RELATIVE BIOAVAILABILITY OF TRACE ELEMENTS AND VITAMINS FOUND IN COMMERCIAL SUPPLEMENTS

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Commercial supplements of trace elements are available in a wide variety of forms. These include the isolated compounds such as inorganic salts, organic salts, amino acid chelates and a yeast form. The yeast form is made from a brewer's yeast grown in a nutrient media containing the inorganic salt. After several generations of yeast cell division the cell walls are removed by proteolytic enzymes and the yeast is then spray dried.

Vitamins are commercially available in two forms for human supplementation; a synthetic or isolated form and a natural form in which the synthetic vitamin is reacted with a natural yeast or plant extract containing proteins, carbohydrates, lipids and other natural substances.

Bioavailability of vitamins and trace elements has been determined in long-term animal supplementation (3-4 weeks) studies by measuring the vitamin or trace element in liver, blood, serum or plasma and comparing the slope of the dose-concentration plots. A preliminary depletion is usually performed using vitamin or trace element deficient food. In short-term experiments the area under the blood, serum or plasma concentration-time curve is used to compare bioavailabilities after a single dose of the test substance is given to either animals or humans.

Results of the trace element and vitamin studies are shown in Tables 1 and 2 on the following page.(1)

Examination of the blood concentration-time curves for the short-term human experiments involving selenium, zinc and copper revealed that the yeast form was more

Table 1. Relative Bioavailability of Different Forms of Trace Elements.

Element	Animal	Length of Study	Analysis	Relative Bioavailability %[a]
Se	Rat	Long	Blood	100I, 60C, 122Y
Se	Rat	Long	Liver	100I, 146C, 226Y
Se	Human	Short	Auc[b]	100I, 122C
Mn	Rat	Long	Blood	100I, 111C, 156Y
Mn	Rat	Long	Liver	100I, 142C, 163Y
Zn	Rat	Long	Blood	100I, 101C, 172Y
Zn	Rat	Long	Liver	100I, 129C, 187Y
Zn	Human	Short	Auc	100I, 111O, 175Y
Fe	Rat	Long	Blood	100I, 57C, 101Y
Fe	Rat	Long	Liver	100I, 72C, 121Y
Cu	Rat	Long	Blood	100I, 930, 124Y
Cu	Rat	Long	Liver	100I, 1300, 195Y
Cu	Human	Short	Auc	100I, 1010 144Y
Cr	Human	Short	Glucose[c] (2)	100I, 356Y

[a]Relative bioavailability for long-term studies is determined from the slope of the dose-concentration curve. For short-term experiments, it is calculated from the area under the concentration-time curve. For all studies, the Inorganic Salt is defined as 100% bioavailable.
I = Inorganic Salt, C = Amino Acid Chelate, O = Organic Salt, Y = Yeast.
[b]Auc = Area under Blood, Serum or Plasma Concentration-Time Curve.
[c]Percent of Fasting Serum Glucose Decrease.

Table 2. Relative Bioavailability of Synthetic and Natural Vitamins.

Vitamin	Animal	Length of Study	Analysis	$\frac{\text{Natural}}{\text{Synthetic}} \times 100$
A	Rat	Long	Blood	149%
B1	Rat	Short	Auc[a]	138%
B2	Rat	Long	Serum	149%
B6	Rat	Long	Serum	254%
B6	Rat	Long	Liver	156%
B12	Rat	Long	Serum	256%
B12	Rat	Long	Liver	159%
Niacinamide	Rat	Short	Blood	394%
Niacinamide	Rat	Short	Liver	170%
C	Guinea Pig	Short	Auc	148% (3)
C	Human	Short	Auc	135%
E	Rat	Short	Liver	260%
Folic Acid	Rat	Long	Serum	107%
Folic Acid	Rat	Long	Liver	213%

[a]Area under Blood Concentration-Time Curve.

slowly absorbed, i.e. took longer to reach its maximum concentration than the other forms of trace elements. This is analogous to the situation of trace elements in foods which have been shown to be more slowly absorbed than the isolated salts of the trace elements. The peptides and free amino acids present in the yeast may associate or bind with the trace element and slow its absorption. As an example it was found for copper that the average time for maximum concentration in the blood of humans was 1.3 hours for copper sulfate, 1.7 hours for copper gluconate and 3.7 hours for the copper yeast. In comparing the area under these curves it was found that the yeast produced the greatest area and thus was the most bioavailable form. The long-term animal experiments also showed that the yeast was the most bioavailable form of the trace elements tested both in the blood and in the liver where many trace elements are stored.

Short-term vitamin experiments were done for vitamin B1 in rats and for vitamin C in guinea pigs and humans. The natural form of the vitamin was found to be more slowly absorbed than the synthetic form. For vitamin C in guinea pigs, ascorbic acid reached a maximum concentration in the plasma after 1.0 hours and after 1.6 hours with the natural vitamin C. In humans ascorbic acid at a dose of 500 mg reached its maximum after 2.9 hours and the natural vitamin C after 4.1 hours. In comparing the areas under the concentration-time curves it was found that the natural vitamin produced the greatest area. The long-term animal supplementations demonstrated that the natural form of the vitamin was more bioavailable in both the blood and liver.

In summary, yeast trace elements and natural vitamins are more slowly absorbed in animals and man; are more bioavailable; and are therefore the preferred form for supplementation.

REFERENCES

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