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Not your grandfather's weed

Cannabis products and their changing potency



By Jeremiah Mosteller



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Introduction

Much has been said in recent years about how today's cannabis products are not the same as those used 50 years ago because of their increased potency. What does this mean beyond the headlines? In this report, we explore changes over time in the potency of both legal and illicit cannabis products.

The research on changes in cannabis potency finds the following:

- The average THC content of illicit cannabis products seized by the Drug Enforcement Administration in 2021 was more than 12 times higher than in 1972.
- It is unclear, given the limited research available, exactly how much of this change in potency may be on account of changes in product quality, consumer product preferences, and the adoption of legalization itself.
- Research indicates that consumers increasingly prefer higher potency forms of cannabis regardless of whether they are purchasing them from illicit or legal providers.

This report marks the eighth installment in our "real facts" report series that seeks to provide an unbiased and comprehensive view of the impact of cannabis legalization in other states.



Average THC content in products seized by DEA, by year, 1972-2021

Increased Cannabis Potency

Tracking the potency of cannabis products over the long term is difficult given the limited number of sources that can provide the necessary data on an illicit market. The National Center for Natural Products Research (NCNPR), located at olina sought to dig deeper into this potency data by analyzing changes in product type and quality alongside changes in potency within the NCNPR data. He found that a type of cannabis called sinsemilla⁴ increased from 3.2% of the prod-

the University of Mississippi, has been tracking the potency of illicit cannabis products seized by the Drug Enforcement Administration (DEA) since 1977. It serves as the only source of such data in the United States that existed before the creation of commercial markets for medical and adult use of state-legal cannabis products.

The NCNPR data shows that the potency of DEA-seized cannabis products has increased from 1.17% THC in 1972 to more than 15% THC in 2021 – a more than 12-fold increase over nearly four and a half decades.¹ As the graph above shows, this trend started before any state legalized cannabis. Seventy-eight percent of this change occurred before Colorado became the first state to allow



ucts seized by the DEA in 2000 to 60% in 2010.⁵ He also found that DEA officers seized fresher products over time.⁶ Ultimately, product quality and freshness⁷ were statistically significant in his analysis and explained up to 43% of the change in THC potency between 1970 and 2010.⁸ To be clear: This means the underlying potency of cannabis has increased significantly and that factors in addition to the raw plant's inherent THC content are also driving the trend seen in the available data.

The amount of THC in any given cannabis product varies based on its form (raw plant matter or manufactured product), how quickly products are moved to the illicit and legal markets, and the availability of more potent strains. These

adult use in 2012 and 24% before California was the first to allow medical use in 1996.

The body of academic research analyzing this data reaches the same conclusions concerning illicit cannabis potency, but the research is not conclusive that this level of increased potency is present in the raw plants themselves.² A few studies find that this increase is less severe after controlling for factors such as product quality or freshness and the market share held by processed products with an inherently higher THC content, such as resin and concentrates.³

For example, Eric Sevigny of the University of South Car-

additional factors will impact any data collection that counts all products as one category as the NCNPR data does.

Impact of Legalization

It is difficult to determine from the raw NCNPR data alone what impact state policy changes allowing for the medical and adult use of cannabis may have specifically had on the underlying potency of the plant and its derivative products. A basic statistical analysis reveals some likely relationship as illustrated in the graph accompanying this brief, but the maxim that "correlation is not causation" is important here.⁹ This is especially true given the questions already raised about how product quality and mix complicate the relationship. We sought to expand our scope to see if other research could help answer this question.

The only academic study that directly analyzes this question finds a statistically non-significant relationship between medical cannabis legalization in a state and trends in cannabis potency.¹⁰ Sevigny and colleagues from the RAND Corporation explored the relationship while controlling for factors such as product type and quality. They found that legalizing medical use increases potency by 0.5% but allowing medical cannabis dispensaries increases that impact to 1% over time.¹¹ The authors concluded that the effect of these laws is driven by how they change which products are sold in a



Potency and medical-use laws

state rather than by directly increasing the potency of raw cannabis.¹²

Some other related research explores whether the potency of commercial cannabis products is higher than the potency of products in the illicit market. There is a split within the research that we were able to find on this topic, with one study on each side of the debate. Michele Glinn and colleagues tested commercial cannabis products in Michigan and found them to have a potency 6% higher than the level reported by NCNPR data on national DEA seizures.¹³ On the other hand, Syed Mahamad and his colleagues recorded the reported THC potency for products sold by 185 legal retailers and 944 illicit retailers and found that products from the illicit providers had a higher average, minimum, and maximum potency.¹⁴

Given these inconclusive findings, we searched for addi-

tional research on related topics. It reveals even more complexities in the relationship between state policy change and the potency of raw cannabis and cannabis products.

