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ORIGINAL ARTICLE

Dynamic Topic Modeling of Kratom Use and Experiences: Insights on 13 Years of Reddit Discussions

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Abstract
Traditionally used in Southeast Asia for common ailments, kratom (*Mitragyna speciosa*) is increasingly being adopted in other regions for the self-treatment of pain and mental health issues (e.g., anxiety, depression, and substance use disorder) in absence of clinical supervision and with several toxicities. To gain better insight into the experiences, the motivations, and the patterns underlying kratom use, previous studies have analyzed material shared among users on social media. However, these investigations often employed manual labeling and categorizations, which constrain scalability and make it difficult to analyze larger datasets. The present work aimed to further enhance the current knowledge in the field by utilizing a natural language processing approach (BERTopic) to extract prominent topics of discussion from a large dataset of kratom-related Reddit posts made between 2010 to 2023 ($n = 188{,}139$ posts). Dynamic Topic Modeling was also implemented to analyze how discussions about these topics evolved over time. From the results, users discussed topics including usage of other substances for unsupervised management of kratom withdrawal symptoms, drug testing for kratom use, kratom consumption methods, logistic issues (e.g., bringing kratom on flights and receiving kratom via mail), tapering off the use of kratom, and providing support to others who are in the process of quitting kratom. The current study supports the need of clinical trials as well as new ecological insights into experiences of kratom users, while supporting the implementation of new policies to regulate its usage.

Keywords Kratom · Topic modeling · Natural language processing · Reddit · BERTopic · Addiction science

Mitragyna speciosa (Rubiaceae family) is a plant from the Southeastern regions of the world, commonly diffused in Thailand, Malaysia, and Indonesia. It can also be found in Africa and Papua New Guinea, among other countries (Grundmann et al., 2023a; Kruegel

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& Grundmann, 2018; Singh et al., 2017; Swogger et al., 2022). Commonly known as kratom, the plant contains several alkaloids and has a complex profile of action, with stimulant effects for doses less than 5 g, and sedative action for higher doses (more than 5 g) (Cinosi et al., 2015; Grundmann et al., 2023a; Swogger et al., 2022). Kratom leaves have been used in traditional medicine for self-treating several common health issues, such as fever or cough, to alleviate opioid withdrawal and pain (Brown et al., 2017; Grundmann et al., 2023a; McCurdy et al., 2024; Singh et al., 2017), and also among poly-drug users in the native countries (Govarthnapany et al., 2025).

Kratom products (e.g., capsules, powder, and others) are derived from the leaves of the plant and have become widely available in the West since 2006, especially in the United States of America (USA) (McCurdy et al., 2024; Smith et al., 2022a, 2023), and are reportedly composed of different mitragynine and other alkaloids (Hill et al., 2025; White et al., 2025). Such products are commonly advertised and sold with different names, generally including a reference to the color and origin of the strains (Huisman et al., 2023). However, since there are no clear regulations around the selling and manufacturing of such products in Western countries, the products might therefore be contaminated with other compounds and potentially result in adverse events (Cinosi et al., 2015; Henningfield et al., 2024; Hill et al., 2025; Papsun et al., 2023; Vadiei et al., 2025). Data from surveys have shown that kratom has been used for the self-treatment of pain, mental health related issues (e.g., anxiety and depression), dependence or withdrawal symptoms associated with stimulant and/or sedative substances (e.g., alcohol or opioids) (McCurdy et al., 2024; Mun et al., 2025; Smith et al., 2023; Swogger et al., 2022), and for lowering metabolic risk factors (Rayanakorn et al., 2025). Such self-reported evidence has also been confirmed by (pre)clinical data (Müller et al., 2024; Prevete et al., 2023b; Vicknasingam et al., 2020). Kratom has also been used to boost energy and to be taken recreationally in combination with other substances (McCurdy et al., 2024; Prevete et al., 2021; Swogger et al., 2015). However, while facing a lack of large control clinical trials, concerns about the safety and risks of unsupervised kratom intake remain high. Some findings suggest that kratom is used particularly among people with substance use disorder, especially opioid use disorder (Green et al., 2024). Evidence has also suggested that kratom has some addictive potential especially when used at high doses for a long time, with the risk of developing a typical withdrawal syndrome, sometimes defined as kratom use disorder (Falise et al., 2023; Hill et al., 2024; Rogers et al., 2024b). For instance, a high number of toxicities (e.g., neurological, liver and renal, cardiological issues, among others; Alsarraf et al., 2019; Jain & Lloyd, 2025; Leong Bin Abdullah & Singh, 2021; Schimmel & Dart, 2020) including fatalities (Corkery et al., 2019; Grundmann et al., 2024a; Kerrigan & Basiliere, 2022; Torrico et al., 2024) have been reported among kratom users. These have been highlighted in several case reports from the West, especially when kratom products are consumed with other substances (e.g., opioids) or contain contaminants (e.g., propylhexedrine and phenylethylamine) (Corkery et al., 2019; Grundmann et al., 2024b; Holler et al., 2011; Nacca et al., 2020; Torrico et al., 2024). Higher concentrations of alkaloids compared to traditional products and drug-drug interactions are often considered responsible for such toxicities, while small doses are thought to pose fewer risks (Dhoble et al., 2025; Grundmann et al., 2023b, 2024b; Kamble et al., 2020; Tanna et al., 2023).

In this context, users' claims have been of paramount importance to enrich knowledge on kratom use. Studies have increasingly considered online reports and social media analyses to gain a more naturalistic understanding of the phenomenon (Prevete et al., 2021; Smith et al., 2021, 2022b; Swogger et al., 2015; Tobacyk et al., 2022). Evidence that emerged from investigations carried out on Bluelight, Twitter, and

Reddit showed that the main discussions were related to quitting kratom and reducing the kratom dose because of the personal perception of dependence. Concerns about quality issues were also reported (Grundmann et al., 2022). In another study, kratom-related discussions were collected from 42 subreddits in 2019–2020. Both beneficial and adverse effects were described by users, highlighting the complex profile of kratom use (Smith et al., 2021). Similarly, and more recently, Rogers et al. (2024a)'s analysis of Reddit data from 2020 to 2022 revealed mixed experiences when using kratom, with users citing benefits like pain relief and symptom management accompanied by alcohol or opioid use. However, users also expressed concerns about addiction and dependence, inconsistent product quality from vendors, and the desire to quit using kratom.

