

CITY OF EASTHAMPTON

Department of Public Health — Board of Health Literature Review

Kratom (*Mitragyna speciosa*) in Massachusetts:

A Literature Review on Chemistry, Manufacturing, Retail Practices, and Public Health

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1. Botanical Overview and Traditional Use

Kratom is derived from ^[1]*Mitragyna speciosa*, a tropical evergreen tree of the Rubiaceae (coffee) family native to Southeast Asia, including Thailand, Malaysia, Indonesia, Myanmar, and Papua New Guinea. The tree commonly grows to heights of 25 meters in humid, tropical forest environments. Its dark, glossy leaves have been used in traditional folk medicine for at least the past century, and informal accounts suggest use dating further back in agrarian communities of the Malay Peninsula and southern Thailand.

In its region of origin, kratom was consumed primarily by laborers who chewed fresh leaves or brewed them as tea to manage physical fatigue, pain from fieldwork, and as a substitute for opium where that drug was scarce or expensive.^[2] Traditional use typically involved modest doses of whole, unprocessed leaf material — a form of ingestion substantially different from the concentrated commercial products now marketed in the United States.

Kratom arrived in Western markets in the 1980s and 1990s but remained a niche product until the mid-2000s, when its use began growing substantially, driven in part by internet retail and the onset of the prescription opioid crisis. By 2021, the Substance Abuse and Mental Health Services Administration (SAMHSA) estimated that approximately 1.7 million Americans aged 12 and older had used kratom in the preceding year, though researchers note that true prevalence is likely higher given underreporting.^[3] Some estimates place the current U.S. consumer base at up to 15–16 million users and the retail market at approximately \$2 billion annually.^[4]

2. Chemical Properties and Pharmacology

2.1 Alkaloid Composition

Kratom contains more than 54 identified alkaloids.^[5] The two most pharmacologically significant are mitragynine and 7-hydroxymitragynine (7-OH). Mitragynine is the most abundant alkaloid, comprising up to 66% of total alkaloid content in Thai-sourced leaf, and is classified in the scientific literature as an indole alkaloid of the corynanthe structural type.^[6] 7-OH is present at only trace levels in natural kratom leaf (generally under 2% of total alkaloids) but demonstrates

substantially greater potency at mu-opioid receptors than mitragynine — estimated at 10 to 20 times more potent — making it a particular focus of regulatory concern.^[7]

The alkaloid profile of any given kratom sample is highly variable. Concentrations of mitragynine in commercially available products have been found to range from 2.76 to 20.05 mg/g, a more than sevenfold variation. This variability is driven by plant age, geographic origin, growing conditions, post-harvest drying methods, and processing technique — and is a central challenge for both consumers trying to self-dose and regulators attempting to set safe limits.

2.2 Mechanisms of Action

Mitragynine and 7-OH are both partial agonists at the mu-opioid receptor (MOR), the same receptor targeted by opioid analgesics such as morphine. However, kratom alkaloids also interact with a diverse array of other receptor systems, including adrenergic, serotonergic, dopaminergic (D2), and adenosine receptors — a pharmacological complexity that distinguishes kratom from classical opioids.^[8] This mixed receptor profile produces dose-dependent effects: at low doses (approximately 1–5 grams of raw leaf), users typically report mild stimulant and mood-enhancing effects; at higher doses (above 5 grams), effects shift toward sedation and analgesia characteristic of opioids.^[9]

Importantly, available research suggests that kratom alkaloids demonstrate functional selectivity for G-protein signaling, with relatively weak recruitment of the beta-arrestin pathway — the mechanism largely responsible for opioid-associated respiratory depression, constipation, and sedation.^[10] This pharmacological distinction is the basis of scientific debate about whether kratom poses classical opioid overdose risk. The FDA has taken the position that the opioid-like risk profile warrants the same level of caution; independent researchers present a more nuanced view. The scientific consensus is that more clinical research is needed.^[8]

2.3 Dose-Dependent Effects

Based on human self-report surveys and observational studies, kratom's effects follow a consistent dose-response pattern. The absence of standardized dosing in commercial products makes translating these ranges to real-world product use difficult:

- Low doses (1–5 g raw leaf equivalent): Mild stimulation, increased alertness, elevated mood, reduced fatigue. Effects onset within 5–10 minutes and last 1–2 hours.
- Moderate doses (5–10 g): Sedation, analgesia, anxiolysis, mild euphoria. Duration 2–5 hours.
- High doses (>10 g): Pronounced opioid-like sedation, nausea, dizziness, increased risk of adverse events including seizure, psychosis, liver toxicity, and — particularly when combined with other substances — overdose.

