



Research Brief

Psilocybin

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LCB Research Program

The Research Program at the Washington State Liquor and Cannabis Board (LCB) is a non-partisan, transparent resource focused on public health and safety outcomes related to the products, policy, and regulation of alcohol, cannabis, tobacco, and vapor products.

Purpose

The Research Program received a request from leadership to examine the scientific literature on psilocybin. Topics covered in this brief include introductory information about psilocybin, therapeutic potential, challenging experiences, safety and dosing, adverse events, cultivation and production, testing, storage, policy options, current regulations, and future considerations. This brief is based on a review of existing evidence including scientific literature, government reports, policies, and other credible information sources.

This document does not represent an official position of LCB.

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lcb.wa.gov/research_program

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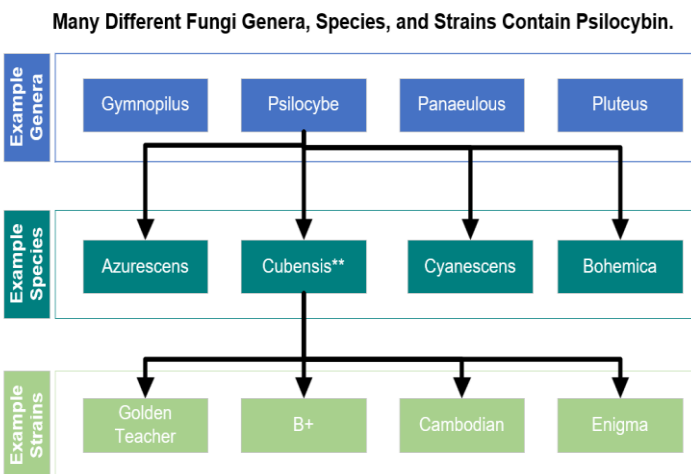
This research brief was written by members of the LCB Research Program. Subject matter experts from LCB, including the Public Health Education Liaison, provided review and feedback.

Background

Psilocybin (pronounced sigh-low-sigh-bin) is a psychoactive compound known for its psychedelic effects. It is found in more than 150 different types of mushroom species, commonly referred to as ‘magic mushrooms’ or ‘shrooms’.¹⁻² Most mushrooms containing psilocybin are within the *Psilocybe* genus (a ‘genus’ describes groups of different species that are related from a common descent).^{2,3} However, there are several known genera (plural for ‘genus’) outside of *Psilocybe* that also contain psilocybin (**Figure 1**).³ Even within the *Psilocybe* genus, there are many different species with diverse appearances, and all of them have psilocybin (**Figure 2**).

There is a long history of people using psilocybin-containing mushrooms. Prehistoric rock drawings and evidence from spiritual rituals in ancient civilizations illustrate use across human history.⁴ Indigenous people in the United States (U.S.), Canada, and Mexico have been using various psychedelics for religious ceremonies across thousands of years.⁴⁻⁶

Figure 1. Simplified Taxonomy of Psilocybin-Containing Fungi.³



Note: ***Psilocybe cubensis* is the only species allowed by both Colorado and Oregon.

Figure 2. Diverse Appearances of *Psilocybe* Species.²



Note: **Psilocybe cubensis* is the only species allowed by both Colorado and Oregon.

Although psilocybin is naturally found across various fungi species, it can also be synthetically produced.⁷⁻⁸ In the U.S., synthesized psilocybin was marketed in conjunction with psychotherapy in the 1960s under the trade name Indocybin.⁹ Psilocybin, in natural or synthesized form, was never formally approved by the Food and Drug Administration (FDA) and was placed as a Schedule 1 substance during President Nixon’s War on Drugs.¹⁰

Due to restrictions following the Controlled Substances Act, research comparing synthetic and natural forms of psilocybin is limited.¹¹ Currently, they are assumed to be fundamentally like one another.¹¹ It is possible, however, that psilocybin-containing mushrooms may produce different effects across different strains. It is also possible that natural and synthetic forms produce different effects. This is because there are other compounds within the mushroom that may change or contribute to the overall experience. This is often referred to as the synergistic theory.¹¹⁻¹² More research is needed on this topic.

