

Gadot Biochemical Industries



Marketing Information

Fortification with Tri Zinc Citrate

The Importance of Zinc

Zinc (Zn) is an essential trace element which functions as a component of various enzymes in the maintenance of structural integrity of proteins and in the regulation of gene expression.

The average adult body contains between 1.5 and 2.5 g of zinc with approximately 60% in the muscles, 30% in the bones and 6% in the skin.

The highest concentrations of zinc are in the prostate gland and sperm in men, and in red and white blood cells. The retina of the eye, liver and kidneys also have high concentrations and there is some zinc in hair.

Zinc is an essential mineral for maintaining a healthy immune system and variety of other important body processes. These include:

- Brain development
- Protein synthesis
- Cell growth
- Proper function of hormones such as insulin, sex and growth hormones.
- Prevention of infections.
- Wound healing
- Helps the body utilize vitamins, such as E and A.

Because of zinc's vital roles in cellular growth and differentiation, and probably for several other reasons, zinc is especially important at specific times of the human life cycle, for example early childhood and during the reproductive cycle.

Zinc deficiency may lead to eczema on the face and hand, hair loss, mental apathy, defects in the reproductive organs, delayed sexual maturation, menstrual irregularities, decreased growth rate and impaired mental development. Deficiency may also lead to postnatal depression, loss of the senses of taste and smell, anemia, poor appetite, impaired conduction and nerve damage, white spots on the nails, mental disorders, susceptibility to infection, delayed wound-healing and impotence in men.

Optimal Zinc intake

Optimal Zinc intake refers to the levels of consumption that are necessary for an individual to achieve the required amount needed in the body.

The Zinc **Recommended Dietary Allowances** (RDA) is shown in the following table:

Age	RDA mg/day
Less than 6 months	2.5
7-12 months	3
1-3 years	3
4-8 years	5
9-13 years	8
14-18 years	9-11
Men 19-70 years	8-11
Women 19-70 years	8-11
Above 70 years	8-11
Women Pregnancy or breast feeding	11-12

The Zinc Sources

There are different sources of Zinc in various forms so how to choose the proper one?

Properties to be considered:

- Bioavailability
- Zinc content
- Solubility
- Organoleptical characteristics
- Interaction with other ingredients

Commonly used Zinc sources:

Organic Zinc	Inorganic Zinc
Zinc Citrate	Zinc Oxide
Zinc Lactate	Zinc Sulfate
Zinc Gluconate	
Zinc Acetate	

So, which is preferable? Organic Zinc or Inorganic Zinc?

Zinc Bioavailability

Zn is absorbed throughout the small intestine, with the highest rate of absorption in the jejunum.

Several Zn salts are available for food fortification, ranging in solubility from very soluble (sulfate and chloride), freely soluble (acetate) to almost insoluble (carbonate and oxide), reviewed by Henderson¹,

Only very limited information is available on the bioavailability of different Zn compounds used for food fortification in humans. Although no conclusive data have been reported in either humans or animals, it would seem that soluble Zn compounds would be preferable as food fortification.

Mineral oxides (e.g., ZnO) are generally considered the poorest-absorbed form of mineral preparations. Mineral sulfates (e.g., Zn Sulfate) are generally better absorbed than oxides, though side reactions with food components are possible (for example, oxidation of lipids can cause food to go rancid).

The following table adapted from by Wayne Greene (1998) from Texas A&M²., compares the relative bio-availability of several trace elements from different sources. In general inorganic form of Zinc would have a lower bioavailability than an organic form of zinc.

	Sulfate	Oxide	Carbonate	Chloride	Organic
Zinc as	100%	-	60%	50%	159-206%

References:

1. Henderson, L.M., Brewer, G.J., Dressman, J.B., Swidan, S.Z., DuRoss, D.J., Adair, C.H Barnett, J.L., Berardi, R.R. Effect of intragastric pH on the absorption of oral zinc acetate and zinc oxide in young healthy volunteers. *Journal of Parenteral and Enteral Nutrition*; 1995; 19; 393-7
2. Paterson J., C. Swenson, B. and R.Ansotegui Life cycle trace mineral needs for reducing stress in beef production Montana State University and Zinpro Corporation

