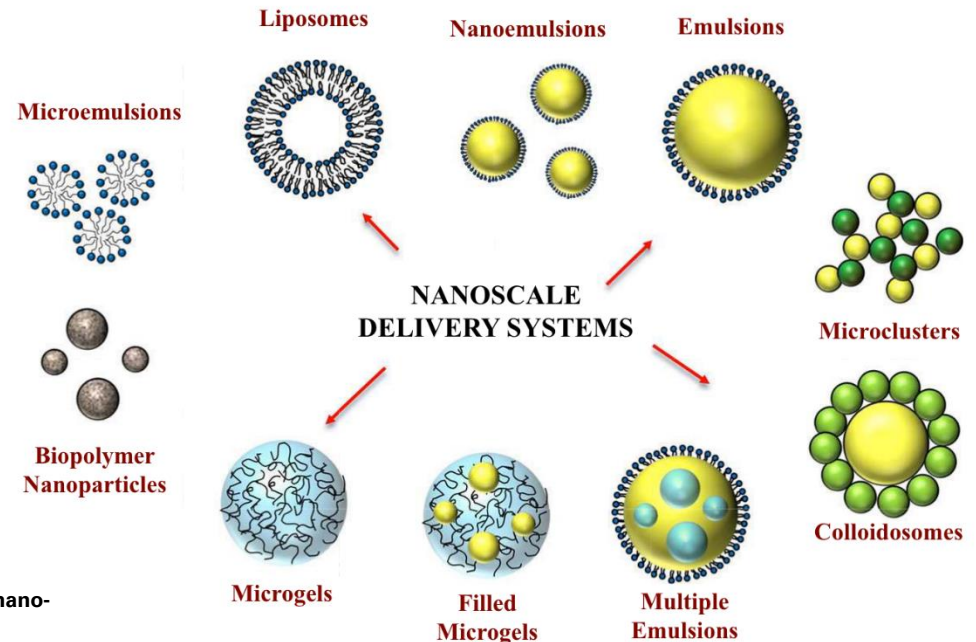
Novel Food: Nano

“Engineered nano material is any material that has been specifically manufactured so that it consists of individual functional and structural particles, either in or on their surface, with sizes of 100 nm or less.”
(European Food Safety Authority)

1 mm	Human hair 1 mm
1 µm	White blood cells 10 µm Bacteria 1-3 µm
1 nm	Viruses ~ 75 –100 nm Organic molecules ~ 10 nm, DNA chain ~ 2 nm Small molecules ~ 0.1nm Atoms ~ 0.01 nm

Food Processing and Production

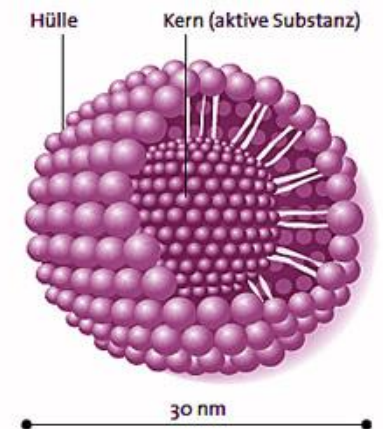
1. **Nano-encapsulation** - protects sensitive food ingredients
2. **Improved Flavor and Texture** - low-fat products
3. **Nutrient Fortification** - delivers essential nutrients such as iron, zinc, and omega-3 fatty.



Novel Food: Nano



Nano content	Product	Uses / Changes
Silicon dioxide (E551)	Ketchup	Viscosity
(Titanium dioxide, E171) Zinc oxide	Salad dressing, sweets, sauces	Bleaching agent (to lighten colour)
	Coatings: Meat, fruit, sweets, baked goods, chocolate	Extend shelf life
Aluminium silicate Silicon dioxide	Powdered foods -Cooking salt -Vegetable stock -Spice mixes -Coffee whitener	Prevents clumping Improves pourability
Micelles (encapsulation) vitamin C, Omega 3 fatty acid	Food supplements, drinks	Invisible, colourless and tasteless Nutrients can be transported to individual areas of the digestive tract in a targeted way



Novel Food: Nano



Impermeable packaging

→ Extends the shelf life of foods

- Use: silicon dioxide
- Changes the properties of packaging so that no gasses or liquids can get in or out and no UV light can penetrate it
- Examples: Foils, fresh storage boxes and bottles made from plastic

Anti-bacterial packaging

→ Prevents bacteria growth and multiplication

- Use: Nano zinc oxide, nano silver
- Today: Packaging with small transmitters; Supply information and make storage management easier (nano sensors)
- Future: Research into nano sensors: Packaging will change colour to indicate changes in temperature or humidity Soon: Cold chain is broken, hole in packaging or product is spoiled
- Examples: Best before data of meat, vegetables, milk

Novel Food: Nano

Agriculture

- New generation of chemicals for conventional cultivation
- Components of their products reduced to nano size or
- The active ingredient is packaged in nano capsules that will only break down under certain conditions, i.e.
- Heat
- Sunlight
- pH level
- Result: Plant protection products and fertilisers can be used more effectively

Cosmetics

Sun cream containing (past. titanium dioxide) zinc oxide

They reflect sunlight like billions of tiny mirrors

- Particularly high SPF factors are therefore possible

Make-up with nano colour pigments

Body and face creams, anti-wrinkle creams

Toothpaste

Novel Food: Nano

Effects on consumers' health

- » Due to the small size and associated increase in surface area, nano materials usually have different chemical properties to larger particles of the same substances -> they can even sometimes have toxic effects.
- » This also changes their effects on consumers. Nano materials can enter the body in many different ways (through the skin, respiratory tract and the mouth) and can also overcome important protective barriers inside the body. Examples: Membrane window of the intestinal lining, alveoli or even nuclear membrane.
- » Can cause damage to genetic material, inflammation and organ damage.

Identification

- » Some foods already contain nano particles without the knowledge of the changed properties and possible risks.
- » Until now, no special identification has been required. Except for products that fall under the “Novel Food” Regulation for new foods.
Introduction of an obligation to identify failed after three years (exception: cosmetics from 2013)
- » Most of the time, they are disguised as an additive.

Functional food: Regulations



Japan

- FOSHU (Foods for Specified Health Uses) program.

Categories of FOSHU foods:

1. Regular FOSHU: Meets all scientific and clinical testing requirements.
2. Reduction of disease risk FOSHU: e.g., certain probiotics reducing cancer risk.
3. Qualified FOSHU: have evidence but may need more long-term studies.
4. Foods with Function Claims: allowing companies to use scientific evidence to make claims without going through the full FOSHU approval process

Canada

Health Canada

Health Claims:

1. Nutrient content claims: "low in fat".
2. Health claims: "a diet low in saturated fat reduces the risk of heart disease".
3. Therapeutic claims: natural health products.

Australia and New Zealand:

FSANZ (Food Standards Australia New Zealand)

Health claims:

1. general health claims: nutrients with health functions
2. high-level health claims: food to the reduction of disease risk.

China:

China Food and Drug Administration (CFDA):

1. Safety: Functional foods must be proven safe for consumption.
2. Scientific Evidence
3. Labeling: Only approved health claims can be used on packaging and advertising.

Functional food: regulations



The European market

- **Progressive regulation in Sweden, Finland, Great Britain and Belgium:** Consumers in Northern Europe accept FF for their health benefits.
- **Restrictive regulation in other European countries:** Direct health-related claims are not allowed. Soft claims that relate to catchwords like fitness, wellness and convenience.

Commercial positioning of Functional Food

- USA, Japan and Central Europe class FF as “**Convenience products with a trend towards health products**”
- In the USA, South/Central and Northern Europe (Germany) “**Return to products with natural active ingredients**”
- However, in Northern Europe technological possibilities are at the forefront: “**Biotechnologically/food technology-produced products, where the additives have come from a laboratory**” and “native enrichments that are supplied by agriculture and then industrially processed”

Prices:

- High in Germany, Central and Southern Europe
- Too low in Northern Europe

Functional food: Advertising



Advertising with	Advertising example	% of the products
HEALTH	<i>Vitamins / Minerals</i> <i>An extra portion of calcium</i> <i>More calcium and magnesium for muscle function</i>	33.2
ACE	<i>Cell activation and protection</i> <i>Protection against free radicals</i> <i>Antioxidative</i>	19.3
Healthy eating	<i>Contributes to a healthy diet</i>	13.9
Health	<i>Valuable contribution to your overall health</i> <i>For health-oriented food-lovers</i> <i>Protect yourself!</i> <i>Real elixir of health</i>	13.9
Strengthens the immune system	<i>Stabilises your immune system</i> <i>Can actively strengthen the body's immune system</i>	10.5
Breakfast replacement	<i>Breakfast drink</i> <i>The healthy breakfast option, our breakfast drink</i>	6.3
Gut microbiota / Intestinal function	<i>Supports the growth and development of the gut microbiota</i> <i>Positive influence on the gut microbiota</i>	5.0
Digestion	<i>Promotes digestion</i> <i>Positive influence on digestive function</i> <i>Supports digestion</i> <i>Regular digestion</i>	3.8
Fat metabolism	<i>Your body needs a daily dose of DHA omega 3 fatty acid</i>	0.4

Functional foods

Probiotics

- » Special bacterial cultures, e.g. *Lactobacillus casei*
- » Have a positive influence on the gut microbiota
- » Found in dairy products, muesli or juices

Prebiotics

- » Indigestible carbohydrates, e.g. inulin, oligofructose
- » Encourages the reproduction of probiotic bacteria
- » Found in dairy products, muesli

Antioxidants

- » Minimise the damaging effects of free radicals
- » Vitamins C and E are particularly effective
- » Found in ACE drinks or mixed vegetables

Omega 3 fatty acids

- » Polyunsaturated, essential fatty acids
- » Help to lower cholesterol levels, protect against cardiovascular diseases
- » Found in eggs, soft drinks, bread



Functional foods

Secondary plant metabolites

- Carotenoids, polyphenols, sterols
- Effects:
 - Antioxidative - Fight against free radicals
 - Boost the immune system
 - Lower cholesterol levels

Folic acid

Positive effect on the cardiovascular system

Folic acid deficiency during pregnancy can lead to embryonic malformations

Fibre

Positive effect on digestion

Minerals

e.g. iodine to fight against thyroid disorders, calcium to tackle osteoporosis

In addition, magnesium or iron



<https://www.medpex.de/quercetin-kapseln-p10199830?a>



<https://www.my-natura-vitalis-shop.com>

Functional food: Effects

1. Gastrointestinal tract

Improves intestinal activity and the gut microbiota, increases immune function, controls fermentation in the intestines and reduces the consequences of lactose intolerance.

2. Defence against reactive oxygen species

-Prevention and reduction of oxidative stress-related illnesses and diseases (cancer).