Effects and Therapeutic Potential

When psilocybin is ingested, it is broken down into *psilocin*, the main active ingredient known to elicit subjective experiences.⁸⁻⁹ The effects typically begin within one hour, are strongest around two hours, and may last for six hours or longer.¹³⁻¹⁴ Common physiological effects include:

- Increased blood pressure;
- Increased body temperature;
- Increased pupil size;
- Increased heart rate;
- Reduced reaction time; and
- Impaired cognition and executive functioning.¹³⁻¹⁴

The subjective effects while intoxicated have often been described as ‘mystical experiences.’ These include:

- Feelings of awe;
- Spiritual experiences;
- Loss of personal identity;
- Out-of-body experiences;
- Insightfulness;
- Perceived changes in time and space;
- Feelings of interconnectedness; and
- Experiences that the self is one with the universe.^{7,13-14}

Research suggests these ‘mystical experiences’ can be therapeutic. Numerous studies indicate potential therapeutic effects of psilocybin for treating:

- Major depressive disorder and suicidality;
- Anxiety disorders (e.g., post-traumatic stress disorder, generalized anxiety disorder, distress from terminal diseases like cancer);
- Substance use disorders (e.g., alcohol, nicotine, opioid);
- Chronic pain (e.g., migraines, intractable pain); and
- Other treatment-resistant disorders.¹⁵⁻¹⁹

Outside of mystical experiences, one theory for why psilocybin may have therapeutic benefits is its ability to increase neuroplasticity (i.e., the brain’s ability to

rewire and reorganize itself), which then leads to changes in thoughts, moods, behaviors, and motivation.²⁰⁻²² Emerging research shows psilocybin-assisted therapy can have quick and sustained reductions in psychological distress that can be more effective than traditional talk therapy and medication.¹⁵⁻²² However, more research is needed, particularly among diverse groups of people. Psilocybin has been granted as a breakthrough therapy designation by the Food and Drug Administration (FDA).¹⁰

Outside of therapeutic uses, there is research suggesting psilocybin may also be beneficial for healthy populations for promoting self-acceptance, strong relationships, and finding meaning or purpose in life.²³ This may support additional purposes outside of psilocybin-assisted therapy and those with mental health problems.

Distressing Experiences and Safety

The effects of psilocybin can also be challenging and overwhelming, particularly when an individual does not feel psychologically and/or physically safe. Common challenging experiences include:

- Anxiety, fear, or dread;
- Grief;
- Confusion;
- Physical discomfort;
- Feelings of isolation;
- Paranoia;
- Psychotic-like symptoms; and
- Feeling as though one is dying.²⁴

One study from a nationally representative sample of U.S. adults found that almost 40% of people who had used any psychedelic at some point in their life had a challenging or distressing experience from their use.²⁵ About 3% sought professional help because of this experience.²⁵ Another study examining challenging experiences specific to psilocybin indicated that about 40% of people said it was among the top five most challenging experiences of their life.²⁶

To minimize distressing experiences, it is critical to establish a safe environment. This is often referred to as ‘set and setting,’ which describes an optimal mental state and physical location before engaging in a psychedelic experience.²⁷ This is one reason why pre-treatment or preparation sessions are important to help people create relaxation techniques, mindfulness skills, intention setting, and therapeutic rapport with their facilitator/therapist.²⁷

Importantly, not all challenging experiences are considered “bad.” These experiences are expected to happen when using psychedelics to heal from ongoing psychological distress.²⁸ However, if the distress is prolonged and unable to be managed, it may contribute to worse outcomes. This is why, when psychedelics are being used to treat severe mental health problems, having a skilled, properly trained professional to guide a person through this process is critical.²⁸⁻²⁹

