There is no documentation in humans that bentonite has any benefit as a trace mineral source or as an aid in removing toxins from the colon.

ADVERSE REACTIONS

At doses usually used in nutritional supplements—5 to 10 mg—there are no reports of adverse reactions. Higher doses, e.g., greater than 10 grams daily, may have a laxative effect—bentonite was used as a bulk laxative—and if not taken with plenty of fluids may cause intestinal obstruction.

INTERACTIONS

DRUGS

Bentonite may adsorb certain drugs. Bentonite should not be taken concomitantly with any drugs.

NUTRITIONAL SUPPLEMENTS

Bentonite may adsorb certain nutritional supplements and should not be used concomitantly with them.

FOODS

Bentonite may adsorb certain food components.

HERBS

Bentonite may adsorb certain herb components.

DOSAGE AND ADMINISTRATION

Bentonite is available in some nutritional supplements as a trace mineral source. Dosage is usually 5 to 10 mg daily. Those who use bentonite as a "colon cleanser" use one tablespoon once or twice a day, which must be taken with at least one glass of water or juice. This is not recommended. Drugs and nutritional supplements should not be used concomitantly with the higher doses.

LITERATURE

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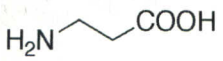
Beta-Alanine

DESCRIPTION

Beta-alanine is a nonprotein amino acid that is a precursor of the peptides carnosine (beta-alanyl-L-histidine), anserine (beta-alanyl-N-methylhistidine) and balenine (beta-alanyl-N-tau-methylhistidine) or ophidine (beta-alanyl-3-methylhistidine). It is also a precursor in the synthesis of the vitamin pantothenic acid, itself the precursor of coenzyme A. All of the amino acids comprising proteins are alpha-amino acids, meaning that the amino group in the amino acid structure is attached to the carbon group adjacent to the carboxyl group. Beta-amino acids contain their amino group one carbon removed from that position. Beta-alanine is one of five beta-amino acids found in mammals. The other four are taurine (contains a sulfonic acid group in place of the carboxylic acid group), *R*-beta-aminoisobutyrate, *S*-beta-aminoisobutyrate and beta-leucine. Beta-alanine is a nonessential amino acid, meaning that it can be made in the body, which it is via the enzyme beta-ureidopropionase, also known as beta-alanine synthase. Beta-ureidopropionase is the third enzyme in the catabolic pathway of the pyrimidine bases uracil and thymine. Beta-alanine can also be produced from carnosine via the enzyme carnosinase, which exists in two isoforms. Beta-alanine is also an agonist for the strychnine-sensitive glycine receptor, suggesting a possible neurotransmitter role.

Recently, there has been interest in the athletic community in the use of beta-alanine as a precursor of carnosine (see Carnosine) to help delay skeletal muscle fatigue. This possible effect is attributed to some of the actions of the beta-alanine metabolite carnosine. Carnosine itself when used as a nutritional supplement is rapidly hydrolyzed in the plasma via carnosinase.

Beta-alanine is also known as beta-aminopropionic acid, 3-aminopropanoic acid and 3-aminopropionic acid. Its molecular formula is $C_3H_7NO_2$, its line formula is $NH_2CH_2CH_2CO_2H$ and its molecular weight is 89.09. The CAS registry number is 107-95-9. Beta-alanine is freely soluble in water and has a slightly sweet taste. Beta-alanine is represented by the following chemical structure.



Beta-Alanine

ACTIONS AND PHARMACOLOGY

ACTIONS

The following possible actions are attributed to beta-alanine: delays muscular fatigue, increases aerobic endurance, increases anaerobic endurance, increases muscle mass, increases muscular strength and power output.

MECHANISM OF ACTION

Oxidative stress is associated with heavy exercise, muscle fatigue and muscle injury. Specific sources of reactive oxygen species (ROS) during exercise include leakage of electrons from the mitochondrial electron transport chain and from activated neutrophils, among others. Exercise may also induce inflammatory reactions similar to the acute phase response occurring in injury, which in turn contributes to an increase in ROS production, particularly during fatiguing exercises. The beta-alanine metabolite carnosine demonstrates antioxidant activity. Studies show that carnosine

scavenges reactive oxygen species and protects against lipid peroxidation. A few, but far from all, studies suggest that certain antioxidants may protect against muscle injury during exercise and improve overall performance. There is little evidence to date that either beta-alanine or carnosine supplementation can prevent muscle injury during exercise.