Zinc Content and Solubility

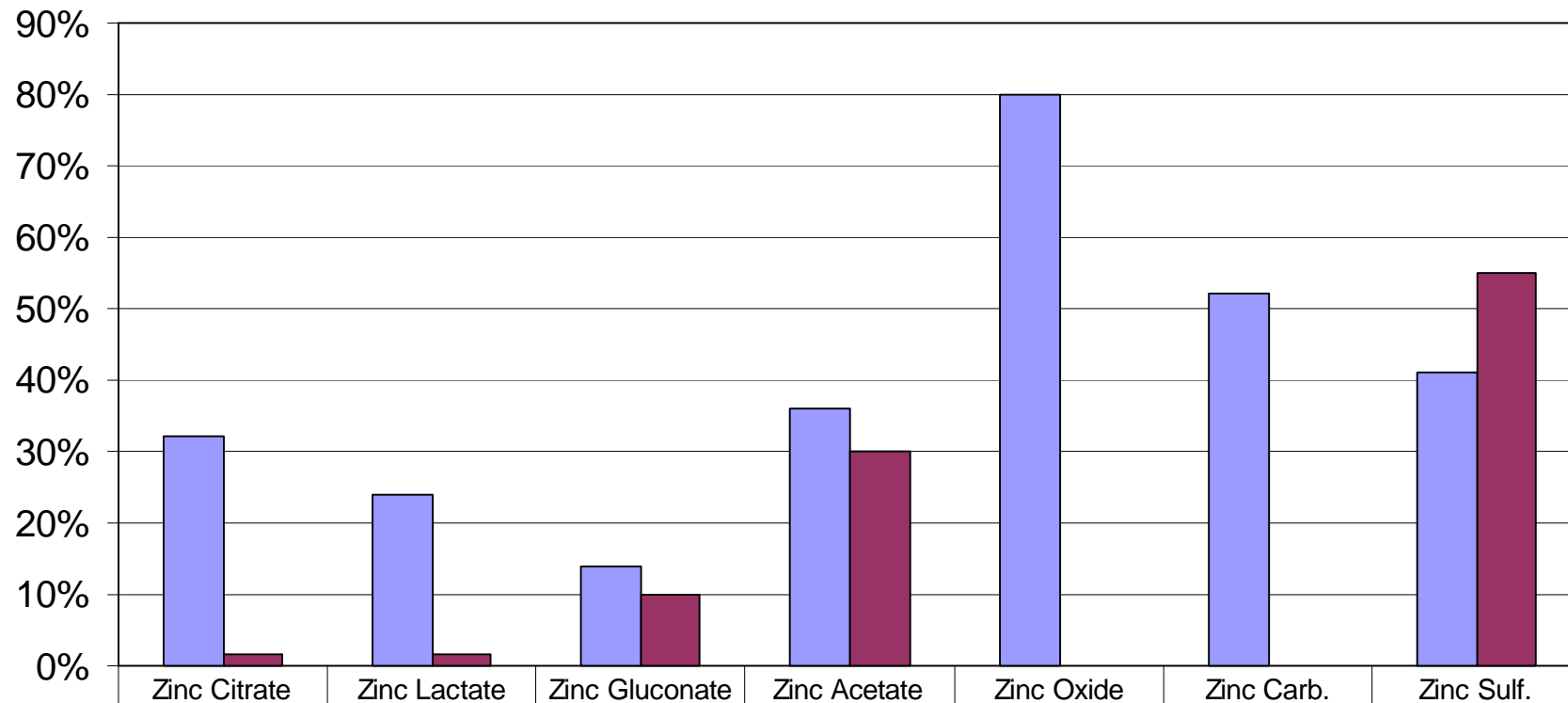
Organic Zinc

	Zinc	Solubility
Zinc Citrate	32%	1.5%
Zinc Lactate	24%	1.7%
Zinc Gluconate	14%	10%
Zinc Acetate	36%	30%

Inorganic Zinc

Zinc Oxide	80%	0.00016%
Zinc Carbonate	52%	0.001%
Zinc Sulphate	41%	55%

Zinc content and Solubility Organic vs Inorganic sources



Zn-content	32%	24%	14%	36%	80%	52%	41%
Solubility	1.5%	1.7%	10.0%	30.0%	0.00016%	0.001%	55.0%

Mouth-feel & Taste of the various Zinc sources

Organic Zinc

Zinc Citrate	Neutral
Zinc Lactate	Neutral
Zinc Gluconate	Strong after taste
Zinc Acetate	Bitter/Vinegar