3. Cardiovascular system

-Reduction of cholesterol levels and blood pressure whereby the tendency to develop thrombosis can be controlled and arterial damage can be prevented.

4. Bone health

-The bioavailability of calcium to build bone mass in children, as well as for the maintenance of bone mass in old age.

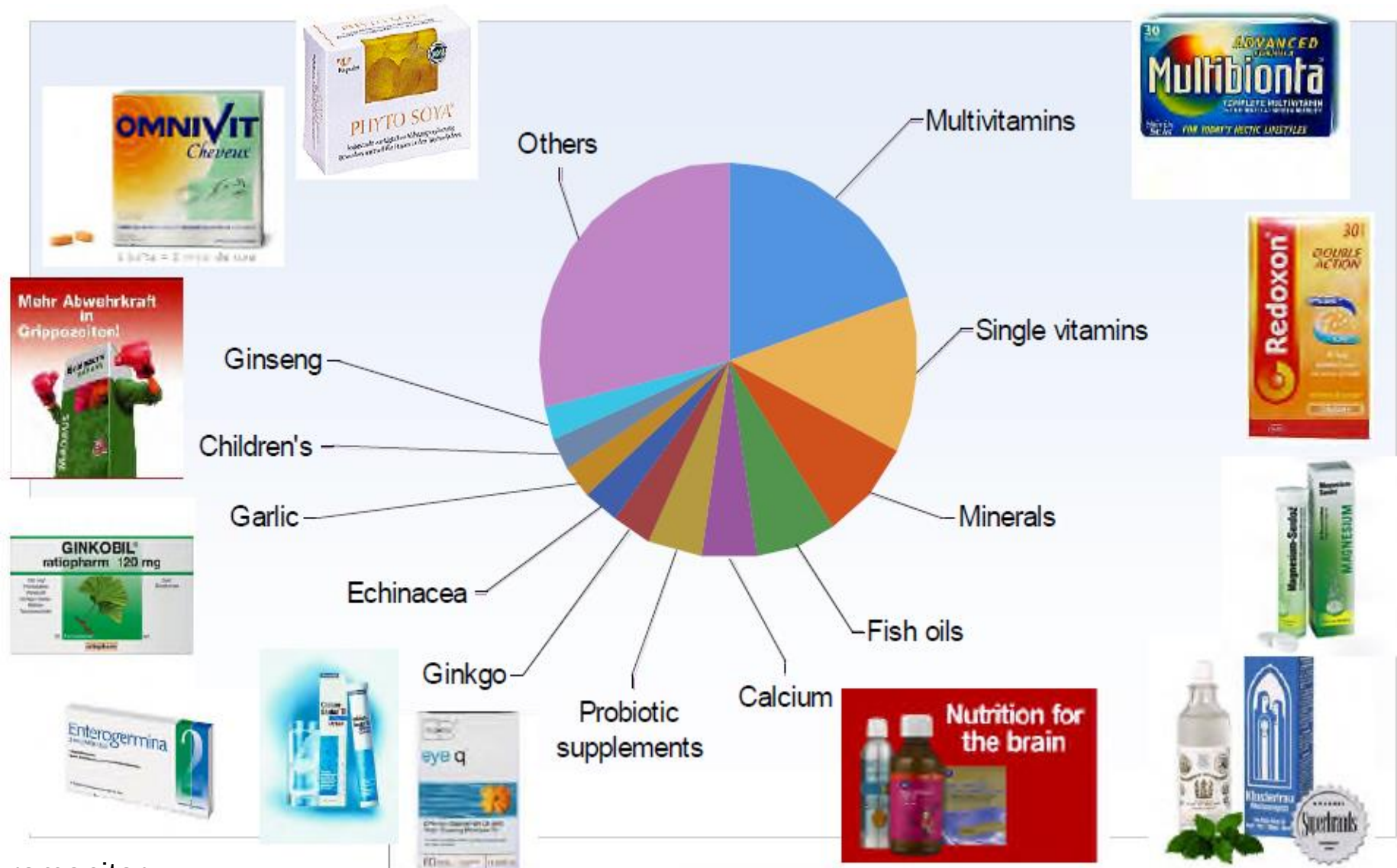
5. Metabolism of macronutrients

Food has a significant influence on blood sugar and blood fat levels. This should help to reduce the risk of consumers becoming overweight and obese.

6. Growth, development and differentiation

- Pregnant women and small children have different nutrient needs to adults and elderly people.

Nutraceuticals



Plant Bioactive Compounds



Primary

Carbohydrates (Mono-, Di-, Oligo-, Polysaccharides)

Lipids

Proteins

Characteristic:

- Main components
- Take part in Metabolism;
- Nutrients

Secondary

Phenolic substances (Phenols, Flavonoids, Phenolic acids, Polyphenols)

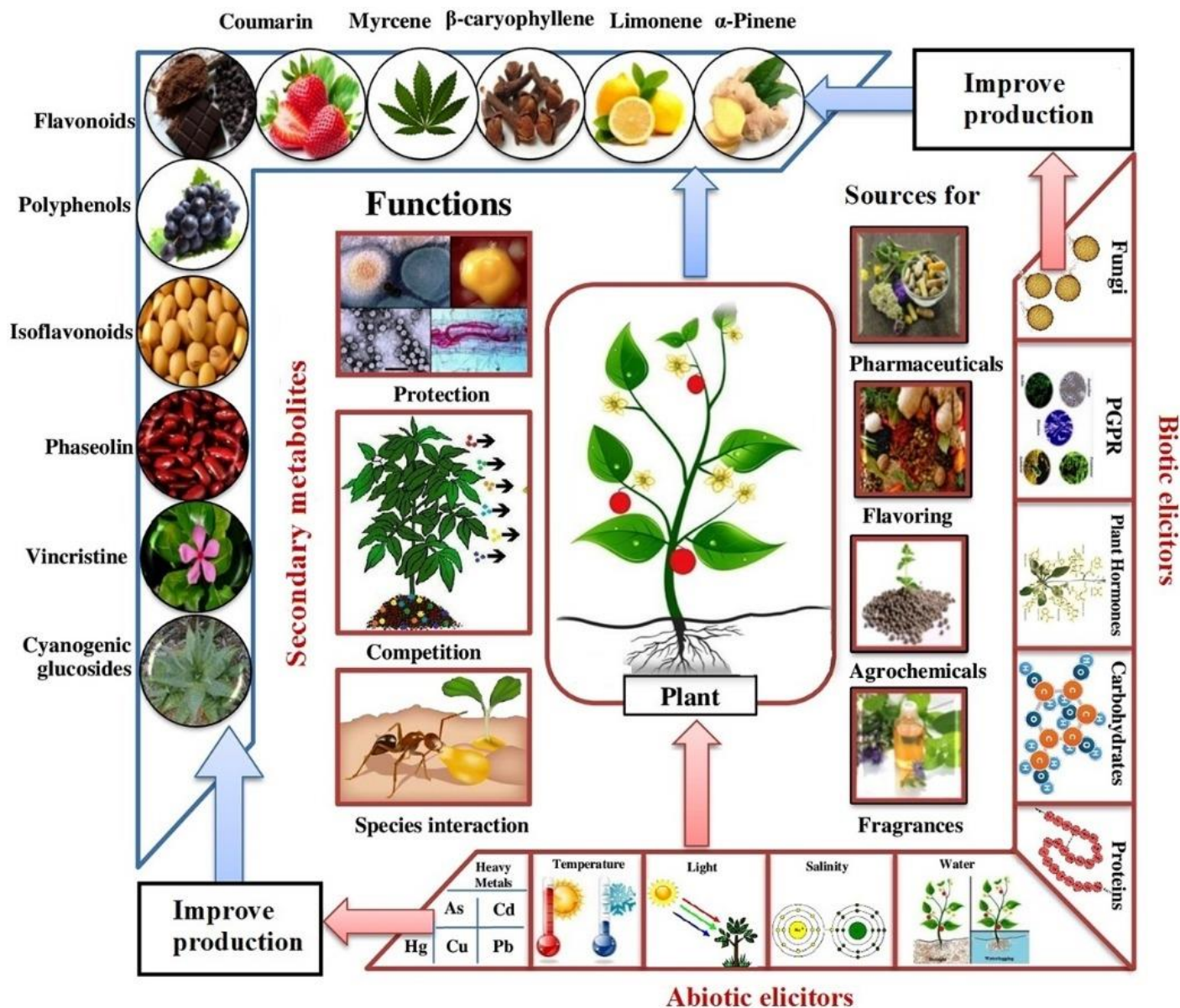
Alkaloids (Indolalkaloids)

Isoprenoids (Terpene, Phytoestrogens, Glycosides (Saponins, Sulfides, Glucosinolates))

Characteristic:

- 120.000
- Small quantities;
- In certain plants;
- Pharmaceutical activity
- Not essential

Plant Bioactive Compounds



Plant secondary metabolites



Secondary compounds	A	B	C	D	E	F	G	H	I	J
Carotinoides										
Phytosterols										
Saponins										
Glucosinolates										
Polyphenols										
Terpens										
Phytoesrogenes										
Sulfide										

A = anti cancer
B = anti microbial
C = Antioxidative

D = antithrombotic
E = immunomodulate

J = improves digestion
H = anti cholesteric
F = anti inflammatory

G = regulation of blood pressure

I = lowers blood pressure

Why plant secondary metabolites?



Application:

Food supplements

Vanilla planifolia - Vanillin – taste and odor



Pharmaceuticals

Atropa belladonna - Atropine – cardiovascular disease



Cosmeceuticals

Vitis vinifera - Anthocyanins – colorant

Protectants

Allium L. - Aliin – plant protectant



Plant secondary metabolites



Bioactive Compounds: Anthocyanins



- 250
 - red, violet, blue color (pH 3-4 - red, pH 8-9 - blue)
 - Red, violet, blue, dark blue color
 - In flowers and fruits (vacuole), primarily in the peels
 - Absorption spectrum is 270-290 and 465-560 nm
 - Color is dependent on pH and the molecular structure (pH 3-4 – red; pH 8-9 blue)
 - Coloration of the leaves in autumn
 - During the germination (UV-protection)
 - Act as attractants for insects and animals
- Application: food supplement for coloring of fruit jellies, sweets, canned fruit, cookies = supplement E-163
- antioxidants, anti-inflammatory, DNA-protective



Food	mg /100 g
eggplant	750
blood orange	200
blackberry	115
blueberry	80-420
Cherry	350-400
currant	80-420
Grape	30-750
Red wine	24-35



Moonaqua™



Moonlite™



Moonshade™



Moonvista™

Bioactive Compounds: Anthocyanins

HOCHSCHULE
WEIHENSTEPHAN-TRIESDORF
UNIVERSITY OF APPLIED SCIENCES



Anthocyane aus Heidelbeerextrakt 25% - 90 Kapseln -
vegan

von herba direkt



13 Sternebewertungen

Preis: Preis exkl. USt nicht verfügbar

EUR 13,95 (22,87 € / 100 g) inkl. USt



<https://www.amazon.de/Herbadirekt-ANTHOCYANE-AUS-HEIDELBEEREXTRAKT-25/dp/B01FLRR5KO>

https://de.vwr.com/store/catalog/product.jsp?catalog_number=43725-10MG-F

Produkte

Themengeblet ▾

Services ▾

Suche mit Stichwort,

Angebot hinzufügen

Zur Einkaufsliste hinzufügen

Hersteller-Artikelnummer: 43725-10MG-F

Delphinidin chloride ≥95% (HPLC)

analytical standard

10 mg

43725-10MG-F

Unbestätigte Lieferzeit: 3 Tage

1 070,00 €

Hersteller-Artikelnummer: 43725-10MG-F

Functional foods: Beverages



Functional beverages are associated with various health benefits:

- healthy cardiovascular system,
- cancer prevention,
- health digestive system,
- immune defense,
- body weight reduction,
- joint health improvement.