Although previous studies have investigated topics of discussion related to kratom on various social media platforms (Grundmann et al., 2022; Rogers et al., 2024a; Smith et al., 2021; Wahbeh et al., 2024), the emerged evidence was based on manual labeling of topics and, as a consequence, on relatively small sets of posts related to kratom, or analyses conducted through classical topic-modeling techniques. For instance, Grundmann et al. (2022) analyzed 379 posts sourced from Bluelight, Reddit, and Twitter, while Rogers et al. (2024a) analyzed 370 Reddit posts. Wahbeh et al. (2024) applied latent Dirichlet allocation (LDA), a classical probabilistic topic-modeling approach, combined with qualitative interpretation and visualization to characterize kratom's benefits and adverse effects. However, their analysis was constrained by the lower semantic resolution and scalability of traditional LDA.

Topic modeling utilizes statistical modeling to extract patterns within a large corpus of unstructured text data in order to derive topics (Egger & Yu, 2022). Building on this, the present work aims to extend the insights of the aforementioned works through a more recently developed algorithm called BERTopic (Grootendorst, 2022). BERTopic enables the efficient extraction of highly relevant topics without the need of extensive human labeling and classification. Unlike LDA, BERTopic is also able to capture nuanced semantics and automatically produces interpretable topic representations using class-based TF-IDF (Blei & Lafferty, 2006; Grootendorst, 2022). These features enable the discovery of prominent discussion themes in large-scale, unstructured social media text. In this way, we aim to identify and extract topics of discussion within a larger-scale dataset of 188,139 kratom-related posts on Reddit from the years 2010 to 2023. Moreover, BERTopic allows for dynamic topic modeling, which provides an insight into how discussions about topics in the corpus evolved over time (Blei & Lafferty, 2006). This approach has previously proven useful in characterizing the online discourse about substance use in social media platforms as well as in other domains of clinical psychology (Fong et al., 2024, 2025). Overall, the present work aims to further enhance the current knowledge in the field by analyzing a larger dataset which will enable a comprehensive understanding of the experiences and motivations behind kratom usage as shared by users on social media platforms.

Method

This study was approved by the University of Trento Ethical Committee (2024–40 ESA).

Data Collection

The current study is based on data collected from Reddit. Reddit is a community-driven online social news platform where registered users can create or join over 100,000 active online subcommunities to discuss their specific interests (Reddit Homepage, 2024). These subcommunities are referred to as "subreddits" and allow users to share and discuss various topics relevant to the subreddit subject (Pont-Fernandez et al., 2023; Smith et al., 2021). For example, the subreddit called "*r/addiction*" (where "r/" indicates a subreddit) provides a space for individuals to engage in addiction-related discourse.

Reddit has previously provided valuable insight relevant to the domain of substance use and health sciences (e.g., Fong et al., 2024, 2025). For instance, previous studies have examined data from Reddit to gain insight into individuals' behaviors or beliefs behind substance use (e.g., Fong et al., 2024; Pont-Fernandez et al., 2023) or to check the consistency between survey findings and Reddit posts to understand kratom use patterns (Smith et al., 2021).

Reddit was chosen as the main source for the current study for two main reasons. The first is that users are not restricted to a 280 character limit (as enforced on Twitter) when writing a post or comment. This enables users to potentially provide more in-depth opinions or engage in more nuanced discussions on various topics. The second reason is that Reddit as a platform allows for user anonymity. Therefore, Reddit is a fairly abundant ecological source of human opinions, attitudes, and experiences (Wanchoo et al., 2023).

Previous work (e.g., Wanchoo et al., 2023; Yao et al., 2023) utilized the Pushshift Reddit application programming interface (API) to scrape Reddit data via the PRAW and/or PSAW Python packages (Baumgartner et al., 2020). However, access to the Pushshift API has been limited to approved Reddit moderators as of June 2023 due to changes in the Reddit API. As a result of this, the Reddit data used in the present work is obtained from a large public dataset containing posts and comments from the top 40,000 subreddits obtained and stored publicly by two approved Reddit moderators prior to Reddit's privacy policy changes (Watchful1, n.d.). This publicly available dataset contains posts and comments spanning from June 2005 to December 2023. Among the available subreddit data in the public dataset, all subreddits with the word "kratom" in its name ($n = 12$) and *r/addiction*, *r/chronicpain*, and *r/opiatesrecovery* were selected to be included in the analysis. In total, we identified 15 subreddits of interest for discussions around kratom: *r/addiction*, *r/chronicpain*, *r/opiatesrecovery*, *r/kratom*, *r/kratomm*, *r/recreationalkratom*, *r/smallbatchkratom*, *r/vendorsofkratom*, *r/vendorsofkratom2*, *r/quittingkratom*, *r/kratomkorner*, *r/Kratom_Info_Exchange*, *r/KratomGarden*, *r/kratomreview100*, and *r/kratomreview101*. While *r/addiction*, *r/chronicpain*, and *r/opiatesrecovery* facilitate more broad and general discussions on addictions beyond kratom, the remaining subreddits facilitate more kratom-specific discussions in terms of usage, purchasing kratom, and stopping kratom usage due to potential negative experiences or other factors. The title, main body ("selftext") of the posts, and the dates that they were created were extracted.

A preliminary analysis showed that including all posts from the three general subreddits (*r/addiction*, *r/chronicpain*, and *r/opiatesrecovery*) introduced a lot of noise into the extracted topics (e.g., topics related to sex addiction, marijuana, and nicotine; see Fig. S1 in the Supplementary Materials). Therefore, the data from *r/addiction*, *r/chronicpain*, and *r/opiatesrecovery* were filtered to only include posts containing the

word "kratom." Additionally, we conducted a robustness analysis and observed that the inclusion of general subreddits does not significantly bias the results towards specific topics (see Fig. S2 in the Supplementary Materials). Prior to further preprocessing, the dataset contained 340,430 posts from the 15 aforementioned subreddits.

Data Preprocessing

A number of preprocessing steps were conducted to reduce non-textual noise content in the dataset of posts to ensure that the BERTopic model would generate meaningful and interpretable topics (Kumi et al., 2024).