Carnosine is found in humans in type I or "slow twitch" muscle fibers and in type IIa and type IIx (formerly called type IIb) or "fast twitch" muscle fibers. Carnosine is highest in type IIx, followed by type IIa, and lowest in type I muscle fibers. Type I fibers are good for endurance and are slow to tire because they mainly obtain their energy via oxidative metabolism. That is, they get their ATP predominantly from the process of oxidative phosphorylation. Type II fibers are used for short bursts of speed and power. Type II fibers fatigue more quickly than type I fibers. Type IIa fibers obtain their energy by both aerobic (oxidative phosphorylation) and anaerobic (glycolysis) metabolism. Type IIx fibers obtain their energy mainly anaerobically (via glycolysis). Carnosine is present in higher concentration in glycolytic muscle fibers than it is in oxidative muscle fibers. The highest levels of carnosine in animals are found in those that perform prolonged hypoxic dives (whales), those that perform frequent sprints (greyhounds) and those that have explosive flight behavior (pheasants).

During high- to- moderate-intensity exercise, there is an accumulation of lactic acid in muscle tissue, causing an increase in hydronium cations and a lowering of muscle pH. Muscle pH can fall from 7.1 to 6.5 or even lower. The drop in pH can cause interference with calcium ion release from the sarcoplasmic reticulum and decreased ATP production, resulting in muscle fatigue. Carnosine with its pKa of 6.83 acts as an intramuscular hydronium cation buffer over the physiological range. It is known that carnosine is a major buffer for animals. Carnosine constitutes about 10% to 20% of the buffering capacity in muscle in humans. It appears to be important in its action as an intramuscular buffer in humans, but there are other factors that contribute to delaying muscular fatigue, as well, including other buffers. More research is needed and warranted to elucidate those factors.

PHARMACOKINETICS

Beta-alanine is absorbed from the small intestine and distributed to various tissues in the body, especially muscle and brain tissues. Beta-alanine is the rate limiting substrate in the carnosine synthase reaction that catalyzes the chemical reaction—Beta-alanine + L-histidine + ATP (adenosine triphosphate) > carnosine + AMP (adenosine monophosphate) + diphosphate.

The enzyme carnosinase converts carnosine to beta-alanine and L-histidine. There are two isoforms of carnosinase. Tissue carnosinase is found in the liver, kidney and spleen, and serum carnosinase is found in the plasma, brain and spinal fluid.

The first step in the catabolism of beta-alanine is the formation of malonic acid semialdehyde via the enzyme, beta-alanine:alpha-ketoglutarate aminotransferase. Malonic acid semialdehyde is subsequently metabolized by malonic semialdehyde dehydrogenase to acetyl-coenzyme A. Interestingly, the neurotransmitter GABA (gamma-aminobutyric acid) is transaminated by the same aminotransferase that transaminates beta-alanine.

INDICATIONS AND USAGE

A few recent studies have suggested that beta-alanine supplementation may enhance athletic performance in some circumstances.

RESEARCH SUMMARY

Beta-alanine is a nonproteogenic amino acid and precursor of carnosine, which is present in skeletal muscle and other excitable tissues, such as nervous tissue. Various studies have demonstrated that muscle-carnosine content is positively correlated with some high-intensity exercise performance parameters. Increased carnosine levels have been reported to help maintain optimal muscle pH, thought to be important since decreased pH has been associated with diminished muscular endurance. Carnosine supplementation itself, however, has not been effective in boosting carnosine concentrations in muscle owing to its hydrolyzation in plasma by the enzyme carnosinase. Thus researchers have concentrated on beta-alanine and have reported that supplementing with this amino acid for two to four weeks has increased carnosine concentration in human skeletal muscle by approximately 60%. Further study by the same group utilized beta-alanine supplements in 13 male subjects to determine, in part, whether the amino acid could positively affect performance on a high-intensity cycling endurance test. A significant increase in a measure called total work done (TWD) was observed in the experimental subjects. TWD in matched controls given placebo did not increase.