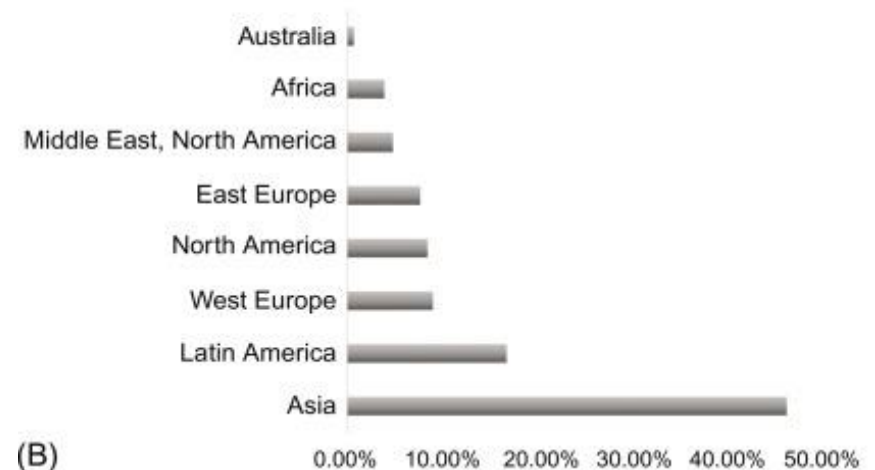
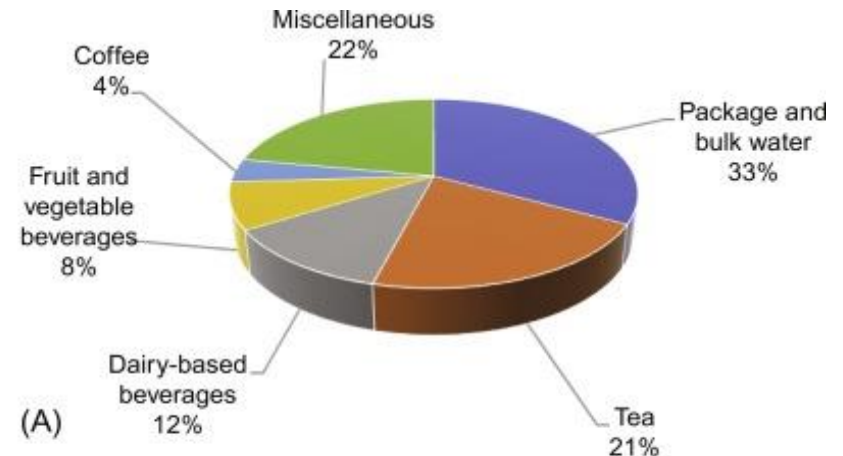
Diversity

in Germany

- **286 ACE drinks:** Energy drinks, sports drinks, vitamin drinks, wellness drinks

- **123 drinks** - with active ingredients (apple cider vinegar, aloe vera, St. John's wort, vitamins)

- **13 active ingredients per drink** - mostly vitamins and/or minerals (ACE followed by plant additives and “power” ingredients in *energy drinks*)



(A) Worldwide market of some selected popular beverages

(B) global beverage consumption

<https://www.beveragedaily.com/Article/2016/05/20/Unprecedented-growth-for-Asia-beverage-market-global-consumption-data>

Functional foods: Beverages

Active ingredient additives

- 54.6% of drinks - Vitamins A, C, E, B6, B12, but folic acid only in 36%

-Up to 200% of the recommended daily dose / 100 ml drink = 1l 20x daily requirements

- Minerals are relatively rare, mostly magnesium (11.3%) and calcium (6.7%)

Magnesium 5-23 mg /100 ml



Functional foods: Drinks

Active ingredient groups	Active ingredients
Vitamins, minerals	Provitamin A (carotene), vitamins C, E and B, biotin, niacin, pantothenic acid, Ca, Mg, Fe, potassium, sodium, iodine, selenium
ACE	Combination of provitamin A (carotene), vitamin C and vitamin E
Plant additives	Aloe vera, artichoke, eucalyptus oil, ginseng, elderberry, ginger, St. John's wort, camomile blossom, lime blossom, seabuckthorn
"Power ingredients" in energy drinks	Carnitine, taurine, caffeine, glucuronolactone, inositol, choline
Probiotics	<i>Bifidobacterium lactis</i> , <i>L. casei</i> , <i>L. acidophilus</i> , <i>L. casei shirota</i> , LC 1, LGG
Secondary plant material	e.g. plant extracts, lycopene, flavonoids (green tea, red wine), anthocyanins (red wine, red grapes), phyto-oestrogen (soy, red clover)
Fermented plant material	Apple cider vinegar, honey, fermented beetroot and celery, fermented bread/grains
Fibre	Fibre from spelt semolina and rye bran, fibre from fruit and vegetables, raw grain fibre/bran, raw oat fibre, oat husk bran, pectin
Prebiotics	Inulin, oligofructose

Functional food: Mood food



The Top 10 Foods Highest in Tryptophan

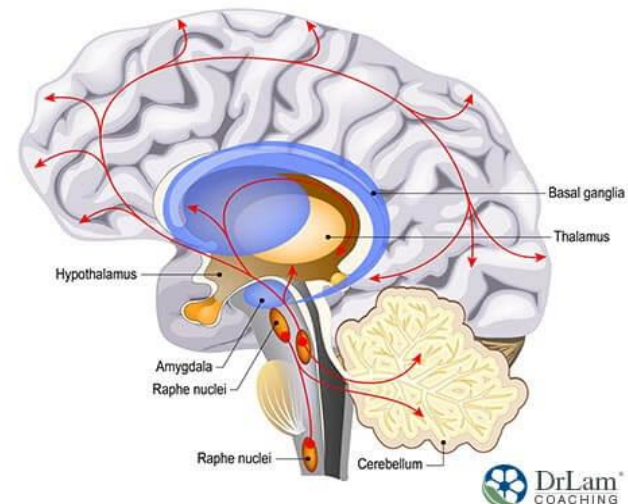
280mg = 100% of the RDI for Tryptophan

01 Seeds and Nuts %RDI per ounce (28g): • Pumpkin and Squash Seeds (58%) • Chia Seeds (44%) • Sesame Seeds (39%) • Sunflower Seeds (35%) • Flax Seeds (30%) • Pistachios (29%) • Cashews (24%) • Almonds (21%) • Hazelnuts (19%)	02 Soya Foods %RDI per ounce (28g): • Dry Roasted Soybeans (57%) • Koyadofu (75%) • Sprouted Soybeans (30%) • Tofu (27%) • Boiled Soybeans (24%) • Tempeh (19%)
03 Cheese %RDI per ounce (28g): • Low Fat Mozzarella (57%) • Parmesan (56%) • Cheddar (56%) • Romano (43%) • Gruyere (42%) • Swiss (40%) • Fontina (36%) • Edam, Gouda, Tilsit (35%)	04 Lamb, Pork, Beef, and Game %RDI per 3 ounces cooked (85g): • Lamb (81%) • Rabbit (133%) • Lean Beef (124%) • Ground Pork (124%) • Goat (123%) • Beef Steak (121%) • Pork Tenderloin (117%) • Wild Boar (115%) • Veal (113%)
05 Chicken and Turkey %RDI per 3 ounces cooked (85g): • Chicken Breast (123%) • Chicken Stew (117%) • Turkey Wing (113%) • Turkey Breast (110%) • Chicken Wing (108%) • Drumstick (102%) • Ground Turkey (94%) • Turkey Drumstick (98%)	06 Fish %RDI per 3 ounces cooked (85g): • Tuna (102%) • Halibut (102%) • Salmon (98%) • Rockfish and Trout (90%) • Snapper (89%) • Mackerel (88%) • Haddock (79%) • Cod (70%)
07 Shellfish %RDI per 3 ounces cooked (85g): • Crab (100%) • Spiny Lobster (112%) • Octopus (101%) • Clam (87%) • Prawns (Shrimp) (79%) • Crayfish (71%) • Oysters (71%) • Scallops (53%)	08 Oats and Other Grains %RDI per cup uncooked (~100g): • Oat Bran (113%) • Whole Oats (130%) • Wheat Germ (130%) • Buckwheat (116%) • Wheat Bran (59%) • 1 cup of Cooked Oats provides 53% RDI
09 Beans and Lentils %RDI per cup cooked (~180g): • White Beans (74%) • Cranberry Beans (70%) • Yellow Beans (68%) • Small White Beans (68%) • Pinto Beans (66%) • Kidney Beans (66%) • Pink, Navy, and Black Beans (65%) • Lentils (57%)	10 Eggs %RDI per egg (~50g): • Whole Egg (30%) • Poached Egg (30%) • Omelette, Fried, and Scrambled (30%) • Hard Boiled Egg (28%)

Improves the mood

- MF are enriched with Tryptophan, which is used by brain for production of the Happiness Hormone – serotonin

Serotonin pathway



Functional foods: Probiotics



Large intestine

Length: 1.5m; Surface area: 400qm

Colonisation: 10^{14} microorganisms (1-1.5kg),
around >400 different species (pathogenic,
neutral, probiotic)

Functions of the large intestine

- Resorption of water and electrolytes, transportation and storage of stools
- Breaking down of fibres, production of butyric acid and vitamins by microorganism flora
- 70% of immune cells live in the intestine's mucous membrane
- Production of immunoglobulins