Cannabis Potency in Other Countries

We surveyed the international research on cannabis potency and discovered that similar increases in potency have been observed in other countries that have legalized and have not legalized cannabis for medical or adult use.¹⁵ Jakob Manthey explored cannabis potency in countries across the European Union and found that the potency of herbal cannabis and cannabis resin had increased significantly from 2010 to 2019.¹⁶ Only the Netherlands had any legal avenue to secure cannabis products at that time.¹⁷

Product Choices by Consumers

As one researcher noted above, product choices of consumers in states with legal access to cannabis could be the driver of increased potency. The available research confirms that consumers in states with legal access are more likely to choose higher-potency products such as concentrates.¹⁸ Deborah Hasin and colleagues surveyed more than 5,200 Americans living in states with a mix of different cannabis policies, inquiring about those consumers' cannabis use.¹⁹ They found that individuals living in states that allow medical and adult use were more likely to use cannabis concentrates — such as a vape pen, "carts" or oils — rather than other lower-potency products when compared to individuals living in states without any form of cannabis legalization.²⁰

Conclusion

The average potency of cannabis products – illegal and legal – is higher today than it was in past decades both domestically and abroad. The current data and research available do not conclusively indicate that such trends are driven by cannabis legalization, but there is initial evidence indicating that part of this trend is being driven by consumer preference for more potent forms of cannabis which appear to be more readily available in legal markets. More research is needed to identify how much legalization in states has driven this trend and how much of this increase is occurring at the cultivation stage rather than the product manufacturing stage.

About the author



Jeremiah Mosteller is an attorney and criminal justice policy expert who is a visiting fellow at the Badger Institute. He also serves as a policy director at Americans for Prosperity, where he supports the organization's efforts to advance policies that expand freedom and opportunity in 36 states and Congress.

Mosteller leads a team of policy experts who focus on policies that advance public safety, border security, free speech, and national security. As part of this role, Mosteller has worked with conservatives across the country to shape state and federal marijuana policies that respect conservative principles like low taxes, free markets, competition, federalism, and the rule of law.

About this project

Mosteller is part of a team at the Badger Institute with varying and sometimes conflicting personal perspectives and affiliations working together to review existing academic literature on the ramifications of marijuana legalization in other states. The goal of our reports is to be as objective and thorough as possible and simply synopsize what others have found. We encourage feedback and suggestions from anyone who thinks we may have missed any relevant findings. The Badger Institute has not taken a position on legalization in any form and may or may not do so in the future.

Endnotes

1: This data had to be compiled from multiple sources reporting from the raw data set since it is not publicly accessible. See National Institute of Drug Abuse, *Cannabis Potency Data*, National Institute of Drug Abuse (2022), <u>https://nida.nih.gov/research/research-data-measures-resources/cannabis-potency</u>-data; National Drug Intelligence Center, *National Drug Threat* Assessment: 2009, U.S. Department of Justice (2008), <u>https://www.justice.gov/archive/ndic/pubs31/31379/31379p.pdf</u>; Zlatko Mehmedic, et al., *Potency trends of delta9-THC and other cannabinoids in confiscated marijuana from 1980-1997*, 45 J. Forensic Sci. 24 (2000); Mahmoud A. ElSohly, et al., *Constituents of Cannabis sativa L. XXIV: The Potency of Confiscated Marijuana, Hashish, and Hash Oil Over a Ten-Year Period*, J. Forensic Sci. (1984) (on file with author).

2: Mahmoud A. ElSohly, et al., *A Comprehensive Review of Cannabis Potency in the United States in the Last Decade*, 6 Biological Psychiatry: Cognitive Neuroscience and Neuroimaging 603 (2021) (finding that THC concentration in seized cannabis to have "increased over the last 10 years, from 9.75% in 2009 to 14.88% in 2018 and 13.88% in 2019"); Mahmoud A. ElSohly, et al., *Changes in Cannabis Potency over the Last Two Decades (1995-2014) - Analysis of Current Data in the United States*, 79 Biological Psychiatry 613 (2016) (finding that the potency of seized cannabis products increased from 4% in 1995 to 12% in 2014); Zlatko Mehmedic, et al., Potency *Trends of \Delta9-THC and Other Cannabinoids in Confiscated Cannabis Preparations from 1993 to 2008*, 55 Forensic Sci. 1209 (2010); See also Desmond Slade, et al., *Is Cannabis Becoming More Potent*? in MARIJUANA AND MADNESS (David Castle, Robin M. Murray, & Deepak Cyril D'Souza eds., 2012).

