

“Home brewed morphine” from genetically engineered yeast? What did the media get wrong?

Not even Breaking Bad's [Walter White](#) could have predicted this was how he was going to be in the media spotlight this week. Nearly a year and a half after the hit TV-show ended, the methamphetamine cooking chemistry teacher turned drug dealer protagonist/anti-hero was [referred](#) to in the news [again](#), but this time in the context of genetic engineering and synthetic biology.

‘Home-brew’ opiates?

John Dueber a researcher at the University of California Berkley along with his PhD student William DeLoache and others published a research paper in [Nature Chemical Biology](#) detailing the creation of a genetically engineered strain of yeast that could complete the early steps of morphine production from glucose. Together with previous research by others, Dueber's work essentially set the stage for a single strain that could be engineered to have all the genes to complete the 15 biochemical steps required to convert glucose to morphine and other opiates

Concurrently with the Nature Chemical Biology paper, three experts including Dr Kenneth Oye, a biotech political science professor at M.I.T. published a commentary expressing great concern about the potential misuse of the technology in the journal [Nature](#) titled “*Regulate ‘home-brewed’ opiates.*”

The title and tone of the commentary along with an image that was titled ‘Brewing Bad’ caught the attention of news media around the world resulting in a flurry of news articles, tweets and Facebook posts, most of them referring to ‘home-brew’ opiates. Some such as this [article](#) in Gizmodo even went so far as to use the headline “You Can Now Make Morphine at Home With a Beer-Brewing Kit.” Another [article](#) stated that policy experts “fear a generation of Walter Whites.”

In a Science Insider [article](#), Robert Service wrote “some researchers are concerned that hype over fears of homebrewed heroin could cause a harmful regulatory backlash.” He quotes Christina Smolke, a researcher at Stanford who created one of the engineered yeast strains in the process a year ago.

“I do believe that a thoughtful discussion of risks, opportunities, and regulatory needs is important with this technology,” Smolke says. However, she says she believes Oye's commentary, for one, was “inflammatory.”

But does this research mean can we really brew opiates at home? How accurate were media reports on the technology and concerns about lack of regulation? What effect did the *Nature* commentary have on the news?

The *Science Insider* [article](#) covers in excellent detail the science and how long the research has been in the making. The promise of the technology is obvious. Not only does this bode well for the production of opiates and other drugs such as antibiotics and cancer drugs more efficiently and possibly for a lower

price, the sensor developed by Dueber and his team could be an essential tool in identifying missing pieces in other important genetically engineered yeast strains by using it in much the same way that the current research did. However like any new technology, it comes with a set of issues.

A knee-jerk reaction or a very real possibility?

At the Genetic Expert News Service ([GENeS](#)), which I am a part of, we approached experts for comments on both the scientific and regulatory aspects of the issue to find out what they thought.

Two of the four experts pointed out that several technical barriers existed before 'home-brew' opiates were possible. Christopher Voigt, a professor of biological engineering at M.I.T pointed out that "300 liters of yeast would have to be grown for one dose" of morphine usable as a drug. The investment required with current technologies to produce significant amounts of opiates would be \$20 – \$100 million said Keith Tyo, a researcher at Northwestern University.

Christina Smolke, the Stanford researcher quoted earlier, said in the *Science Insider* echoed that yeast engineered to make morphine isn't quite here yet

Smolke also emphasizes that researchers remain a considerable distance from putting together the full chain of chemical transformations needed for yeast to make morphine. And if and when that occurs, the organisms will still make only vanishingly small amounts of the drug. "In fact, it is more likely that a person could more easily access morphine by dumping a bunch of poppy seeds in their homebrew (or tea)," she says

George Church, a world-renowned researcher and genetic engineering pioneer noted that the ability to improve the technology meant the cause for concern was real

Many pharmaceuticals are already made by yeasts and bacteria at high yield commercially. This sort of metabolic engineering optimization is fairly straightforward. Once the recipe is published it becomes very easy to reproduce it — something that any [DIYBIO](#) user could do.

Voigt also agreed, and much like Dueber did in many news reports, he mentioned that it is technically feasible to get to home-brew status with improvements in the yeast strain and other production techniques.

In addition to the technical difficulties that existed to home-brew opiates, Megan Palmer, a fellow at the Center for International Security and Cooperation (CISAC) at Stanford University and an investigator at the Synthetic Biology Engineering Research Center (SynBERC), where Church, Oye and Dueber are also investigators, pointed out to GENeS that the economic aspects of how this technology would affect legal and illegal drug markets have yet to be determined and would play an important role in regulatory approaches. Like Smolke, she acknowledged that the commentary might have set off an unsavory reaction, but also saw it as a positive step

It is unfortunate that the editorial framing of this article, especially the imagery, is inflammatory, laying a questionable groundwork for a more meaningful and holistic discussion of both benefits and risks. It is, however, heartening to see researchers proactively engaging in these discussions and welcoming more transparent debate.

In retrospect, the framing the regulatory issue as a 'home-brew opiate problem' generated a significant amount of media attention with many news articles that focused on the concern expressed in the commentary alone, creating hype and exaggerating what is possible with the technology. However, it was interesting to note that there were articles such as the ones in the [New York Times](#), [Science Insider](#), and [BuzzFeed](#) which took a more measured approach and presented differing points of view discussing risks posed by the technology, its viability and the risks posed by improper regulation.

Reading the commentary, it was also hard not to be reminded of the calls for a moratoria on gene-editing human embryos that has filled the news waves over the past month (indeed the Nature commentary by Oye and others did refer to it as well).

It is important to acknowledge the stark difference in this case when compared to the gene-editing of human embryos by Chinese researchers last month. Here, John Dueber and Vincent Martin, the researchers who published the study, recognized the implications of their experiments well in advance. When they weren't sure of what the regulatory implications were, they did the right thing and reached out to Oye, the policy expert. Both Dueber and Oye are part of [SynBERC](#), suggesting that the NSF funded "research program to make biology safer and easier to engineer" functioned as it was designed to.

It is worth wondering whether the contrasting ways in which the gene-editing human embryo research and this one were handled altered the viewpoints that were presented in the news. It is quite likely that the ethical implications of the issue being discussed – unregulated opiate production versus genetically modifying the human genome resulted in the difference in intensity of media and public reaction. But for example, did the approach taken by Dueber in contacting Oye and the lead time offered to reporters by the press release on the research and commentary allowed for a more measured media response? If so it is definitely a positive takeaway that we would do well to remember in the future.

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Additional Resources

- [Does DIY synthetic biology promote science, or distort it?](#), Biopolitical Times
- [Will synthetic biology face same fate as GMOs?](#) New Yorker
- [Can the same regulatory systems that now oversee GMOs work for synthetic biology?](#) Genetic Literacy Project

Disclosure: I'm a member of the staff at GENeS which provides rapid access to scientific expertise and opinion on the latest genetics and biotechnology news. GENeS is an independent project affiliated with the World Food Center Institute for Food and Agricultural Literacy at University of California, Davis and funded in part by the Genetic Literacy Project. For more information see our website.