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Effect of *Aloe vera* preparations on the human bioavailability of vitamins C and E

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Abstract

There are no literature references describing the effect of consumption of *Aloe vera* liquid preparations on the absorption of water- or fat-soluble vitamins. There is a very large population worldwide which consume vitamins and many people also consume Aloe. Thus we report the effect of Aloe on the human absorption of vitamins C and E, the most popular vitamin supplements. The plasma bioavailability of vitamins C and E were determined in normal fasting subjects, with eight subjects for vitamin C and ten subjects for vitamin E. In a random crossover design, the subjects consumed either 500 mg of ascorbic acid or 420 mg of vitamin E acetate alone (control), or combined with 2 oz of two different Aloe preparations (a whole leaf extract, or an inner fillet gel). Blood was collected periodically up to 24 h after consumption. Plasma was analyzed for ascorbate and tocopherol by HPLC with UV detection. There was no significant difference in the areas under the plasma ascorbate–time curves among the groups sincerely due to large differences within the groups. For comparative purposes the control area was 100%. The Aloe Gel area was 304%, and Aloe Whole Leaf 80%. Only Aloe Gel caused a significant increase in plasma ascorbate after 8 and 24 h. For vitamin E, the results for the relative areas were control 100%, Gel 369%, and Leaf (198%). Only the Aloes produced a significant increase in plasma tocopherol after 6 and 8 h. Both Aloes were significantly different from the control after 8 h. Aloe Gel was significantly different from the baseline after 24 h. The Aloes slowed down the absorption of both vitamins with maximum concentrations 2–4 h later than the control. There was no difference between the two types of Aloe. The results indicate that the Aloes improve the absorption of both vitamins C and E. The absorption is slower and the vitamins last longer in the plasma with the Aloes. Aloe is the only known supplement to increase the absorption of both of these vitamins and should be considered as a complement to them.

Keywords: *Aloe vera*; Vitamin C; Vitamin E; Bioavailability; Plasma

Introduction

The number of people who take vitamin supplements is increasing due to a greater awareness of the benefit. In the USA it is estimated currently that between 51% and 61% of the population consume vitamin supplements (Subar and Block, 1990; Hensrud et al., 1999). The elderly population is greatly increasing in developed nations. This group is especially vulnerable to vitamin deficiency, due to age-related decreases in absorption, reduced food intake, and increased drug use (Fairfield and Fletcher, 2002).

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Vitamin C (ascorbic acid) is a water-soluble vitamin essential to prevent scurvy. It is a common supplement because there is epidemiological evidence that it reduces the risk of cancer, diabetes, cataracts, and Alzheimer's disease. Vitamin C has been proven to increase greatly the absorption of iron and improves poor iron status (Sandstrom, 2001). A recent report showed that *Helicobacter pylori* infection significantly impairs the bioavailability of vitamin C (Woodward et al., 2001). This bacterium infects half of the world's population (Go, 2002) and is especially common in peptic ulcer patients (Vyse et al., 2002; Gisbert and Pajares, 2002). Individuals with kidney problems are deficient in C, and hemodialysis further decreases ascorbate levels (Wang et al., 1999). The amount recommended for vitamin C consumption by the US Government has been increased recently to 75 mg per day for women and 90 mg for men. Smokers should add an additional 35 mg per day because their metabolic turnover of vitamin C is more rapid, as is their rate of oxidative stress (Food and Nutrition Board, 2000). In a comprehensive study of its pharmacokinetics in humans, it was suggested that the amount be increased to 200 mg/day, representing maximum bioavailability (Levine et al., 1996). This amount can be obtained by eating 5 servings of fruits and vegetables. Because the majority of Americans do not consume 5 servings (Stables et al., 2002), then either a supplement of C or ingestion of an agent that can increase the absorption of C may be needed.

Vitamin E (tocopherol), a lipid-soluble vitamin, is needed in much smaller amounts than C. E is present mainly in oils that are often avoided in the diet of individuals with weight problems. Vitamin E can reduce cognitive decline (Morris et al., 2002) and improve the immune system (Meydani, 2002) in older persons. Higher intakes of vitamin E were shown recently to be associated with a lower risk of Alzheimer's disease (Engelhart et al., 2002) and prostate cancer (Fleshner, 2002). Age-related cataract and age-related macular degeneration are delayed by consumption of antioxidant nutrients such as vitamins C and E (Jacques, 1999). Epidemiological studies indicate vitamin E may also reduce the risk of cardiovascular disease, although results from supplementation studies are mixed (Blumberg, 2002). Dietary fiber (Hoffmann et al., 1999) and low fat meals (Dimitrov et al., 1991) reduce the bioavailability of E as do the long-term consumption of Orlistat (a fat absorption inhibitor used for weight loss), and Olestra, a fat substitute (Melia et al., 1998).

The genus *Aloe* belongs to the Asphodelaceae Alooidea sub family, and includes ~420 species of succulent plants (Smith and Van Wyk, 1998). The correct name is *Aloe vera* (L.) Burm f. Its chemical and therapeutic properties have recently been reviewed (Coats and Ahola, 1979; Shelton, 1991). In commerce the full botanical name, *A. vera*, is used to refer to gel products. The Aloe plant has yellow flowers and triangular leaves arranged in a rosette configuration. The leaves are triangular and, when mature, are filled with a gel that exudes from the clear central mucilaginous pulp. The Arabic word Aalloeh means shining and bitter. The peripheral bundle sheath cells give rise to a bitter, yellow exudate (latex) that is responsible for the cathartic effect. For 3000 years it has been used externally (initially in Mesopotamia and Egypt) for skin infections and wounds, and internally as a cathartic. Careful processing of aloe gel is necessary to maintain activity.

Aloe is processed using the hand-filleted technique or whole leaf procedure (Goldberg, 1999). Hand-filleted processing removes the inner gel while avoiding the yellow latex found next to the rind. Whole leaf extracts for consumption are prepared after sterilization and blending by grinding the entire leaf and then removing the bitter yellow component (alloin) by charcoal filtration. Aloin and its derivatives are anthraquinones. Polysaccharides are considered to be the active ingredients for Aloe's anti-inflammation and immune modulation effects (Pugh et al., 2001). The major carbohydrate fraction isolated from aloe gel, "Aacemannan," is composed of β-1,4-linked acetylated mannan interspersed with *O*-acetyl groups. (Pugh et al., 2001).

Materials and methods

Materials

The two Aloe products were selected by The International Aloe Science Council (Irving, TX 75062) from commercial samples, blinded upon receipt, and certified by the Council. These products passed quality control certification, which consisted of testing for total solids, calcium and magnesium content and L-malic acid (a marker for processing in a timely fashion without excess heat, time, and pressure). NMR was used to detect acetylated polysaccharides, acids, and suspected adulterants. The gel product is designated AVG and the whole leaf AVL. Both were kept in a refrigerator until use. Vitamin C tablets (500 mg) and vitamin E acetate soft capsules (420 mg) were prepared by Summa Rx Laboratories, Inc. (Ft. Worth, TX 76116), an FDA-registered contract drug and supplement manufacturer.

Subjects

There were 11 healthy subjects in the study pool, ranging in age from 21 to 42. They were not taking vitamin supplements. Eight volunteers participated in the vitamin C study and 10 (5 males and 5 females) in