Inorganic Zinc

Zinc Oxide	Bitter
Zinc Carbonate	Chalky
Zinc Sulfate	Astringent

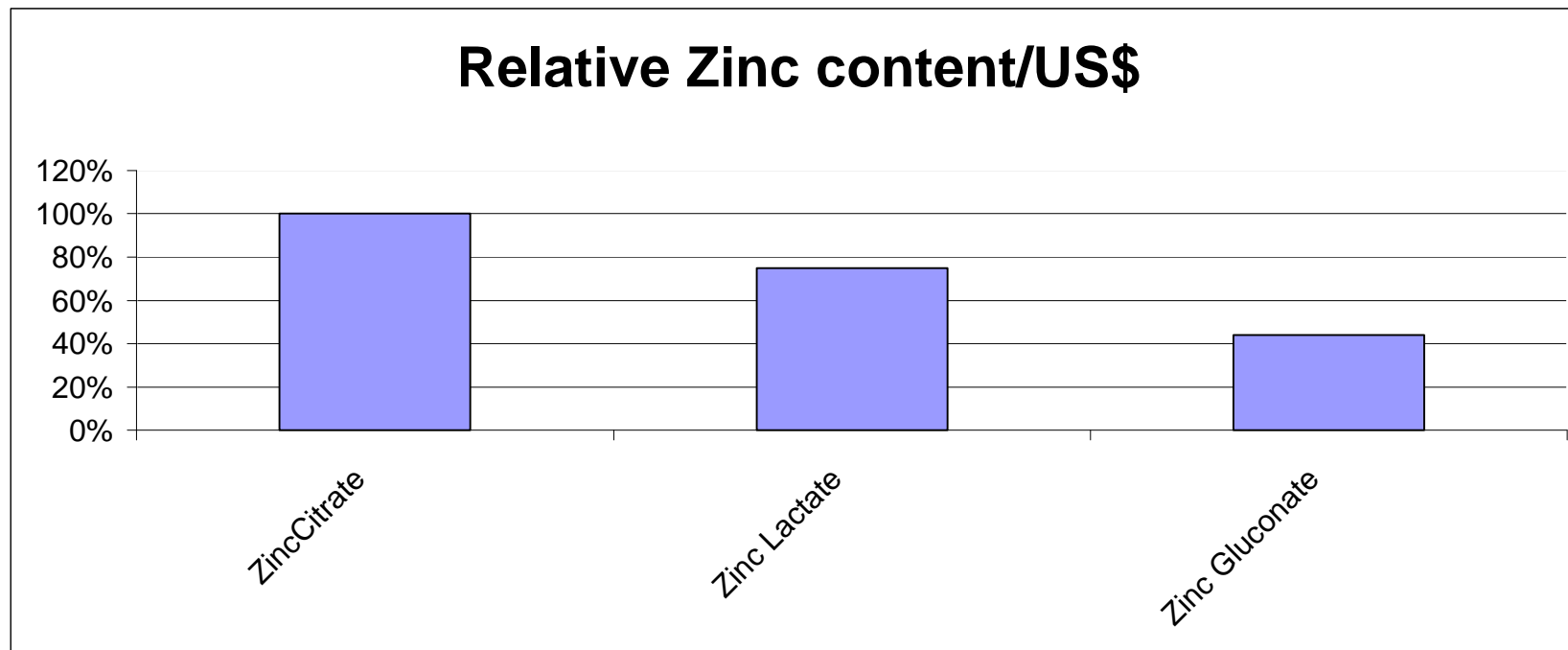
Conclusion: Organic Zinc sources have a better bioavailability, better organoleptical characteristics and sufficient level of solubility.

Which organic Zinc is preferable?

Costs

For the same amount of money one will get 100% amount of Zinc as Citrate or 75% of that amount of Zinc as Lactate or only 44% of that amount Zinc as Gluconate.

Zinc Citrate is by far a more cost effective source than any other Organic Zinc source.



Solubility

Is the solubility, consist of a barrier for the use of Zinc Citrate?

The solubility of Zinc Citrate enables to introduce approx. 1500 mg into 100ml of water which represents 1500% of the RDI.

With this solubility a Zinc content level of 25-35% of the RDI is easily achieved.

Such level of RDI can be considered optimal.

CONCLUSION: TRI ZINC CITRATE WILL BE THE MOST SUITABLE AND MOST COST EFFECTIVE AMONG ORGANIC ZINC SOURCES.

Benefits of Zinc Citrate - Summary

- High bioavailability.
- High Zinc content: Cost effective Zinc source.
- Neutral flavor.
- Sufficient solubility.