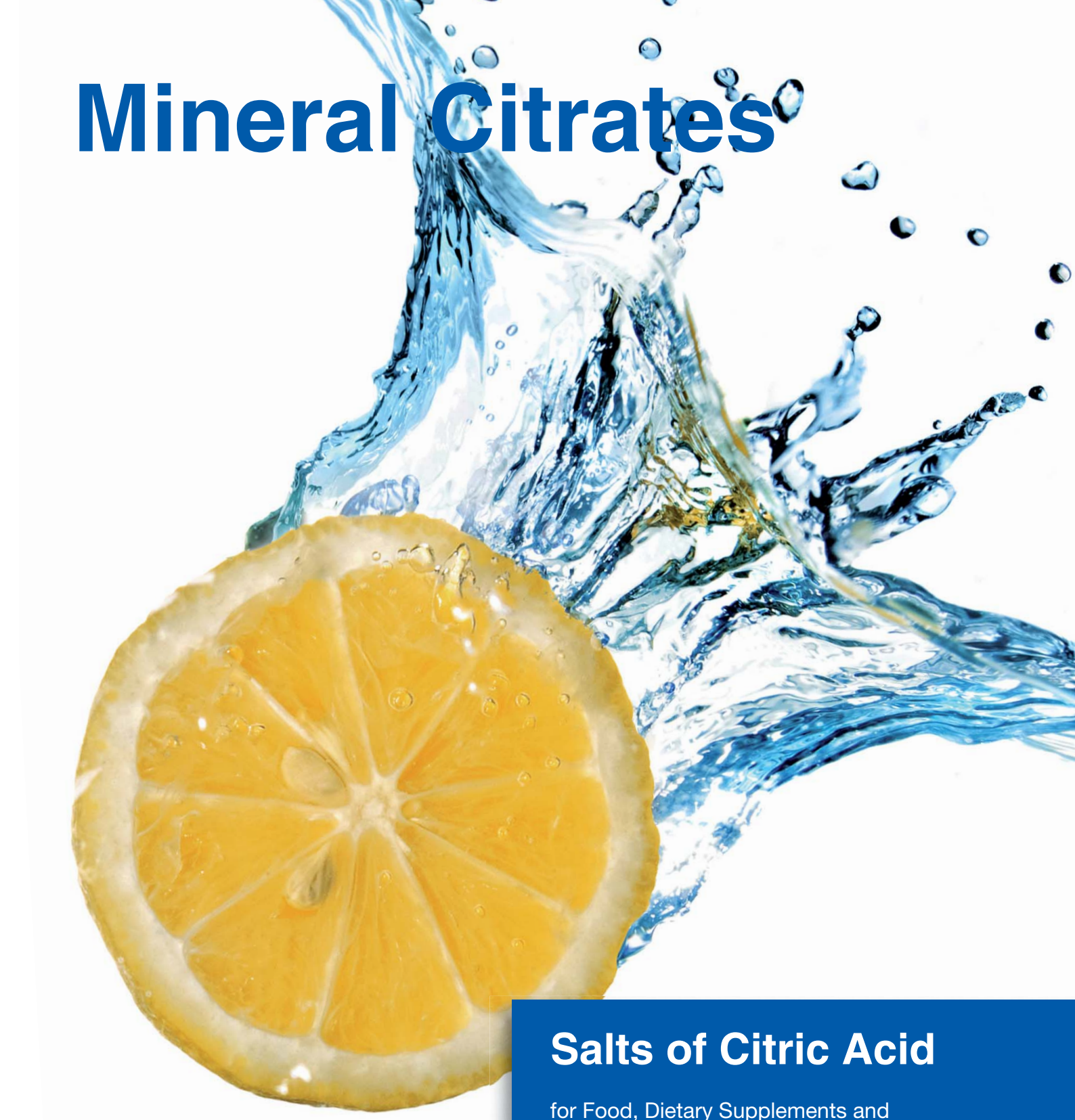
Mineral Citrates



Salts of Citric Acid

for Food, Dietary Supplements and Pharmaceutical Products

Dr. Paul Lohmann®

High value mineral salts

Citrates

Citrates are the salts of citric acid. They are generally highly to very highly soluble, with good bioavailability and a taste ranging from neutral to pleasantly sour or slightly salty.

