Taurine

Nutritional therapy

EFFECT

Taurine is a sulphur-containing amino-acid type substance that fulfils numerous functions in the maintenance of health. It is a metabolic product of the sulphur-containing amino acids cysteine and methionine. Although often included in the amino acid category, it is actually not a real amino acid, because instead of the carboxyl group, it contains a sulfonic acid group and therefore cannot be incorporated in protein structures.

For a long time, Taurine was thought to be non-essential because it can be produced in the liver from the amino acids methionine and cysteine via three possible synthesis routes, all of which require vitamin B6. However, during recent years, it has become clear that there are actually situations where taurine is essential for humans. In comparison to other mammals, humans have a relatively low activity of the enzyme that is responsible for a crucial transformation step in the synthesis of taurine. This possibly implies that humans have a limited capacity to synthesise taurine themselves. In the event of stress or illness, or in young children, the synthesis can be too limited to provide for their own needs. The synthesis capacity of taurine also differs between men and women because the hormone oestradiol inhibits the synthesis of taurine in the liver. In animals, females are found to have lower concentrations of crucial enzymes in taurine synthesis; the effects of taurine deficiency are also greater.

In the body, the highest concentrations of taurine are found in immune cells (neutrophil granulocytes) and in the retina and the highest stocks are in the skeletal muscles and cardiac muscle.

Taurine is found at high concentrations in red algae (not brown or green algae!); otherwise it is almost exclusively present in animal products. In many animals (including humans) it is one of the most frequently occurring organic components with a low molecular weight. A 70-kg human contains around 70 grams of taurine.

Taurine ingestion through food is between 0 and 400 mg per day; this is strongly dependent on individual dietary habits. Vegans ingest no taurine through food, whilst people who eat fish and seafood-rich foods ingest the highest amount of taurine.

Taurine is well-absorbed. The absorption of taurine mainly takes place through the amino acid transport system in the small intestine. Then, via the portal vein, it arrives in the liver where it is transported to the remainder of the body through the circulation. There it is transported into cells.

Dietary sources of taurine are meat and seafood, particularly shellfish such as mussels, cockles and oysters. Anyone who does not eat this food frequently (such as vegetarians) run the risk of taurine deficiency when they are unable to obtain, from their food, sufficient quantities of methionine and cysteine which are two important building materials of taurine. Milk products contain only low levels of taurine, and eggs almost none.

Diabetics often have lower taurine levels. Primary taurine deficiencies have been found in vegans and diabetics, but sub-optimal taurine levels occur in numerous other people, particularly in times of physical or emotional stress or illness.

Taurine excretion takes place through the urine. However, during a period of taurine deficiency most of the taurine is reabsorbed from the primary urine to prevent large losses. Taurine can also be excreted through the bile, where it binds with bile acids. Zinc deficiency, potentially in combination with vitamin A deficiency, is associated with a higher level of taurine excretion through the urine and reduced taurine levels in the tissues.

Taurine protects against the two main causes of cellular toxicity, which are oxidative stress and calcium ion accumulation. This cell-protecting effect also expresses itself in the long term. Later in life, animals that were taurine deficient at a young age, suffer growth delay, organ damage and abnormal functioning of the cardiovascular and renal system (kidneys). Research is still underway to discover whether this also applies to humans.

Taurine has, amongst others, the following characteristics:

- Protection against calcium ion accumulation: Influx and accumulation of calcium ions (Ca2+) within the cell is a major toxicity factor in the cell and is deemed to be a major factor in neuronal damage. It leads to a loss of membrane potential and, if it continues, ultimately to cell death. Through a minimum of three different routines, taurine is capable of protecting the cell against the toxic action of surplus Ca2+ ions.
- Protection against oxidative stress: Taurine is capable of deactivating hypochlorite, a powerful and high-reactive oxygen

