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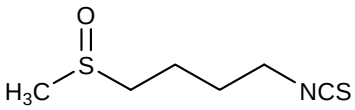
ProductInformation

D,L-Sulforaphane

Product Number **S 4441**
Storage Temperature –20 °C

CAS# 4478-93-7
Synonym: 1-isothiocyanato-4-(methylsulfinyl)-butane



Product Description
Molecular Formula: $C_6H_{11}NOS_2$
Molecular Weight: 177.3
Appearance: yellow liquid

Sulforaphane is a naturally occurring isothiocyanate found in high concentrations in the SAGA (Mariner) variety of broccoli (*Brassica oleracea italica*). It is an anti-oxidant and a potent monofunctional inducer, which accounts for its anticarcinogenic properties in animal models. Studies have documented important antibiotic activities. This product is a mixture of isomers and L-sulforaphane is the biologically active isomer.

It has long been known that the consumption of green and yellow vegetables, especially crucifers, is associated with a lower cancer risk. A mechanism has now been elucidated for sulforaphane, a natural compound found in many widely consumed vegetables. It acts as a potent monofunctional inducer of detoxification enzymes involved in xenobiotic metabolism. Detoxification enzymes are classified into two families: Phase I cytochrome P450 oxido-reductases and Phase II conjugation enzymes, which modify xenobiotic compounds with endogenous ligands mainly glutathione, glucuronic acid, and sulfate. Monofunctional inducers have their protective function via the induction of phase II, but not phase I enzymes, which can also activate procarcinogenic compounds to their carcinogenic metabolites. Sulforaphane has been shown to induce quinone reductase (EC 1.6.99.2),[1] glutathione S-transferase (E.C. 2.5.1.18),[1] and glutathione reductase.[2]

Enzyme induction has been observed in cell lines including murine hepatoma (Hepa 1c1c7),[1] the BP^rc1 p450-deficient mutant,[1] and human adult retinal pigment epithelial cells (ARPE-19)[2] as well as in organs (liver, stomach, small intestine, and lung) of mice fed sulforaphane.[1] Protection against oxidative damage was observed as increased cell survival in *in vitro* treatment with oxidants like menadione, t-butyl hydroxide, hydroxynonenal, and peroxynitrite.[2] Experimental chemical carcinogenesis with DMBA (9,10-dimethyl-1,2-benzanthracene) in rats confirmed the efficacy of sulforaphane in reducing mammary tumor incidence, multiplicity and size.[3] Chemoprotection with sulforaphane also resulted in the delayed appearance of tumors.[3] In HT29, a human colon cancer cell line, sulforaphane induces apoptotic cell death with the appearance of proapoptotic protein bax, release of cytochrome c into the cytosol and cleavage of PARP, poly(ADP-ribose) polymerase.[4]

Direct linkage has been made between the activity of sulforaphane and the cellular molecular sensor, Nrf2-KEAP1 complex,[5] that regulates the induction of phase II enzymes. Nrf2, a member of the NF-E2 transcription factor family, induces phase II enzymes by binding to the ARE (Anti-oxidant response element) region of the promoter. Under basal condition Nrf2 is suppressed by binding to Keap1, a cytoplasmic protein anchored to the actin cytoskeleton. Sulforaphane, among other titrants of thiol groups, reacts with the cysteine-rich intervening region of Keap1 located between the BTB region, an actin-binding site and the Kelch repeat (double glycine region, DGR) for inter-action with Nrf2.[5] Disruption of Nrf2-Keap1 complex by the phase II inducers frees Nrf2 to translocate into the nucleus where it can heterodimerize with other trans-cription factors on ARE regions of phase II genes leading to activation of gene transcription. It is consistent that while sulforaphane is chemoprotective in wild type animals, it loses its efficacy in the reduction of benzo[*a*]pyrene-induced gastric tumors in Nrf2 deficient mice.

Sulforaphane is bactericidal to *Helicobacter pylori* in both the extracellular and intracellular forms in a human epithelial cell line.[6] Also significant is its bacteriostatic activity against three reference strains and 45 clinical isolates of *H. pylori* regardless of their resistance to conventional antibiotics.[6] Given the endemic nature of *H. pylori* infection in many developing countries and the etiologic connection between infection, gastritis, peptic ulcers, and gastric cancer, sulforaphane holds promise as a both an antibiotic and anticancer agent.

Precautions and Disclaimer
This product is for laboratory research use only, not for drug, household, or other uses. Please consult the Material Safety Data Sheet for information regarding hazards and safe handling practices.

Storage/Stability
It is recommended to store the product at –20 °C.

References

1. Zhang, Y., et al., A major inducer of anticarcinogenic protective enzymes from broccoli: isolation and elucidation of structure. Proc. Natl. Acad. Sci. USA, **89,** 2399-403 (1992).
2. Gao, X., et al., Powerful and prolonged protection of human retinal pigment epithelial cells, keratinocytes, and mouse leukemia cells against oxidative damage: the indirect antioxidant effects of sulforaphane. Proc. Natl. Acad. Sci. USA, **98**, 15221-15226 (2001).
3. Zhang, Y., et al., Anticarcinogenic activities of sulforaphane and structurally related synthetic norbornyl isothiocyanates. Proc. Natl. Acad. Sci. USA, **91,** 3147-3150 (1994).
4. Gamet-Payrastre, L., et al., Sulforaphane, a naturally occurring isothiocyanate, induces cell cycle arrest and apoptosis in HT29 human colon cancer cells. Cancer Res., **60**, 1426-1433 (2000).
5. Dinkova-Kostova, A.T., et al., Direct evidence that sulfhydryl groups of Keap1 are the sensors regulating induction of phase 2 enzymes that protect against carcinogens and oxidants. Proc. Natl. Acad. Sci. USA, **99,** 11908-13 (2202).
6. Fahey, J.W., et al., Sulforaphane inhibits extracellular, intracellular, and antibiotic-resistant strains of *Helicobacter pylori* and prevents benzo[a]pyrene-induced stomach tumors. Proc. Natl. Acad. Sci. USA.**, 99,** 7610-7615 (2002).

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