The citric acid used for the production of our mineral citrates is obtained by fermentative production without using genetically modified organisms.

Citric acid is a significant and the name-inspiring interim product of the citric acid cycle in any living organism. This chain of biochemical reactions is a fundamental mechanism by which living organisms generate energy. That is why citric acid is widely distributed in living nature and found there in high quantities.

Properties and Applications

Many citrates are used for the mineral fortification of beverages or foodstuffs rich in water because they are highly water soluble. Citrates are also often utilized in producing dietary supplements, such as effervescent tablets.

Apart from that mineral citrates tend to build bases in the body. Due to this they are very often used in mixes for acid-base balance.

Other than their application in the area of **food fortification**, mineral citrates are also suitable in many ways as technological additives due to their acidic and buffering effects. They are, for example, used as acidity regulators, acidifying agents, or as complexing agents.

Acidity regulators

Citrates have an excellent buffering capacity. They are used in confectionery, sugar syrup, fruit preparations, pasta, desserts, pickled preserves, aspic and marinades.

Acidulants

The sour salts of citric acid can also be applied as acidulants. In bakery goods, they contribute to improving the characteristics of dough, and thus extending the durability of the product.

Complexing Agents

Citrates work very well as complexing agents. Tertiary citrates form stable compounds with a low hygroscopicity. This makes them particularly easy to process, besides contributing to the stability of the end product. Because of their complexing capacity, citrates are also used synergistically with antioxidants in products high in fat content.

Another application area for citrates is in the heat treatment of milk and cream, where citrates are used as anticoagulants to inhibit the coagulation of proteins. As such, they are also applied to support the grinding process in sausage production or in enzyme preparations.

Emulsifying salts

Sodium, potassium and calcium citrates are frequently used as emulsifying salts. They convert proteins contained in cheese into a dispersed emulsifiable form and thereby bring about homogenous distribution of fat and other components, thus create a smooth creamy texture.

Application of Citrates in ...

... Food

FUNCTION	CITRATE	APPLICATION FOOD
Nutrient for fortification	K, Ca, Mg, Fe, Zn, Cu, Mn	Drinks, confectionery, bakery goods, milk products, cereals, dietary supplements, dietary food
Acidity regulator and buffer medium	Na, K, Ca	Bakery goods, desserts, confectionery, canned fruit and vegetables, marinades, aspic, jams
Stabilizer for colorants and flavors	Na, K, Ca	Fruit, vegetables
Complexing agent, stabilizer	Na, K, Ca	Fats, oils, fat-containing products, as well as meat, fish and poultry products
Carrier substance for flavors	Na, K, Ca	Instant beverages, confectionery
Emulsifying salt (emulsifier)	Na, K, Ca	Process cheese preparations, sausage products
Acidulant	Na, K, Ca	Desserts, confectionery, pickled preserves, marinades, aspic
Hydrolyzing and inverting agent	Na, K, Ca	Starches, monosaccharides and disaccharides
Firming agent	Ca	Fruit, vegetables, gels

... Pharmaceuticals / Cosmetics

FUNCTION	CITRATE	APPLICATION PHARMACEUTICALS / COSMETICS
Anticoagulant	Na	Parenteral feeding, dialysis solutions, blood preserves
Active ingredient	Ca, Mg, Fe, Zn, Mn	Pharmaceuticals
Humectant	Al, Ca, Mg	Dental care products
Astringent	Ca, Mg	Dental care products
Acidity regulator and complexing agent	Na, NH_4	Bath essence, shampoos, cleansing agents, skin and hair care products, colorations and hair colorants
Regulator for acid-base-balance	Na, K, Ca, Mg	Dietary supplements

For the use in pharmaceutical products, we offer various qualities in line with Ph.Eur., USP and other pharmacopeias.

In order to facilitate pharmaceutical registrations, we can provide **C**ertificates **o**f **S**uitability (**CoS**/**CEP**) or **E**uropean **D**rug **M**aster **F**iles (**EDMF**).

