Zinc

Zinc Salts for Food, Nutritional Supplements and pharmaceutical Products

Dr. Paul Lohmann®

High value mineral salts

www.lohmann4minerals.com

Zinc

With a total amount of about 2 g per person, zinc and iron are quantitatively the most important trace elements for the human organism.

It is predominantly a divalent cation in the human body and takes part in more than 300 enzymatic reactions. On the one hand, it acts as a cofactor for enzymes. On the otherhand, it is an integral part of the enzyme. This trace element takes part in nearly all life processes because zinc-dependent enzymes are ubiquitous.[1]

Physiology

Physiological function[2,3,4]	
Antioxidative mechanisms	◆ Participation in the enzymatic catalysis ◆ Separate antioxidative effects; bonding to different molecules as "site-specific-antioxidants"
Regulation of the acid-base balance	◆ Participation in carbon dioxide transport as a part of the carbonic anhydrase in erythrocytes
Participation in the visual system	◆ Synthesis of the retinol-binding protein (RBP) ◆ Retinol dehydrogenase reaction in phototransduction
Immuno-modulatory effects	◆ Formation of the thymulin hormone in the thymus gland ◆ Thymulin is essential for the maturation of T-lymphocytes for the acquired immune response
Synthesis of testosterone	◆ Development and maturation of male sexual organs ◆ Spermatogenesis
Insulin metabolism	◆ Direct participation in insulin synthesis
Regulation of gene expression	◆ Integral part of transcription factors

- Zinc contributes to normal cognitive function
- Zinc contributes to normal acid-base metabolism
- Zinc contributes to the maintenance of normal vision
- Zinc contributes to the normal function of the immune system

Zinc and nutrition

Foods predominately of animal origin help to cover the zinc requirement due to the presence of absorption-promoting factors (promoters) such as animal proteins the bioavailibility is increased.[5, 6] Good sources of zinc include lean red meat, offal and hard cheese as well as whole grains, legumes, nuts and seeds. Fruits and vegetables only contain trace amounts of zinc. Moreover, plant-based foods have a high content of absorption-repressive substances (inhibitors).

A modern lifestyle significantly complicates the maintenance of a normal balanced diet. The enrichment of foods or the supplementation of individual trace elements can help to prevent a deficiency.

Inhibitors	Promoters
◆ Phytate	◆ Animal protein
◆ Phosphate	◆ Organic acids (citrate)
◆ Casein	◆ Inulin
◆ Fiber (cellulose, hemicellulose, lignin)	◆ Histidine, cysteine
◆ Alcohol	◆ Peptide

Metabolism

Zinc is predominately absorbed in the small intestine via an energy-dependent transport system. The iron transport protein plays an important role for active absorption along with various zinc-specific transporters. At higher doses, absorption via simple diffusion also gain in importance.[7]

Zinc is bonded to metallothionein and stored in the mucosa cells and released into the blood as needed. Excessive zinc is excreted via the stool during the course of physiological exfoliation of the enterocytes. The zinc storage of the organism is relatively small, therefore, larger amounts cannot be mobilized if needed.[8, 9]

- Zinc contributes to the maintenance of normal hair
- Zinc contributes to the maintenance of normal nails
- Zinc contributes to the maintenance of normal skin
- Zinc contributes to the protection of cells from oxidative stress

Requirement/Deficit

Intake recommendations

In order to ensure a sufficient supply of zinc, the German Nutrition Society recommends a daily intake of 10 mg of zinc for males and 7 mg for females. This recommendation increases to 10 and/or 11 mg/d during pregnancy and while breastfeeding. The recommendation for children up to 15 years of age – depending on age and gender – is between 3 and 9.5 mg/d.[10] The NRV (Nutrient Reference Value) for zinc is 10 mg.[11]

Zinc deficiency

Eating a well-balanced diet seldom leads to a zinc deficiency. In case of a general nutritional deficiency, a zinc deficiency needs to be monitored because it affects nearly all areas of the metabolism.[1] The risk groups for a light to moderate zinc deficiency include, among others, multimorbid seniors, alcoholics, as well as patients suffering from gastrointestinal diseases.[12, 7] A zinc deficiency can result for example, in an increased susceptibility to infection, dermatitis, immunodeficiency, hair loss and delayed wound healing.[4] Systems of zinc deficiency usually subside by taking a zinc supplement.[1, 4]