1) Empty posts (null or containing empty strings), emojis, and those indicated as [removed] or [deleted] were removed to ensure that only posts with actual content are analyzed (Kumi et al., 2024).
2) Each post's title and body text were merged to ensure a comprehensive analysis of the post to leverage all available textual content. This is because Reddit users often use the title to summarize their thoughts while elaborating in the body text, or, in other cases, the body may only contain pictures or brief follow-ups, while the title will provide the main context. Accordingly, photos (i.e., links to photos with.png file format as indicated by Reddit) were also deleted as they do not provide textual data for topic modeling.
3) Dates of post creation were converted from unix timestamps to Coordinated Universal Time (UTC) for dynamic topic modeling (see section "Dynamic Topic Modeling" for more details).
4) All remaining posts were converted to lowercase (Yao et al., 2023).

No further preprocessing (e.g., tokenization, lemmatization, or removing stop words) was performed to retain each posts' original structure. In this way, the transformer-based topic models can take the context that the words in a sentence occur in into account in order to generate more representative embeddings (i.e., numeric representations of the text posts) (Grootendorst, n.d-c; Yao et al., 2023).

After preprocessing, the dataset contained 188,139 posts. The dates that the subreddit posts were made spanned from September 2010 to December 2023. The number of posts per subreddit was as follows: *r/addiction* ($n = 651$ posts), *r/chronicpain* ($n = 654$ posts), *r/opiatesrecovery* ($n = 3323$ posts), *r/kratom* ($n = 95{,}572$ posts), *r/kratomm* ($n = 2330$ posts), *r/recreationalkratom* ($n = 1660$ posts), *r/smallbatchkratom* ($n = 1787$ posts), *r/vendorsofkratom* ($n = 5{,}483$ posts), *r/vendorsofkratom2* ($n = 1099$ posts), *r/quittingkratom* ($n = 64{,}935$ posts), *r/kratomkorner* ($n = 5486$ posts), *r/Kratom_Info_Exchange* ($n = 1360$ posts), *r/KratomGarden* ($n = 975$ posts), *r/kratomreview100* ($n = 1258$ posts), and *r/kratomreview101* ($n = 1566$ posts).

Topic Modeling

The present work utilizes an NLP technique called topic modeling to extract the main topics of discussion within the kratom-related subreddit datasets. Specifically, we utilize BERTopic (Grootendorst, 2022) for topic modeling as it was found to effectively generate interpretable topics in previous studies that analyzed unlabelled Reddit posts (Choi & Jang, 2023; Ng et al., 2023; Pleasants et al., 2023; Yao et al., 2023).

BERTopic utilizes embeddings generated from Bidirectional Encoder Representations from Transformers (BERT) (Devlin et al., 2019) and class-based term frequency-inverse document frequency (TF-IDF) to cluster posts into semantically similar topics (Ng et al., 2023). The BERT embeddings enable BERTopic to generate meaningful topic representations as context and meaning of words are taken into account (Grootendorst, 2022; Ng et al., 2023). Class-based TF-IDF computes the significance of a word to a cluster of posts and calculates their frequency to generate the topics (Yao et al., 2023).

Python version 3.10.12 was used for data preprocessing and training BERTopic. A BERTopic model was trained using the BERTopic python library (version 0.16.0) (Grootendorst, 2022). Model hyperparameters were predominantly kept at their default out-of-the-box settings. The hyperparameters set for the model have been included in Table S1 in the supplementary materials. While most of the default out-of-the-box values remained unchanged, we added a random state of 42 for the Uniform Manifold Approximation and Projection (UMAP) model to prevent stochastic behavior (i.e., producing different results each run) and therefore make the results reproducible. Lastly, additional stop words were filtered out during tokenisation to attempt to reduce noise being added to the topics (i.e., "http," "https," "amp," "com") (Grootendorst, n.d-b).

Subsequent to model training, the topics extracted by BERTopic are represented by a set of keywords and representative posts most relevant for a given topic. By default, these topics are labeled Topic 0 to $N-1$, where N is the number of topics generated minus 1. For clarity purposes, we modify the labeling to start from Topic 1, ending at Topic N. The keywords and samples of representative posts were provided to ChatGPT-4o using the following prompt template to create more descriptive topic labels for the top 10 topics (Grootendorst, n.d.-a):

> "I have a topic that contains the following documents:
> [DOCUMENTS]
> The topic is described by the following keywords: [KEYWORDS].
> Based on the information above, extract a short topic label in the following format:
> topic: < topic label > ".

Each topic label generated by ChatGPT-4o was also manually validated to ensure its appropriateness with respect to the representative keywords and documents. In addition, the representative posts within each cluster were visually inspected to support accurate interpretation and discussion of the topics.

Dynamic Topic Modeling

Dynamic topic modeling (DTM) is an NLP technique used to outline the temporal evolution of the emergent topics within the time-stamped Reddit posts (Blei & Lafferty, 2006; Grootendorst, 2022; Jung et al., 2023). Thus, it can provide us with insight into the trajectory of the increase or decline in discussions about specific topics over time (Blei & Lafferty, 2006). We considered the entire timeframe of the dataset, spanning from September 2010 to December 2023. This range was selected because it captures the full historical evolution of discussions within the dataset, ensuring a comprehensive analysis of trends over time.

After training the BERTopic topic model (which does not consider any temporal component), a c-TF-IDF representation is computed for each topic and timestamp using BERTopic (version 0.16.0)'s *topics_over_time* module. The number of bins that are

generated when computing the topic representations was set to 5 due to computational resource availability and to therefore increase the efficiency of the computations. To account for the growth in Reddit activity over the study period, topic prevalence was computed as the proportion of posts assigned to each topic within each time bin relative to the total number of posts in that bin. This normalization ensures that observed trends reflect changes in kratom-related discourse rather than overall increases in Reddit activity.

Results

To conduct an exploratory analysis on the topics that emerged between September 2010 and December 2023, we first look at the top 10 topic representations and their accompanying keywords that emerged from training the BERTopic model on the dataset ("Main Topics of Discussion Around Kratom" section). We subsequently conduct DTM to investigate the temporal variation in the frequency of discussions about these topics ("Dynamic Topic Modeling" section).