Product	Art. No.	Quality	Physical Appereance
Monoammonium Citrate	502089001	chem. pure	crystalline powder
Diammonium Citrate	502075002	food grade	crystalline powder
	502075003	chem. pure	
Triammonium Citrate	502065001	chem. pure or E 380 or JECFA	crystalline powder
Monocalcium Citrate 1-hydrate	502050001	E 333	powder
Tricalcium Citrate, anhydrous	502042001	food grade or E 333 or USP	powder
	502042002		micronized powder
Tricalcium Citrate 4-hydrate	502041001	E 333 or FCC or DAC or USP or NF	powder
	502041002		fine powder
	502041006	E 333 or FCC or USP or Erg.B.6	micronized powder
	502041009	High Purity Food Grade	micronized powder
Tricalcium Citrate 4-hydrate DC 100	502041011	E 333 or FCC or USP	granulate, directly compressible
Copper(II) Citrate 2.5-hydrate	511003001	chem. pure	powder
Copper(II) Sodium Citrate	511004001	chem. pure or Erg.B.6	powder
Ferric Choline Citrate	505054001	chem. pure	powder
	505054003		
Ferric Citrate	503005001	Erg.B.6	granulate
	503005002	FCC or USP XXII (Purity) or JFSA	
	503005003	USP XXII (Purity)	powder
Ferrous Citrate	503070001	chem. pure	powder
	503070002	food grade	
Ferric Ammonium Citrate, brown	503007001	Ph.Franc.VIII	powder
	503007001	FCC or USP XIV or NF XI	
	503007002	DAC or BP 73 or food grade	
	503007003	chem. pure	
Ferric Ammonium Citrate, green	503003001	FCC or NF XI or BPC 54	powder
	503003001	Erg.B.6	
Ferric Ammonium Citrate, Solution	503097001	Purity according to USP XIV	solution
	503097002	chem. pure	
Ferric Manganese(II) Citrate	503018001	BPC 49	powder
Ferric Sodium Citrate	503016001	chem. pure	powder
	503016002		
Ferrous Sodium Citrate	503080001	food grade or Japanese Food Standard or JPC 2002	powder
Trilithium Citrate 4-hydrate	502056001	Ph.Eur. or USP or BP or Erg.B.6	powder
Magnesium Citrate	503088001	food grade	powder
	503088002	Ph.Franc.X	
	503088003	Ph.Franc.X	fine granulate
Magnesium Citrate, sour	503086001	chem. pure	powder
Magnesium Hydrogen Citrate	503033001	DAC or food grade or Erg.B.6.	crystalline powder
	503033001		
	503033004	Erg.B.6 or DAC	granulate
	503033800	Ph.Franc.	crystalline powder
Trimagnesium Dicitrate, anhydrous	503043001	food grade or DAC or USP or Ph.Eur. or chem. pure	powder
	503043002		
	503043003	DAC or USP	micronized powder
Trimagnesium Dicitrate 9-hydrate	503042002	DAC or food grade or Ph.Eur. or USP	powder
	503042003		micronized powder
	503042008	Ph.Eur. or USP or DAC or chem. pure	graulate
Trimagnesium Dicitrate 14-hydrate	503044002	food grade or USP or Ph.Eur.	
Trimagnesium Dicitrate DC 100	503043007	Ph.Eur. or USP	granulate, directly compressible
Magnesium Potassium Citrate	502011001	food grade	crystalline powder
Manganese(II) Citrate, soluble	503017001	food grade or DAC or USP or Ph.Eur.	powder
Monopotassium Citrate, anhydrous	502037001	E 332 (i) or JSFA or JECFA	powder
Dipotassium Citrate	502047001	chem. pure	crystalline powder
Tripotassium Citrate, anhydrous	502038001	E 332 or Ph.Eur.	powder
Tripotassium Citrate 1-hydrate	502040001	E 332 or Ph.Eur. or BP	fine crystalline powder
	502040002	E 332 or FCC or USP or Ph.Eur. or BP or JPC	crystalline powder
	502040004	E 332 or FCC or USP or Ph.Eur. or BP	powder
	502040005	E 332; with aerosil	flowable powder
Monosodium Citrate, anhydrous	502015002	E 331 or DAC or JECFA	crystals
	502015004	E 331 or DAC	powder
	502015005	E 331 or DAC or JECFA	fine powder
	502015007	E 331 or DAC	micronized powder
	502015001	DAC; low in endotoxins	crystalline powder
Disodium Citrate 1.5-hydrate	502006001	E 331 or BP	crystalline powder
	502006002		powder
	502006005		fine powder
Trisodium Citrate, anhydrous	502010002	E 331 or FCC or USP or JSFA or JPC	powder
	502010004	USP	fine powder
	502010005		fine granulate
Trisodium Citrate 2-hydrate	502009001	Ph.Eur. or USP; low in endotoxins	crystalline powder
	502009003	E 331 or FCC or Ph.Eur. or USP or BP or Ph.Franc. or JP or JSFA	
	502009005	E 331 or FCC or Ph.Eur. or USP or BP	fine crystalline powder
	502009007	E 331 or FCC or Ph.Eur. or USP or BP	powder
	502009008	E 331 or Ph.Eur.	fine powder
	502005220	pH 7.0-7.3; E 331 (special quality for meat processing purposes)	powder
	502005330	E 331	fine granulate
Trisodium Citrate 5.5-hydrate	502003001	Erg.B.6 or USP VIII	crystalline powder
Strontium Hydrogen Citrate	502030003	chem. pure	powder
Zinc Citrate 3-hydrate	502017001	chem. pure or food grade	powder
	502017006		micronized powder
	502017003	chem. pure or food grade oder toothpaste grade	fine powder
	502017004	chem. pure or food grade	fine granulate