Dosing

Most research to date has administered either weight-adjusted doses or fixed doses.^{8,20} There is mixed evidence as to if one dosing procedure is more optimal than another. Most research suggests that 20 to 30 mg of psilocybin produces therapeutic effects, regardless of weight.^{8,20} However, treatment-resistant patients may respond better at higher doses. **Table 1** provides current dosing ranges among research trials.²⁰ Typically, only one or two dosages within a specified treatment window (e.g., 4 weeks) can provide symptom reduction.¹⁵⁻²²

Table 1. Dosing Ranges.²⁰

	Typical Dose	High Dose	Supra-Therapeutic Dose
Psilocybin (extracted or synthetic)	25 mg	35 mg	50-60 mg
Dried whole or powdered mushroom	2.5 grams	3.5 grams	5-6 grams

Note: Conversion assumes 1% of psilocybin per 1 gram of dried Psilocybe cubensis mushroom.

Current Trends

Today, about 10% of U.S. adults report using of psilocybin sometime in their life.³⁰ In Washington, about 6% of people between 16 and 65 years old reported using psilocybin within the past year.³¹ About half report using for both medical and non-medical purposes.³¹ Some research suggests psilocybin use is more common among college-educated and Non-Hispanic White individuals.³⁰

Potential Adverse Events

Most national studies indicate low rates of long-term harm, with the most frequent adverse events after psilocybin being headaches, nausea, anxiety, dizziness, and increased blood pressure.³²⁻³³ Most of these adverse experiences were manageable and resolved within two days after use.³³

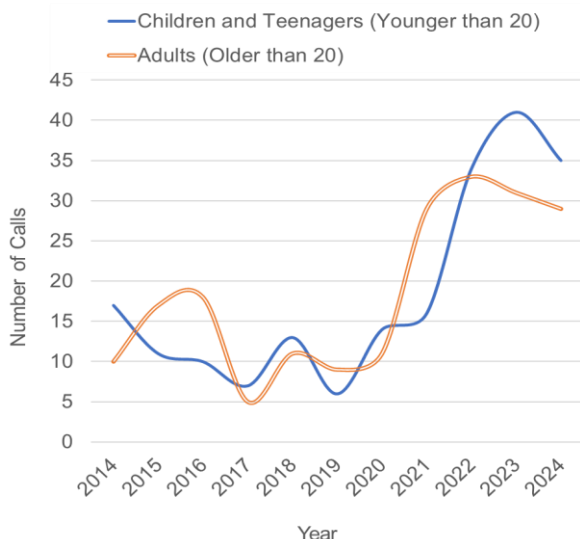
Psilocybin typically accounts for less than 0.1% of all drug-related emergency department visits in the U.S. each year.³² In 2023, 0.2% of U.S. individuals met criteria for a hallucinogen use disorder, which includes any psychedelic substance (e.g., psilocybin, LSD, ecstasy, ketamine, etc.).³⁴ This is compared to about 10% of individuals meeting criteria for an alcohol use disorder.³⁴

Hallucinogen Persisting Perception Disorder (HPPD) is another potential adverse outcome characterized as continued

perceptual disturbances, hallucinations, and flashbacks that can last for months or years after a psychedelic experience.³⁵⁻³⁶ However, this disorder appears to be extremely rare within controlled clinical settings.³⁷

Poison call centers in the U.S. have shown increases in adolescent (13 to 19 years old) and young adult (20 to 25 years old) cases between 2019 and 2022.³⁸ Data from Washington State show a similar trend across all age groups (**Figure 3**).³⁹

Figure 3. Washington Poison Calls Related to Psilocybin.³⁹



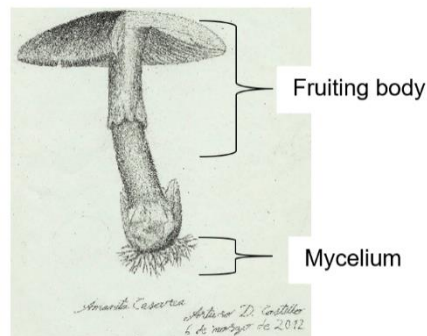
Note: These are total numbers and not adjusted for population size.