The absence of standardized dosing in commercial products is a critical public health gap. One 2021 PMC study found that mitragynine levels in commercial kratom beverages varied from 2.76 to 20.05 mg/g, and that the number of advertised servings per container ranged from 1 to 15 — creating substantial risk of unintentional overdose.^[11]

2.4 Potential Medicinal Properties: State of the Evidence

The FDA has not approved kratom for any medical use, and the agency states explicitly that "there is no evidence that kratom is safe or effective for treating any condition."^[3] At least six kratom products submitted to FDA as new dietary ingredient notifications have been rejected.^[12]

Despite this regulatory posture, a growing body of preclinical and observational research has explored kratom's potential utility for pain management, opioid use disorder (OUD), and mood disorders. A 2024 systematic review in *Frontiers in Pharmacology* by Henningfield, Grundmann, Huestis, and Smith synthesized several hundred papers and concluded that many kratom users report improved health, wellbeing, and quality of life, consistent with preclinical evidence of analgesic and anti-withdrawal effects.^[8] However, the same review emphasized that self-report data cannot substitute for controlled clinical trials, and that no kratom product has demonstrated safety and efficacy to FDA standards.

The WHO's Expert Committee on Drug Dependence conducted a pre-review of kratom in 2021, concluding that while medical and scientific use cases exist, insufficient evidence was available to recommend scheduling under international conventions.^[13] Numerous researchers have noted that kratom use in the United States has grown precisely in the context of the opioid crisis, with many users reporting that kratom serves as a self-managed harm-reduction strategy to manage pain or reduce dependence on prescription opioids or illicit fentanyl.^[14]

The literature presents three distinct positions that a board of health should understand: (1) regulatory/clinical authorities (FDA, DEA, Mayo Clinic) emphasize risk, lack of approval, and opioid-like dependence potential; (2) independent academic researchers emphasize a more nuanced risk profile, potential utility, and the urgent need for regulation rather than prohibition; and (3) industry-affiliated researchers and advocacy groups emphasize consumer autonomy and harm reduction framing. A balanced reading of the peer-reviewed literature supports caution while acknowledging genuine scientific uncertainty.

3. Natural Kratom vs. Manufactured and Adulterated Products

3.1 Traditional vs. Commercial Forms

Traditional kratom use — chewing fresh leaves, brewing dried leaf tea — involves whole plant material at relatively modest doses. Commercially available products in the United States are a substantially different category. Kratom is imported primarily from Indonesia, Malaysia, and Thailand as dried leaf powder, then manufactured domestically (primarily in Florida) into capsules, tablets, loose powder, concentrated liquid extracts, beverages, gummies, vape extracts, and shots.^[15] The extract and beverage categories are of particular concern because they concentrate alkaloids far beyond what traditional use would entail.

Research specifically notes that products purchased online contain higher concentrations of psychoactive alkaloids than the natural plant.^[16] A 2022 PMC study using UPLC-HRMS found that mitragynine content in commercial products ranged from 13.9 to 270 mg/g — a near-20-fold range — while US-grown specimens showed a comparably high mitragynine content, suggesting that American cultivation is beginning to produce high-alkaloid material as well.^[17]

3.2 7-OH: From Trace Constituent to Commercial Product

7-hydroxymitragynine (7-OH) occurs naturally in kratom leaf at under 2% of total alkaloids. However, 7-OH is increasingly concentrated, isolated, or synthesized and sold as a standalone

product. The FDA stated in July 2025 that 7-OH poses serious public health risks and should be classified as a Schedule I controlled substance, and it is the target of multiple pending state prohibitions.^[7] Pending Massachusetts legislation tracks this concern, with multiple proposals targeting products where 7-OH content exceeds 2% of total alkaloid composition.

Semisynthetic 7-OH products — derived by chemically oxidizing mitragynine — are often labeled simply as "kratom" or "botanical mitragynine" in a manner that obscures their true composition.^[11] This mislabeling is a distinct public health hazard because consumers have no reliable means of distinguishing a product containing 2% natural 7-OH from one containing 40% semisynthetic 7-OH.

