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What's that smell?

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For some, garlic just spells bad breath. Yet it is a vegetable whose past is far richer than its smell. Botanists believe that it was one of the first plants to have been domesticated; ancient remains have been found in habitats which date back 10'000 years. The plant probably originated in Asia and made its way slowly to the West, leaving in its wake the most diverse folklore and beliefs. The Hindus, the Scandinavians, the Greeks and the Germans believed that garlic had protective powers against evil influences. In Norse mythology, garlic was worn to ward off trolls. In central European mythology, it fought off witches and vampires, so much so that a man who refused to eat garlic was considered to be a potential vampire! Garlic cloves were thought to impart strength and bravery and as a consequence were fed to the Egyptian pyramid builders and Roman soldiers. And all because of a pungent odour…

Garlic and Chopper, Gillian Servais

Courtesy of the artist

Garlic would not have its smell without an enzyme known as alliinase. Alliinase is an enzyme that modifies a chemical component known as alliin (diallyl disulfide oxide, related to the amino acid cysteine) into allicin (or diallyl thiosulfinate), giving rise to all the garlic sulfur compounds we know today. The reason why any vegetable gives off such a stench in the first place would be to ward off herbivores that have just dug their teeth into its flesh. Microbes are also put off – although not by the smell but by allicin, which has antimicrobial properties. Alliinase is trapped within cytosolic vacuoles; foreign bodies, such as bacteria, are usually lured into vacuoles to be destroyed. The presence of alliinase in vacuoles could hence be a kind of primitive defence system.

The strategy used to create the typical sulfurous smell is ingenious and echoes the means used by onions[1] to deliver the sulfur-containing compounds which make us cry. The enzyme is trapped in vacuoles, and alliin – its substrate – is free in the cytoplasm. When the cell is disrupted, by way of a herbivore's bite or a microbe, the vacuoles burst open releasing alliinase which heads straight for alliin to synthesize allicin – a particularly reactive compound that gives rise to a hoard of other sulfur components. As a matter of interest, it was the Austrian gynaecologist Ernst Wertheim (1864-1920) who distilled the pungent substance from garlic and called it allyl, the Latin name for garlic. Hence allicin.

Allinase is a dimer of identical subunits. The active sites – for the substrate alliin and the cofactor pyridoxal-5'-phosphate (PLP) – are sandwiched between the two monomers which, viewed down the two-fold axis, form an S-shape structure that is the result of a 180º orientation of one monomer with respect to the other. A surprising feature of allinase is the presence of an epidermal growth factor (EGF)-

like domain. EGF domains are commonly found in animal proteins and are there to help one protein bind to another. They are very rare in plant proteins, and allinase is the first example of a catalytic domain fused to an EGF-like domain. Alliinase may use the EGF-like domain to bind to other proteins, or to dock an allinase receptor for example. No one knows. What is known though is that alliinase stays intact in the body once ingested; anti-allinase antibodies are found in human blood serum after garlic consumption.

Besides the plant's own defence system, and the various powers bestowed upon garlic cloves in the past millennia and its folklore, it has also been used – and for thousands of years – for healing numerous ailments. The Ebers Papyrus[2], which appears to have been written between 3'000 and 1'500 BC, mentions the benefits of garlic for high blood pressure, headaches, bites, worms and tumours. In 1858, the French microbiologist Louis Pasteur was the first to demonstrate that garlic had antimicrobial properties. Allicin can inactivate a variety of enzymes by reacting with specific free thiol groups. And besides its antimicrobial properties, garlic is now known to reduce blood pressure, blood cholesterol levels, coronary arterial plaques and is toxic to a number of cancer cell lines. Allicin added to soil before seeding can also protect plants from soil pathogens such as fungi and nematodes. Garlic's healing properties certainly seem to be numerous. Who knows, perhaps it does keep evil influences of a different nature at bay too.

[1] Spotlight issue November 2002
[2] Spotlight issue April 2001

Cross-references to Swiss-Prot

Alliin lyase 1, *Allium sativum* (Garlic) : Q01594
Alliin lyase 2, *Allium sativum* (Garlic) : Q41233

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