Cultivation

There is limited science on the optimal conditions for growing psilocybin-containing mushrooms. The species *Psilocybe cubensis* has been the most researched to date, in part due to the relative ease of cultivation and its ability to produce high amounts of psilocybin.³ Generally, this type of fungi thrives in high humidity environments with ample hydration.³ However, various strains of *Psilocybe cubensis* and other psilocybin-containing mushrooms may need different environments for optimal yield.

Natural cultivation typically involves one of two main production methods; fruiting body cultivation or mycelium cultivation.³ Fruiting body refers to the reproductive structure (i.e., what is commonly called a 'mushroom'). Mycelium refers to the root-like vegetative body (**Figure 4**). Each method has its own advantages and disadvantages. For example, fruiting body cultivation can produce greater psilocybin concentrations, but they are labor intensive, time consuming, and inconsistent across grows.³ Mycelium cultivation is easier to standardize, has more consistent growth patterns, and is quicker to produce.³ However, mycelium often has lower concentrations of psilocybin and involves more equipment.

Figure 4. Fruiting body vs. Mycelium.⁴⁰



Note: This drawing does not illustrate a psilocybin-containing fungi. However, the structure is similar.

All mushrooms are delicate to produce. Preventing contamination is critical, especially since the humid environment needed for cultivation can easily produce illness-causing bacteria, such as *Listeria*.⁴¹ There are also several fungi contaminants known to be a risk to people when consumed. These include, heavy metals, and pesticides that can impact crops at different stages of growth.⁴¹⁻⁴²

Best practices for natural cultivation include:

- Ensuring hygiene standards for workers;
- Regular monitoring for pests and standard pest management protocols;

- High water quality with no detectable *E. coli* (*E. coli*);
- Proper cleaning and sanitation of work surfaces and tools;
- Regular sanitation of the grow room, including floors, cracks, drains, pipes, etc.; and
- Proper refrigeration.⁴¹

Mushrooms do best as a local crop, where they do not need to be transported long distances.⁴¹ Given how delicate mushrooms are to cultivate, some scientists believe growing psilocybin-containing mushrooms from natural sources has limited economic and scaling feasibility.⁴³⁻⁴⁴

Synthetic Production

Most clinical research trials on the therapeutic effects of psilocybin have used synthetic sources.⁴⁴ This has been due to the increased ability to produce standardized batches that meet strict regulatory criteria, and the ability to develop large enough quantities to support clinical trial requirements.⁴⁴ There are several different syntheses (methods to create synthetic psilocybin), one of the most common being the Speeter-Antony tryptamine synthesis.⁴⁴ Synthetic production can be complex but various methods are continuing to develop.⁴⁴

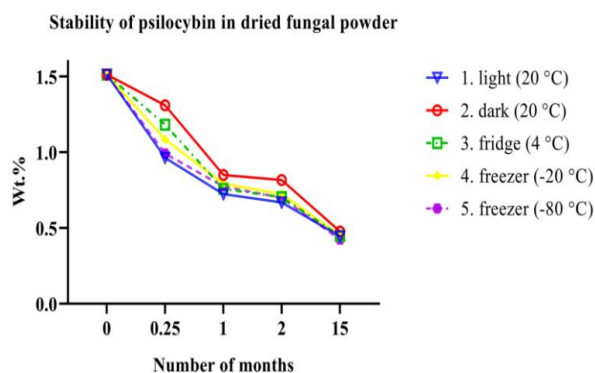
Testing

There are several testing methods available to identify psilocybin and specific strains. The most common technique is high-performance liquid chromatography (HPLC) coupled with ultraviolet (UV), fluorescence, or mass spectrometry.³ Different techniques have unique advantages and disadvantages. For example, HPLC-UV methods are known to have low limits of detection (LOD; the ability to detect psilocybin at low levels). Liquid chromatography mass spectrometry is considered an ideal choice for high precision quantification of psilocybin and its analogs.³

