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Alkasite restorative materials in dentistry: a bibliometric analysis from 2020 to 2025

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ABSTRACT

Aims: The aim of this study was to evaluate the global scientific output related to alkasite restorative materials in dentistry through a bibliometric analysis covering the period from 2020 to 2025.

Methods: A comprehensive literature search was conducted using the Scopus database. English-language original research articles (including in vitro and clinical studies) published between 2020 and 2025 and indexed under the subject area of dentistry were included. A total of 70 articles met the inclusion criteria. Bibliometric indicators such as publication trends, citation performance, contributing countries, journals, and keyword networks were analyzed using Microsoft Excel and VOSviewer software.

Results: The results demonstrated a steady increase in alkasite-related publications, with the highest research output and citation counts observed in 2022. India, Turkiye, and Egypt were the leading countries in terms of publication volume, whereas China, Croatia, and Thailand showed high citation impact despite limited output. Journal analysis revealed that general dental journals published the majority of studies, while specialized journals in adhesive and restorative dentistry achieved higher citation impact. Keyword analysis indicated a predominant focus on in vitro evaluations, particularly microleakage and shear bond strength.

Conclusion: This study provides the first bibliometric overview of alkasite research in dentistry, highlighting evolving research trends, geographical distribution, and scientific impact, and offers a valuable reference for future investigations.

Keywords: Alkasite, Cention N, bibliometric analysis, restorative dentistry, dental materials

INTRODUCTION

Advances in restorative dentistry have been largely driven by the growing demand for materials that combine esthetics with improved functional performance. This demand has encouraged extensive research efforts aimed at enhancing the optical and mechanical properties of restorative materials used in daily clinical practice.[1] Consequently, several innovative restorative materials have been developed to overcome the limitations of conventional systems and to better fulfill the requirements of contemporary esthetic dentistry.[2] Resin-based composite materials currently represent the most frequently utilized restorative option, as they offer a favorable balance between strength, durability, and esthetic appearance.[3] While these materials are fundamentally composed of a resin matrix reinforced with filler particles, ongoing modifications in their composition have resulted in multiple generations of composites with enhanced clinical properties.[4] Within this context, Cention N (Ivoclar Vivadent, USA) has recently been introduced as a tooth-colored restorative material and classified under the category of "alkasites," which are considered a distinct subgroup within resin-based composite materials.[5]

Bibliometric analyses have been increasingly utilized in the field of dentistry as a systematic approach to evaluate research productivity, scientific impact, and evolving trends within specific disciplines. These studies enable the quantitative assessment of published literature by analyzing publication output, citation patterns, authorship networks, and collaborative structures, thereby providing an objective overview of the scientific landscape.[6-8] In recent years, bibliometric methods have been widely applied across various dental specialties, including restorative dentistry, orthodontics, periodontology, and oral and maxillofacial surgery, reflecting their growing importance in evidence-based research evaluation.[9-12] By identifying influential authors, institutions, journals, and countries, bibliometric studies contribute to a deeper understanding of research dynamics and help guide future investigations in dentistry.

In recent years, there has been an increase in the number of studies in the literature on the physical, mechanical performance, and clinical performance of alkasite restorative materials.[13-16] However, a comprehensive bibliometric analysis covering recent years and focusing specifically on "alkasite"

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materials is yet to be found in the literature. The aim of this study is to analyze the global scientific output related to alkasite materials between 2020 and 2025 using the Scopus database and to document the evolution of this new group of materials in the dental literature.

METHODS

This study was conducted in accordance with the fundamental principles of the Declaration of Helsinki and was based exclusively on the analysis of bibliometric data derived from articles indexed in a single electronic database. As the research did not involve experiments on human participants, animals, or biological specimens, formal approval from an ethics committee was not required. Scopus is a widely recognized and bibliographic database known for its high-quality content. It was chosen as the source for extracting publications related to alkasite restorative materials in dentistry.

