NEWS

Tidbits of Science

Climatic truth is in the wine

Of all the different ways to learn about the climate of the past, winemakers' tasting notes are probably the least likely to come to mind. However, research into historical archives has yielded valuable insights into a hitherto barely documented era in Europe. Historian Christian Pfister from the University of Bern, a pioneer in the field of research into the climate of the past and its relationship to social and economic changes, has gone to the trouble of trawling through the must tasting notes kept in cellars and monasteries in Germany, Luxembourg, France and Switzerland since 1420. Pfister spent many years poring over historical records and weighty tomes such as the Württembergische Wein-Chronik (wine records for the Württemberg region surrounding Stuttgart). In doing so, he was able to shed light on what neither geology nor tree rings could determine with certainty: the European climate between the 15th and 19th centuries. The best harvests were those that were harvested early, and if they were harvested early, it was because the heat and sunlight had a strong influence on the ripening of the grapes that year. This means that the grapes contain more sugar and therefore produce more alcohol when the wine ferments. By contrast, the worst grape musts were those that were harvested very late due to a cold and rainy summer: half-ripened grapes, low sugar and alcohol content. This is why the tasting notes of the winegrowers and monks act as a thermometer for centuries past. The accuracy of this method is remarkable. The best wines were produced from 1470 to 1479, from 1536 to 1545 and from 1945 to 1954, i.e. during the warmest and sunniest periods. It is also possible to precisely trace the cooler periods back to the worst tasting notes. Interestingly, the 1470s, which we have previously regarded as one of the periods with the best must ratings, more or less coincided with the beginning of the 'Little Ice Age' that cooled Europe between the 14th and 19th centuries. However, the first lowest temperature of this regional mini-ice age did not occur until 1650 (the last was in 1850), and it is possible that the plentiful harvest of the 1470s reflected a period of relative warmth in that context. The researchers in Bern are exploring ways to continue refining the climate calendar of this period. Who says historians don't have great ideas?

How bacteria metabolize plastic

Plastic is practical but problematic: although some plastic products can be recycled, they often accumulate in the environment instead, where they can last for centuries. Up until now, recycling materials made from different types of plastic has proved very difficult or barely feasible. These include products coated with the plastic polyester urethane (PEU), such as fishing nets, ropes and certain textiles. While PEU increases product longevity, it also makes them more difficult to break down.

A research team led by Jan de Witt from the Jülich Research Centre has

now taken a closer look at a type of bacteria that could offer a solution. The so-called Halopseudomonas bacteria are found in extreme environments, including deep ocean areas that are polluted with crude oil or heavy metals. The species that de Witt and his team were studying, however, Halopseudomonas formosensis FZJ, was isolated by researchers in a German compost heap. Their experiments showed that these bacteria can also break down the hydrocarbon structure of some plastics. The bacterium is able to grow on different types of PEU and utilizes this plastic as its sole carbon source. After 72 hours of cultivation, some PEU coatings were completely depolymerised. In addition to the high degradation rate, the research team discovered an important advantage of the isolated strain over other Halopseudomonas species: it was particularly tolerant of high temperatures and capable of degrading plastic at up to 50 degrees Celsius. Most other species only grow at temperatures of up to 37 degrees Celsius. This characteristic is important for potential industrial applications where high temperatures are often generated – similar to inside a compost heap, the natural habitat of H. formosensis.

The research team discovered that the bacterium produces an enzyme that is important for degrading plastic. When they switched off the gene for this enzyme, the genetically modified bacteria were barely able to break down the PEU. This finding demonstrates the crucial role of the identified enzyme and also shows that it is possible to genetically modify H. formosensis. In future applications, it would therefore also be conceivable to genetically increase enzyme production and thus the activity in plastic degradation.

Nuclear fusion: Big energy from small quantities

Nuclear fusion, the holy grail of energy, is moving ever closer to reality thanks to the efforts of around twenty start-ups in Europe, the United States and Canada. The most optimistic forecasts suggest that we could replace hydrocarbons with hydrogen atoms to power our factories and cities in just a decade's time. In contrast to nuclear fission, in which atomic nuclei are split to release energy, nuclear fusion involves the fusion of atomic nuclei at extremely high temperatures to produce enormous amounts of energy.

Fusing atoms to generate energy is not a new concept. As early as 1950, the Soviet physicist Andrei Sakharov designed the 'tokamak', a donut-shaped machine in which deuterium and tritium (two hydrogen isotopes) can reach the required temperature to fuse together and produce helium atoms, releasing an enormous amount of energy during the reaction.

Will the widespread use of nuclear fusion change the composition of the atmosphere one day? In nuclear fusion, nuclear reactions take place that are very different from the chemical processes we are familiar with from fuel combustion. And the advantage of nuclear fusion is that it can generate large amounts of energy with just a few grams of fuel. One gram of fuel can provide the energy equivalent of eight tonnes of oil. Just as the sun supplies the Earth with energy through fusion reactions, nuclear fusion could also provide large amounts of energy in the future.

Fusion reactors require very little fuel compared to conventional power plants. Exploiting nuclear fusion neither changes the composition of the atmosphere nor does it release greenhouse gases. Hydrogen isotopes such as deuterium and tritium are used for nuclear fusion. Deuterium is abundant in seawater, while tritium is produced in the reactor itself. At temperatures of over 100 million degrees, the atomic nuclei fuse in the plasma, releasing enormous amounts of energy.

Unlike the combustion of fossil fuels, the generation of energy in nuclear fusion is based on nuclear reactions. The nuclei fuse to form a new element, whereby the mass that is converted into energy is less than the sum of the initial masses according to Einstein's formula $E=mc^2$. Fusion experiments show that the required fuel density is extremely low, far lower than the density of air. As a result, nuclear fusion has no significant impact on the atmosphere, as neither hydrogen consumption nor helium emissions pollute the environment.

Nuclear fusion also produces waste. A fusion power plant produces radioactive waste because the high-energy neutrons generated during fusion activate the walls of the plasma vessel. The intensity and duration of this activation depend on the materials that the neutrons hit. However, compared to nuclear fission, which produces highly radioactive waste, nuclear fusion produces only a small amount of waste in the form of tritium and helium. It is important to note that the radiation from this fusion waste decreases much faster than that from highly radioactive waste from fission power plants. Researchers are working to develop materials that could further reduce activation and recycling technologies to reuse the components of a fusion reactor. Unlike fossil fuels and nuclear fission, which produce CO_2 emissions and hazardous radioactive waste, nuclear fusion generates neither CO_2 nor long-lasting radioactive waste.