Functional foods: Probiotics

A probiotic yoghurt contains more bacteria than normal yoghurt

Theory: Probiotic yoghurt cultures take over in the stomach and can colonise the large intestine, displacing any bacterial colonisation (e.g. by yeast)

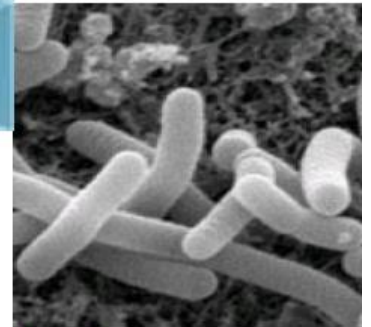
Practice: Many bacteria die before they reach the stomach and are attacked by stomach and bile acid

A probiotic yoghurt can contain up to 100 million microorganisms/ml, others contain “only” around 130,000/ml

Two of the most common bacterial strains used are: *Lactobacillus* and *Bifidobacterium*



L. reuteri



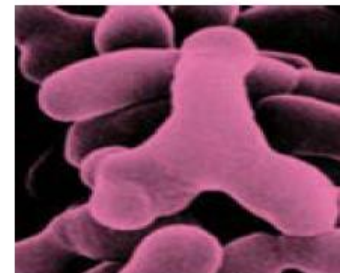
L. johnsonii



B. lactis



B. animalis



B. breve

Functional foods: Probiotics



- Ilya Metchnikoff (1845–1916) - Lactic acid bacterium and their therapeutic uses (*The Prolongation of Life*, 1907)
- 1857: Lactic acid bacterium are discovered by Pasteur
- 1878: Lister isolates lactic acid bacterium from rancid milk, and later from the intestinal tract
- 1889: Tissier discovers *Bifidobacterium spp.*
- 1900: Moro discovers *Lactobacillus acidophilus*
- 1906: Tissier presents the health benefits of probiotic foods
- 1930: Minoru Shirota - the first stable culture of *Lactobacillus casei*
- 1935: Minoru Shirota develops “Yakult”: Daily consumption of dairy products containing the *L. casei* bacterial strain is proven to have a positive effect on consumers’ health:
 - the term “probiotic” is now used



Functional food: Probiotics



**Yogurt with
special bacterial cultures**



Kefir



Sauerkraut



Natto



Kvass



Kombucha



Coconut Kefir



Functional foods: Probiotics



Tempeh

- » From Indonesia
- » Made from soy beans - the cooked soy beans are injected with *Rhizopus oligosporus*, an edible mould, which binds the beans with a mycelium within 24-36 hours
- » It is rich in protein, Ca, P, Fe, vitamins B1, B2, B6 and B12, as well as soy saponins and isoflavones



Miso

- A mixture of soy beans, rice or barley, salt, water and yeast
- Stored in wooden barrels (3 years)
- Buddhist monks - miso soup and was eaten by samurai
- Rich in fibre, protein, vitamins and minerals
- Anticarcinogenic effect due to the high isoflavone content



Functional foods: Probiotics



Requirements for probiotics:

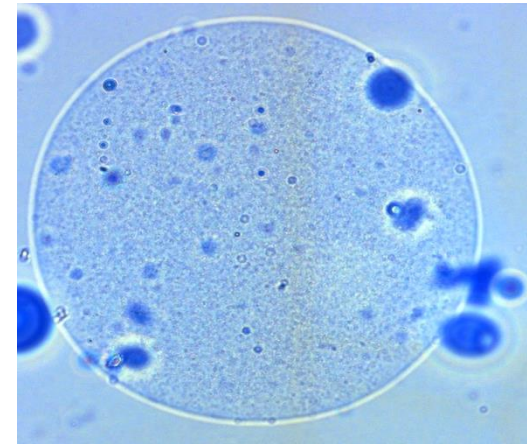
Living - should be able to reach the intestine alive
and then have a positive impact on the gut
microbiota when there

Resistant - to stomach and bile acid

Must be able to grow under anaerobic conditions

Should not be toxic

Lactobacillus, streptococcus and bifidobacterium



A microcapsule is filled with 20,000 probiotic bacteria, only leaves the casing once in the intestine

Components	Source	Benefits
Probiotic		
Different types and strains of lactobacillus and bifidobacterium, yeast	Yoghurt, different dairy products	Positive influence on the gut microbiota and immune system
Prebiotic		
Inulin, fructooligosaccharides, polydextrose, arabinogalactan	Grains, onions, bananas, honey, garlic, artichokes	Improves intestinal activity and Ca sorption

Functional foods: Probiotics

Technological problems

- Fundamental challenge: Ensuring that there is a sufficient number of bacteria in the product ► reaching the effective dose of 10^8 - 10^9 /day

Viability of Probiotic Strains

- Survival during Processing:** Probiotics are sensitive to heat, pressure, and other processing conditions.

Solution: Microencapsulation

- Survival in Storage:** Many probiotics are not stable over long periods

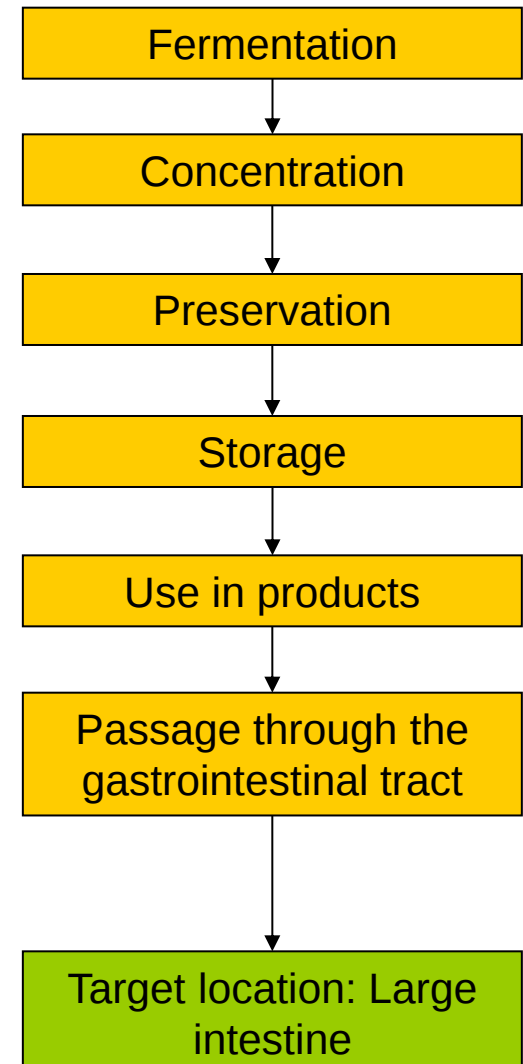
Solution: Freeze-drying

- Thermal Stability during Food Preparation and Shelf Life:** many probiotic strains are heat-sensitive

Solution: Cold-chain

- Acid and Bile Tolerance**

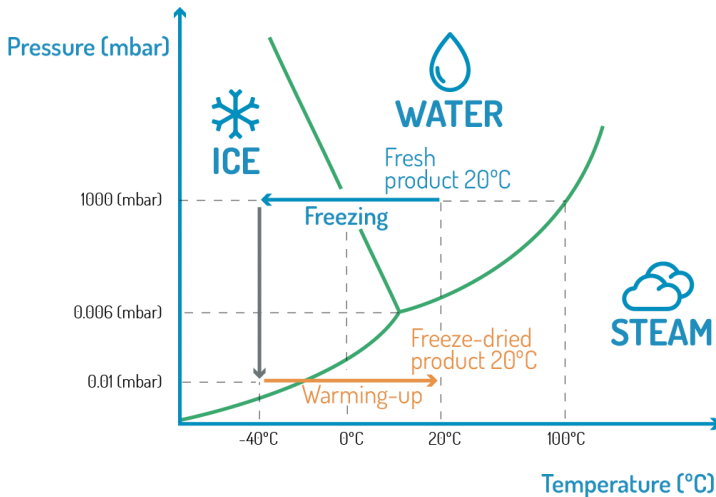
Solution: Selecting acid- and bile-resistant strains or using protective coatings



Functional foods: Probiotics

Conservation by means of dehydration

Freeze-drying



- Transition to non-metabolising, storable state
- Reduced transport costs
- Easier handling

1

Freezing

Materials are carefully frozen to control the size and shape of ice crystals



2

Sublimation

Pressure is decreased and temperature increased to sublime ice into vapor



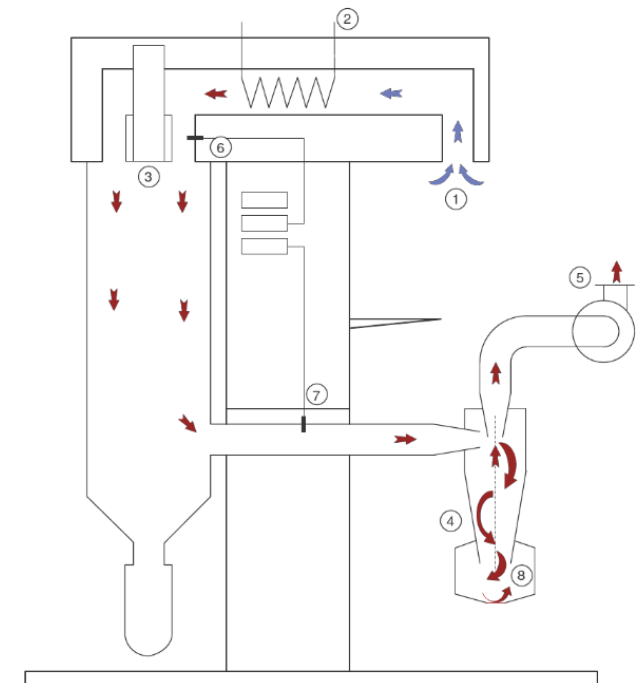
3

Desorption

Temperature increases to break ionic bonds and release last water molecules



Spray-drying



$$T_{\text{out}} = 80^{\circ}\text{C}$$

Functional foods: Probiotics

Improvement of vitality and stability

Microorganisms

- Genetic modification

Cultivation

- Improvement of the culture media
- Modification of the growth conditions

Processing

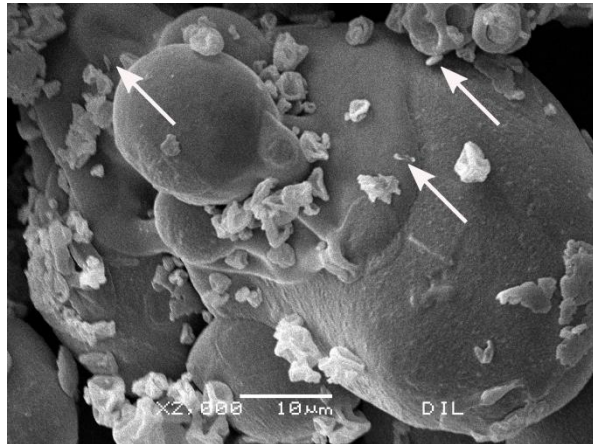
- Addition of protective substances
- Encapsulation
- Additional physical or chemical treatment
- Optimised process conditions
- Storage conditions