A comprehensive literature search was conducted using the Scopus online database to identify English-language studies focusing on alkasite materials in the field of restorative dentistry. In the Scopus database, the subject area was limited to "Dentistry" and the publication language to "English," and a search was performed using the keyword "Alkasite." Articles published within the last five years (2020–2025) and classified as original research articles (including in vitro and clinical studies) were included. Conference papers, letters to the editor, data set reports, and other non-relevant publication types were excluded from the analysis. After applying all inclusion criteria and keyword restrictions, a total of 70 articles were retrieved. No records unrelated to the topic were identified, and thus all 70 articles were included in the final analysis. Following detailed screening, key bibliometric parameters for each study such as title, journal name, first author, country of origin, year of publication, citation counts, and keywords were recorded. To minimize potential variations in citation data resulting from continuous database updates, data collection was independently completed by a single researcher within a single day (18 December 2025).

Data Analysis and Visualization

The analysis and visualization of the 70 included publications and their associated datasets were carried out using multiple tools and software packages, namely MS Excel (version 16.0) and VOSviewer (version 1.6.20). VOSviewer was employed to generate Graph Modeling Language (GML) files from the original data. In VOSviewer maps, node size reflects the number of publications, while the thickness of the links between nodes represents the strength of the connections. Bibliometric indicators related to citations, documents, sources, authors, institutions, and countries were examined. In addition, publication and citation trends, authorship patterns, bibliographic coupling (at the levels of journals, countries, and authors), keyword co-occurrence, author cocitation networks, and thematic evolution were visualized using these tools.

RESULTS

Research on Alkasites

Figure 1 presents the annual publication and citation trends related to alkasite restorative materials in restorative dentistry from 2020 to 2025. A total of 70 articles were analyzed, showing an overall increase in research output over time. The highest number of publications was recorded in 2022 (n=18; 25.7%), followed by 2024 (n=17). In terms of citation impact, articles published in 2022 received the highest number of citations (177), while more recent publications, particularly those from 2024 and 2025, showed lower citation counts due to their recency.

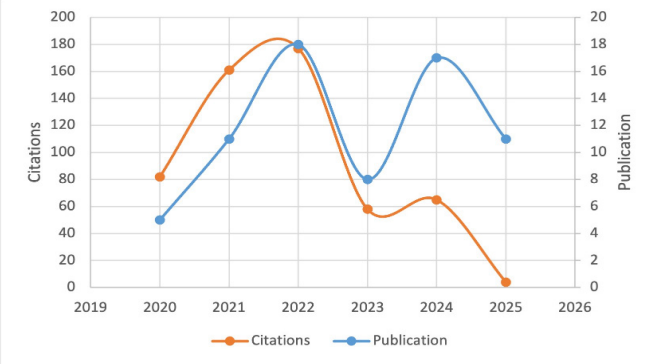

Figure 1. Annual publication and citation trends

Publishing and Citation Structure of Alkasite Research

Table 1 presents the annual publication and citation profile of alkasite related studies published between 2020 and 2025. It also shows the total publications (TP), total citations (TC), number of cited publications (NCP), citation/publication (C/P), and citation/cited publication (C/CP).

Table 1. Citation structure of alkasites research between 2020 and 2025

PY	TP	TC	NCP	C/P	C/CP
2020	5	82	5	16	16
2021	11	161	11	14	32
2022	18	177	18	9	35
2023	8	58	6	7	11
2024	17	65	13	3	13
2025	11	4	1	0	0

PY: Publishing year, TP: Total publications, TC: Total citations, NCP: Number of cited publications, C/P: The average citations per publication, C/CP: Average citations per cited publication

A total of 70 publications were identified, receiving 547 citations overall. The highest publication output was observed in 2022 (TP=18), which also accounted for the greatest number of citations (TC=177).

Publications published in 2021 and 2022 showed the strongest citation impact, with average citations per cited publication (C/CP) of 32 and 35, respectively. In contrast, articles published in 2025 demonstrated lower citation impact, likely due to their recent publication. Overall, the results indicate an increasing research interest in alkasite materials, with citation patterns influenced by publication age.

Leading Countries in Alkasite Research

Table 2 summarizes the leading countries contributing to alkasite research based on publication output and citation performance (Citation Index (CI)) =Citation/Publication). India ranked first in terms of total publications (TP=22), receiving 118 citations (CI= 5.36), followed by Turkiye (TP=15; TC=76; CI=5.07) and Egypt (TP=11; TC=49; CI=4.45).