compound (HOCl). This species is produced by neutrophil granulocytes in inflammatory processes. In this way, taurine can block the amount of damage that occurs as a result of an inflammation and toxicity by combating aldehydes. Without taurine, hypochlorite would be converted into toxic aldehydes. Taurine is unable to deactivate other reactive oxygen species. There are, however, different indirect mechanisms by means of which taurine is nevertheless able to offer protection against oxidative stress. First and foremost there are indications that taurine stimulates the antioxidative defence mechanisms. Furthermore, taurine inhibits the activity of neutrophil granulocytes, meaning these can produce fewer free radicals. In addition, inhibition of the aforementioned accumulation of calcium ions inhibits the formation of free radicals and finally taurine binds itself to xenobiotics, preventing these from generating free radicals. Finally, taurine also protects against oxidative damage by (through a complex mechanism) reducing the biological availability of lipids for peroxidation.

- Osmoregulation: As already indicated, taurine is a frequently occurring substance in animal cells and practically never occurs in the plant world. Animal cells can be distinguished from plant cells through the presence of a reinforced cell wall, meaning that regulation of the osmotic pressure and the cell volume is very important for animal cells. Through exchange of sodium, potassium and chloride ions, the cell is able to regulate the osmotic pressure, and therefore also regulate the cell volume. Taurine plays an important role in this mechanism. For example, osmoregulation with the help of taurine plays an important role in cell contraction as a result of apoptosis.
- Membrane stabilisation: Taurine has a function in electrically active tissues such as the brain and heart, where it stabilises the cell membranes, preventing erroneous stimulation of nerve cells. The stabilising effect of taurine on the cell membrane can be attributed to a number of the aforementioned effects: the regulation of the osmotic pressure, maintenance of the mineral balance, inhibition of the phosphorylation of the membrane proteins and prevention of lipid peroxidation.
- Inhibitory neurotransmitter: Taurine is structurally related to the inhibitory neurotransmitter GABA and also has an agonistic effect on GABA. Taurine can bind itself competitively to the GABA receptors without bringing about the same effects as GABA. This means it has the opposite effect to the stimulating glutamine acid.
- Detoxification of xenobiotics: Taurine can bind to toxic compounds that are then excreted with the bile. People with taurine deficiency are more susceptible to tissue damage through xenobiotic substances such as certain environmental toxins, but also endogenously produced toxic substances such as aldehydes, chloride and certain amines.
- Conjugation of bile acids: Bile acids are substances that can be formed in the liver from cholesterol, that are involved in the absorption of fat and fat-soluble vitamins. This can only take place if bile acids bind to glycine or taurine. These conjugates of amino acids and bile acids are also known as bile salts. Taurine is responsible for keeping the bile acids in a liquid state at physiological pH, which prevents, amongst others, the formation of gall stones. It is estimated that 80% of bile acids are reabsorbed into the body at the end of the ileum, into the so-called enterohepatic cycle.
- Eye function: Taurine occurs in the retina in extremely high concentrations, a place where extremely high concentrations of unsaturated fatty acids occur that require optimal antioxidative protection. Taurine deficiency results in damage of the retina. Much is, however, still unclear about the function of taurine in the eye.
- Glucose metabolism: Taurine helps the blood glucose to stabilise in both type I and type II diabetics. Taurine seems to effect this by stimulating insulin receptor activity. Long term, a daily dose of 1.5 grams keep the glucose levels lower and reduces abnormal activity of blood platelets. In patients with type II diabetes, it improves cellular sensitivity to insulin.
- Immune system: Taurine is the most commonly occurring amino acid in the white blood cells. It probably protects the immune cells against the weapons that they themselves produce in the fight against viruses, bacteria and other invaders. The exact role of taurine in the immune system is, however, still largely unknown and is currently the subject of research.
- Fertility: Taurine plays a role in sperm cells, but the exact role is still largely unexplained.

INDICATIONS

- Various types of cardiovascular disorders, including myocardial infarction, hypercholesterolemia, hypertension, heart rhythm disturbances and heart insufficiency
- Epilepsy/seizures
- Asthma
- Growth and development, for example in pregnant women, nursing babies or nursing mothers.
- Alcoholism
- Hepatitis
- Gall stones
- Alzheimer’s disease
- Cystic fibrosis
- Diabetes

CONTRA-INDICATIONS

It is possible that taurine stimulates the secretion of gastric acid and for that reason caution is recommended in people with stomach ulcers. Otherwise, at the recommended doses, there are no known contra-indications to the use of taurine.