Functional foods: Probiotics

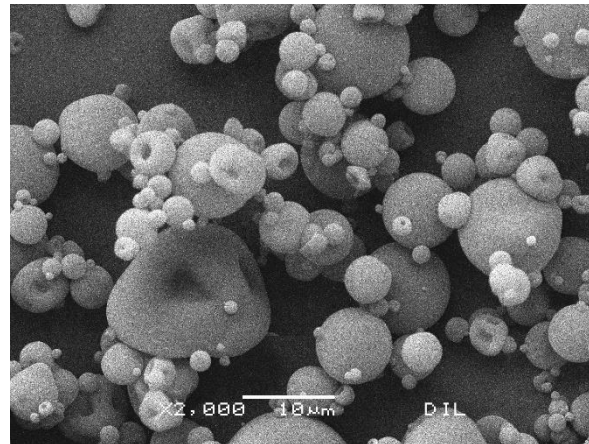
Encapsulation

Whey proteins

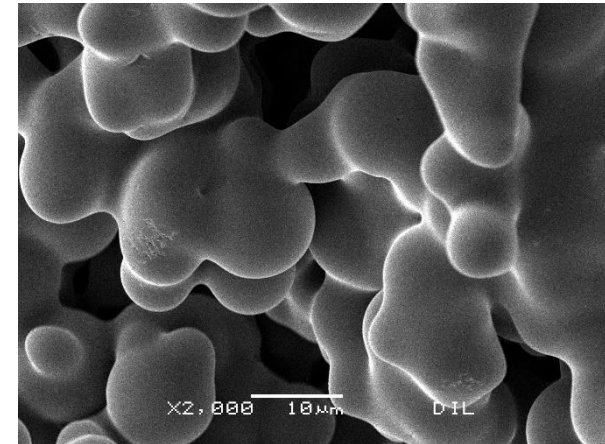
- Gardiner et al, 2000: SEM images of lactobacilli dried in skimmed milk powder: Microorganisms are stored in the powder particles
- Whey proteins may be responsible for the formation of these “capsules”



Casein + Starch



Whey protein



Trehalose

- Best encapsulation properties with whey proteins
 - Unencapsulated microorganisms in casein/starch powder
 - Encapsulation is also possible with trehalose
- Other, not yet known, protective mechanisms of whey proteins

Functional food



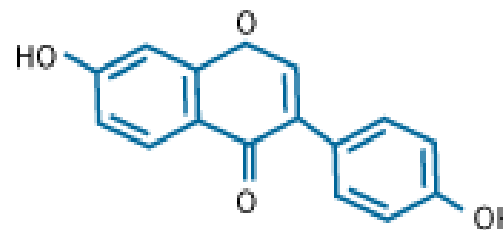
Cholesterol lowering margarine

- margarines enriched with naturally occurring phytosterols
- can lower levels of bad cholesterol (LDL-cholesterol) by up to 10 %

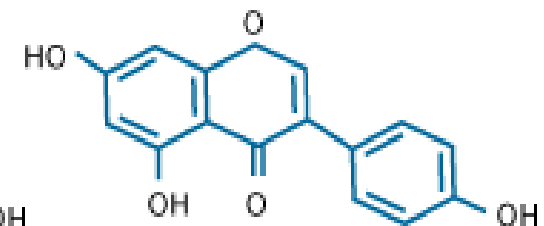


Phytosterols

- occur in seeds, nuts and legumes, but the quantities are small to have a major effect on lowering cholesterol
- have a similar structure to cholesterol
- reduce the amount of cholesterol absorbed from the small intestine into the bloodstream
- lower levels of carotenoids in the body (may increase risk of heart disease)



Daidzein



Genistein

Plant sterol enriched foods cannot replace the medicines!

Beauty Food

HOCHSCHULE
WEIHENSTEPHAN-TRIESDORF
UNIVERSITY OF APPLIED SCIENCES



**Anti-Aging-
Bier**



Collalift



Collagen drink

Norelift



Skin-firming marmalade



Kanebo



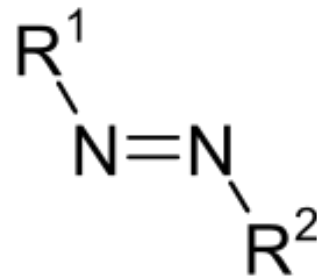
Deo-chewing gum

Frutels



Fruit drops against acne

Nutraceuticals: Food colorants



Nutraceuticals: Food colorants



5 Colors of Phytonutrients

8/10 Americans Don't Eat Enough Color...



74% Don't Eat Enough Red

Phytonutrients:
lycopene, ellagic acid, quercetin, hesperidin, anthocyanidins



Red Benefits

Supports prostate, urinary tract and DNA health. Protects against cancer & heart disease.

76% Don't Eat Enough Purple/Blue

Phytonutrients:
resveratrol, anthocyanidins, phenolics, flavonoids



Purple Benefits

Good for heart, brain, bone, arteries, & cognitive health. Fights cancer & supports healthy aging.

69% Don't Eat Enough Green

Phytonutrients:
lutein/zeaxanthin, isoflavones, EGCG, indoles, isothiocyanates, sulphoraphane



Green Benefits

Supports eye health, arterial function, lung health, liver function, & cell health. Helps wound healing & gum health.

83% Don't Eat Enough White

Phytonutrients:
EGCG, allicin, quercetin, indoles, glucosinolates



White Benefits

Supports healthy bones, circulatory system, & arterial function. Fights heart disease & cancer.

80% Don't Eat Enough Yellow/Orange

Phytonutrients:
alpha-carotene, beta-carotene, beta cryptoxanthin, lutein/zeaxanthin, hesperidin



Yellow Benefits

Good for eye health, healthy immune function, & healthy growth & development.

Nutraceuticals: Natural food colourants



Carotenoids

a group of organic compounds that are not water-soluble

Red, orange, yellow

approx. 700

Due to their numerous conjugated double bonds, they look colourful (yellow, orange to dark red) and are sometimes used as food colouring

Carotenoids authorised for use as food colouring are regulated
Certain carotenoids are vitamin A provitamins (e.g. beta carotene)

For humans:

- Catch free radicals
- Prevent damaged cells from transforming into cancerous cells
- Stimulate the immune system
- Protect against UV radiation

β -carotene E160a

Is extracted from plants or microorganisms

Is used as food colouring and as an addition to vitamin preparations

β -carotene is a precursor of retinol and is also known as provitamin A

It is added to many foods (such as butter, cheese and lemonade),
sometimes in high quantities



Nutraceuticals: Natural food colourants



Browning:

1. Enzymatic – discoloration through oxidation of phenolics through polyphenoloxylase
2. Non-enzymatic - pre-harvest (cultivars, soil, fertilizers, climate, harvesting) and post-harvest (light)

Controlling of browning:

1. Chemical methods

sulfites, inactivation of enzyme with citric acid (pH opt 7), but it can influence taste

2. Physical methods

Temperature : low temperature ($\downarrow$ enzymatic activity, $\downarrow$ metabolic rates)

Oxygen availability ($\downarrow$ O₂, $\uparrow$ CO₂ $\rightarrow$ $\uparrow$ anaerobic respiration $\rightarrow$ off-flavor, MO): MAP, edible coating



Nutriceuticals: Natural food colourants



E140 Chlorophyll



Ingredients: 49% peanuts, starch (potato, corn, wheat), vegetable oil, salt, rice flour, sugar, modified cornstarch, flavouring, spices (with mustard), yeast powder, dextrose, whey powder, colouring (**E 140, E 141, E 100**)

*E140-141 - Chlorophyll

*E100 – Curcumin

E162 Betanin



Ingredients:

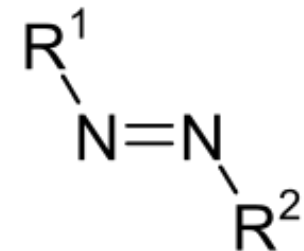
Strawberries (11.5% fruit content), sugar, glucose-fructose syrup, thickener, locust bean gum, guar gum, pectins; acidifier (citric acid), acidity regulator (calcium citrate), **betanin plant extract**, flavouring), sugar, glucose, chocolate, glucose-fructose syrup, aroma.

Nutriceuticals: Artificial food colourants



Azo dyes

- Molecule contains at least one azo group
- Particularly intense colour
- Light-resistant and acid stable → Used in drinks and decorative confectionery
- Only water-soluble azo dyes are authorised for use
 - E102 Tartrazine
 - E 104 Quinoline Yellow
 - E 110 Sunset yellow FCF
 - E 122 Azorubine
 - E 124 Cochineal Red A
 - E 129 Allura Red



Since the 20th of July 2010, if these dyes are used in a food the phrase **“May have an adverse effect on activity and attention in children”** must be included on the label, in accordance with Regulation (EC) No. 1333/2008.

Nutriceuticals: Artificial food colourants



Ingredients: Water, sugar, apple juice concentrate
Acidifier (citric acid)
Flavouring,
Food colourings (depending on taste):
Sulphite ammonia caramel
Quinoline Yellow
Azorubine
Brilliant Blue FCF, Patent Blue V
Stabilisers: Xanthan gum and pectin

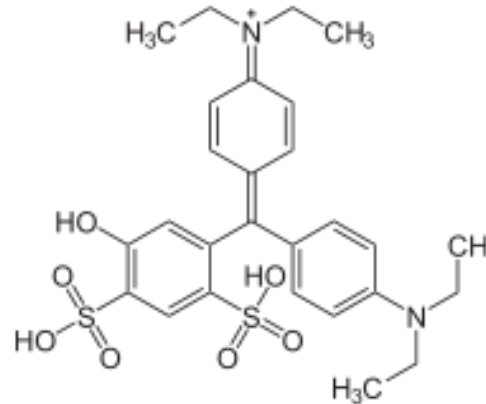


Ingredients: Starch
Acidifier: Citric acid
Glazing agent: Beeswax, white and yellow, carnuba wax
Flavouring;
Food colourings:
Indigotine I
Cochineal Red A

Nutraceuticals: Blue food colourants



Patent Blue V E 131



- Triarylmethane food colouring
 - (three phenyl radicals and one central carbon atom)
 - Colour: Dark blue
 - Form: Powder
 - Water-soluble, alcohol-soluble, heat resistant
 - Blue in basic solution, greenish tone in acidic solution
 - Negative: Low lightfastness
 - Positive: Brilliant colour intensity
-
- ADI value: 0-15mg / kg body weight
 - Classed as toxicologically harmless as it is largely excreted by the body
 - Limit values when added to food: Between 100 and 500 mg / kg of food
 - Not authorised for use in Australia, USA and Norway (allergies)