3.3 Contamination: Microbial and Heavy Metal Hazards

Multiple independent studies have identified contamination of commercial kratom products with heavy metals and pathogenic bacteria. In 2018–2019, FDA testing of 30 commercial kratom products found significant levels of lead and nickel at concentrations exceeding safe oral daily drug intake thresholds.^[18] A 2020 study published in the *International Journal of Environmental Research and Public Health* by Prozialeck et al. found that all raw leaf kratom products purchased from Chicago-area smoke shops contained potentially dangerous levels of nickel, lead, and chromium, while processed extracts showed lower metal contamination but potentially different risk profiles.^[19]

A 2018 multistate *Salmonella* outbreak linked to kratom products was investigated by the CDC and FDA, resulting in 199 confirmed illnesses across 41 states, with 54 hospitalizations.^[20] *Salmonella* was detected in 33 of 66 (50%) tested kratom samples during the investigation. A subsequent three-year monitoring study (2022–2024) in the Czech Republic found *Salmonella* in 16 of 96 kratom samples, with multiple isolates demonstrating antimicrobial resistance, underscoring that contamination risk is ongoing.^[21]

These contamination risks are attributable in part to the conditions in which kratom is grown and minimally processed. Possible pathways include animal-based fertilizer, tainted irrigation water, and inadequate sanitation during manufacturing. The heavy metal content may reflect elevated lead and nickel concentrations in Southeast Asian and Indonesian soils where the trees are cultivated.^[19] Without mandatory good manufacturing practices (GMP), microbial safety testing, or batch traceability requirements, no systematic safeguards exist at the federal level.

3.4 Adulteration with Pharmaceutical Drugs

Research has documented cases of kratom products adulterated with opioids, benzodiazepines, and other controlled substances, as well as instances of products labeled as "kratom" that contained synthetic or semi-synthetic kratom analogs not derived from the plant.^[19] Adulteration with opioids such as oxycodone or fentanyl would substantially increase both analgesic potency and dependence liability — potentially without any indication to the consumer. Some kratom products have also been found to be labeled "not for human consumption" or sold under categories such as "potpourri" or "incense" while being marketed and purchased for ingestion, a pattern the FDA has documented.^[3]

4. Manufacturing, Retail Distribution, and Point-of-Sale Practices

4.1 The Manufacturing and Supply Chain

The United States kratom industry is largely unregistered and fragmented. According to the FDA, the entities that manufacture and distribute kratom "are not usually registered with FDA, may operate out of residences, and distribute kratom through sales made on the internet, social media, smoke/vape shops, other small stores, or by using the mail."^[3] Kratom is imported as a raw botanical — primarily dried leaf powder — from Southeast Asia, then processed domestically into a range of consumer product formats.

Because the FDA has concluded that kratom is not lawfully marketable as a dietary supplement, drug product, or food additive, the industry technically operates without a lawful regulatory framework at the federal level.^[12] Voluntary good manufacturing practice (GMP) certifications issued by trade groups such as the American Kratom Association provide some quality differentiation, but such certifications are neither required nor federally verified.

4.2 Retail Channels and Store Placement

Kratom is available through a diffuse, largely unregulated retail network. A 2023 telephone survey of tobacco specialty stores across the United States found that 72% sold kratom, and in 21 states at least 90% of such stores reported selling it.^[22] A 2023 California study of vape shops found kratom available in 62.4% of stores surveyed, with availability highest (81.1%) in combined vape-and-smoke shops.^[16]

In gas stations, convenience stores, and smoke shops, kratom products are commonly positioned behind or near the point-of-sale counter — a placement traditionally used for tobacco, lottery, and impulse-purchase items. This placement maximizes visibility and accessibility, and shares space with products like energy drinks, vaping supplies, and tobacco.^[23] There is no federal or Massachusetts state requirement that kratom products be stored separately, placed out of reach of minors, or kept behind a locked case.

4.3 Product Formats, Dosing, and Packaging

Commercially available kratom products in the U.S. include:

- Loose powder: Sold in bags ranging from 28 g to 1 kg. Requires consumer self-dosing, with no standardized measure.
- Capsules and tablets: Typically marketed as dietary supplements. Capsule counts range from a single-dose packet to bottles of 100+. Mitragynine content per capsule is often unstated or unreliable.
- Liquid extracts and shots: Typically, 2-oz bottles concentrated to deliver high alkaloid doses. These have surpassed some leading energy drinks in convenience store sales velocity.
- Beverages: 12-oz canned drinks sold for approximately \$8. Mitragynine levels are often not disclosed, and serving size disclosures may indicate between 1 and 15 servings per container.
- Gummies and edibles: A newer and growing format, frequently appealing to younger consumers.