SIDE EFFECTS

Taurine is not associated with any toxic effect. Research in patients who were given up to 6 grams of taurine a day revealed no adverse effects worthy of mention. In addition, absolutely no teratogenic effect was found. In some epileptic patients, taurine (1.5 grams a day) can cause nausea, headache, drowsiness and coordination disorders.

INTERACTIONS

Monosodium glutamate, or Vetsin, a commonly used seasoning, lowers the levels of taurine. High doses of vitamin B5 reduce the effect of taurine. Conversely, zinc reinforces the effect of taurine. Other interactions with mainstream or natural medicines are possible. Consult an expert for this.

DOSAGE

For indications relating to cardiac function, doses are required of several grams a day. For other indications, for example, relating to brain function, less will suffice.

SYNERGISM

The amino acid cysteine and vitamin B6 are the most crucial cofactors in the synthesis of taurine. For that reason, supplementation with NAC and/or Vitamin B6 is a good way of supporting the endogenous biosynthesis of taurine. To meet the other co-factors, a basic supplementation of a good multi-vitamin with vitamin C is also recommended.

REFERENCES

1. *Taurine - monograph. Altern Med Rev. 2001 Feb;6(1):78-82.*
2. *Aerts L, Van Assche FA. Taurine and taurine-deficiency in the perinatal period. J Perinat Med. 2002;30(4):281-6.*
3. *Birdsall TC. Therapeutic applications of taurine. Altern Med Rev. 1998 Apr;3(2):128-36.*
4. *Foos TM, Wu JY. The role of taurine in the central nervous system and the modulation of intracellular calcium homeostasis. Neurochem Res. 2002 Feb;27(1-2):21-6.*
5. *Hansen SH. The role of taurine in diabetes and the development of diabetic complications. Diabetes Metab Res Rev. 2001 Sep-Oct;17(5):330-46.*
6. *Kuriyama K, Hashimoto T. Interrelationship between taurine and GABA. Adv Exp Med Biol. 1998;442:329-37.*
7. *Lima L, Obregon F, Cubillos S et al. Taurine as a micronutrient in development and regeneration of the central nervous system. Nutr Neurosci. 2001;4(6):439-43.*
8. *Lourenco R, Camilo ME. Taurine: a conditionally essential amino acid in humans? An overview in health and disease. Nutr Hosp. 2002 Nov-Dec;17(6):262-70.*
9. *Militante JD, Lombardini JB. Taurine: evidence of physiological function in the retina. Nutr Neurosci. 2002 Apr;5(2):75-90.*
10. *Militante JD, Lombardini JB. Treatment of hypertension with oral taurine: experimental and clinical studies. Amino Acids. 2002;23(4):381-93.*
11. *Olive MF. Interactions between taurine and ethanol in the central nervous system. Amino Acids. 2002;23(4):345-57.*
12. *Redmond HP, Stapleton PP, Neary P, Bouchier-Hayes D. Immunonutrition: the role of taurine. Nutrition. 1998 Jul-Aug;14(7-8):599-604.*
13. *Saransaari P, Oja SS. Taurine and neural cell damage. Amino Acids. 2000;19(3-4):509-26.*
14. *Schaffer S, Takahashi K, Azuma J. Role of osmoregulation in the actions of taurine. Amino Acids. 2000;19(3-4):527-46.*
15. *Schaffer S, Solodushko V, Azuma J. Taurine-deficient cardiomyopathy: role of phospholipids, calcium and osmotic stress. Adv Exp Med Biol. 2000;483:57-69.*
16. *Schuller-Levis GB, Park E. Taurine: new implications for an old amino acid. FEMS Microbiol Lett. 2003 Sep 26;226(2):195-202.*
17. *Stapleton PP, Redmond HP, Bouchier-Hayes DJ. Taurine and inflammation--a new approach to an old problem? J Leukoc Biol. 1997 Feb;61(2):231-2.*