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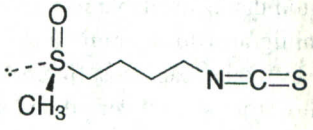
Sulforaphane

DESCRIPTION

Sulforaphane is the aglycone breakdown product of the glucosinolate glucoraphanin, also known as sulforaphane glucosinolate (SGS). Glucosinolates are beta-thioglucoside-N-hydroxysulfates and are primarily found in cruciferous vegetables (cabbage, broccoli, broccoli sprouts, brussels sprouts, cauliflower, cauliflower sprouts, bok choy, kale, collards, arugula, kohlrabi, mustard, turnip, red radish and watercress). Young broccoli sprouts and young cauliflower sprouts are especially rich in glucoraphanin.

Sulforaphane may have cancer chemopreventive activity. However, glucosinolates themselves typically have low anticancer activity. Sulforaphane is produced from sulforaphane glucosinolate via the action of the enzyme myrosinase (thioglucoside glucohydrolase), an enzyme present in cruciferous vegetables that is activated upon maceration of the vegetables.

Sulforaphane is also classified as an isothiocyanate. Its molecular formula is $C_6H_{11}NOS_2$, and its molecular weight is 177.29 daltons. It is also known as 4-methylsulfinylbutyl isothiocyanate and (-)-1-isothiocyanato-4(R)-(methylsulfinyl) butane. Sulforaphane glucosinolate (glucoraphanin) is also known as 4-methylsufinylbutyl glucosinolate. The structural formula is:



Sulforaphane

ACTIONS AND PHARMACOLOGY

ACTIONS

Sulforaphane may have anticarcinogenic activity.

MECHANISM OF ACTION

Sulforaphane's possible anticarcinogenic activity is accounted for by its ability to induce phase II detoxication enzymes, such as glutathione S-transferase and quinone reductase [NAD(P)H: (quinone-acceptor) oxidoreductase]. These enzymes may afford protection against certain carcinogens and other toxic electrophiles, including reactive oxygen species.

PHARMACOKINETICS

Little is presently known about the pharmacokinetics of sulforaphane in humans. Some preliminary studies indicate that sulforaphane is absorbed and that it is metabolized by first undergoing conjugation with reduced glutathione to form a dithiocarbamate. The dithiocarbamate is then converted sequentially to conjugates with cysteinylglycine, cysteine and N-acetylcysteine.

INDICATIONS AND USAGE

Experimental data suggest that sulforaphane may have anticarcinogenic effects.

RESEARCH SUMMARY

Sulforaphane has significantly reduced the incidence, multiplicity and rate of development of chemically induced mammary tumors in rats. It has demonstrated an ability to detoxify a number of carcinogens and thus might have the ability to protect against a variety of cancers. It has been shown that dietary supplementation with sulforaphane enhances glutathione S-transferase (GST) enzyme activity, which is known to detoxify many carcinogens.

One group of researchers has reported that three-day-old sprouts of certain broccoli and cauliflower cultivars contain 10 to 100 times higher levels of glucoraphanin, the glucosinolate of sulforaphane, than do mature broccoli and cauliflower sprouts. Thus they have concluded that "small quantities of crucifer sprouts may protect against the risk of cancer as effectively as much larger quantities of mature vegetables of the same variety." Additionally they have noted that the indole glucosinates that are prevalent in mature broccoli, for example, are present in only small quantities in the sprouts. One report suggested that the degradation products (e.g., indole-3-carbinol) of these glucosinates might themselves promote tumorigenesis, but several other investigators have not confirmed this.

CONTRAINDICATIONS, PRECAUTIONS, ADVERSE REACTIONS

CONTRAINDICATIONS

Sulforaphane is contraindicated in those who are hypersensitive to any component of a sulforaphane-containing product.

PRECAUTIONS

Pregnant women and nursing mothers should avoid sulforaphane supplementation pending long-term safety data.

ADVERSE REACTIONS

No adverse reactions reported.

DOSAGE AND ADMINISTRATION

Sulforaphane is available in a few different formulations, usually in combination with other dietary phytochemicals. There are no typical doses.