Dosing inconsistency is a major documented hazard. The 2021 PMC analysis of 16 commercial kratom products found that mitragynine levels ranged from 2.76 to 20.05 mg/g, and that products frequently omit or obscure quantitative alkaloid content.^[11] Health officials have noted that dosing

in commercially available products is often inconsistent or poorly labeled, making it difficult for consumers to know how much they are ingesting.^[24]

Pricing is accessible and may reduce barriers for adolescents: a 90-capsule package typically retails for approximately \$26, while a canned kratom beverage sells for approximately \$8.^[24]

4.4 Marketing Strategies and Youth Appeal

The marketing of kratom products employs several strategies associated with youth-oriented product promotion. Researchers and public health officials have identified the following patterns:^{[22][25][26]}

- "Natural" and "plant-based" branding: Products are routinely marketed as herbal supplements, plant tonics, or all-natural remedies. This naturalistic framing exploits the documented "health halo effect" — the tendency of consumers, including young people, to associate natural labeling with safety. Health officials in multiple jurisdictions have specifically cautioned that "natural does not mean safe."
- Flavored beverages and edibles: Kratom is increasingly sold in fruit-flavored beverages, gummies, and candy-adjacent formats. Public health researchers have explicitly drawn comparisons to the e-cigarette industry's use of flavors to recruit young and non-traditional users.
- Bright, colorful packaging: A prevention specialist from Dallas described gas station kratom displays as using "bright colors" and "eye-level" placement that "attract the visual of a kiddo."
- Social media and influencer marketing: Kratom companies have used social media platforms and podcast influencers to market products as alcohol alternatives, wellness supplements, and sobriety aids. One prominent brand, Botanic Tonics (Feel Free), was marketed by podcast personalities to audiences seeking sober alternatives — a demographic that includes young adults and people in recovery.
- "Sober alternative" and wellness positioning: Products have been marketed as healthy alternatives to alcohol, targeting young professionals, athletes, and people in recovery. One brand marketed its product with a "Cheers to a Dry January" banner.
- Limited or absent warnings: Until recently, many products lacked addiction warnings, age restrictions, or disclosure of psychoactive alkaloid content. A landmark class action lawsuit settled in September 2024 for \$8.75 million found that one kratom beverage brand had failed to disclose how much kratom was in each bottle or alert consumers to risks of taking the substance in large quantities.

Adolescent exposure data, though limited, is concerning. The 2019 National Survey on Drug Use and Health found that approximately 70,000 adolescents reported regular kratom use.^[25] That figure has almost certainly grown since 2019. Research links adolescent kratom uses with co-use of cannabis and tobacco, raising concerns about polydrug initiation.^[26]

5. Public Health Challenges: Evidence and Community Experience

5.1 Adverse Health Effects

The FDA's documented adverse event reports associated with kratom include liver damage, seizures, respiratory depression, cardiac arrhythmia, psychiatric disturbance (including psychosis), neonatal abstinence syndrome in infants born to mothers who used kratom, and death.^[3] Poison control center calls about kratom increased tenfold from 2010 to 2015, from 26 to 263 cases.^[27]

A 2024 study published in *Frontiers in Psychiatry* analyzing coroner data from Kern County, California found kratom present in 4 of 214 opioid-related accidental overdose deaths in 2020. In all four cases, at least one additional substance was present, including fentanyl in three of the four cases.^[28] The polydrug context of most kratom-associated deaths is important: the literature generally suggests that kratom alone rarely causes fatal respiratory depression, but that kratom combined with opioids, benzodiazepines, or alcohol substantially elevates overdose risk.^[8]

Physical dependence and withdrawal are well-documented, though researchers emphasize that withdrawal severity is generally lower than classic opioid withdrawal. Symptoms include muscle aches, insomnia, irritability, nausea, and anxiety. Users who have developed significant physical dependence may require medical management, including in some cases treatments used for opioid addiction such as buprenorphine.^[29]

5.2 The Regulatory Vacuum and Its Consequences

Kratom occupies a profound regulatory gray zone. It is not approved by the FDA as a drug, dietary supplement, or food additive, yet it is sold as all three in various products. The FDA lacks adequate enforcement resources to address the complex, fragmented supply chain. At least six kratom products submitted as new dietary ingredient notifications have been rejected, yet the product continues to be sold.^[12]

At the state level, the resulting patchwork has placed the enforcement burden on local boards of health, which typically lack the laboratory testing capacity, legal infrastructure, and staff resources to systematically monitor and enforce product standards.^[23] There is no mandatory age verification for kratom purchases in most jurisdictions, no required alkaloid disclosure, no standardized warning label, and no batch traceability requirement that would enable rapid response to contamination events similar to the 2018 Salmonella outbreak.