Table 2. Leading countries in alkasites research between 2020 and 2025

Country	TP	TC	CI
India	22	118	5.36
Turkey	15	76	5.07
Egypt	11	49	4.45
Brazil	3	3	1.00
Croatia	3	82	27.33
Saudi Arabia	3	47	15.67
Indonesia	2	13	6.50
Iraq	2	3	1.50
Thailand	2	40	20.00
United Kingdom	2	33	16.50
China	1	45	45.00
Malaysia	1	20	20.00
Mexico	1	10	10.00
Singapore	1	0	0.00
Switzerland	1	8	8.00

TP: Total publications, TC: Total citations, CI: Confidence interval

Despite lower publication volumes, some countries demonstrated high citation impact. China showed the highest citation impact (CI=45.00) based on a single publication, while Croatia and Thailand, Malaysia also exhibited strong citation performance (CI=27.33 and 20.00, respectively). These findings indicate that citation impact is not necessarily proportional to publication output and varies considerably across countries.

Leading Journals.

Table 3 presents the leading journals contributing to alkasite related research based on publication output and citation performance. A total of 42 journals were initially identified; however, based on citation impact (CI=TC/TP), the top 20 journals were selected for inclusion in the analysis. Among these sources, BMC Oral Health ranked first in terms of publication volume (TP=7), followed by the Journal of Contemporary Dental Practice (TP=4) and the European Archives of Paediatric Dentistry (TP=3).

In terms of citation impact, several journals demonstrated notably high citation performance despite limited publication counts. The Journal of Adhesive Dentistry showed the highest citation impact (CI=45.0) based on a single publication, followed by the Saudi Dental Journal (CI=36.0) and the Journal of Dentistry (CI=35.0). Journals such as Acta Stomatologica Croatica and the Journal of Esthetic and Restorative Dentistry also exhibited strong citation impact with CI values.

With respect to publishers, "Springer Nature" emerged as the most prominent publisher among the leading journals. Overall, the results indicate that while publication output is concentrated in a limited number of journals, citation impact varies considerably and is not directly proportional to the number of publications.

Keyword Co-Occurrence Analysis

Figure 2 illustrates the keyword co-occurrence network based on author-provided keywords in alkasite-related research. The analysis was conducted using VOSviewer, with the minimum number of occurrences of a keyword set to one. The visualization reveals the overall structure of research themes and the relationships among keywords within the field. Closely related keywords were grouped into clusters, reflecting major thematic areas of alkasite research. The size of each node represents the frequency of keyword occurrence, while the thickness of the links indicates the strength of co-occurrence between keywords. Overall, the

Table 3. Leading journals and publishers in alkasites research between 2020 and 2025

Journal	TP	TC	CI	Publisher	CS
Journal of Adhesive Dentistry	1	45	45	Quintessenz Verlags-GmbH	4.30
Saudi Dental Journal	1	36	36	Springer Nature	3.20
Journal of Dentistry	1	35	35	Elsevier Ltd	7.50
British Dental Journal	1	32	32	Springer Nature	2.70
Acta Stomatologica Croatica	2	47	23.5	University of Zagreb	3.30
Clinical Oral Investigations	1	22	22	Springer Nature	6.30
Journal of Esthetic and Restorative Dentistry	2	33	16.5	John Wiley & Sons	7.70
Biomaterial Investigations in Dentistry	1	15	15	Medical Journals Sweden AB	5.10
Journal of Applied Oral Science	2	27	13.5	Faculdade de Odontologia de Bauru da Universidade de Sao Paulo	3.90
Pesquisa Brasileira em Odontopediatria e Clinica Integrada	1	13	13	Association of Support to Oral Health Research (APESB)	1.00
European archives of paediatric dentistry: official journal of the European Academy of Paediatric Dentistry	3	31	10.3	Springer Nature	5.00
Journal of Conservative Dentistry	2	18	9	Wolters Kluwer Health	2.10
International Journal of Dentistry	1	9	9	John Wiley & Sons	4.40
Journal of Contemporary Dental Practice	4	35	8.7	Jaypee Brothers Medical Publishers (P) Ltd	1.90
Journal of Oral Science	1	7	7	Nihon University, School of Dentistry	4.20
Journal of Indian Society of Pedodontics and Preventive Dentistry	1	7	7	Wolters Kluwer Health	1.70
Journal of Stomatology	1	6	6	Termedia Publishing House Ltd.	0.60
BMC Oral Health	7	38	5.4	Springer Nature	3.90
Contemporary Clinical Dentistry	3	15	5	Wolters Kluwer Health	2.20
Ain Shams Dental Journal (Egypt)	1	5	5	Ain Shams University, Faculty of Dentistry	0.50