3: Eric L. Sevigny, Is today's marijuana more potent simply because it's fresher?, 5 Drug Testing Anal. 62 (2013); Slade, supra note 2; See also Rosanna Smart, et al., Variation in cannabis potency and prices in a newly legal market: evidence from 30 million cannabis sales in Washington state, 112 Addiction 2167 (2017) (finding that the market share of THC inhalants – products with higher THC content than traditional smoked cannabis – grew by 145.8% between October 2014 and September 2016).

4: This category of cannabis is female plants that are intentionally separated from male plants to prevent pollination and the development of seeds so that the concentration of THC stays higher in the plant itself.

5: Sevigny, supra note 3 at 65.

6: Sevigny, supra note 3 at 65.

7: The main type of THC in cannabis products – called delta-9 or Δ 9 – oxidizes over time and becomes a separate substance called CBN which only has about 25% of the psychoactive effect. This means that as cannabis ages it becomes less intoxicating. See S.A. Ross & M. A. Elsohly, *CBN and D9-THC concentration ratio as an indicator of the age of stored marijuana samples*, United Nations Office on Drugs and Crime (1992), <u>https://www.unodc.org/unodc/en/data-and-analysis/bulletin/bulletin_1997-01-01_1_page008.html</u> (finding that the concentration of THC in cannabis plant material declines by 16.6% after one year and 26.8% after two years on average).

8: Sevigny, supra note 3 at 66.

9: A basic statistical analysis of the potency data and the cumulative states legalizing cannabis use reveals a statistically significant relationship for both medical cannabis legalization (r = 0.95322092, p = < .00001) and adult use legalization (r = 0.698065392, p = < .00001) but this relationship does not control for any of the factors discussed above.

10: Eric L. Sevigny, et al., *The effects of medical marijuana laws on potency*, 25 Int'l J. Drug Pol'y 308 (2014) (finding a non-statistically significant increase in cannabis potency in states that legalized medical use which was largely on account of changes in the composition of products available toward higher potency ones rather than the individual products themselves becoming more potent).

11: Sevigny, supra note 10 at 313-315; But see Mary Catherine Cash, et al., Mapping cannabis potency in medical and recreational programs in the United

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States, PLOS ONE (2020), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230167 (finding that the potency of cannabis products provided in 653 medical and adult use cannabis dispensaries across nine states was similar — 19.2% versus 21.5%).

12: Sevigny, supra note 10 at 315, 318.

13: Michele A. Glinn & Gregoire P. Michaud, *Potency levels of regulated cannabis products in Michigan 2021–2022*, 68 J. Forensic Sci. 1984 (2023) (finding that the average THC potency levels in cannabis products from Michigan's regulated cannabis suppliers were between 21.4% and 24.1%, which represents a potency 6% higher than illicit products nationally).

14: Syed Mahamad, et al., Availability, retail price and potency of legal and illegal cannabis in Canada after recreational cannabis legalization, 39 Drug Alcohol Rev. 295 (2020) (finding that illicit cannabis products had a higher average, minimum, and maximum THC levels than products sold by legal providers across nearly all Canadian providences two months after the market opened).