Nutraceuticals: Blue food colourants



Spirulina

- Freshwater algae (spirulina) → blueish-green cyanobacteria
- Contains chlorophyll (the blue food colouring phycocyanin)

Uses:

- Lake Texcoco in Mexico - Aztecs - Added to bread
- Lake Chad - Kanembu - *Dine* algae cakes (used in 70% of all dishes)
- Supplement: In powder- or tablet-form
- Nutrient-rich ingredient (pasta, fruit bars, drink powder)
- Ingredient in lots of types of fish food and some types of cat food

3000 tons/year from commercial cultivation



<https://evergreen-food.de/pages/die-algen>

100 g *Spirulina* :

65 g protein

! all essential amino acids

Vitamins B1-2-12, E

! β -carotene (precursor of vitamin A)

5-9% minerals (Ca, Fe, Mg)

!no iodine

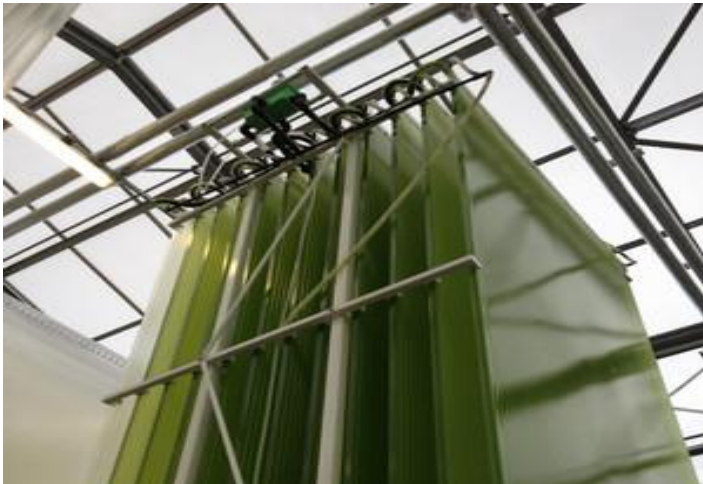
Nutraceuticals: Blue food colourants



Algae Mass production

1. Open containers

- The dry mass content is low and the layer thickness is kept low so that the sun's rays can penetrate
- Turbulence caused by impellers, circulating pumps and gassing systems
- Problems: Evaporation loss, danger of contamination and impurities due to the large contact area with the environment



<http://www.makebiofuel.co.uk>

2. Closed containers

Developed in the 1950's

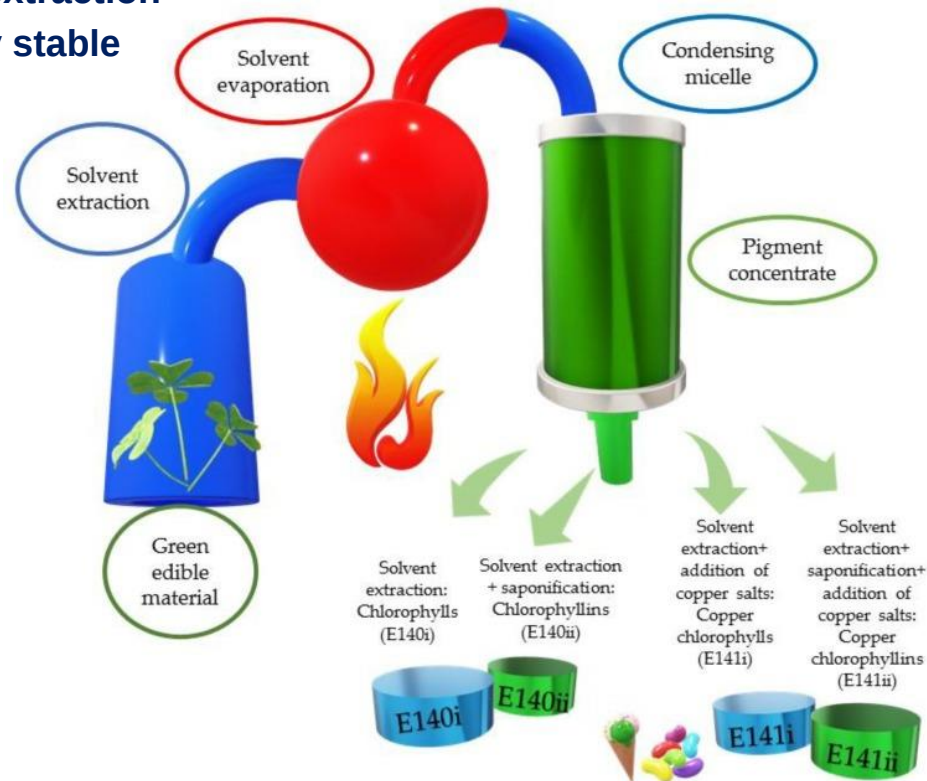
- Glass tube for lighting
- Works continuously
- Higher energy requirements and acquisition costs

Nutraceuticals: Blue food colourants



Blue food colouring made from spirulina algae

- Obtained through extraction
- Water-soluble, very stable



Viera I, Pérez-Gálvez A, Roca M. Green Natural Colorants. Molecules. 2019 Jan 2;24(1):154. doi: 10.3390/molecules24010154. PMID: 30609768; PMCID: PMC6337735.



<https://www.amazon.de/Blaues-Spirulina-pulver>

Spirulina ingredients are used individually or in combination with other colouring foods:

- when used on its own: creates a blue colour (similar to the colour of blueberries)
- in combination with safflower: greenish colour, similar to gooseberries



Nutriceuticals: Vitamins



- Vitamins are essential organic compounds: cannot be synthesised in the body (except from vitamin D)
- Calorie-free nutrients - do not provide the body with any energy
- Cofactors of enzymatic reactions

Functions:

- Strengthen the immune system
- Essential for building cells, blood cells, bones and teeth
- Each vitamin fulfils specific tasks

Uses:

- Different foods are enriched with vitamins (ACE products)
- Some vitamins also take on the role of additives (vitamin B2 food colouring) or antioxidants (vitamin C)
- Additives in animal feed

Vitamins



Ergänzende bilanzierte Diät

orthomol immun



Zusammensetzung

1 Tagesportion zu 15 g Granulat

	pro Tagesportion	pro 100 g
Vitamine		
Vitamin A	450 µg (1.500 I.E.*)	3 mg (10.000 I.E.*)
Vitamin C	950 mg	6,3 g
Vitamin E (TE**)	150 mg	1 g
(enthält u. a. Alpha- und Gamma-Tocopherol)		
Vitamin B ₁	25 mg	167 mg
Vitamin B ₂	25 mg	167 mg
Nicotinamid	60 mg	400 mg
Vitamin B ₆	20 mg	133 mg
Vitamin B ₁₂	6 µg	40 µg
Vitamin K ₁	60 µg	400 µg
Vitamin D ₃	5 µg (200 I.E.*)	33 µg (1.332 I.E.*)
Folsäure	800 µg	5,3 mg
Pantothensäure	18 mg	120 mg
Biotin	165 µg	1,1 mg
Spurenelemente		
Selen	50 µg	333 µg
Eisen	8 mg	53 mg
Zink	10 mg	67 mg
Mangan	2 mg	13 mg
Kupfer	500 µg	3,3 mg
Chrom	30 µg	200 µg
Molybdän	60 µg	400 µg
Jod	150 µg	1 mg
Sekundäre Pflanzenstoffe		
Citrus-Bioflavonoide	5 mg	33 mg
Gemischte Carotinoide	5 mg	33 mg
(enthalten Beta-Carotin, Lutein und Lycopin)		
Physiologischer Brennwert		
	204 kJ (48,6 kcal)	1.360 kJ (324 kcal)
Eiweiß	< 0,1 g	< 0,1 g
Kohlenhydrate	11 g	74 g
Fett	< 0,1 g	< 0,1 g



Vitamin	mg	% RDA
C	60,0	100
Niacin	18,0	100
E	10,0	100
Panthoten-acid	6,0	100
B6	2,0	100
B2	1,6	100
B1	1,4	100
Folsäure	0,2	100
Biotin	0,15	100

Nutriceuticals: omega fatty acids



HL Woodworth, SJ McCaskey, DM Duriancik, JF Clinthorne, IM Langohr, EM Gardner, and JI Fenton. Dietary fish oil alters T lymphocyte cell populations and exacerbates disease in a mouse model of inflammatory colitis Cancer Res canres.1396.2010

***Fish oil and the omega 3 fatty acids** that it contains is often presented as being “healthy” without any criticism and is sold in the form of pills, capsules or as an additive in food and animal feed. Now research and investigations carried out by scientists from Michigan State University are raising considerable doubts about fish oil’s positive image. As scientists in “Cancer Research” reported, mice that were given high doses of fish oil in their feed started to develop colitis and colon cancer after just four weeks.*

Even medium doses increased the severity and aggressiveness of cases of cancer. Clearly, the mice’s immune systems were unable to produce the cancer-killing bacteria they needed when under the influence of fish oil.

*The scientists therefore ask **that intake of this additive be limited as a precaution.** The scientists stressed they are unable to define a harmless dose of fish oil with omega 3 fatty acids.*



<http://www.amazon.de/>

Trend: Molecular cooking

Molecular cooking (molecular gastronomy) explores the science behind cooking.

Techniques:

- **Spherification**
- **Gelification**
- **Emulsification**
- **Flash Freezing with Liquid Nitrogen**
- **Sous-Vide**
- **Dehydration**
- **Foams (Aero)**
- **Carbonation**
- **Powderization**
- **Transglutaminase (Meat Glue)**
- **Smoking**
- **Vacuum Infusion**



Molecular cooking: Spherification



A process that transforms liquids into small, caviar-like spheres with a liquid center.

Sodium alginate (from algae) is added to the liquid, which is then dropped into a bath of calcium chloride. The calcium ions react with the sodium alginate, forming a gel-like outer membrane.

Fruit juice or cocktails turned into tiny spheres



Red Cabbage Kaivar



Molecular cooking: Spherification



Caviar Substitute

Artificial caviar, imitation caviar, vegan caviar

- spherical food items that resemble traditional fish roe (caviar) in appearance but are made from non-fish ingredients.
- is an alternative to real sturgeon caviar.

Lumpfish is a North Atlantic fish that can produce up to 700 gr. of roe.