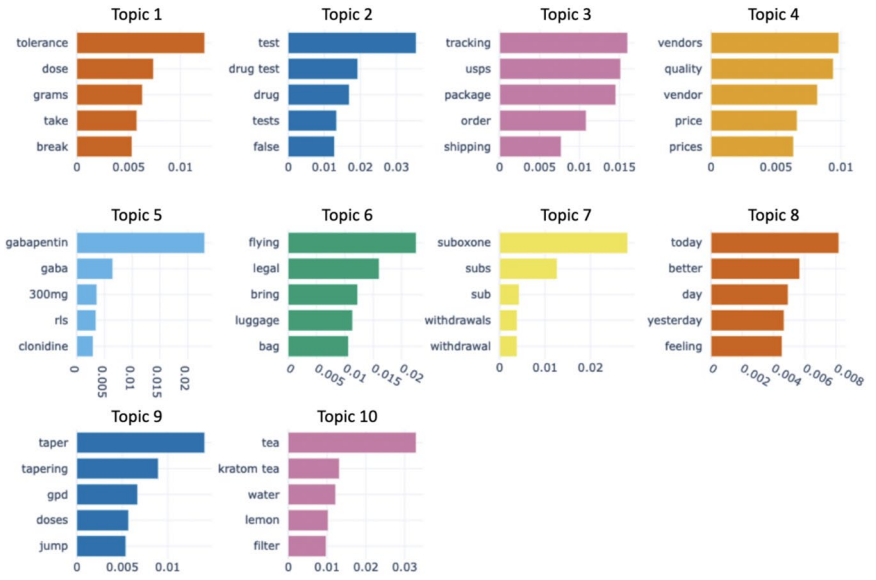

Fig. 1 Top 5 representative words based on class-based term frequency-inverse document (c-TF-IDF) scores for the top 10 topics generated from the dataset. The higher the c-TF-IDF score, the more relevant the word is in the context of a given topic. The ChatGPT-generated labels for each of the topics are as follows: Topic 1 (Managing Kratom Tolerance and Dosage), Topic 2 (Kratom and Drug Testing: False Positives and Detection), Topic 3 (Kratom Shipping and Delivery Issues), Topic 4 (Kratom Vendor Reviews and Price vs. Quality Debate), Topic 5 (Kratom Withdrawal and Gabapentin Use for Symptom Management), Topic 6 (Traveling with Kratom: Legal Considerations and Packing Tips), Topic 7 (Suboxone and Kratom: Risks, Interactions, and Addiction Management), Topic 8 (Daily Encouragement and Well-being Updates), Topic 9 (Kratom Tapering Strategies and Withdrawal Management), and Topic 10 (Methods and Recipes for Making Kratom Tea)

Main Topics of Discussion Around Kratom

Figure 1 visualizes the top 10 topics and the top 5 words with the highest class TF-IDF scores most representative of the topics for the dataset. The c-TF-IDF score indicates how relevant a word is in the context of a topic compared to other words (e.g., as shown in Fig. 1, topic 4's representation is most dependent on the occurrence of the word "gabapentin" in a post) (Yao et al., 2023). Therefore, the top 5 keywords for each topic are those with the highest c-TF-IDF scores, indicating their importance and relevance in defining each topic.

Table 1 provides an overview of the top 10 thematic topics that emerged, along with respective topic labels generated by ChatGPT-4o, top 10 representative words with the corresponding c-TF-IDF scores, and the number of posts per topic.

The "Topics that Emerged in the Dataset" section will outline the top 10 topic representations for the present work's dataset in more detail.

Topics That Emerged in the Dataset

BERTopic classified 130,235 posts out of the total 188,139 posts in the dataset as outliers and did not cluster them into particular topics. Initial results generated two similar topics related to kratom consumption in terms of dosage and tolerance within the top 10 most frequent topics. These two topics were therefore merged to improve interpretability. With the present hyperparameters, 524 topics were generated in total. An overview will only be provided about the top 10 most frequent topics that emerged as they represent the most frequently discussed themes from the analysis.

The most frequently discussed topic (Topic 1) centered on the theme of "Managing Kratom Tolerance and Dosage." This topic encompassed a total of 2643 posts with specific terms shaping the conversation around the theme of kratom usage. The word "tolerance" had the highest c-TF-IDF score (0.0123), indicating its central role in the conversations. Similarly, terms like "dose" (0.0074) and "grams" (0.0063) were commonly used, reflecting users' concerns about the appropriate quantities for optimal consumption. Other keywords such as "take" (0.0058) and "break" (0.0053) point to common practices and strategies, such as taking specific dosages or initiating tolerance breaks. Additionally, the mention of everyday time frames like "day" (0.0039) and "per" (0.0037) suggests a collective interest in establishing routines and dosage schedules. As a whole, these keywords provide insight into a community interested in understanding and handling their kratom use through careful management of both dosage and tolerance.

The second most frequent topic was Topic 2, labeled "Kratom and Drug Testing: False Positives and Detection," and was discussed in 1140 posts. The key terms automatically extracted by the BERTopic model were "test" (0.0355), "drug test" (0.0193), and "drug" (0.0169), reflecting conversations surrounding concerns about how kratom may affect drug testing results. Discussions also frequently mentioned "false" (0.0128), "false positive" (0.0102), and "tested" (0.0123), emphasizing worries about inaccurate results.

Topic 3 ("Kratom Shipping and Delivery Issues") and Topic 4 ("Kratom Vendor Reviews and Price vs. Quality Debate") are closely linked as they both focus on the broader kratom purchasing experience. While Topic 3 centers on concerns about the shipping process, such as tracking, delivery times, and postal services, Topic 4 shifts the focus to the vendors themselves, highlighting the quality and pricing of kratom. For instance, the most frequent keywords in Topic 3 included "tracking" (0.0160), "USPS"

Table 1 Top 10 thematic topics that emerged with respective topic labels, top 10 keywords, and number of posts for the dataset consisting of 15 subreddits (*r/addiction*, *r/chronicpain*, *r/opiatesrecovery*, *r/kratom*, *r/kratomm*, *r/recreationalkratom*, *r/smallbatchkratom*, *r/vendorsofkratom*, *r/vendorsofkratom2*, *r/quittingkratom*, *r/kratomkorner*, *r/Kratom_Info_Exchange*, *r/KratomGarden*, *r/kratomreview100*, and *r/kratomreview101*)