15: Francesca Vernich, et al., Trends in Illicit Cannabis Potency based on the Analysis of Law Enforcement Seizures in the Southern Area of Rome, 11 Toxics 649 (2023) (finding that the potency of cannabis products seized by law enforcement in Rome increased from 13.7% (2015) to 27.1% (2022)); Carole M. Lindsay, et al., Potency trends of cannabis in Jamaica during the period of 2014 to 2020, 16 Drug Testing Analysis 174 (2023) (finding that the average THC levels in cannabis had increased between 2014 (1.1%) and 2020 (10.2%) in Jamaica); Jakob Manthey, et al., Public health monitoring of cannabis use in Europe: prevalence of use, cannabis potency, and treatment rates, 10 Lancet Reg. Health 1 (2021); Tom P. Freeman, et al., Changes in delta-9tetrahydrocannabinol (THC) and cannabidiol (CBD) concentrations in cannabis over time: systematic review and meta-analysis, 116 Addiction 1000 (2021) (finding that THC potency increased from 1970 to 2017 in Netherlands, France, Denmark, Italy, and New Zealand); Luca Zamengo, et al., Cannabis potency in North-East Italy: A ten-year study (2010-2019), 317 Forensic Sci. Int'l 1 (2020) (finding that cannabis products potency increased by 6-11% between 2010 and 2019 in North-East Italy); Suman Chandra, et al., New trends in cannabis potency in USA and Europe during the last decade (2008-2017), 269 Eur. Archives Psychiatry Clinical Neuroscience 5 (2019) (finding potency increases among cannabis products seized by the DEA and similar trends in 28 European countries among a mix of legal and illicit products); Tom P. Freeman, et al., Increasing potency and price of cannabis in Europe, 2006–16, 114 Addiction 1015 (2019) (finding that cannabis product increased in potency across Europe from 2006 to 2016); Kristine Rømer Thomsen, et al., Changes in the Composition of Cannabis From 2000–2017 in Denmark: Analysis of Confiscated Samples of Cannabis Resin, 27 Experimental Clinical Psychopharmacology 402 (2019) (finding that THC potency in cannabis resin samples from Denmark increased by three times between 2000 and 2017): Laurence Dujourdy & Fabrice Besacier, A study of cannabis potency in France over a 25 years period (1992-2016), 272 Forensic Sci. Inter. 72 (2017) (finding that the THC potency of both cannabis resin and herbal cannabis has increased from 1992 to 2016 in France); Femke Pijlman, et al., Strong increase in total delta-THC in cannabis preparations sold in Dutch coffee shops, 10 Addiction Biology 171 (2005) (finding that the THC potency of legal cannabis products in Dutch establishments "nearly doubled over 5 years"); But see Yacine Boumrah, et al., Hashish seizures in Algeria over the 2019-2020 period: The rise of potent hashish hybrids, 67 J. Forensic Sci. 889 (2022) (finding that the potency of seized cannabis products seized in Algeria stayed stable between 2019 and 2020); Raymond J. M. Niesink, et al., Potency trends of Δ9-tetrahydrocannabinol, cannabidiol and cannabinol in cannabis in the Netherlands: 2005– 15, 110 Addiction 1941 (2015) (finding a marginal decline in the potency of legal cannabis products in the Netherlands between 2005 and 2015); Jennifer McLaren, et al., Cannabis potency and contamination: a review of the literature, 103 Addiction 1057 (2008) (finding that cannabis potency has increased in the United States, Netherlands, United Kingdom, and Italy but not in the rest of Europe and New Zealand); See also Yukari Tsumura, et al., A survey of the potency of Japanese illicit cannabis in fiscal year 2010, 221 Forensic Sci. Inter. 77 (2012) (finding that illicit cannabis products in Japan "contained an average of 11.2% and a maximum of 22.6% THC"); Slade, supra note 2.

16: Manthey, supra note 15 (6.9% to 10.6% THC for herbal cannabis and 7.6% to 24.1% for cannabis resin).

17: France 24, Germany becomes the biggest EU country to legalise recreational cannabis, France 24 (2024), <u>https://www.france24.com/en/live-news/20240401-germany-gives-controversial-green-light-to-cannabis</u>.

18: Deborah S. Hasin, et al., Adult use of highly-potent Δ 9-THC cannabis concentrate products by U.S. state cannabis legalization status, 2021, 140 Addictive Behav. 1 (2023) (finding that the odds a cannabis user consumes concentrates – a type of cannabis product with high THC levels – is higher in states

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with both adult-use and medical legalization); Deborah S. Hasin, et al., Use of highly-potent cannabis concentrate products: More common in U.S. states with recreational or medical cannabis laws, 229B Drug Alcohol Depend. 1 (2021); Samantha Goodman, et al., Prevalence and forms of cannabis use in legal vs. illegal recreational cannabis markets, 76 Int'l J. Drug Pol'y 1 (2020) (finding that individuals in states with adult use cannabis markets were 1.4 to 1.8 times more likely to use high-potency concentrates or edibles than those in states without legal access and Canada); See also Smart, supra note 3.

19: Hasin. Supra note 18 at 3.

20: Hasin. Supra note 18 at 4.