Keta Salmon Caviar

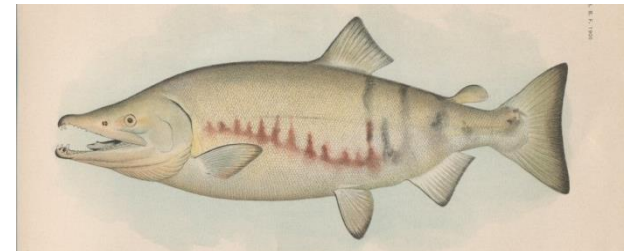
Keta salmon caviar from Alaska. The roe has a red color and is very delicate. In culinary terms, this caviar is considered a substitute for sturgeon caviar.

Trout Caviar

Trout caviar is golden orange in color and the eggs are small. It is similar to beluga caviar, but tastes milder.

Price per 1 kg:

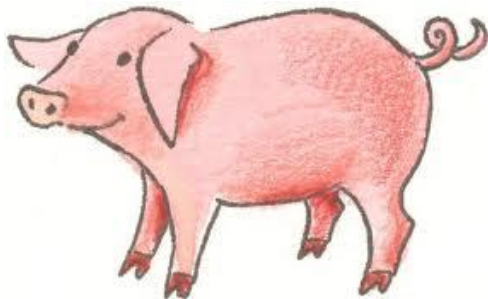
Artificial caviar 5 euros,
Keta salmon caviar 90 euros,
Trout caviar 100 Euro,
Beluga caviar - 2000 Euro



Molecular cooking: Gelification



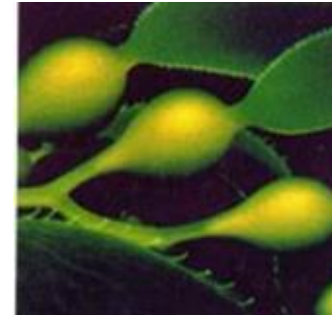
Gelatin



Pectin



Alginate



from slaughterhouse waste (collagen from muscle fibres and bones)	from plants (apple pomace)	algal
collagen	polysaccharide	polysaccharide
stabile	less stable	stabile
no E Nummer (not additive)	E440	E400-404



Molecular cooking



Agar (E406)

Gelling agent, binding agent

Galactan polysaccharide, algae hydrocolloid

- from red algae

- in Japan since the 17th century

Nutritional value: ≤ 4 kcal/g

Functional food additive

Emulsifying and stabilising effect

Not soluble in cold water, easily soluble in hot water

During cooling, the solution solidifies into a gel

High temperature stability and easier to process

Binds water

Indigestible ► has a creamy consistency

- 70% agarose, 30% from the non-gelling agaropectin

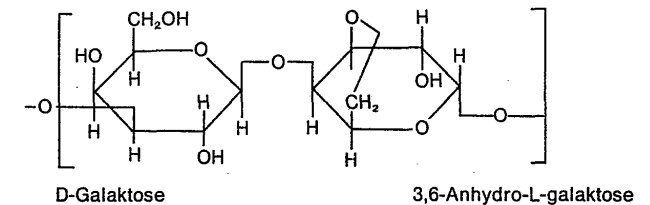
- Used in food without animal-derived gelatin (gummy bears, ice cream and marmalade/jams)

Used to thicken soups, sauces and desserts

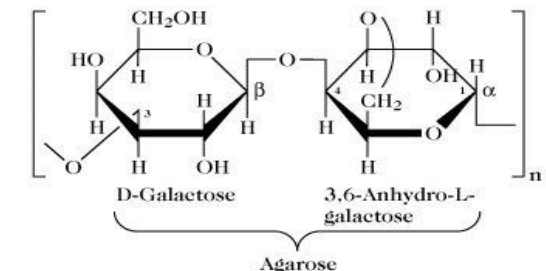
Lots of “light” products contain thickening agents



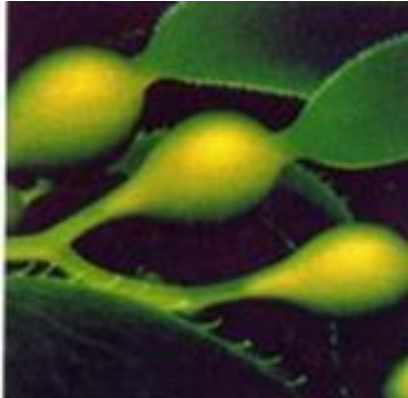
Foto: Rotalge, Copyright S. Glasmacher



Agar-Agar



Molecular cooking Agar (E406)



Kelp

Kelp (*Macrocystis*)

- Harvested since 1900
- **Alginate** (thickening agent and stabiliser used in foods and ice cream, in the textile industry and as an encapsulation for medicines)
- **Agar** (used to make gels, for cultivating microbes and gel electrophoresis)
- **L-glutamate** (flavour-enhancing amino acid)

Laminaria

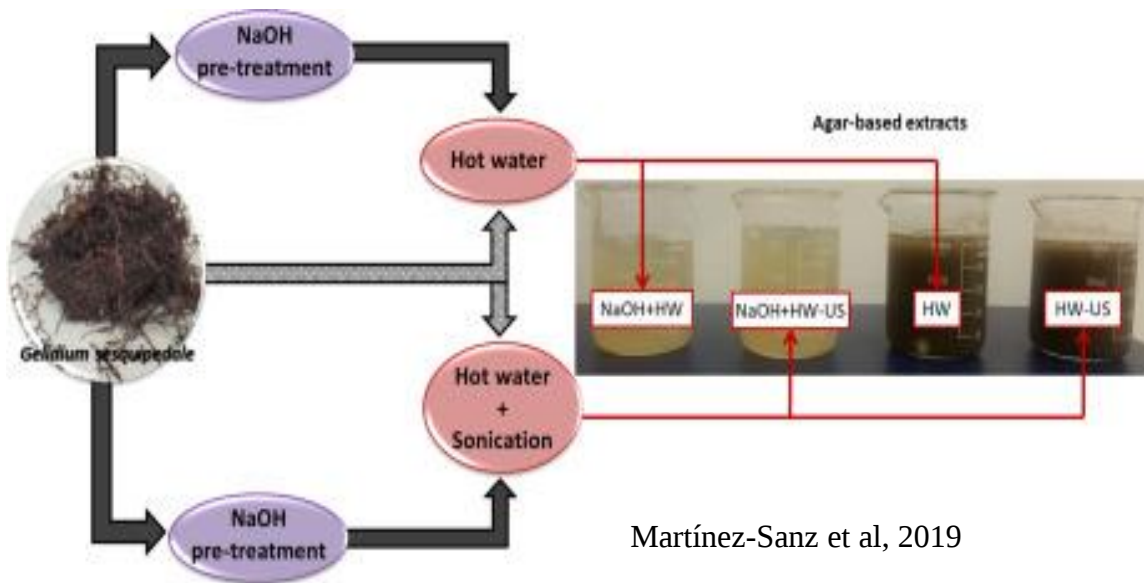
- Japan and China
- Found in flowing water below the tidal limit
- Alginic acid contributes to the detoxification and cleaning of the intestines
- For salads, soups, noodles
- Market value 600 million USD / year
- 20,000 tons / year



Molecular cooking: Gelification



Agar-Agar
red algae



Martínez-Sanz et al, 2019



Tomato Mozzarella Basilic
(Smetanska, 2024)



Tomato Sauce Spaghetti
(Smetanska, 2024)

Foliennummer

Molecular cooking: Foams



- Light, airy foams created from liquids or purées.
- Whipping siphon or blender, air or nitrous oxide is incorporated into the liquid to create foam.
- Example: Savory foams for sauces, or sweet foams from flavored syrups.



Bread foam (Smetanska, 2024)



Functional food: Calories reduction

Low calorie

Less than 50 kcal / 100 g for solid foods

Less than 20 kcal / 100ml for drinks (even if the product is “naturally” low in calories)



Schinkenfleischwurst, 80g

Durchschnittliche Nährwerte pro 100g	
Brennwert	365kJ/87kcal
Eiweiß	15,0g
Kohlenhydrate	1,0g
davon Zucker	0,5g
Fett	2,5g
davon gesättigte Fettsäuren	0,8g
Cholesterin	30mg
Ballaststoffe	1,0g
Natrium	1,0g

unter 3% Fett
100% lecker

Pro Portion = 1 Scheibe (ca. 13g)	
Kalorien: 11,0	0,6%*
Fett: 0,3g	0,4%*
Zucker: 0,1g	0,1%*
Gesättigte Fettsäuren: 0,1g	0,5%*

* Tageszufuhr, basierend auf einer Ernährung von täglich 2000 kcal



Reduced calories

The product has at least 30% less calories than the standard version of this food

“Light”

Does not always relate to the energy content of a food With products sweetened with sweeteners, the term “light” always means less calories



Functional food: Calories reduction



Ingredients in Low-Calorie, Light, and Reduced-Calorie Products:

1. Sugar Substitutes:

- **Artificial Sweeteners:** Aspartame, sucralose, saccharin (diet sodas or light desserts).
- **Natural Sweeteners:** Stevia, monk fruit (in beverages, yogurts, and snack bars).
- **Sugar Alcohols:** Erythritol, xylitol (in gum, candies, and low-calorie baked goods).

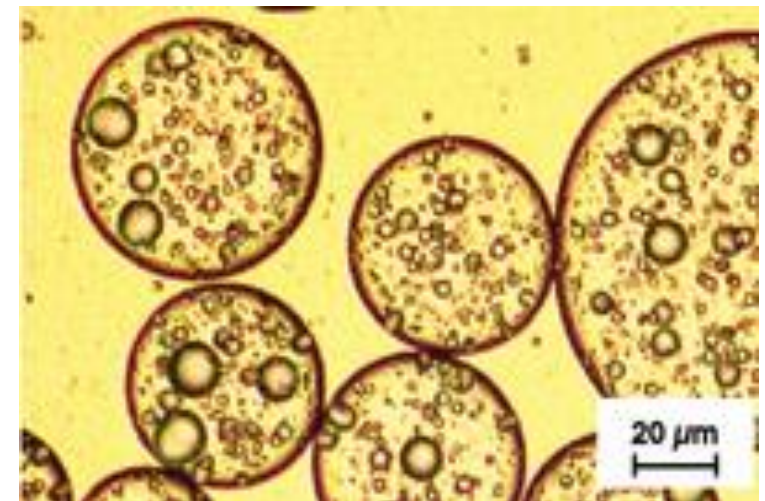
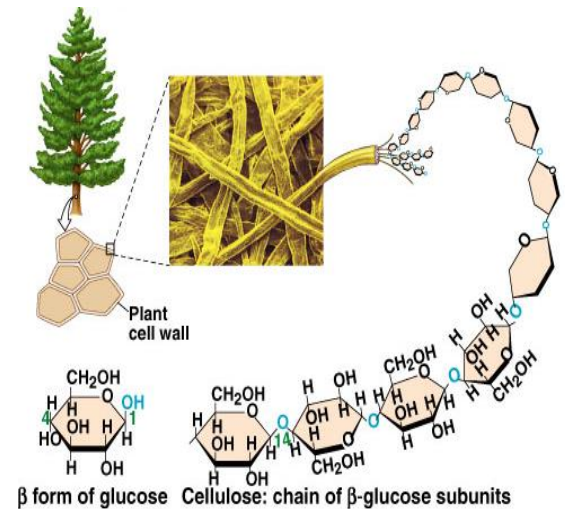
2. Fat Replacers:

- **Starch-Based Replacers:** Modified starches that mimic the mouthfeel of fat without the calories (reduced-fat dressings or dairy).
- **Protein-Based Replacers:** Whey protein or soy protein used to replace fat (dairy products, creamy sauces).