In a more recent study, 22 women were randomly assigned to either a beta-alanine regimen or placebo and then given a continuous, incremental cycle ergometry test to exhaustion in order to evaluate the possible effect of the amino acid on a number of performance parameters. The researchers reported that 28 days of beta-alanine supplementation (86 mg per kg of body weight per day) significantly delayed the onset of neuromuscular fatigue and ventilatory threshold and delayed the time to exhaustion in the experimental subjects. These researchers concluded that it would be premature to call for

the use of this supplement until further clinical evidence accumulates.

Another group of researchers has also recently reported positive results, in this case using beta-alanine in trained sprinters. Fifteen male athletes participated in this double-blind, placebo-controlled study. Over a four-week period they received either placebo or 4.8 grams of beta-alanine daily. They were evaluated by their performance on knee extension tests, by endurance on muscular contractions and by 400 meter sprinting times. Magnetic resonance spectroscopy confirmed significant increases in carnosine concentration in calf muscles of beta-alanine-treated subjects, compared with controls. Fatigue was judged to be significantly attenuated during repeated isokinetic contraction bouts in the experimentals but not in the controls. Performance on the 400 meter race times, however, was not significantly enhanced, possibly, the researchers posited, because the challenge to these trained athletes in a 400 meter sprint was insufficient to reveal an experimental effect.

Though results to date are promising, the studies are small and few, and more research is needed and warranted to determine whether beta-alanine can be a significant aid in athletic performance.

Finally, a decline in carnosine of about 30% takes place between age 10 years and 70 years, which may be associated with the decline in muscle function and sarcopenia that generally occurs during aging. Research is also needed and warranted to determine if beta-alanine and carnosine have any effect in slowing this decline.

CONTRAINDICATIONS, PRECAUTIONS, ADVERSE REACTIONS

CONTRAINDICATIONS

Beta-alanine is contraindicated in those with known hypersensitivity to the supplement or its components, or with the very rare disease hyper-beta-alaninemia, thought to be due to a deficiency of beta-alanine pyruvate aminotransferase. There is a report of one infant death from inherited hyper-beta-alaninemia.

PRECAUTIONS

Pregnant women and nursing mothers should avoid beta-alanine supplements.

ADVERSE REACTIONS

Beta-alanine may cause paresthesia (a sensation of tingling and numbness in the skin) when ingested in amounts above 10 mg per kg body weight. Typically, paresthesia starts about 20 minutes after ingestion and may last for up to one hour. It is caused by the beta-alanine getting absorbed across the gut into the blood stream very rapidly and subsequently transported too quickly into muscle and CNS cells. Those who use beta-alanine supplements should thus take it in small doses up to eight times throughout the day. Controlled time-release pills are available which may avoid the paresthesia problem.

INTERACTIONS

DRUGS

None known.

NUTRITIONAL SUPPLEMENTS

Creatine and beta-alanine may increase skeletal creatine phosphate and carnosine and may work synergistically to delay fatigue and increase exercise performance, especially in trained athletes.

HERBS

None known.

FOOD

None known.

OVERDOSAGE

There are no reports of overdosage in those taking beta-alanine supplements.

DOSAGE AND ADMINISTRATION

Beta-alanine is available as a powder and in pill form. Controlled time-release pills are available. Athletes, based on a few studies, have been using around three grams to six grams daily. As mentioned above, ingestion of amounts above 10 mg per kg body weight may cause paresthesia. For those taking the powder form, it is recommended that beta-alanine be taken in doses up to eight times throughout the day.

The optimal dose of beta-alanine is unknown.