Topic number	Topic label generated by ChatGPT-4o	Representative words (c-TF-IDF score)	Number of representative posts in topic
1	Managing Kratom Tolerance and Dosage	"tolerance" (0.0123), "dose" (0.0074), "grams" (0.0063), "take" (0.0058), "break" (0.0053), "doses" (0.0048), "effects" (0.0042), "tolerance break" (0.0040), "day" (0.0039), "per" (0.0037)	2643
2	Kratom and Drug Testing: False Positives and Detection	"test" (0.0355), "drug test" (0.0193), "drug" (0.0169), "tests" (0.0134), "false" (0.0128), "tested" (0.0123), "urine" (0.0121), "positive" (0.0109), "false positive" (0.0102), "testing" (0.0089)	1130
3	Kratom Shipping and Delivery Issues	"tracking" (0.0160), "usps" (0.0152), "package" (0.0145), "order" (0.0108), "shipping" (0.0077), "orders" (0.0072), "delivery" (0.0067), "shipped" (0.0066), "post office" (0.0065), "ordered" (0.0063)	1119
4	Kratom Vendor Reviews and Price vs. Quality Debate	"vendors" (0.0098), "quality" (0.0094), "vendor" (0.0082), "price" (0.0066), "prices" (0.0063), "buy" (0.0059), "online" (0.0050), "quality kratom" (0.0048), "sell" (0.0047), "order" (0.0046)	1075
5	Kratom Withdrawal and Gabapentin Use for Symptom Management	"gabapentin" (0.0231), "gaba" (0.0065), "300 mg" (0.0036), "rls" (0.0034), "clonidine" (0.0029), "withdrawal" (0.0027), "day" (0.0027), "night" (0.0026), "taking gabapentin" (0.0025), "prescribed" (0.0025)	1049
6	Traveling with Kratom: Legal Considerations and Packing Tips	"flying" (0.0226), "legal" (0.0160), "bring" (0.0122), "luggage" (0.0113), "bag" (0.0106), "tsa" (0.0098), "traveling" (0.0096), "checked" (0.0090), "bringing" (0.0089), "carry" (0.0086)	1031
7	Suboxone and Kratom: Risks, Interactions, and Addiction Management	"suboxone", 0.0282), "subs" (0.0126), "sub" (0.0043), "withdrawals" (0.0038), "withdrawal" (0.0038), "2 mg" (0.0034), "suboxone kratom" (0.0032), "kratom" (0.0032), "taking suboxone" (0.0030), "mg" (0.0030)	1019

Table 1 (continued)

Topic number	Topic label generated by ChatGPT-4o	Representative words (c-TF-IDF score)	Number of representative posts in topic
8	Daily Encouragement and Well-being Updates	"today" (0.0082), "better" (0.0057), "day" (0.0049), "yesterday" (0.0047), "feeling" (0.0045), "sleep" (0.0043), "tomorrow" (0.0042), "hope" (0.0041), "last night" (0.0037), "everyone" (0.0037	905
9	Kratom Tapering Strategies and Withdrawal Management	"taper" (0.0141), "tapering" (0.0090), "gpd" (0.0067), "doses" (0.0057), "jump" (0.0054), "dose" (0.0045), "tapered" (0.0041), "drop" (0.0039), "ct" (0.0037), "day" (0.0033)	874
10	Methods and Recipes for Making Kratom Tea	"tea" (0.0329), "kratom tea" (0.0132), "water" (0.0122), "lemon" (0.0103), "filter" (0.0097), "boil" (0.0094), "boiling" (0.0084), "make tea" (0.0082), "powder" (0.0080), "lemon juice" (0.0079)	783

(0.0152), and "package" (0.0145), highlighting concerns about tracking shipments and using postal services. Conversely, Topic 4's most representative keywords related to kratom sellers and their quality, including "vendors" (0.0098), "quality" (0.0094), and "price" (0.0066). Overall, while Topic 3 was related to users' logistical concerns, Topic 4 was more so related to the selection and evaluation of vendors, with both topics contributing to the full picture of the kratom purchasing process.

Topics 5, 7, and 9 are all linked by their focus on kratom withdrawal and methods for managing withdrawal symptoms. However, each topic pertains to discussions addressing different approaches and substances.

Topic 5, which was labeled as "Kratom Withdrawal and Gabapentin Use for Symptom Management," examines the use of "gabapentin" (0.0231) for alleviating symptoms associated with kratom withdrawal. Discussions in this topic made specific references to dosage ("300 mg") and managing discomfort at different times of day ("day," "night"). Moreover, conversations often mentioned "withdrawal" (0.0027) and related terms like "rls" (0.0034) and "clonidine" (0.0029), reflecting the specific symptoms and medications involved in managing kratom withdrawal.

On the other hand, Topic 7 ("Suboxone and Kratom: Risks, Interactions, and Addiction Management") shifts the focus to the interaction between "suboxone" (0.0282) and kratom, as both substances are used for addiction management. Keywords such as "withdrawals" (0.0038) and "suboxone kratom" (0.0032) highlight conversations about its usage for managing kratom dependency or withdrawal. In a similar direction, discussions in Topic 9 ("Kratom Tapering Strategies and Withdrawal Management") appeared to focus on strategies for gradually reducing kratom use. Terms like "taper" (0.0141) and "tapering" (0.0090) were central to the discussions, and keywords like "doses" (0.0057), "drop" (0.0039), and "jump" (0.0054) indicate the conversations about the process of reducing doses at the end of the tapering process to minimize withdrawal symptoms. Taken together, topics 5, 7, and 9 highlight the various methods that users consider for managing kratom withdrawal, whether it is through the unsupervised use of medications like Gabapentin or Suboxone, or through gradual dose reduction strategies.

The sixth topic of discussion contained 1031 posts related to potential challenges and concerns about traveling with kratom. It was therefore labeled as "Traveling with Kratom: Legal Considerations and Packing Tips." The most common keywords related to the logistics of traveling with kratom, including concerns about airport security ("legal" (0.0160), "bring" (0.0122), "flying" (0.0226), and "tsa" (0.0098)). Other commonly occurring keywords like "luggage" (0.0113), "bag" (0.0106), and "checked" (0.0090) indicated users' discussions about how kratom should be packed and transported and also shared tips on carrying it safely through security checks.

