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Biotechnology

Genetically modified tobacco plant makes cocaine in its leaves

Alex Wilkins

THE complex biochemistry that sees coca plants make cocaine has been unpicked and replicated in a relative of the tobacco plant. Recreating the process by modifying other plants or microorganisms could lead to a way to manufacture the stimulant or produce chemically similar compounds with unique properties.

Biochemists have tried to map out how cocaine is made by the coca plant for more than a century, both because of its unique structure and for its uses in medicine, most recently as an anaesthetic. Much of this process had been identified, but there was still a missing link between cocaine and a chemical precursor called MPOA.

Now, Sheng-Xiong Huang at the Kunming Institute of Botany in China and his colleagues have bridged this gap by identifying two enzymes involved in converting MPOA to cocaine.

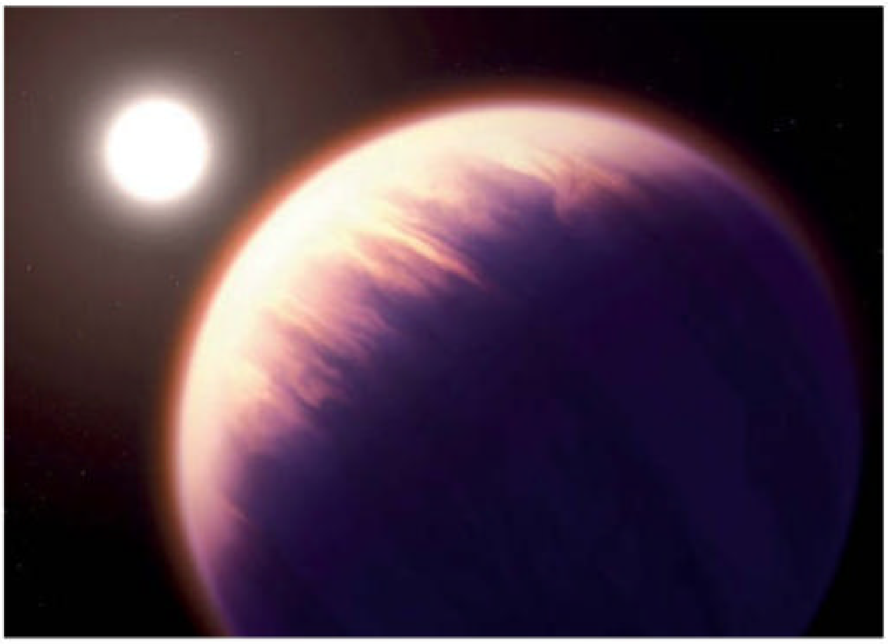
The team then genetically modified a close relative of the tobacco plant, *Nicotiana benthamiana*, to make cocaine using these enzymes. It could produce about 400 nanograms of cocaine per milligram of dried leaf, roughly a 25th of the level in a coca plant (*Journal of the American Chemical Society*, doi.org/gq9dxr).

"The available production of cocaine in tobacco is not enough to meet the demand on a mass scale," says Huang, but the biosynthetic pathway could be assembled in organisms with large biomass and quick growth, such as the bacterium *Escherichia coli* or the yeast *Saccharomyces cerevisiae*, he says.

Using less-productive plants to make cocaine won't offer an advantage for illicit producers, says Benjamin Lichman at the University of York, UK. But transferring this mechanism to microorganisms could allow pharmaceutical firms to ferment it and avoid plant-based production, he says.

Space

JWST spots chemical reactions in exoplanet atmosphere



NASA/JPL-CALTECH/ROBERT HURT; CENTER FOR ASTROPHYSICS–HARVARD & SMITHSONIAN/MELISSA WEISS

Chemical reactions occurred on the exoplanet WASP-39b

THE James Webb Space Telescope (JWST) has picked up on chemical reactions driven by starlight taking place in the atmosphere of a distant alien world for the first time, raising hopes the telescope could help identify exoplanets hosting life.

Many of the compounds in Earth's atmosphere, including some that are essential for life, didn't exist when the planet formed. Instead, they were the product of chemical reactions triggered by light from the sun.

These photochemistry reactions also occur in the atmospheres of almost all the other planets in our solar system and so were predicted to happen in exoplanet atmospheres. But until now, they had never been observed.

In August, JWST observations of the exoplanet WASP-39b, a 900°C ball of gas as massive as Saturn and wider than Jupiter, found the first evidence for carbon dioxide in an exoplanet atmosphere. But astronomers also spotted a strange bump in the signature of the planet's light, which suggested an unknown element or molecule was absorbing the host star's light as it passed through the planet's atmosphere.

Now, Katy Chubb at the University of St Andrews, UK, and her colleagues have analysed data on WASP-39b's light taken from four infrared instruments on JWST. "The large range of wavelengths covered by the four different instruments really allows us to build a complete as possible picture of this atmosphere as we can," says Chubb.

The team used a range of atmospheric models to mimic JWST's signal. Only models that included chemical reactions involving sulphur could reproduce the data, suggesting the bump was caused by atmospheric sulphur dioxide, says team member Éric Hébrard at the University of Exeter, UK. "We were very surprised because as soon as we each independently implemented the sulphur chemistry, it fit right away."

The levels of sulphur dioxide were far higher than they should be if the planet is made only from material created when the star system formed (arXiv, doi.org/gq9tf7 and doi.org/jnkn). The only explanation, says Chubb, is that light from the planet's star, WASP-39, caused a chain of chemical reactions in the planet's atmosphere and produced the sulphur dioxide.

"We haven't been able to probe such processes in the deep atmosphere before the JWST era," says Nikku Madhusudhan at the University of Cambridge.

Identifying photochemical reactions on WASP-39b may also help indicate whether the planet formed further out from its star and moved inwards, picking up material across its star system, or whether it formed at its current location and simply accumulated material there. Early observations of the oxygen-to-carbon ratio suggests it formed far away from its star, but more definitive data will be needed, says Chubb.

The find also bodes well for observing more compounds produced by photochemical processes, such as ozone on Earth, says Hébrard. "Even if [WASP-39b] is very different than what we have on Earth – it's hot, it's hydrogen dominated, you don't want to live there – having that first detection of a photochemical product is one way forward."

> **"We haven't been able to probe such processes in the deep atmosphere before the JWST era"**

Ultimately, such detections could help in one of JWST's mission goals: searching for signs of an exoplanet that could host life. AW