Sulforaphane, in the form of its glucosinolate glucoraphanin, is abundant in three-day old broccoli sprouts, which are available in the marketplace. The levels of glucoraphanin in three-day old broccoli sprouts are from 10 to 100 times greater than in mature broccoli.

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Supplemental Enzymes

DESCRIPTION

Enzymes are biological catalysts. Until recently, it was thought that all enzymes were protein in nature. It is now known that ribonucleic acids and other non-protein substances can have enzymatic activity, as well. Enzymes have important roles in medicine. They are used for the rapid lysis of blood clots (streptokinase, tissue plasminogen activator or TPA, urokinase) and for the treatment of Gaucher's disease (glucocerebrosidase), among other things. Enzymes are also used in the treatment of pancreatic insufficiency secondary to such disorders as cystic fibrosis and chronic alcoholic pancreatitis. Enzymes, in addition to being used therapeutically, are marketed as nutritional supplements. They are principally used as digestants. Some enzymes, in particular proteolytic enzymes, have putative anti-inflammatory and anticarcinogenic activities. The enzymes marketed for supplemental use are derived from animal, plant and fungal sources. The following describes the enzymes that are available in the nutritional supplement market place.

ALPHA-GALACTOSIDASE

Alpha-galactosidase is an enzyme that is derived from selected strains of the fungus *Aspergillus niger.* Alpha-galactosidase catalyzes the hydrolysis of the alpha-1→6 linkages in such carbohydrates as the disaccharide melibiose, the trisaccharide raffinose, the tetrasaccharide stachyose and the nonsaccharide verbascose. These oligosaccharides are widely found in legumes and cruciferous vegetables, including beans, peas, broccoli, brussels sprouts and cabbage. These carbohydrates are gas productive in some. Hydrolysis of melibiose yields D-galactose and D-glucose; hydrolysis of raffinose yields D-galactose and sucrose; hydrolysis of stachyose yields D-galactose and sucrose; and verbascose yields D-galactose, D-glucose and D-fructose. The activity of alpha galactosidases is expressed in galactose units or GalU. A tablet of alpha-galactosidase typically contains 150 GalU.

AMYLASE

Amylases are enzymes that catalyze the hydrolysis of alpha-1, 4-glycosidic linkages of polysaccharides to yield dextrins, oligosaccharides, maltose and D-glucose. Amylases are derived from animal, fungal and plant sources. Pancreatin and pancrelipase contain amylase derived from the pancreas of animals, usually porcine pancreas. Amylase is also derived from barley malt and the fungus *Aspergillus oryzae.* There are a few different amylases. These enzymes are classified according to the manner in which the glysosidic bond is attacked. Alpha-amylases hydrolyze alpha-1, 4-glycosidic linkages, randomly yielding dextrins, oligosaccharides and monosaccharides. Alpha-amylases are endo-amylases. Exoamylases hydrolyze the alpha-1, 4-glycosidic linkage only from the non-reducing outer polysaccharide chain ends. Exoamylases include beta-amylases and glucoamylases (gamma-amylases, amyloglucosidases). Beta-amylases yield beta-limit dextrins and maltose. Gamma-amylases yield glucose. Amylases are used as digestants. Amylase activity is expressed as Dextrinizing Units or DU.

BROMELAIN

Bromelain refers to proteolytic enzymes which are derived from the ripe and unripe fruit, as well as the stem and leaves, of the pineapple plant, *Ananas comosus (Ananas sativus).*

Bromelain is comprised of several proteolytic enzymes which differ in their specificities. These enzymes hydrolyze proteins to form oligopeptides and amino acids. Bromelain is used as a digestive aid. It also has putative anti-inflammatory activity. The activity of bromelain may be expressed in bromelain units or BU. The assay is based on a 60-minute proteolytic hydrolysis of casein at pH 6.0 and 40°C. One BU is defined as that quantity of enzyme that liberates the equivalent of one microgram of L-tyrosine per hour. The bromelain proteolytic enzymes are cysteine proteinases. There are at least four distinct bromelain cysteine proteinases. The activity of bromelain may also be expressed in gelatin dissolving units (GDU) or milk clotting units (MCU). One GDU is equivalent to about 1.5 MCU.