Topic 8, labeled "Daily Encouragement and Well-being Updates," consisted of 905 posts focused on sharing personal experiences and offering support regarding mental and physical well-being during the process of quitting kratom. The most common keywords, such as "today" (0.0082) and "tomorrow" (0.0042), reflected users' daily reflections and their outlook for the future. Posts also frequently included words like "better" (0.0057) and "feeling" (0.0045), highlighting progress or struggles in personal well-being. Additionally, terms such as "hope" (0.0041) and "everyone" (0.0037) indicated a focus on maintaining a positive mindset and offering encouragement to others. Overall, this topic indicated that users would commonly provide a safe space for individuals to share their daily experiences, progress, and support for one another's well-being journeys.

Lastly, Topic 10 ("Methods and Recipes for Making Kratom Tea") contained 783 posts centered around the preparation of kratom tea. Posts often included terms like "tea" (0.0329), "water" (0.0122), and "boil" (0.0094), indicating the basic preparation steps, such as boiling water to make the tea. Ingredients such as "lemon" (0.0103) and "lemon juice" (0.0079) were frequently mentioned, suggesting that users often add lemon to when brewing. Other keywords like "filter" (0.0097), "boiling" (0.0084), and "powder" (0.0080) pointed to specific techniques for straining the tea or mixing the kratom powder. Overall, this topic focused on the different methods and recipes for preparing kratom tea, with users sharing tips and variations for making the process more enjoyable or effective.

Dynamic Topic Modeling

Dynamic topic modeling was conducted to analyze how the frequency of the main topics of discussion that emerged from the Reddit posts varied over time (Blei & Lafferty, 2006; Grootendorst, 2022; Jung et al., 2023). Figure 2a and b depict this temporal variation in the relative frequencies of the Top 10 topic representations for topics 1 to 5 and topics 6 to 10, respectively.

For topics 1 to 5 that emerged from the dataset (Fig. 2A), Topic 4 ("Kratom Vendor Reviews and Price vs. Quality Debate") was the most frequently discussed topic before 2014, reaching its peak around 2013. However, its relative frequency dropped sharply after 2013, reaching its lowest in 2018. Topic 3 ("Kratom Shipping and Delivery Issues") also peaked in 2013, but subsequently declined in parallel with Topic 4 in the following years. In contrast, Topic 1 ("Managing Kratom Tolerance and Dosage") became the dominant topic of discussion after 2016 and maintained higher relative frequency through 2021. Topic 2 ("Kratom and Drug Testing: False Positives and Detection") remained relatively stable over time, with gradual increases but consistently below other topics. Topic 5 ("Kratom Withdrawal and Gabapentin Use for Symptom Management") started being discussed around 2013, with its frequency rising after 2016 and surpassing Topics 2, 3, and 4 after 2018.

For the remaining topics (Topics 6–10; Fig. 2B), Topic 6 ("Traveling with Kratom: Legal Considerations and Packing Tips") was relatively stable across time, while Topic 10 ("Methods and Recipes for Making Kratom Tea") initially grew in frequency, peaking around 2013, before gradually declining. From around 2013 onward, Topics 7 ("Suboxone and Kratom: Risks, Interactions, and Addiction Management"), 8 ("Daily Encouragement and Well-being Updates"), and 9 ("Kratom Tapering Strategies and Withdrawal

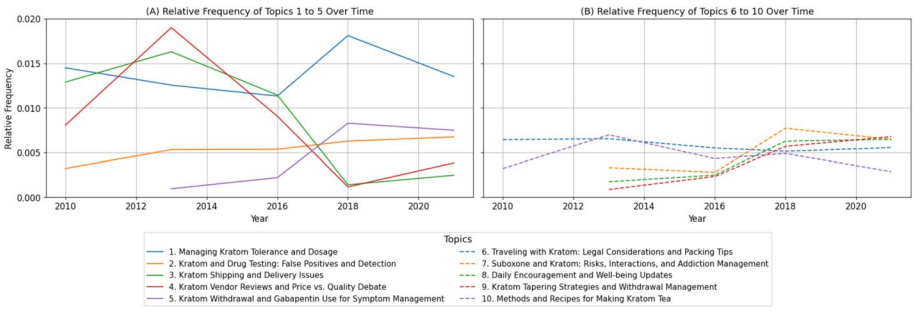

Fig. 2 Temporal variations in the relative frequencies of (**A**) topics 1–5 and (**B**) topics 6–10 in the dataset

Management") steadily increased in prominence. By 2018, these three topics had overtaken Topics 6 and 10, and continued to increase or remain consistently higher in frequency of discussion through 2021.

Overall, we observe a decline in interest towards vendor reviews, products quality-price, and shipping/delivery issues. Conversely, we observe an increase in interest towards discussions related to kratom tolerance and dosage, management of withdrawal symptoms, tapering strategies, and peer support.

Discussion

The present work utilized an NLP topic modeling approach (BERTopic) to identify common topics from and analyze the discourse made in kratom-related subreddits between September 2010 and December 2023. The analyzed dataset ($n = 188{,}139$) consisted of posts from 15 different subreddits processed from a public dataset containing data from the top 40,000 subreddits (Watchful1, n.d.). ChatGPT-4o was used to label the extracted topics based on the keywords and representative documents that emerged. The automatically generated labels were also manually validated to ensure appropriateness. In addition, the representative posts within each cluster were visually inspected to support accurate interpretation and discussion of the topics. DTM was also conducted to understand the temporal variation and evolution of the extracted topics from the dataset.