Storage Conditions

Proper storage is critical as the concentration of psilocybin can rapidly decrease (Figure 5).⁴⁵ Generally, the most suitable storage conditions are to dry the mushrooms and store in the dark at room temperature (e.g., 68 degrees Fahrenheit).⁴⁵ Best practice is storing in an inert gas environment.⁴⁵

Figure 5. Concentrations of psilocybin decrease across time.⁴⁵



Policy Options

There are many policy options to consider as governments begin to legalize psilocybin and other psychedelic substances. Policy options exist within three general areas:

- 1) The extent to which psilocybin is intended for therapeutic purposes;
- 2) The extent to which psilocybin is able to be legally grown, used, and sold; and
- 3) The extent to which there is an organized structure that regulates and enforces laws.⁴⁶

Among the three policy areas, there are six unique options that have been identified:

- 1) *Unregulated personal use*, where those who use are doing so outside of legal regulations (current law in most states);
- 2) *Authorized adult use*, where personal use is legal but there is no regulatory structure to commercialization;
- 3) *Regulated adult use*, where personal use is allowed and there are regulations on cultivation and sales;
- 4) *Regulation-engaged religious use*, where use of psilocybin in religious contexts is allowed;

- 5) *State-regulated therapeutic use*, where psilocybin is allowed only for therapeutic intent, and where cultivation and sale are only for medical use; and
- 6) *FDA regulated medical use*, which would allow for interstate commerce and federal approval of psilocybin as a medicine.⁴⁶

Current U.S. State Regulations

Psilocybin is illegal in most U.S. states. Some cities have passed measures to decriminalize psilocybin. Currently, Oregon and Colorado are the only states that have legalized psilocybin in some form. Both states focus on therapeutic use, restrict access to people who are at least 21 years old, and require that products are from the *Psilocybe cubensis* species only.^{47,48} Both states also have multiple license types including cultivation, testing, and service center licenses.

In 2020, Oregon legalized psilocybin and has 10 manufacturers, one testing lab, and 28 licensed service centers currently listed on their website.⁴⁷ Cultivation licenses allow the production of whole dried mushrooms, ground homogenized fungi, extracts, and edible products.⁴⁷ Cultivators may not possess more than 200 grams of psilocybin analyte. They must conduct sample testing within 180 days of harvest to confirm the presence of the specific *Psilocybe cubensis* mushroom type, concentration levels of psilocin and psilocybin, and solvents.⁴⁷ Products are not required to be tested for pesticides, microbial contaminants, or metals unless there is a written request by the state.⁴⁷ Oregon mandates all psilocybin be used only at a licensed service center.⁴⁷ Service centers must get a Land Use Compatibility Statement from their local governmental jurisdiction and must be located at least 1,000 feet from a school.⁴⁷

Colorado legalized psilocybin in 2023 and is currently in the process of allocating licenses.⁴⁸ Their legalization structure allows for personal and therapeutic use. Personal use laws allow adults to cultivate

their own psilocybin mushrooms in a maximum of a 12x12 foot space.⁴⁸ Adults may share, but not sell, what they grow.⁴⁸ In contrast, regulated psilocybin is only available at Healing Centers or other approved locations.⁴⁸

Colorado has two cultivation licenses, which are based on storage capacity.⁴⁸ Standard Cultivation Licenses are able to store up to 5 kilograms (about 11 pounds) of dried mushrooms on-site (mycelium, spores, and growing fruiting bodies are not included).⁴⁸ Micro-Cultivation Licenses allow up to 750 grams (less than 2 pounds) of dried mushrooms on-site.⁴⁸

Colorado also allows product manufacturers to make either (1) teabags or capsules or (2) extract psilocybin into products like chocolate, gummies, or tinctures. Each harvested lot must be tested in a certified testing facility for psilocybin, psilocin, and other natural compounds (i.e., baeocystin, aeruginascin, and norbaeocystin).⁴⁸ The product must be tested once every nine months.