PY: Publishing year, TP: Total publications, TC: Total citations, NCP: Number of cited publications, C/P: The average citations per publication, C/CP: Average citations per cited publication

network highlights the diversity of research topics and the interconnected nature of keywords within the literature. As a result, all 201 identified keywords met the threshold and were included in the analysis. Among the most prominent keywords, alkasite demonstrated the highest connectivity, with 24 occurrences, 76 links indicating its central role within the research network. Cention-N also showed strong co-occurrence characteristics, with 11 occurrences, such as microleakage (9 occurrences), glass ionomer cement (6 occurrences) and shear bond strength (5 occurrences).

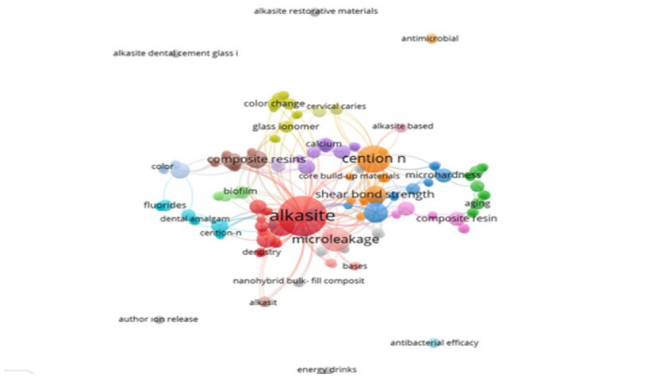

Figure 2. Keyword co-occurrence analysis

Bibliographic Coupling of Authors

Figure 3 illustrates the bibliographic coupling network of authors contributing to alkasite-related research. The analysis was performed using VOSviewer, with the minimum number of documents per author set to two. Under this criterion, 18 authors out of a total of 250 met the inclusion threshold and were incorporated into the network visualization.

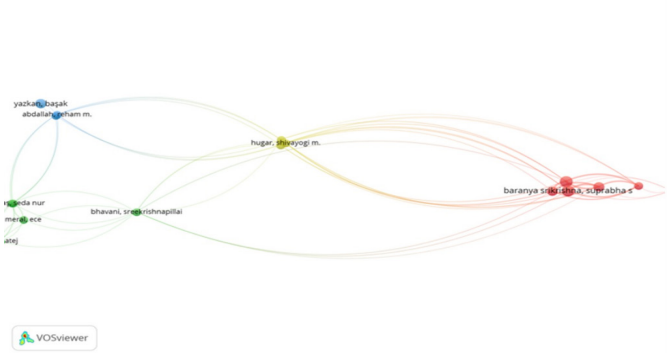

Figure 3. Bibliographic coupling of authors

The resulting map reveals patterns of shared references among authors, indicating similarities in research focus and intellectual background. Authors were grouped into distinct clusters based on the strength of their bibliographic coupling relationships. Cluster 1 exhibited the strongest coupling activity, with authors showing the highest numbers of links and total link strength, particularly Baranya and Rao (9 links; total link strength=130). Cluster 2 comprised authors with moderate coupling intensity, characterized by link counts ranging from 5 to 7 and total link strength values up to 32. In contrast, Clusters 3 and 4 demonstrated lower but notable coupling activity, with total link strength values varying between 2 and 56. Overall, the results indicate heterogeneous bibliographic coupling patterns among authors, reflecting varying degrees of shared reference structures within the field.

Citation Analysis of Sources

Figure 4 presents the citation network of sources based on alkasite-related publications. The analysis was conducted using VOSviewer, with the minimum number of citations per source set to two. Out of 43 identified sources, 16 met the threshold and were included in the visualization. The resulting network illustrates the citation relationships among the most influential sources in the field.