Color	Flavor	Metal Content (pro 100 g)	Retest Period (Months)	Solubility (g/100g H_2O) 20°C	pH (1 % Solution / * Suspension)
white	sour	approx. 8.5 % NH_4	24	approx. 75	approx. 4
white	sour / bitter	min. 95 %; ca. 16 % NH_4	24	approx. 105	approx. 5
		min. 98 %; min. 15.5 % NH_4			
white	bitter	approx. 22 % NH_4	24	approx. 192	approx. 7.5
white	sour	approx. 9 % Ca	36	approx. 1	approx. 3.5
white	neutral / sandy	approx. 24 % Ca	24	< 1	approx. 6*
white	neutral / sandy	approx. 21 % Ca	36	approx. 1	approx. 6*
white	neutral / sandy	approx. 21 % Ca	36	< 1	approx. 6*
blueish-green	neutral	approx. 35 % Cu	24	approx. 0.02	approx. 6*
blue-green	metallic	min. 10 % Cu	24	approx. 60	approx. 6
yellowish brown	sour, slightly sweet-salty	approx. 14 % Fe(III)	36	> 150	approx. 3
		10.9 - 11.5 % Fe(III); approx. 36.7 % Choline		-	-
red-brown	neutral	18 - 20 % Fe(III)	36	approx. 4	approx. 3
		16.5 - 18.5 % Fe(III)			
grey-green	neutral, metallic	approx. 21 % Fe(II)	24	approx. 1	approx. 4
brownish-yellow	sweet, mild-bitter, metallic	16.8 - 18.2 % Fe(III)	36	approx. 350	approx. 7
		16.5 - 18.5 % Fe(III)			
red-brown		20.5 - 22.5 % Fe(III)		approx. 500	
darkred-brown		approx. 28 % Fe(III)			
green	sweet, slightly bitter, metallic	14.5 - 16 % Fe(III)	36	approx. 350	approx. 4.5
		min. 12.85 % Fe(III)		> 150	approx. 5
red-brown	sweet, slightly bitter, metallic	8 - 9 % Fe(III)	36	solution	approx. 5
		approx. 15.5 % Fe(III)			approx. 8
red-brown	earthy	14 - 16 % Fe(III); min. 7 % Mn(II)	24	> 150	approx. 9
red-brown	neutral	approx. 20 % Fe(III)	24	approx. 66	approx. 8
		31 - 34 % Fe(III)			
greenish-white	metallic	approx. 10.5 % Fe(II)	24	approx. 12	approx. 6
white	slightly salty	approx. 7 % Li	24	approx. 65	approx. 9
white	sourish	approx. 10 % Mg	24	approx. 20	approx. 4
				approx. 43	
white	sour	approx.7 % Mg	24	approx. 20	approx. 3.5
white	sour	approx. 8 % Mg	24	approx. 4	approx. 4
		8 - 9 % Mg			
		min. 8 % Mg			
		min. 9 % Mg			
white	slightly sweet, slightly bitter	approx. 15 % Mg	36	approx. 9	approx. 7
white	slightly sweet, slightly bitter	approx. 12 % Mg	36	approx. 2	approx. 8
white to cream	slightly sweet, slightly bitter	approx. 11 % Mg	24	approx. 2	approx. 7
white to cream	slightly sweet, slightly bitter	approx. 15 % Mg	24	approx. 9	approx. 7
white	neutral	min. 26 % K; min. 4 % Mg	6	approx. 37	approx. 7.5
yellowish	neutral	approx. 15 % Mn; approx. 10 % Na	36	approx. 58	approx. 8
white	sour	approx. 17 % K	24	approx. 22	approx. 4
white	slightly bitter, sour	approx. 29 % K	24	approx. 98	approx. 5
white	bitter	approx. 38 % K	24	approx. 150	approx. 8
white	bitter	approx. 36 % K	36	approx. 172	approx. 8
colorless	slightly sour	approx. 10.5 % Na	36	approx. 17	approx. 4
white					
white	slightly sour	approx. 17.5 % Na	36	approx. 63	approx. 5
white	slightly salty	approx. 27 % Na	24	approx. 52	approx. 8
white	salty	approx. 23.5 % Na	36	approx. 59	approx. 8
colorless / yellowish	salty	approx. 19 % Na	36	approx. 88	approx. 8
white	neutral	approx. 30 % Sr	36	< 1	ca. 4.5*
white	neutral	approx. 31 % Zn	36	< 1	approx. 6*

