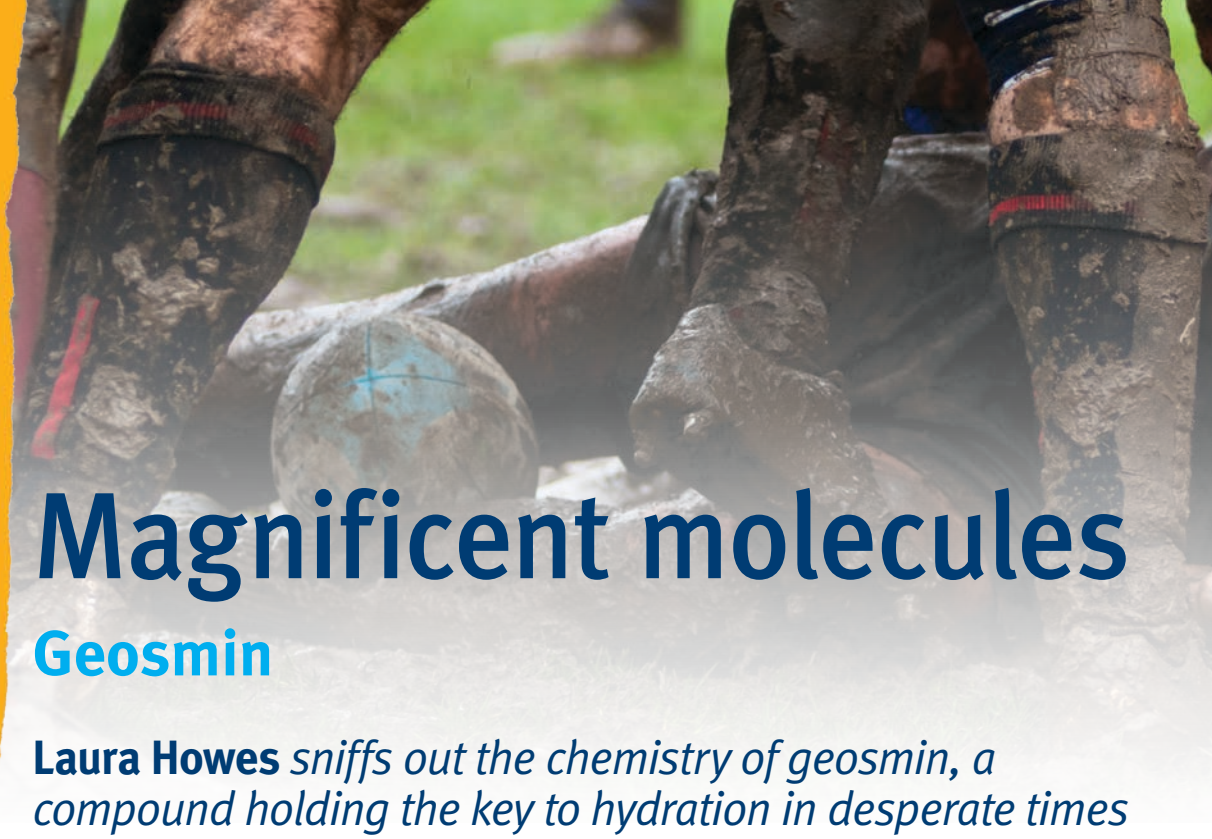

Magnificent molecules

Geosmin

Laura Howes *sniffs out the chemistry of geosmin, a compound holding the key to hydration in desperate times*

It's a smell that I will forever associate with cold wet rugby games as our studs gripped into the pitch and the whistle blew. That unmistakeable smell of mud and earth that you might associate with weeding the garden or hiding from the rain. And the main compound responsible, rather fittingly, is called geosmin: earth odour.

Microorganisms

Geosmin is a terpene made by microorganisms in the soil, particularly the *streptomyces* family of bacteria that live in soil and decaying matter and produce most of our antibiotics. However, the biosynthesis of geosmin was only discovered in 2007 after the genetic code of *Streptomyces coelicolor*, a bacterium that munches on plant matter in the soil, was solved. It turns out that a single protein converts farnesyl diphosphate (a common starting material for the biosynthesis of terpenes) into germacradienol, which is then converted into geosmin. The resulting molecule is a volatile alcohol that you can smell at incredibly low concentrations, down to around 0.7 parts per billion. But why would you want to?

Beetroot, wine and fish

Apart from rugby fields, geosmin is the compound responsible for the earthy taste of beetroot and it can also find its way into freshwater fish, as well as wine. Somehow, what's tasty in beetroot isn't quite so good in other foods on your plate. Geosmin can be degraded with acid, which is why potentially muddy tasting freshwater fish are often liberally doused with lemon juice or vinegar. However, that option isn't really feasible for winemakers with geosmin-contaminated stock and so there's a great deal of research into other options for removing it from wine.

The most effective treatment for reducing the amount of geosmin in wine seems to be grapeseed oil, with the oil acting as a solvent for the geosmin. Unfortunately, this treatment also seems to reduce the volatile aroma compounds that you probably want to keep in the wine as well. In fact, even though you can remove much of the geosmin, the reduction in other volatiles can actually make the geosmin even more pronounced. Now that the enzyme responsible for geosmin's production has been identified, the hope is that people can find a way of stopping it being produced in the first place, rather than unsuccessfully trying to remove it later on.

Finding water

The question remains, of course, why we are so sensitive to it, considering that we find the compound so distasteful in our food and drink. One theory is that our ancestors used the odour of geosmin to identify sources of water. That might seem unnecessary in the land of wellington boots and a national obsession with the weather, but in more arid climes it could be a lifesaver. Keith Chater of the John Innes Centre in Norwich, one of the team who originally sequenced the genome of *Streptomyces coelicolor*, has suggested that camels might be so sensitive to geosmin that they can smell oases miles away, and track the scent to find water in the desert. The spores of the bacterium, in return, can then hitch a ride and travel to the next waterhole.

You might not like it in a wine glass, but geosmin is more than the smell of a wet rugby pitch: it could be the smell of survival.

Did you know?

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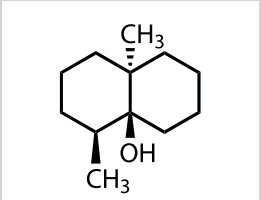
Terpenes like geosmin are found throughout nature. *R*-limonene is found in orange peel and smells strongly of oranges. However, it is a chiral molecule with two optical isomers. The other enantiomer, *S*-limonene, smells of pine needles.



Geosmin is made by bacteria in the soil and is also present in beetroot. It's sometimes found in fish, but can be removed with lemon juice or vinegar.