

Should there be more marijuana genome projects?

It would have been inconceivable only a few years ago, but the United States is embracing marijuana in a big way.

[Legal pot is the new gay marriage](#): Polls are showing that public approval of legalization is hovering around 50%, mirroring the rapid rise in approval for legal same-sex unions. The *New York Times* just published a long piece reporting [pot's relatively benign effects in California](#), where it has been medically legal for 17 years and is easily available to the healthy as well.

As California goes, historically speaking, so goes the nation. Eventually. Marijuana is legal for medical uses in 20 states, legal for any use in 2, and the subject of active lobbying in the others. The federal government still declares marijuana illegal, but also says [it will permit states to regulate it themselves](#). With the threat of federal prosecution gone, more states are likely to legalize.

Ignorance about marijuana's genetic properties

Despite this rapid revisionism, we remain remarkably ignorant about pot's properties, including its genetic properties. There are anecdotes galore about the medical effects of marijuana, but not much actual data. Politics has made [research on real medical applications](#)—for example pain, Alzheimer's disease, cancer—next to impossible, as neuroscientist David Nutt and his colleagues complained in a *Nature* journal last June.

The obvious place to start is the marijuana genome. The draft genome of *Cannabis sativa* was published only in 2011—and it was the product of Canadian scientists, not US research. Researchers sequenced a popular medical pot variety known as Purple Kush, finding that it has about 30,000 genes. By comparing Purple Kush with genomes of two kinds of hemp—varieties of cannabis used for making fibers, not smoked—they showed that hemp lacks the psychoactive compound trans- Δ^9 -tetrahydrocannabinol (THC), source of nearly all marijuana's high, because it lacks the enzyme that produces THC.

THC is just one of cannabis's cannabinoid compounds. The plant contains dozens of them—I've seen estimates as high as 100—but properties of most cannabinoids are unknown.

One that has been studied a little is cannabidiol, CBD. The most popular pots for smoking usually contain a lot of THC and not much CBD. That's because CBD is not very psychoactive; it doesn't produce the high of THC. But CBD has interesting medical properties. One is especially intriguing: it [appears to be able to counteract or even prevent the memory loss](#) that heavy pot smokers often experience.

The genome of Purple Kush

The Canadian cannabis genome project sequenced a single popular strain of medical marijuana, Purple Kush. But there are a zillion different cannabis strains, most bred by enthusiasts. They are often knowledgeable about genetic differences between pot varieties and skilled at breeding their strains. But they don't publish in journals, so access to their expertise about cannabis genes is not readily to be had.

Dispensaries in the states where medical marijuana is legal sell different genetic strains for different purposes and recommend accordingly: this one for neuropathic pain, that one for chemo-induced nausea. These recommendations may often be accurate, but they are based on individual reports, not systematic studies. Anecdotes, not data.

Which suggests that more than one cannabis genome project is needed. I consulted the senior author of the Purple Kush project about whether he thought additional genomes would be useful. That would be Jonathan Page, an adjunct professor in the Biology Department at the University of Saskatchewan. In an email Page told me, "Yes, I envision that there will be the need to do resequencing of different cannabis strains in order to catalog the genomic variation that exists between them, and to help identify the variants that result in different pharmacological effects."

The pharmaceutical industry has looked at cannabis's medical attributes and may be inclined to do more as pot becomes increasingly respectable (and legal.) Pharmas need solid genome information about their raw materials in order to get approvals from regulatory agencies.

[For a sense of the work involved in standardizing a pot product](#), take a look at a paper by the aptly named David Potter, a scientist at the UK's GW Pharmaceuticals. The company markets Sativex, a cannabis nasal spray approved for treating the spasms of multiple sclerosis. It is now available in several countries. But the hurdles the company has had to jump to get this distribution are many.

To begin with, Potter points out in what is probably an understatement, the "plant material is extremely inhomogeneous." Pot's gene expression, and its active ingredients, are affected by a number of environmental factors that must be controlled in order to get rid of that inhomogeneity. And that's just the beginning. Should medical pot be grown outdoors or indoors? (The company compromised, settling on a glasshouse.) What kind of security to provide? What are the optimum storage conditions? Etc, etc.

Pharma interest in cannabis products

That sort of effort is among the reasons why, as Page told me, "I think that pharmaceutical industry will remain uncomfortable with products that are essentially herbal drugs—they prefer pure synthetic compounds—and with a plant that continues to be illegal in many places." He does, however, think there's an opportunity to use traditional plant breeding, genomics, and metabolite profiling for developing new cannabis varieties for medicine (and also for fun.)

Page forecasts: "These will most likely be private sector initiatives since governments are not keen on funding cannabis research." That sounds a lot like what we've got now: Few publications and no publicly available genome databases for sharing genetic information and guiding future research.

Page says additional genomics studies could also help settle a perennial question that is probably of more interest to scientists than to users: is *Cannabis* a single species or three: *C. sativa*, *C. indica*, *C. ruderalis*?

Will there be genetically modified *Cannabis*? Page is doubtful. Attempts at making transgenic cannabis, he says, have not so far been successful. Gene transfers might be coaxed to work, given investment of a great deal of lab effort. But is GM *Cannabis* desirable? Says Page, “I’m not convinced that it is, given the power of selective breeding to create plants with optimized traits.”

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Additional Resources:

- [“Is There Really GMO Pot?”](#) Science 2.0