The results from the analysis of the dataset report a wide variety in the topics of discussion about kratom. The most discussed topic from 2016 onwards was about implementing effective strategies related to tolerance and dosage. Users shared posts on increased tolerance, dosage management, and also asked for advice on handling withdrawal symptoms experienced during tolerance break. Available research data suggest that a safe kratom dose is around 1.14–10.9 g in the US, which means 6.25–53.2 mg of mitragynine (Huestis et al., 2024; Prevete et al., 2025; Smith et al., 2024; Tanna et al., 2022). Moreover, regular users in the traditional context can consume several glasses of kratom per day, with different and higher mitragynine concentration (Singh et al., 2019a, 2019b, 2019c). However, traditional preparations, typically based on raw or brewed kratom leaves, differ substantially from many Western formulations, which often include concentrated extracts or products enriched with 7-hydroxymitragynine (Grundmann et al., 2024a, 2024b; Hill et al., 2025). Existing studies show that kratom can cause withdrawal symptoms (Stanciu et al., 2019). These include both physical and psychological symptoms as described in regular users (Singh et al., 2018a, 2018b), especially among prolonged high-dose kratom users and outside native countries (Grundmann et al., 2023a). To date, there is only limited clinical evidence on the pharmacological and toxicological profile of kratom and its alkaloids (Huestis et al., 2024; Prevete et al., 2025; Smith et al., 2024; Tanna et al., 2022). Thus, the findings highlight the need of more clinical trials for clarifying this aspect and facing challenges of kratom use outside of its traditional context, particularly in the absence of clear guidelines on safe dosage levels, on regulation on labeling of kratom products and potential interactions with other substances (Grundmann et al., 2024b; Henningfield et al., 2024; Prozialeck et al., 2019).

The second most commonly discussed topic was about kratom and drug testing. Users would query about whether kratom usage shows on a urine or blood drug test. They would also ask how long kratom stays in one's body system. This highlights the growing concern around kratom detection, which aligns with the growing scientific effort in developing

methods for accurate detection and assessment of kratom use (Helander & Rylski, 2023; Sempio et al., 2025).

The third most common discussion topic that emerged from the dataset revolved around the challenges and complications that occur with the delivery process when receiving kratom in the mail. Users would describe their frustration, dissatisfaction, and issues with various postal services (predominantly USA and Canada based) losing, delaying, or not updating tracking information on kratom orders. Related to this is the fourth commonly discussed topic pertaining to reviewing vendors in the kratom market. In accordance with what was found by Rogers et al. (2024a), users would share experiences with various kratom sellers (e.g., with regards to reliability and customer service) and also discuss whether prices correlate with the quality of the kratom product. It is known that purity and safety concerns appear more prevalent in Western markets. This might be due to factors like the absence of a specific regulation, the risk of contaminants in kratom products which are not typically seen in traditional kratom (Prozialeck et al., 2020, 2022; Schwensohn et al., 2022), or also higher mitragynine or 7-hydroxymitragynine concentrations (Smith et al., 2025), among other factors. These concerns highlight the potential risky diffusion of unregulated kratom products, including their availability on the dark web (Prevete et al., 2023a), which, like other new psychoactive substances, represent a challenge to traditional approaches to drug monitoring, surveillance, and control (Kuypers et al., 2021). Different ways to manage withdrawal symptoms when drug tapering were also frequently discussed in Topics 5, 7, 8, and 9. The central theme among the posts and keywords in the fifth most discussed topic captured users' experiences with utilizing Gabapentin, a medication commonly prescribed to alleviate withdrawal symptoms (Vento et al., 2021; White, 2019), but also associated with misuse (Evoy et al., 2021). In line with this, Reddit users in our analysis would express concerns with becoming dependent on Gabapentin and would seek out community support and advice. Similarly, the seventh most discussed topic saw users discussing the use of Suboxone to manage addictions to kratom. While Suboxone is another drug often provided to treat opioid disorder (Demick et al., 2020), some representative posts from Topic 7 showed that Reddit users would describe experiences with addiction transfer from kratom to Suboxone. These discussions likely reflect broader patterns of polysubstance self-management. In many cases, kratom does not represent users' first substance of dependence; individuals frequently report prior use of prescription opioids or benzodiazepines, and medications such as Gabapentin or Suboxone were likely introduced during earlier treatment attempts. Kratom is then adopted as a self-directed tapering tool (e.g., Perry & Chin, 2025; Rogers et al., 2024a; Smith et al., 2021), giving rise to cyclical rather than linear transitions between substances. When users describe turning to Gabapentin or Suboxone to mitigate kratom withdrawal, these medications appear to be consumed without clinical supervision, often sourced from leftover prescriptions or informal channels, and accompanied by explicit worries about replacing one dependency with another. These practices should therefore not be understood as formal medical interventions for kratom cessation, but rather as lay adaptations of opioid withdrawal management strategies enacted in the absence of established clinical guidance. During the withdrawal process, users would also share their progress, express gratitude for community support, and provide words of encouragement to those also trying to stop their kratom usage (Topic 8). The ninth most discussed topic involved more broad discussions about desires and methods to quit kratom (e.g., including dosing schedules), withdrawal symptoms and coping strategies, as well as weighing the pros and cons of tapering versus quitting kratom cold-turkey. This finding supports earlier research (Rogers et al., 2024a; Smith et al., 2021) that individuals may turn to platforms like Reddit for support from former kratom users

when trying to reduce or quit use. Moreover, the DTM results showed that the frequency of discussions of Topic 5, 7, 8, and 9 have been increasing since 2016, i.e., the frequency in Topics 5 and 7 (using Gabapentin and Suboxone, respectively) have mostly increased from 2016 onwards, with a continual increase in Topic 8 ("Daily encouragement and well-being updates") and Topic 9 ("Kratom tapering strategies and withdrawal management"). This continual increase is in line with the prevalence of Topic 1 ("Managing Kratom Tolerance and Dosage), possibly suggesting an interest in kratom usage and management of kratom use disorder. Such temporal patterns may also reflect broader external events influencing public discourse on kratom. In 2016, the U.S. Drug Enforcement Administration (DEA) announced its intent to classify mitragynine and 7-hydroxymitragynine as Schedule I substances, a proposal that triggered widespread public debate and likely contributed to the spike in online discussions about kratom tolerance, dependence, and withdrawal management. Similarly, the COVID-19 pandemic may have further amplified interest in self-medication and alternative treatments, as individuals faced limited access to healthcare and heightened psychological distress. These contextual factors could partially explain the sustained increase in topics related to self-management, substance tapering, and community support observed in our dataset. Overall, these topics highlight the need of further studies to better understand if kratom should be considered as a dangerous plant-based novel psychoactive substance or a potential plant-based medicine, whose potential still needs to be fully understood.