Excessive zinc intake

Zinc intoxications rarely occur. An acute poisoning can occur after the consumtion of foods that have been stored in zinc-bearing containers. Typical symptoms include abdominal pain, vomiting, feelings of anxiety, headaches and fever. The single dose required for triggering the symptoms is approx. 2 decimal powers higher than the daily recommended intake.[7]

Legal Conciderations

Our documentation department has already created zinc salt ASMFs/DMFs for medicinal product registrations.
An APIMF is available for zinc sulfate 1-hydrate for WHO applications.

In the EU, various zinc salts are approved for the fortification of foods, infant formula and follow-on formula, processed cereal-based foods as well as food for special medical purposes, total diet replacement for weight control and dietary supplements.[19, 20, 21]

The EFSA has approved several health claims in the area of mineral substances. Due to the various effects on the human organism and the good study situation, 18 health claims have been approved for zinc.

Zinc	Food*	Food Supplements**	Infant formulae and follow-on formulae***	Processed cereals-based foods and baby foods for infants and young children***	Food for special medical purposes***	Total diet replacement for weight control***
Zinc acetate	✔	✔	✔	✔	✔	✔
Zinc bisglycinate	✔	✔			✔	✔
Zinc carbonate	✔	✔			✔	✔
Zinc chloride	✔	✔	✔	✔	✔	✔
Zinc citrate	✔	✔	✔	✔	✔	✔
Zinc gluconate	✔	✔	✔	✔	✔	✔
Zinc lactate	✔	✔	✔	✔	✔	✔
Zinc L-ascorbate		✔				
Zinc L-aspartate		✔				
Zinc L-lysinate		✔				
Zinc L-pidolate		✔				
Zinc malate		✔				
Zinc mono-L-methionine sulphate		✔				
Zinc oxide	✔	✔	✔	✔	✔	✔
Zinc picolinate		✔				
Zinc sulphate	✔	✔	✔	✔	✔	✔

blue = in the Dr. Paul Lohmann® portfolio

* Regulation (EC) No 1925/2006 of the European Parliament and of the Council on the addition of vitamins and minerals and of certain other substances to foods

** Directive 2002/46/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to food supplements

*** Regulation (EU) No 609/2013 of the European Parliament and of the Council on food intended for infants and young children, food for special medical purposes, and total diet replacement for weight control

Zinc – Our Product Line

Product	Product No.	Quality	Physical appearance	Color
Zinc Acetate anhydrous	515056001	chem. pure	powder	white
Zinc Acetate 2-hydrate	515006002	E 650 or USP	powder	white
	515006001	E 650 or Ph.Eur. or Erg.B.6 or USP or BP or chem. pure	crystalline powder	
Zinc L-Ascorbate	501048001	chem. pure	powder	light yellow
Zinc DL-hydrogen Aspartate	501063001	chem. pure	powder	white
Zinc L-hydrogen Aspartate	501062001	chem. pure	powder	white
Zinc Bisglycinate	505081001	food grade	powder	white
Zinc Hydroxide Carbonate	515008020	chem. pure	powder, precipitated	white
Zinc Citrate 3-hydrate	502017001	chem. pure or food grade	powder	white
	502017006		micronized powder	
	502017003	chem. pure or food grade or toothpaste grade	fine powder	
Zinc Citrate, microencapsulated	502017009	with 40 % vegetable fat	granules	white
Zinc Formate 2-hydrate	502073001	chem. pure	crystalline powder	white
Zinc Gluconate	503077006	Ph.Eur. or USP	powder	white
	503077004		fine granulate	
Zinc Glycerophosphate	512047001	chem. pure	powder	white
Zinc Lactate 2-hydrate	515012001	chem. pure	powder	white
Zinc Lactate 3-hydrate	515012001	chem. pure	powder	white
Zinc Oxalate 2-hydrate	515081001	chem. pure	powder	white
Zinc Oxide	515007000	FCC or chem. pure	powder	white
	515007600	Ph.Eur.		white to light yellow white
Zinc Oxide, microencapsulated	515007950	with 50 % vegetable fat	fine granules	white to off-white
Zinc Peroxide	515074001	chem. pure	powder	pale yellow
Zinc L-Pidolate	503096001	chem. pure	powder	white to yellowish white
	503096002			
Zinc Pyrophosphate	515079001	chem. pure	powder	white
	515079002		fine powder	
Zinc Stearate	515038200	analysed acc. to: Ph.Eur.	powder	white to almost white
Zinc Sulfate 1-hydrate	515059002	USP or FCC or Ph.Eur.	powder	white
	515059008	WHO APIMF232		
	515059004	USP or FCC	micronized powder	
	515059005	Ph.Eur.		
	515059006	FCC or USP or Ph.Eur.	fine powder	
Zinc Sulfate 7-hydrate	515009002	FCC or USP or Ph.Eur. or JP XVI or chem. pure	crystalline powder	colorless/whitish
	515009001		crystals	

