

**It's in the details.**

**JOST**

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**MINERAL GUIDE**

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# Reference Guide to Jost Mineral Compounds

Jost Chemical Co. manufactures a line of mineral compounds that are used in the nutritional supplement, pharmaceutical, food and precision industrial markets. This reference guide highlights several key points to consider when formulating a product: **Solubility**, **Metal Content** and **Taste**.

The minerals discussed in the guide include Ca, Cu, Fe, Mg, Mn and Zn. K and Na salts are included in the guide for completeness. Additional factors that play a role in mineral selection are referenced at end of the guide.

Generally, the mineral salts in each chart are arranged by descending solubility and increasing metal content.

Jost manufactures all products mentioned in this guide under bulk pharmaceutical cGMP guidelines in our FDA registered facilities in St. Louis, MO. Our products are Kosher/HALAL certified, non-GMO, non-allergenic, BSE/TSE free, and free of residual solvents.



**JUST CHEMICAL CO.**

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# Calcium

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Calcium Content %	Taste <sup>4</sup>
Calcium Gluconate Anhydrous	3-20 <sup>100</sup>	8.9-9.5	Neutral
Calcium Lactate Anhydrous	3.1 <sup>0</sup> -7.9 <sup>30</sup>	18.0-18.6	Exothermic, Sharp
Calcium Fumarate Trihydrate	2.1 <sup>30</sup>	19.0-19.2	Neutral
Calcium Fumarate Anhydrous	2	23.0-29.9	Neutral
Calcium Malate Anhydrous	0.8 <sup>0</sup> -1.2 <sup>37.5</sup>	20.0-23.5	Slightly Salty
Calcium Hydroxide	0.185 <sup>0</sup> -0.077 <sup>100</sup>	51.6-54.7	Biting
Calcium Citrate Tetrahydrate	0.10	20.5-21.2	Neutral
Calcium Phosphate Tribasic Anhydrous (TCP)	0.002	34.0-40.0	Neutral
Calcium Succinate Monohydrate	0.004	22.0-25.0	Salty, Strong Aftertaste
Calcium Carbonate Anhydrous	0.0014	39.4-40.5	Neutral
Calcium Phosphate Dibasic Anhydrous (DCPA)	Insoluble	28.8-30.9	Neutral

1. Generally arranged by descending solubility and increasing metal content.

2. Solubility in percent. Superscript is temperature; if no superscript, 25°C.

3. CRC Handbook and Merck Index are the main sources of this information.

4. Taste profiles developed by Jost personnel and are subjective.



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# Copper

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Copper Content %	Taste <sup>4</sup>
<b>Copper Sulfate Pentahydrate</b>	31.6 <sup>0</sup> -203.3 <sup>100</sup>	24.9-26.8	Sharp, Bitter
<b>Copper Gluconate Anhydrous</b>	30	13.7-14.3	Mild, Sweet
<b>Copper Sulfate Anhydrous</b>	14.3-75.4 <sup>100</sup>	39.2-40.0	Sharp, Bitter
<b>Copper Citrate Hemi-Trihydrate</b>	Insoluble	36.0-37.8	Mild
<b>Basic Copper Carbonate</b>	Insoluble	57.4	Neutral
<b>Copper Oxide Anhydrous</b>	Insoluble	78.7-80.7	Mild

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# Iron

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Iron Content %	Taste <sup>4</sup>
<b>Ferric Ammonium Citrate Brown</b>	Very Soluble	16.5-18.5	Strong
<b>Ferrous Ammonium Sulfate Hexahydrate</b>	20-34.2 <sup>70</sup>	13.5-14.2	Strong
<b>Ferrous Gluconate Dihydrate</b>	9 <sup>28</sup> -60 <sup>80</sup>	USP 10.9-11.9 EP 11.8-12.5	Salty, Bitter
<b>Ferrous Lactate Dihydrate</b>	2-8.5 <sup>100</sup>	20.1-20.8	Mild
<b>Ferrous Fumarate Anhydrous</b>	0.14	30.3-33.2	Neutral
<b>Ferric Pyrophosphate</b>	Insoluble	24.0-26.0	Neutral
<b>Ferrous Citrate Dibasic Monohydrate</b>	Insoluble	20.0-22.0	Mild
<b>Ferric Citrate x-Hydrate</b>	Insoluble	16.5-20.0	Mild