Finally, Colorado has two types of service centers. The first is called a “Healing Center” and they are allowed an unlimited amount of psilocin as long as they meet specific security requirements. The second is called a “Micro-Healing Center” and they are allowed no more than 750 mg of total psilocin (about 10 grams of dried mushrooms) and have reduced security requirements.⁴⁸

Colorado’s new law allows for the possible expansion of psychedelic substances outside of psilocybin (e.g., ibogaine, mescaline) if recommended by the state’s advisory board.⁴⁸ Discussions to allow synthetic psilocybin are also occurring among the legislature.⁴⁹

Packaging and Labeling

Both Colorado and Oregon have requirements that product packaging may not be appealing to those under 21 years

old.^{47,48} Other requirements or recommendations include package labeling of:

- Total psilocybin and/or psilocin content in milligrams or weight percent;
- A list of ingredients used to manufacture the product;
- No safety or health benefits claims;
- Date content analysis was performed;
- Intended use;
- Dosage instructions;
- Warnings;
- Lot number and expiration date;
- Child-resistant packaging;
- Tamper resistant seals; and
- Large, readable-sized font.^{47,48}

Regulatory Considerations

There are several possible risks that may prevent successful psilocybin regulation.

First, there are many types of mushrooms that contain psilocybin and many ways to synthetically produce psilocybin.⁵⁰ This may allow for increased product availability outside of the regulated market as the industry grows.⁵¹

Second, psychedelics have existed within indigenous cultures for centuries. It is important to consult with communities who have traditionally used these substances in order to create thoughtful regulatory policies that are culturally sensitive.^{4-6,52}

Third, newly regulated markets have high startup and maintenance costs. For example, Oregon requires annual fees of \$10,000 for each manufacturer and testing lab.⁴⁷ Licensed facilitators must pay an annual licensure fee of \$2,000.⁴⁷ Without appropriate support mechanisms, these financial hurdles may disproportionately impact smaller businesses.

Fourth, in addition to the fees for participating in the legal market, the cost of psilocybin-assisted therapy can be prohibitive.⁵² It is important to identify best funding models to ensure this treatment can

be accessible regardless of socioeconomic status. Alternative therapeutic approaches may also be an option. For example, policies allowing group therapy rather than individual therapy can reduce costs and support access.⁵³

Fifth, safety is key, especially when considering the use of psilocybin for treatment of a severe mental health condition, such as suicidality. People with these health conditions are at-increased risk for having challenging experiences when using psilocybin.⁵² Regulations should take all precautions to ensure that facilitators are well-trained health professionals (e.g., psychologists and psychiatrists) who are equipped to work with populations being treated and psychedelics.

Sixth, there are many other psychedelics outside of psilocybin, both natural (e.g., ibogaine, mescaline) and synthetic (e.g., LSD, MDMA), that have therapeutic potential.⁴⁶ Determining if there will be pathways for future legalization of these substances is important, particularly as research continues to grow in this area. For example, Colorado has developed an advisory board which will recommend if other psychedelics should be allowed in the future.⁴⁸

Finally, there appear to be uses for psilocybin outside of clinical populations by healthy adults.^{23,54} Risk of misuse and adverse outcomes are low, but do exist.^{32,34} As psilocybin legalization increases across the U.S., personal use of psilocybin outside of a clinical setting may become popular and adverse outcomes may also increase.

As future policies are considered, it is important to further research the potential positive and negative impacts of on public health and economic outcomes.

Suggested Citation

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