Bioavailability of Silicon from Three Sources

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Since the early 1970s, scientific evidence has shown that silicon is an essential nutrient for higher animals, including humans.[1] Its role in human physiology is not fully defined, but it appears to be required for optimal growth and development of bone, cartilage, and connective tissues. Both metabolic and structural roles have been proposed.[2] In bone, silicon is localized in active growth areas where it is thought to promote growth and mineralization.[3] In cartilage and connective tissues, silicon is thought to form cross-links with proteoglycan complexes that interlace with collagen and contribute to structural integrity.[1,2] Silicon also appears to promote collagen synthesis.[2]

Given its nature as an essential nutrient, silicon is often included in mineral supplements. Sources include sodium metasilicate, calcium silicate, and ground horsetail grass or *Equisetum arvense*. However, little scientific information exists on the relative bioavailability of silicon from these sources. This comparative study was undertaken to provide such information for three silicon sources: calcium silicate, horsetail grass, and silicon amino acid complex.

Methods

This prospective, double-blind crossover study involved six healthy male volunteers. It compared the bioavailability (absorption/ urinary excretion) of silicon derived from three sources: calcium silicate (specifically, calcium salt of silicic acid), horsetail grass, and silicon amino acid complex. Given the crossover design, each subject participated in each treatment in random, serial fashion, with a washout period (at least 48 hours) between treatments. Subjects were instructed to abstain from beer, whole grain cereal products, and root crops (major sources of dietary silicon), as well as vitamin supplements containing silicon for three days before the start of the study and throughout the remainder of the study.

Prior to the first treatment, baseline 10-hour urine collections were obtained from each participant. Subjects then took a supplement (gelatin capsule) containing 20 mg of elemental silicon from one of the three test forms. Urine samples were again collected for 10 hours following supplementation. On test days, participants were given standard meals for breakfast and lunch. This protocol, beginning with a baseline urine collection, was repeated twice more as the subjects rotated through all three treatments. All 10-hour urine samples were analyzed for silicon concentration by ICP, and total silicon excretion was calculated (urine volume X silicon concentration). Data were analyzed statistically, and differences between treatments were assessed by ANOVA.

Results

Results showed that all three sources of dietary silicon were to

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some degree bioavailable, but that calcium silicate (in the form used in this study—see *Discussion*) was clearly superior (Figure 1). Baseline (pre-supplementation) levels of urinary silicon were remarkably consistent across the study. Values averaged 6.5 ± 1.4 mg silicon per 10 hours.

Supplementation with the silicon amino acid complex and with powdered horsetail grass provided numerical increases in silicon excretion (to 8.9 ± 3.8 mg and 9.0 ± 4.2 mg silicon per 10 hours, respectively). However, statistical analysis showed that these amounts were not significantly different from baseline. Supplementation with calcium silicate, however, boosted silicon excretion to 16.6 ± 4.0 mg of silicon per 10 hours, a 2.5-fold increase with respect to baseline. This increase was statistically significant ($p < 0.0001$).

Discussion

Results from this study indicate that, with respect to bioavailability, calcium silicate is a superior source of nutritional silicon. Supplementation with 20 mg of silicon as silicon amino acid complex or powdered horsetail grass gave only small (2.4–2.5 mg) increases in 10-hour urinary silicon excretion over baseline. These amounts represented roughly 12% of the silicon administered. By contrast, the calcium silicate supplement increased urinary calcium excretion by 10.1 mg over baseline, representing a full 50% of the silicon administered. As such, the silicon in calcium silicate appears to be some four times more bioavailable than the silicon supplied by the other two sources.

It is important to note that many different forms of calcium silicate are known, and they differ markedly in solubility (and presumably in bioavailability). The material used in this experiment was a calcium salt of silicic acid that had a relatively high solubility in water. Some forms of calcium silicate are practically insoluble in water and would presumably have low bioavailability. Therefore, it is important to distinguish between these forms and select the more bioavailable materials for use in nutritional supplements.

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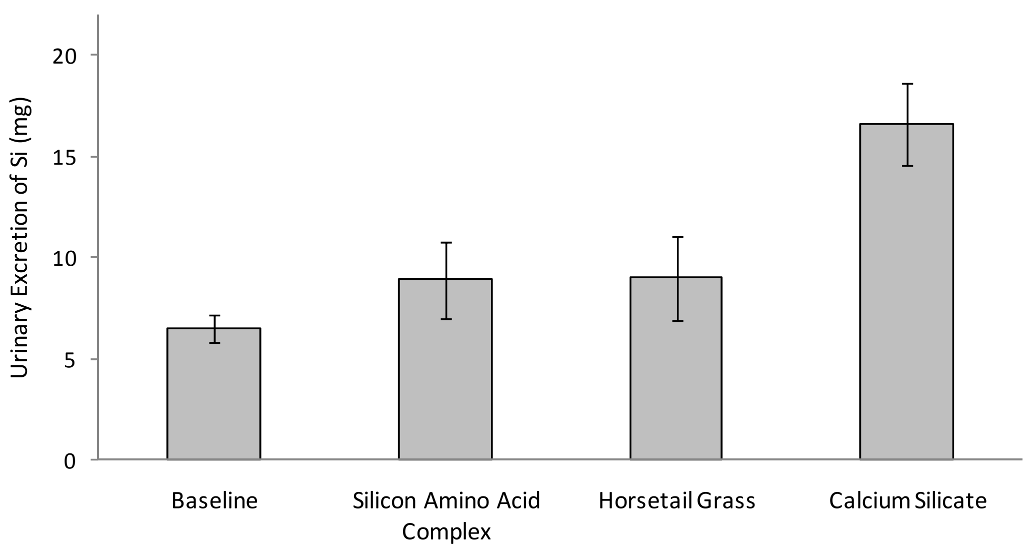
References

1. Nielsen FH. Other trace elements. 1996. In EE Ziegler and LJ Filer (eds), Present Knowledge in Nutrition. ILSI Press, Washington DC. pp353-77.
2. Groff JL, et al. Advanced Nutrition and Human Metabolism. 1995. West Publishing Co, New York. 575pp.
3. Carlisle EM. Silicon in bone formation. 1981. In TL Simpson and BE Volcani (eds), Silicon and Siliceous Structures in Biological System. Springer, New York. pp69-94.

Figure 1

Total 10-hour urinary excretion of silicon prior to supplementation (baseline) and following supplementation with 20 mg of silicon as silicon amino acid complex, powdered horsetail grass, or calcium silicate.



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