In contrast to what was mentioned above, posts from Topic 7 also discussed the use of kratom for substance use disorder recovery and maintenance. In this regard, some users reported considering using kratom to curb Suboxone addiction. These findings are in line with data from large surveys or studies, which have demonstrated that kratom is used without medical supervision in self-treating pain, psychiatric symptoms (e.g., depression and anxiety), dependence, and interrupting consumption of different substances, such as opioids, and methamphetamine (Coe et al., 2019; Govarthnapany et al., 2025; Grundmann, 2017; Prevete et al., 2023b; Rogers et al., 2021, 2024b; Singh et al., 2022). Moreover, the use of kratom for substance use disorder recovery and maintenance aligns with the interest of the scientific community. Through in vitro and animal models as well as pre-clinical studies, previous scientific work has found that kratom has potential in reducing alcohol intake (Gutridge et al., 2020, 2021), opioid withdrawal and dependence (Harun et al., 2020), and diminishing alcohol withdrawal or seeking behavior (Gutridge et al., 2020; Vijeepallam et al., 2019). Additionally, a review by Mukhopadhyay et al. (2023) has outlined the use of kratom and its alkaloids as potential pharmacotherapies for substance use disorder, pain, and opioid withdrawal. While related clinical work has been conducted (e.g., Huestis et al., 2024; Tanna et al., 2022; Vicknasingam et al., 2020), it is limited and leaves room for further investigation.

Another common topic of discussion was related to the logistics of traveling with kratom for personal usage. Keywords and representative documents from Topic 6 showed that users were concerned with the legality of kratom in various states and countries as well as seeking advice on storing kratom in carry-on and checked luggage to avoid issues with airport security.

Lastly, methods to optimize brewing kratom as tea was the 10th most commonly discussed topic that emerged in the dataset. Kratom is traditionally and commonly consumed as tea (Grundmann et al., 2023b). Reddit users would provide instructions on how to prepare kratom tea as well as how to enhance its taste (e.g., using nutmeg, cinnamon, and citrus juice) while still ensuring its potency.

Limitations

There are a few limitations to the present study. First, the present investigation only considers a single social media platform (Reddit) and may further benefit from analyzing discussions from other forums or platforms. Additionally, although the majority of Reddit traffic comes from the USA, the absence of detailed user demographic information means that our findings should be interpreted as reflecting the experiences and perspectives of Reddit users rather than the general population. Secondly, only posts were considered for topic modeling analysis and not the accompanying comments. Further sub-discussions that may have occurred within the comments to a given post may have also revealed further insight into discussions about kratom on Reddit. Thirdly, a substantial number of posts (130,235 of 188,139) were classified as outliers and not assigned to topics due to the default hyperparameter settings, which ensures a conservative clustering approach. While adjusting hyperparameters may reduce the outlier rate, it may force posts into poorly defined clusters, compromising the reliability and interpretability of results (Grootendorst, n.d.-c). Consequently, our insights primarily reflect the most thematically consistent discussions across 13 years, while less frequent or idiosyncratic conversations may not be captured and represented. Future research could explore alternative clustering strategies or parameter settings to better include these posts. For example, although regulatory debates surrounding the attempted Drug Enforcement Administration/Food and Drug Administration scheduling of kratom in 2016–2017 generated substantial public attention (Perry & Chin, 2025), such discourse did not emerge as a distinct cluster in our BERTopic model, likely due to its brief temporal concentration and dispersion across mixed-context threads rather than forming a sustained, cohesive topic. Moreover, it should be noted that the kratom market has evolved rapidly since December 2023, with extract-based and 7-hydroxymitragynine-enriched products becoming increasingly common. This temporal limitation should be considered when interpreting our findings, as the dataset may not fully capture more recent shifts in product availability and consumption patterns. Additionally, while the topic modeling procedure produced 524 clusters in total, only the most prevalent topics were manually inspected for coherence, as these accounted for the majority of the corpus and drove the key findings. Conducting an exhaustive manual validation of all clusters would offer limited additional value relative to its scale; however, we acknowledge that some infrequent or ambiguous topics may not be fully represented in our interpretation. Fourthly, the number of bins that were generated when computing the topic representations for dynamic topic modeling was set to 5 due to computational resource availability and to therefore increase the efficiency of the computations. Future research could explore using more bins to capture additional nuances in discussion content. Lastly, and as similarly addressed by Valdez and Patterson (2022), some caution must be applied towards drawing definitive insights from our analysis as the anonymity granted to Reddit users can put the authenticity of the posts into question. Further studies that include keywords related to kratom's main alkaloids (e.g., mitragynine, 7-hydroxymitragynine, speciogynine, paynantheine, and corynantheidine) should be encouraged to enhance understanding of its use and impact.

Conclusion

The present work utilized BERTopic, an NLP topic modeling approach, to efficiently extract and analyze the main topics of discussion from a large corpora of Reddit posts made in kratom-related subreddits between September 2010 and December 2023 ($n = 188{,}139$).

In general, the results of the study reveal and contextualize what individuals on Reddit think about kratom and how they communicate about it on a platform that allows them to fairly freely express themselves in an anonymous format. Various topics emerged including concerns about kratom and drug testing, recommendations for methods of consumption, and strategies to taper off kratom usage. The findings from our study, conducted on a larger scale, not only corroborate previous research but also strengthen their conclusions (e.g., Rogers et al., 2024a; Smith et al., 2021), revealing that users have reported both favorable and unfavorable experiences with kratom usage. Additionally, the DTM analysis furthermore suggests a declining interest towards vendor reviews, products quality-price, and shipping/delivery issues and a growing trend in discussions about negative experiences with kratom, which encourages individuals to use other substances (e.g., Gabapentin and Suboxone) without medical supervision in order to mitigate kratom withdrawal symptoms, taper off, or quit using it. Overall, the findings demonstrate the potential of social media discussions for informing healthcare professionals, policymakers, and researchers about users' attitudes and experiences with kratom, thereby guiding interventions, policies, and further scientific studies and supporting future clinical trials, which are necessary for generating a more balanced perception on kratom safety and risks.

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Data Availability The raw data used for the present study was obtained from a public repository in light of Reddit's application programming interface (API) privacy policy changes in June 2023. The repository is a large public dataset containing posts and comments from the top 40,000 subreddits obtained and stored publicly by an approved Reddit moderator. It was accessed via the following link: https://www.reddit.com/r/pushshift/comments/1akrhg3/separate_dump_files_for_the_top_40k_subreddits/.

Declarations

Ethical Approval This study was approved by the University of Trento Ethical Committee (2024–40 ESA).

Conflict of Interest The authors declare no conflict of interest.

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