Flavor	Metal content (per 100 g)	Retest period (months)	Solubility 20 °C	pH (1 % solution/ *suspension)
neutral, slightly sour	approx. 35 % Zn	36	−	approx. 7*
adstringent, bitter	approx. 30 % Zn	36	++	approx. 7
slightly adstringent	approx. 15.5 % Zn	24	++	approx. 6.5
neutral, slightly sweet	approx. 18 – 21 % Zn	24	+	approx. 5
slightly sweet, slightly adstringent	approx. 20 % Zn	24	+	approx. 5
slightly sweet, slightly adstringent	approx. 27 % Zn	36	+	approx. 8
neutral	approx. 58 % Zn	36	− −	approx. 9*
neutral	approx. 31 % Zn	36	− −	approx. 6*
neutral	approx. 19 % Zn	36	− −	
adstringent, bitter	approx. 34 % Zn	24	+	approx. 6
neutral	approx. 13.5 % Zn	36	+	approx. 6
nearly neutral	approx. 25 % Zn	36	− −	
slightly sour, salty, slightly bitter	approx. 23 % Zn	36	−	approx. 9*
slightly sour, salty, slightly bitter	min. 21.5 % Zn	36	−	approx. 9*
sandy, neutral	approx. 34.5 % Zn	36	− −	approx. 6*
neutral	approx. 80 % Zn	36 24	− −	approx. 7.5*
neutral	37 – 43 % Zn	36	− −	
slightly adstringent	min. 50 % ZnO_2	24	−	approx. 7.5*
sweetish, slightly adstringent	19.4 – 21.3 % Zn	12	++ +	approx. 4.5 approx. 5.5
neutral	min. 35 % Zn	36	− −	approx. 8*
slightly adstringent	approx. 10 % Zn	24	− −	approx. 5.5 (10 % solution)
bitter	approx. 36.5 % Zn	36	++	approx. 5 approx. 5.5 approx. 5.5 approx. 5.5 approx. 6
bitter	approx. 22.5 % Zn	24	++	approx. 6

++ > 100 g/l + 10 – 100 g/l − 1 – 10 g/l − − < 1 g/l

The solubility specified here was measured in water.
The solubility is influenced by many factors in the application.

Use in Foods, Dietary Supplements and pharmaceutical Products

Zinc salts are almost exclusively used for the enrichment of foods and dietary supplements. However, they also have applications in pharmaceutical products and personal care products.

The bioavailability of dietary supplements with zinc varies strongly, but organic zinc compounds indicate better availability than inorganic compounds. In general, the bioavailability is higher when taken on an empty stomach with sufficient time between meals.[1, 6]

Zinc acts as a cofactor as well as an integral component of many enzymes, fulfilling essential physiological functions. These functions can be maintained by using dietary supplements and pharmaceutical preparations. The focus here is on the preventative and therapeutic effects of zinc. Sufficient zinc intake provides an elementary function for maintaining an intact immune system. An optimal zinc supply is a prerequisite for an immune activation in the case of natural exposure to an antigen. A slight deficiency results in a limited immune response and thus is associated with an increased susceptibility to infections.[13] Zinc supplementation can shorten the duration and severity of colds.[14] Additionally it has been demonstrated that the sooner zinc is taken, the cold symptoms will be less severe.[15]