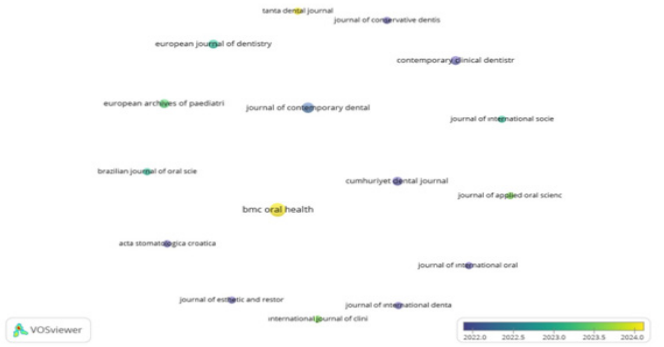

Figure 4. Citation analysis of sources

Co-Citation Analysis of Cited References

Figure 5 illustrates the co-citation network of cited references in alkasite-related research. The analysis was performed using VOSviewer, with the minimum number of citations per cited reference set to three. Of the 525 cited references identified, 23 met the threshold and were included in the analysis. The resulting visualization highlights the most frequently co-cited references and their interrelationships, reflecting the intellectual foundations of the field.

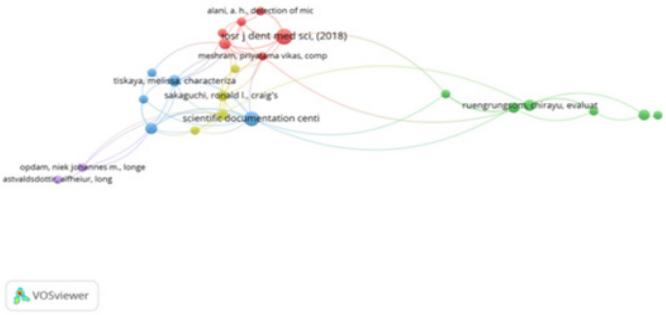

Figure 5. Co-citation analysis of cited references

DISCUSSION

To the best of the authors' knowledge, this study represents the first bibliometric analysis specifically focusing on alkasite restorative materials in dentistry. Although an increasing number of experimental and clinical studies have investigated the physical, mechanical, and clinical performance of alkasite restorative materials in recent years, the overall structure, growth patterns, and global distribution of scientific research in this field have not previously been systematically evaluated. By quantitatively analyzing publication trends, citation patterns, contributing countries, and leading journals, the present study provides a comprehensive overview of the evolution of alkasite related research and places this emerging material class within the broader context of contemporary dental materials science.

In previous bibliometric analyses conducted in the field of dentistry, a variety of software tools have been employed throughout the stages of data collection, screening, analysis, and visualization. For network analysis and visualization, VOSviewer has been widely used to map keyword co-occurrence, author collaboration, and citation networks.[17-20] More advanced network analyses and graph modeling have been performed using Gephi software, while Bibliometrix has been applied to examine publication trends and thematic evolution. In addition, basic tools such as Microsoft Excel and Microsoft Access have been utilized for the systematic organization of data and the execution of descriptive analyses and simple calculations.[21] In the present study, VOSviewer and Microsoft Excel programs were used.

In the present study, the analysis of global scientific output on alkasite restorative materials revealed that India, Turkiye, and Egypt were the top three contributing countries. This geographical distribution presents a distinct pattern compared to bibliometric analyses in technology-intensive fields such as digital dentistry or virtual reality, which are typically dominated by high-income countries.[22] The prominence of developing and emerging economies in alkasite research can be attributed to the specific clinical positioning of this material group. Alkasite restorative materials were introduced as cost-effective, bulk-fill alternatives to dental amalgam and expensive resin composites.[5] Therefore, it is unsurprising that research interest is concentrated in countries with high caries prevalence and a strong demand for affordable, time-saving restorative solutions.