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# Magnesium

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Magnesium Content %	Taste <sup>4</sup>
Magnesium Ascorbate x-Hydrate	72	6.1-6.6	Neutral, Slightly Tart
Magnesium Aspartate Monobasic Dihydrate	70	7.1-7.7	Metallic
Magnesium Citrate Tribasic Anhydrous	15	14.5-16.4	Neutral
Magnesium Aspartate Dibasic Anhydrous	14.5	14.2-15.7	Strong
Magnesium Gluconate Hydrate <sup>5</sup>	8	5.7-6.0	Slightly Tart
Magnesium Lactate Anhydrous <sup>6</sup>	3.5	11.8-12.2	Mild, Sweet, Slightly Spicy
Magnesium Lactate Dihydrate	3.3-16.7 <sup>100</sup>	10.0-10.4	Mild, Sweet, Slightly Spicy
Magnesium Malate Trihydrate	2	11.3-11.8	Neutral
Magnesium Citrate Tribasic x-Hydrate	0.4-2.8 <sup>95</sup>	11.2-12.0	Neutral
Magnesium Phosphate Dibasic Trihydrate	Slightly Soluble	13.4-14.0	Neutral
Magnesium Phosphate Tribasic Pentahydrate	Insoluble	20.2-20.9	Neutral

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2. Solubility in percent. Superscript is temperature; if no superscript, 25°C.

3. CRC Handbook and Merck Index are the main sources of this information.

4. Taste profiles developed by Jost personnel and are subjective.

5. Jost's Magnesium Gluconate is typically a dihydrate.

6. Calculated based on dihydrate solubility.



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# Manganese

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Manganese Content %	Taste <sup>4</sup>
<b>Manganese Sulfate Monohydrate</b>	50	31.8-33.2	Mild
<b>Manganese Gluconate Dihydrate</b>	17	11.0-11.9	Mild
<b>Manganese Lactate Dihydrate</b>	10	20.0-20.8	Mild
<b>Manganese Citrate Decahydrate</b>	<1	22.0-23.9	Neutral
<b>Manganese Ascorbate Dihydrate</b>	Insoluble	12.5-14.0	Very Bitter

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# Potassium

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Potassium Content %	Taste <sup>4</sup>
<b>Di-Potassium Citrate Anhydrous</b>	Very Soluble	29.1	Very Salty
<b>Potassium Gluconate Anhydrous</b>	300	15.7-17.2	Mild Metallic
<b>Potassium Phosphate Dibasic</b>	167	44.9	Mild Salty, Exothermic
<b>Potassium Carbonate Anhydrous</b>	112 <sup>20</sup> -156 <sup>100</sup>	56.3-56.9	Mild Salty, Exothermic
<b>Potassium Phosphate Monobasic</b>	33-83.5 <sup>90</sup>	28.7	Very Salty, Metallic
<b>Potassium Nitrate</b>	13.3 <sup>6</sup> -247 <sup>100</sup>	38.7	Very Salty, Metallic
<b>Potassium Sulfate</b>	12	44.2-45.3	Very Salty, Metallic

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# Sodium

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Sodium Content %	Taste <sup>4</sup>
Sodium Phosphate Monobasic Monohydrate	59.9 <sup>0</sup> -427 <sup>100</sup>	16.7	Very Salty
Sodium Phosphate Monobasic Anhydrous	76	19.2	Hurts Tongue, Salty
Sodium Phosphate Dibasic Anhydrous	Very Soluble	32.4	Exothermic, Salty
Sodium Phosphate Dibasic Dihydrate	100 <sup>50</sup> -117 <sup>80</sup>	29.8	Salty
Sodium Nitrate Anhydrous	92.1-180 <sup>100</sup>	27.0	Endothermic, Salty
Sodium Sulfate Anhydrous	42.5 <sup>100</sup>	32.4	Very Salty
Sodium Carbonate Monohydrate	33-52 <sup>100</sup>	37.1	Salty
Sodium Bisulfate Monohydrate	28.6-100 <sup>100</sup>	16.7	Hurts Tongue, Very Salty
Sodium Sulfate Decahydrate	11 <sup>0</sup> -92.7 <sup>30</sup>	14.3	Very Salty
Sodium Carbonate Anhydrous	7.1-45.5 <sup>100</sup>	43.4	Exothermic, Salty