Citrates - Our Top Products

Magnesium Citrate

Magnesium citrate is available in different compositions. Trimagnesium dicitrate with 15 % magnesium contains an extra portion of this mineral. The neutral, slightly sweet taste and the good solubility in water are what makes it so well suited as an ingredient for beverages and liquid dietary supplements.

Magnesium citrate is metabolized by the enterocytes already present in the small intestine[1]. It has an alkalizing effect[1], and thus is of particular interest to athletes. The alkalizing effect of Magnesium citrate is based on the citrate metabolizing into a bicarbonate. This creates a buffer effect and neutralizes metabolic acids, such as lactate, which is generated in muscles during physical activity. [2,3]

Magnesium Hydrogen Citrate

Magnesium hydrogen citrate is highly soluble, has a similar effect as Trimagnesium dicitrate, and distinguishes itself by a fresh, sour taste.

Calcium Citrate, micronized

Calcium citrate has a good bioavailability and neutral taste. This makes it especially suitable for foods and dietary supplements.

Our micronized calcium citrate has a particle size of approx. 2 µm (d50). This small grain size provides foodstuffs with an optimal mouth-feel for consuming foodstuffs that have special sensory requirements.

Zinc Citrate

A zinc salt that is neutral in taste and provides good bioavailability. Apart from being used in foodstuffs and dietary supplements, it is suitable for application in toothpaste [3].
Our zinc citrate is characterized by high zinc content and neutral pH-value, in addition to a low level of reactivity as it is organically bound.

Iron Citrate

Iron citrate works in many applications, is neutral in taste, well bioavailable and has a neutral pH-value. It is a bright powder, which is ideal for the usage in foods especially in dry mixes.

Trace Elements
Manganese Citrate
Copper Citrate

In addition to our various top products we also provide trace elements as citrate. They are particularly well suited for, e.g. high-quality nutritional supplements based on citrates.

Food Regulatory Aspects

In Europe, the acceptable application areas for the individual citrates are defined on EU Community lists in various regulations and directives.

Citrates are generally approved as technological additives without quantitative ceilings for many foods (quantum satis).

In addition to the European requirements for using mineral salts, the relevant national regulations must also be met. In the US, only citrate salts that have GRAS status (Generally Recognized As Safe) as specified by the Food and Drug Administration (FDA) can be used for food fortification and as technological additives.