India emerged as the most productive country (TP=22). This finding aligns with recent bibliometric trends in dentistry, where India has shown exponential growth in scientific output, driven by a vast number of dental institutions and a large pool of postgraduate students requiring thesis topics.[23] Similarly, Turkiye ranked second (TP=15), maintaining its status as a significant contributor to dental literature in the region. Previous bibliometric studies focusing on Turkiye's dental research output have linked this productivity to the increasing number of universities and the academic promotion criteria that encourage publication.[24] An interesting discrepancy was observed between publication volume and citation impact. While India and Turkiye led in the number of articles, China demonstrated the highest Citation Index (CI=45.00) despite having only a single publication. This suggests that while emerging economies are driving the quantity of research, high-impact studies may still originate from or be collaborative efforts with major research hubs that garner more immediate global attention.

The frequent occurrence of the keywords "microleakage" and "shear bond strength" in our keyword analysis indicates that researchers have primarily focused on the most critical clinical performance parameters of this novel restorative material. A review of the existing literature reveals that the microleakage values of Cention N are generally reported to be lower than those of glass ionomer cements which explains the central role of this keyword within the research network.[25,26] Similarly, studies evaluating bond strength have demonstrated that alkasite materials exhibit a dentin bonding potential that is competitive with other esthetic restorative materials, thereby supporting the prominent clustering of the term "bond strength" observed in our bibliometric analysis.[27,28]

The analysis of journals publishing alkasite-related research revealed a heterogeneous distribution in terms of publication volume and citation impact. "BMC Oral Health" stood out as the most productive journal thanks to its comprehensive range of publications. However, journals with a smaller number of publications, such as the "Journal of Adhesive Dentistry" (CI:45, CS: 4.30) and the "Journal of Dentistry" (CI:35, CS: 7.5), demonstrated substantially higher citation indices, suggesting that studies published in more specialized or higher-impact journals tend to achieve greater scientific visibility.

This finding is consistent with previous bibliometric studies in dentistry, which have shown that publication quantity does not necessarily correlate with citation performance.[21,29] Journals focusing on specific subfields, particularly adhesive and restorative dentistry, often attract a more targeted readership, resulting in higher citation rates despite lower publication volumes (Journal of Adhesive Dentistry CI:45, "Journal of Esthetic and Restorative Dentistry" TC:16.5). In contrast, general dental journals may serve as platforms for disseminating early or exploratory research on novel materials, such as alkasites.

From a publisher perspective, the dominance of major publishing houses, particularly "Springer Nature", highlights their role in shaping the dissemination of alkasite research. Journals published by major publishers in developed countries such as the USA, UK, and Switzerland (Elsevier, Wiley, Sage, Nature, Springer, etc.) have a much stronger international reach thanks to their proficiency in the English language and global distribution networks.[16] Overall, these findings suggest that both journal scope and publisher influence play a critical role in determining the academic impact of alkasite-related publications.

Limitations

Despite providing a comprehensive overview of alkasite related research, the present bibliometric analysis has several limitations that should be acknowledged. First, the study was restricted to publications indexed in a single database (Scopus), which, although widely recognized for its extensive coverage and data quality, may not capture all relevant studies indexed in other databases such as Web of Science or PubMed. Second, only English-language articles were included, potentially excluding valuable research published in other languages and introducing a degree of language bias. In addition, the analysis was limited to publications published between 2020 and 2025, which may not fully reflect earlier exploratory research or long-term citation trends associated with alkasite materials. Future studies could expand the time frame to include earlier years as the field matures, allowing for a more comprehensive evaluation of research evolution and citation dynamics. Finally, as citation counts are time-dependent, recently published articles may be underrepresented in terms of citation impact. Despite these limitations, the findings provide a reliable snapshot of current research trends and offer a solid foundation for future bibliometric investigations in this emerging field.

CONCLUSION

This bibliometric study presents the first comprehensive overview of alkasite research in dentistry between 2020 and 2025. The results demonstrate a growing research interest,

predominantly driven by developing and emerging countries, with notable differences between publication output and citation impact. Current studies predominantly focus on in vitro investigations evaluating clinically relevant outcomes such as microleakage and bond strength. Overall, these findings provide a useful reference for understanding research trends and guiding future investigations in restorative dentistry.

ETHICAL DECLARATIONS

Ethics Committee Approval

Since the study involved no human or animal subjects, clinical interventions, or identifiable patient data, ethics committee approval was not required.

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

The author is solely responsible for the conception, data collection, analysis, and writing of this manuscript

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