In the area of oral hygiene, the antibacterial properties of zinc can be applied. In this case, zinc has been shown to inhibit the growth of plaque.[16] The cause of gum bleeding is usually the result of a bacterial infection of the gums. Therefore, zinc is a proven, active antibacterial substance against gingivitis (gum bleeding) as an ingredient of toothpaste and mouthwash.[17] It has also been documented that zinc has an astringent effect on infected oral mucosa.[18]

Zinc salts are used to treat acne for topical applications in the area of dermatology due to their antibacterial properties. The therapeutic treatment of pruritus (itching) is achieved by the astringent effect of zinc in cremes, lotions or ointments. Zinc compounds have also been successful in the treatment of wounds within bandages and tissue adhesives due to the function of zinc in wound healing and collagen synthesis. The collagen-forming and thus skin-tightening properties are also used in the cosmetics industry for anti-aging products.

Recommended Zinc Compounds

Food applications

Product	Zinc compounds
Milk/Dairy products	Zinc citrate Zinc gluconate Zinc sulfate
Infant formula and follow-on formula/ Processed cereal-based foods	Zinc citrate Zinc gluconate Zinc sulfate
Baked goods/ Confectionery	Zinc citrate Zinc gluconate Zinc lactate Zinc sulfate
Beverages/Juices	Zinc bisglycinate Zinc gluconate Zinc sulfate
Dietary supple-ments/Efferves-cent tablets	Zinc L-ascorbate Zinc bisglycinate Zinc citrate Zinc gluconate Zinc lactate

Pharmaceutical product applications

Indication	Zinc compound
OTC against common colds	Zinc acetate Zinc L-ascorbate Zinc gluconate Zinc sulfate
Itching	Calamine (zinc oxide + iron oxide or zinc carbonate)
Acne	Zinc acetate

Personal care/ Nutricosmetics applications

Product	Zinc compound
Mouthwash	Zinc bisglycinate Zinc L-pidolate (PCA)
Toothpaste	Zinc bisglycinate Zinc L-pidolate (PCA)
Anti-Aging	Zinc gluconate
Skin/Hair care	Zinc lactate

Properties of Zinc

Our top products

Zinc acetate 2-hydrate
- Highly water-soluble
- White powder
- E-number, pharma grade

Zinc sulfate 1-hydrate
- Highly water-soluble
- Micronized product available
- High zinc content
- Pharma grade

Zinc gluconate
- Easily water-soluble
- Neutral taste

Zinc citrate
- Slightly water-soluble
- Micronized product available
- Neutral taste
- Pharma grade

Zinc bisglycinate
- Good bioavailability
- Easily water-soluble

Zinc sulfate 7-hydrate
- Highly water-soluble
- High zinc content

Dr. Paul Lohmann® – Your competent Partner for high value Mineral Salts

With over 130 years of producing mineral salts that meet only the highest quality standards, we have established ourselves as a leading global supplier to the pharmaceutical, biopharmaceutical, nutritional supplement, food, and personal care industries.

Our Expertise

- GMP and DIN EN ISO 9001:2015 certified production sites
- FSSC 22000/ISO 22000 certified
- Successfully inspected production site in Emmerthal by FDA (U.S. Food and Drug Administration) in the context of FSMA (food safety modernization act)
- Tailor-made and innovative solutions for customer requests
- R&D lab with large experience and a wide variety of possibilities to develop new products and applications
- Joint product and application development together with our customers
- Own products are exclusively Made in Germany since 1886
- High social responsibility as a family-owned business
- A wide range of more than 400 various mineral salts
- Products in compliance with the most relevant pharmacopoeias (Ph.Eur., USP, BP), food codices (FCC, E-numbers, etc.) and customer specific requirements
- Regulatory documentation (CEP, ASMF, etc.)
- REACH compliance on request
- Wide range of production methods
- Processes according to HACCP
- Social and environmental standards (DIN EN ISO 50001, Sedex)
- High purities can be realized under certified requirements

Modification

- Physical properties
- Chemical properties
- Packaging
- Labeling

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20 Directive (EC) No 2002/46 on the approximation of the laws of the Member States relating to food supplements

21 Regulation (EU) No 609/2013 on food intended for infants and young children, food for special medical purposes, and total diet replacement for weight control

22 Regulation (EC) No 1924/2006 on nutrition and health claims made on foods

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