Application as Nutrient

Citrates approved by the EU for fortification:

	Food [I]	Dietetic Foods [II]	Infant formulae and follow-on formulae [III]	Processed cereals-based foods and baby foods for infants and young children [IV]	Food Supplements [I]
Calcium salts of orthophosphoric acid	✓	✓	✓	✓	✓
Magnesium salts of citric acid	✓	✓	✓	✓	✓
Ferrous citrate	✓	✓	✓	✓	✓
Cupric citrate	✓	✓	✓	✓	✓
Zinc citrate	✓	✓	✓	✓	✓
Manganese citrate	✓	✓	✓	✓	✓
Sodium citrate	✓	✓	✓		✓
Potassium citrate	✓	✓	✓	✓	✓

Blue/cursive = in the Dr. Paul Lohmann® portfolio

Application as Additive

Citrates approved by the EU as technological additivs:

E-NO.	COMPOUND	TECHNOLOGICAL FUNCTION
E 331*	Sodium Citrate	Acidity Regulator, acidulant, complexing agent, emulsifying salt
E 332	Potassium Citrate	
E 333*	Calcium Citrates	

* Food additives and processing aids – in accordance with the EU Regulation on organic products.

CITRATES WITH GRAS** STATUS
Calcium Citrate
Ferrous Ammonium Citrate
Ferrous Citrate
Potassium Citrate
Manganese Citrate
Sodium Citrate

**21 CFR184 Substances affirmed as GRAS (Generally Recognized As Safe)

References

1 Biesalski, H.K., Köhrle, J., Schümann, K.: Vitamine, Spurenelemente und Mineralstoffe (Vitamins, trace elements and minerals). Thieme-Verlag, Stuttgart, 2002
2 Remer T, Dimitriou T, Manz F: Dietary potential renal acid load and renal net acid excretion in healthy, free-living children and adolecents. Am J Clin Nutr 77, 1255–1260 (2003)
3 Buchwald, M.: Kalium - Eine Übersicht über die physiologischen Wirkungen (An overview of physiological effects). Deutsche Lebensmittel-Rundschau, 104; 8/2008

GRAS Substances (SCOGS) Database;
http://www.fda.gov/Food/FoodIngredientsPackaging/GenerallyRecognizedasSafeGRAS/GRASSubstancesSCOGSDatabase/default.htm

Relevant EU Regulations and Directives

Fortification:
I Commission Regulation (EC) No 1170/2009 and (EC) No 1161/2011
amending Directive 2002/46/EC of the European Parliament and of Council and Regulation (EC) No 1925/2006 of the European Parliament and of the Council as regards the lists of vitamin and minerals and their forms that can be added to foods, including food supplements
II Commission Regulation (EC) No 953/2009 and (EC) No 1161/2011
on substances that may be added for specific nutritional purposes in foods for particular nutritional uses
III Commission Directive 2006/141/EC
on infant formulae and follow-on formulae and amending Directive 1999/21/EC
IV Commission Directive 2006/125/EC
on processed cereal-based foods and baby foods for infants and young children
Directive 2002/46/EC
on the approximation of the laws of the Member States relating to food supplements
Regulation (EC) No 1925/2006
on the addition of vitamins and minerals and of certain other substances to foods
Commission Directive 96/8/EC
on foods intended for use in energy-restricted diets for weight reduction

Technological additives:
Regulation (EC) No 1333/2008
on food additives
Directive No 95/2/EC
on food additives other than colours and sweeteners
Regulation (EC) No. 889/2008
laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labeling of organic products with regard to organic production, labeling and control

Cosmetic Products:
Regulation (EC) No. 1223/2009 of the European Parliament and of the Council of November 30, 2009 on cosmetic products

Dr. Paul Lohmann GmbH KG

Hauptstrasse 2
31860 Emmerthal
Germany

T +49 5155 63-0
F +49 5155 63-5818

sales@lohmann4minerals.com
www.lohmann4minerals.com

Dr. Paul Lohmann (Asia) Pte. Ltd.

25 International Business Park
#04-71 German Centre
Singapore 609916

T +65 6562 9536
F +65 6562 9537

service@lohmann-asia.com
www.lohmann-asia.com

Dr. Paul Lohmann Inc.

1757-10 Veterans Memorial Highway
Islandia, NY 11749
USA

T 1-877-4DPL-USA
F 1-631-851-8815

service@lohmann-inc.com
www.lohmann-inc.com

Hameln Pyrmont Region Weserbergland

Dr. Paul Lohmann®

DNR 130 Rev. C - 12/2012