LITERATURE

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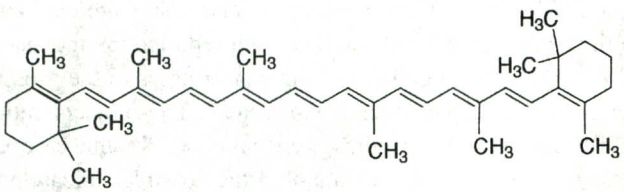
Beta-Carotene

DESCRIPTION

Beta-carotene is a member of a class of substances called carotenoids. Beta-carotene, similar to the other carotenoids, is a natural fat-soluble pigment found principally in plants, algae *(Dunaliella salina, Dunaliella bardawil)* and photosynthetic bacteria, where it serves as an accessory light-gathering pigment and to protect these organisms against the toxic effects of oxygen. Carotenoids are polyisoprenoids which typically contain 40 carbon atoms and an extensive system of conjugated double bonds. They usually show internal symmetry and frequently contain one or two ring structures at the ends of their conjugated chains. Beta-carotene contains a cyclic structure at each end of its conjugated chain. The structural formula for beta-carotene is:



Beta-Carotene

Carotenoids are the principal pigments responsible for the red, orange, yellow and green colors of vegetables and fruits. Beta-carotene is responsible for the color of carrots.

Beta-carotene along with alpha-carotene, lycopene, lutein, zeaxanthin and beta-cryptoxanthin are the principal dietary carotenoids. Three of these carotenoids, alpha-carotene, beta-carotene and beta-cryptoxanthin, can serve as dietary precursors of retinol (all-*trans* retinol, vitamin A). Collectively, these carotenoids are called provitamin A carotenoids or provitamin A. Dietary carotenoids that are not converted into retinol (lutein, zeaxanthin, lycopene) are referred to as nonprovitamin A carotenoids.

Beta-carotene occurs naturally as all-*trans* beta-carotene and 9-*cis* beta-carotene. Smaller amounts of 13-*cis* beta-carotene are also found naturally. Synthetic beta-carotene consists mainly of all-*trans* beta-carotene with smaller amounts of 13-*cis* beta-carotene and even smaller amounts of 9-*cis* beta-carotene. Carrots are the major contributors of beta-carotene in the diet. Beta-carotene is also found in cantaloupe, broccoli, spinach and collard greens. Palm oil, which is used as a food colorant, is rich in beta-carotene as well as alpha-carotene. Dietary intake of beta-carotene in the American diet ranges from 1.3 to 2.9 milligrams daily. The consumption of five or more servings of fruits and vegetables per day—which is recommended by a number of federal agencies and other organizations, including the National Cancer Institute—would provide 3 to 6 milligrams daily of beta-carotene.

Beta-carotene is considered a conditionally essential nutrient. Beta-carotene becomes an essential nutrient when the dietary intake of retinol (vitamin A) is inadequate. It is unclear whether beta-carotene has any biological function for humans other than as a precursor for vitamin A. There is some evidence that beta-carotene may play a beneficial role in human nutrition beyond its provitamin A function. Beta-carotene has antioxidant activity, at least *in vitro*, and it may enhance intercellular communication and may have immunomodulatory and anticarcinogenic activities in certain circumstances. However, the evidence for a unique role in human nutrition beyond its provitamin A function is, to date, not compelling.

The absorption efficiency of beta-carotene and the other carotenoids from food sources is highly variable. For this reason, it has been difficult to define a general numerical factor for converting provitamin A carotenoids to vitamin A. There are two systems of units which are currently used which do not agree with each other and which have caused confusion. In the first system, 1 IU (international unit) is equal to 0.6 micrograms of all-*trans* beta-carotene or 1.2 micrograms of mixed other provitamin A carotenoids. In this system, which is the one generally used for nutritional labeling, 3 milligrams of beta-carotene is equal to 5,000 IU. The U.S. RDA for vitamin A is 5,000 IU. The second system uses retinol equivalents in place of international units. In the second system, one retinol equivalent (RE) is defined as one microgram of all-*trans* retinol (vitamin A), six micrograms of all-*trans* beta-carotene or 12 micrograms of other provitamin A carotenoids. In the first system, two micrograms of all-*trans* beta-carotene are defined as being equal to one microgram of all-*trans* retinol. In the second system, six micrograms of dietary all-*trans* beta-carotene are assumed to be nutritionally equivalent to one microgram of all-*trans* retinol. It is clear that these two systems do not agree with each other. In any case, all-*trans* carotene, as found in nutritional supplements, should be converted according to the first system. That is, two micrograms of all-*trans*