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# Zinc

Salt <sup>1</sup>	Solubility % <sup>2,3</sup>	Zinc Content %	Taste <sup>4</sup>
Zinc Gluconate Hydrate <sup>5</sup>	13	12.3-14.6	Mild, Faint Taste
Zinc Lactate Dihydrate	1.7-17 <sup>100</sup>	22.0-24.0	Mild, Faint Taste
Zinc Citrate Trihydrate	Slightly Soluble	30.9-31.5	Neutral
Zinc Citrate Dihydrate	Slightly Soluble	31.3-32.1	Neutral

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4. Taste profiles developed by Jost personnel and are subjective.

5. Jost's Zinc Gluconate is typically a dihydrate.



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# Categories to Consider When Choosing Mineral Compounds

## Animal Origin

Jost products are BSE/TSE free and no animal products come into our facility.

## Bio-Availability

Not all mineral compounds are equally bio-available. Literature searches may be required.

## Bulk Density

For processing reasons, the bulk density may dictate the choice of the compound.

## cGMP

GMP manufacturing provides mandated assurance that the requisite systems and procedures are in place to document and ensure product integrity, quality, consistency, safety, and traceability from raw material receipt to finished product distribution.

## Color

Color can reflect product quality and stability.

## Effectiveness

Citrates, Gluconates, Lactates, Ascorbates, Fumarates and Malates are commonly recognized as preferred mineral sources for nutritional supplements.

## GMO-Origin

For political and health reasons, concern for GMO has limited the use of certain raw materials.

## Heavy Metal Content

Limitation of heavy metals is key. The industry trend is a 1- 5 ppm maximum for Hg, Pb, Cd, and As. Limitations of less than 5 ppm maximum are also often required for Al, Mn, and Cr.

## Interaction with Other Molecules

Some salts can be strong oxidizing agents and will therefore interact with other molecules in premixes or in solutions. For instance, iron is very reactive with Vitamin C.

## Kosher or HALAL Certification

Market globalization has pushed international standards to comply with the various cultural obligations.

## Mineral Content

Mineral content is provided as a % range and is described according to hydration level. When formulating it is important to know a compound's "as-is" mineral content. Some mineral compounds are simply blends and not fully reacted thus inhibiting their stability in formulations. Jost only manufactures fully reacted mineral salts.

## Monographs

The USP, EP and FCC monographs establish agreed upon specifications and test methods for products. Some suppliers use the term "Purified" to describe products when no monograph is available. Jost defines "Purified" as meeting specifications that are equivalent to USP, had there been a monograph.

## Nutritional Claims

Many claims in the nutritional supplement literature are not supported by either clinical or scientific studies.

## Odor

Odor may reflect the raw material quality and can impact the final product acceptance level.

## Particle Size

Particle size is a major consideration in solid dosage process controls, taste, formulation stability of slurry, and solubility concerns. If a salt is insoluble an ultrafine particle size can help keep the salt suspended in liquid.

## Particle Size Consistency

A consistent particle size allows for repeatability of manufacturing.

## pH

pH range is a major consideration for stability of the end product, taste and process considerations.

## Price and Production Costs

Mineral content per price can be a clear factor in the choice of product.

## Residual Solvents

For Pharma applications, the amount of some residual solvents are highly regulated.

## Shelf Life/Retest Date

Jost ensures our products are stable up to a specified retest date when the product is stored in the original, unopened container under normal warehouse conditions.

## Solubility

Solubility plays a key role, especially for powders being mixed into a liquid.

## Taste

Citrates, Gluconates, Lactates and Malates generally have a neutral or mild taste.

## Tolerance

Many Sulfates, Chlorides or Fumarates are not easily tolerated by the body as they can impact the gastric pH.

## USP, FCC, EP, ACS, Custom

The application of the product will determine which grade will be preferred.



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