3. Fiber and Bulking Agents:

- **Inulin** (low-calorie yogurts and protein bars).
- **Cellulose:** A non-digestible fiber that adds bulk and texture to low-calorie products (baked goods, sauces, and snacks).

4. Air Incorporation



Functional food: Sweeteners

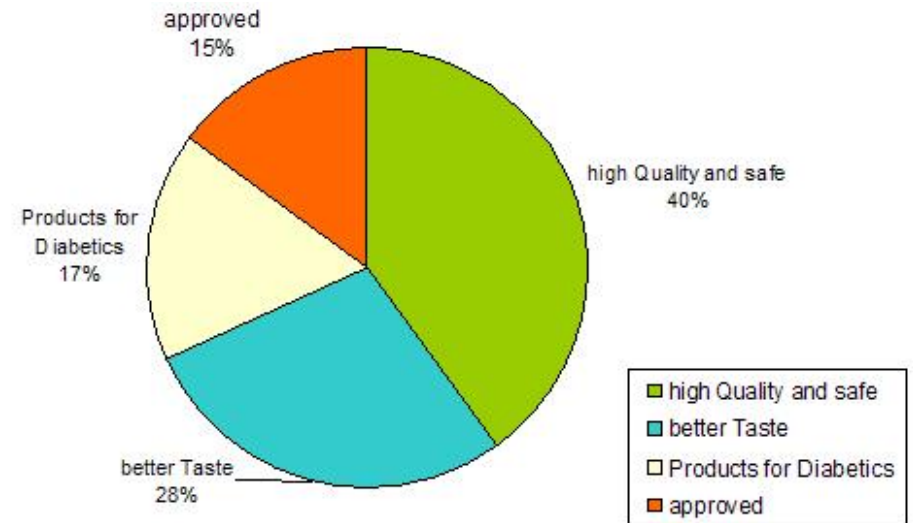


Advantages:

- Replacement for sugar, 10-3000x sweeter
- Supply very little / no energy (calories)
- No sustenance for decay-causing bacteria
- Synergism (aspartame and acesulphame)

Disadvantages: certain sweeteners...

- Sweetening is delayed or very fast ► are combined
- Have a bitter, metallic aftertaste
- The sugary taste stays in the mouth for a very long time
- Can cause stomach-ache
- May be carcinogenic
- Increase appetite (secretion of insulin, hunger pangs)
- Do not cause serotonin production

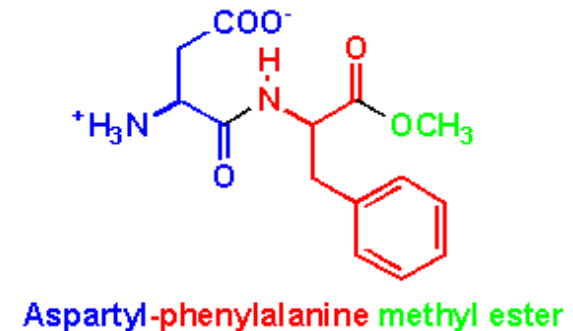


German Consumers Survey

Sweeteners: Aspartame



- E 951
- Consists of the amino acids phenylalanine and aspartic acid
- Used in "light" products and diabetic food
- 200x sweeter than sugar
- Was developed in 1965



Advantages:

- Low in calories 1 g of aspartame = 4 kcal
- Does not cause caries ► used in tooth-friendly confectionery products - does not damage teeth
- Can be broken down like any other protein

Side effects:

- Should not be consumed by people with phenylketonuria ► foods containing aspartame must be labelled with the warning *"Contains a source of phenylalanine"*
- Can cause brain tumours and allergies

Sweeteners: Aspartame



Uses of aspartame

- Not heat-stable ► not suitable for cooking or baking
- No bitter / metallic aftertaste, even when used in high concentrations
- Intensifies citrus and fruit flavours
- 2000 – Authorised – European Food Safety Authority (EFSA)



http://www.food-detektiv.de/exklusiv.php?action=detail&id=37&volvox_locale=zh_CN

Manufacturing:

“Alitame” - produced by the American biotech company Pfizer

Commercial names: "NutraSweet",
"Canderel", "Sanecta"

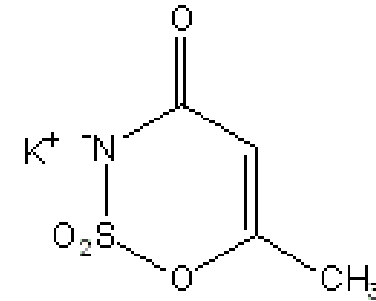


Holland Sweetener Company; Aspartame Plant Geleen, NL

Sweeteners: Acesulphame



- Calorie-free
- 200x sweeter than sugar
- Sweetness is quickly noticeable
- Good storage stability, very stable and heat-resistant ►
can be used in all standard preparations
- Is not metabolised, is instead excreted unchanged
- Is commonly used as an ingredient in sweetener mixtures used in food production
- Synergistic
- Good taste



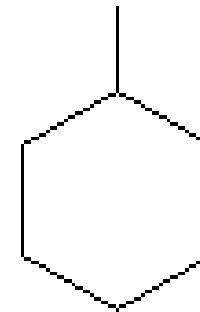
<http://www.jergym.hiedu.cz/~canovm/kyseliny/bvzorce1/sladidla.htm>



*“Mild yoghurt made from
GMO-free skimmed milk, 5%
strawberry juice from
concentrate, fructose,
stabiliser: guar gum,
colouring: beta carotene,
flavouring, carrot juice
concentrate, sweeteners:
aspartame*, acesulphame K,
acidifier: citric acid, acidity
regulator: calcium citrate,
*Contains a source of
phenylalanine*

Sweeteners: Cyclamate

- Lowest sweetness intensity (35x sweeter than sugar)
- Authorised for use in the EU
- Excellent taste
- Mixture: 10 cyclamate: 1 saccharin ► optimises the sensory properties of saccharin
- Synergistic properties ► can be easily combined with all other sweeteners
- Extremely heat-stable and can be stored for long periods of time
- Is not metabolised and leaves the organism unchanged via the kidneys
- Only very few people have bacteria in their gut microbiota that convert cyclamate to a small extent



<http://www.jergym.hiedu.cz/~canovm/kyseliny/bvzorce1/sladidla.htm>

Sweeteners: Thaumatin



E 957

Protein

2000-3000x sweeter than sugar

Discovered in 1850

- Obtained from ripe katemfe fruit (*Haumatococcus danielli*) which can be found in West African rainforests.

1 kg fruit ► approx. 6 g thaumatin

1 g thaumatin = € 5,000

Commercial name “Talin”

Stable in water and during freeze-drying

Heat-stable

Flavour enhancing

Liquorice-like aftertaste

Authorised under the maximum quantity specifications for cocoa- or dried-fruit-based confectionery, chewing gum

The German Nutrition Society (DGE): Thaumatin is classed as safe



http://www.thaumatinnaturally.com/about_thaumatin/thaumatin_katemfe_fruit.jpg



Sweeteners: Steviosides



• *Stevia rebaudiana*

• Stevia leaves in Matetee of Native American (30-times sweeter as sugar).

- Steviosides - 300-time sweeter as sugar, natural sweeteners.
- 1970 - Stevia in Japan - 25 % market of sweeteners.
- In Brazil and Korea is allowed as sweetener, in USA as food supplement.

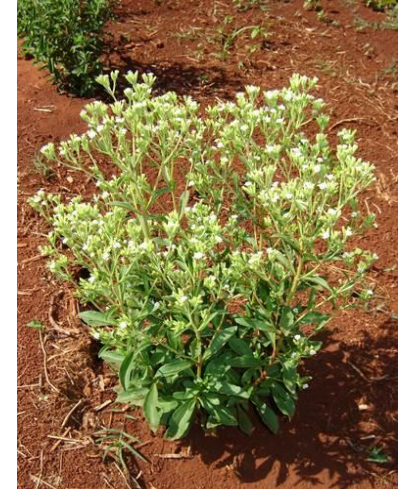
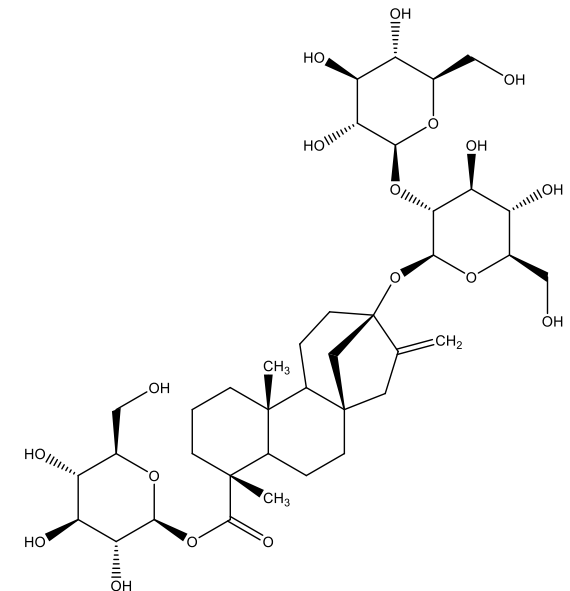


Abbildung 6: Anbaubereiche von Stevia im Jahr 2012 (Quelle: Süßlin et al., 2012, S. 15, modifiziert)



Modern food



Stevia Getrocknet Lose Blätter - 100% BIO Certified Premium Qualität 500 G

Marke: BlendNature



73 Sternebewertungen

Amazon's Choice

für "stevia blätter bio"

Preis: 21,40 € exkl. USt

25,90 € (51,80 € / kg) inkl. USt

Typ	Bezeichnung	VE	Katalognummer	Planlieferzeit	Listenpreis
Certified reference material	Total Phenolics	2 ml	QC1134-2ML	Unbestätigte Lieferzeit: 3 Tage	45,90 €

Hersteller-Artikelnummer: QC1134-2ML

Thank you for your attention!