5.3 Community-Level Public Health Actions in Massachusetts

Massachusetts communities have been at the forefront of local kratom regulation. The CDC's overdose prevention program specifically documented the Belchertown, MA experience: in January 2024, the Belchertown Board of Health voted to ban kratom, synthetically derived cannabinoids, and delta-8 THC products after a local Drug-Free Communities coalition presented findings from retail inspections and scientific research.^[30] This was the first municipal kratom ban in the Commonwealth.

Dracut, Lowell, North Attleborough, and Canton followed with their own regulations. Northampton — adjacent to Easthampton — enacted a targeted ban on synthetically derived kratom products effective October 2025, while permitting natural whole-leaf products, citing public health concerns about altered alkaloid profiles. A South Shore regional analysis published in October 2025 identified a meaningful "displacement" effect, in which municipal bans drive consumers and retail sales to neighboring, unregulated communities.^[23]

5.4 The Opioid Crisis Context

The rise of kratom in U.S. markets has closely tracked the opioid epidemic. A 2021 review in *Frontiers in Psychiatry* (Prozialeck et al.) documents that kratom use grew substantially after 2015, when regulatory efforts to restrict prescription opioid prescribing resulted in increased use of illicit opioids and heightened demand for alternatives to manage both pain and withdrawal.^[14]

This context creates a genuine tension for public health practitioners. On one hand, many kratom users are self-managing pain or opioid dependence and may have few accessible alternatives; aggressive prohibition could displace this population toward more dangerous substances. On the other hand, the absence of quality control, age restrictions, dosing standards, and warning labels creates conditions for a new population — including adolescents and young adults with no prior opioid history — to develop dependence on an opioid-acting substance without clinical support or supervision.

The literature broadly supports a regulated access model over either unregulated availability or outright prohibition, with mandatory alkaloid disclosure, 7-OH concentration limits, age restrictions, standardized labeling, and batch-traceable quality control as the most evidence-aligned regulatory tools available at the local level within Massachusetts' Board of Health authority framework.

6. Summary of Key Findings

This review draws on peer-reviewed pharmacology and public health literature, federal agency publications (FDA, CDC, DEA, WHO), credible investigative journalism, and municipal regulatory precedents to offer the following summary for the Board's consideration:

- **Botanical identity:** Kratom is a Southeast Asian tree whose leaf contains 54+ alkaloids. Its primary active compounds (mitragynine, 7-OH) act on opioid receptors and produce dose-dependent stimulant to sedative effects. It is chemically distinct from classic serotonergic entheogens and pharmacologically more similar to partial opioid agonists.
- **Natural vs. commercial:** Traditional kratom use involved whole leaf at modest doses. U.S. commercial products are often concentrated, adulterated, or formulated with semisynthetic 7-OH, representing a substantially different and less understood risk profile.
- **Manufacturing hazards:** Commercial kratom products have documented contamination with *Salmonella* and heavy metals (lead, nickel, chromium). No mandatory federal quality standards, GMP requirements, or batch traceability exist.
- **Retail environment:** Kratom is predominantly sold at gas stations, convenience stores, and smoke shops — with no age verification requirement in Massachusetts — in formats including brightly packaged beverages, gummies, and shots that public health researchers have compared to youth-appealing e-cigarette marketing strategies.
- **Youth risk:** Colorful packaging, fruit flavors, social media influencer marketing, and "natural" wellness branding create documented risk of adolescent exposure. An estimated 70,000 adolescents reported regular kratom use in 2019, a figure believed to have grown substantially.
- **Overdose and death:** Kratom alone carries lower fatal overdose risk than classical opioids, but the combination of kratom with fentanyl, benzodiazepines, or alcohol is documented in overdose deaths. Enhanced and synthetic 7-OH products are of greater concern.

- Massachusetts landscape: State kratom regulation remains stalled, creating a local enforcement vacuum. Multiple Massachusetts communities have used Board of Health authority under G.L. c. 111, §31 to regulate or ban kratom. A regional displacement effect has been documented as bans in one community shift sales to adjacent unregulated areas.

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