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Hydroxypropyl cellulose research over two decades (2005–2024): A systematic review with bibliometric analysis and translational insights

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ADMINISTRATIVE INFORMATION

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 7 September 2025 and was last updated on 7 September 2025.

INTRODUCTION

Review question / Objective The objective of this review is to provide a comprehensive bibliometric analysis of HPC research between 2005 and 2024, integrating both H-HPC and L-HPC. Specifically, it aims to map global publication and citation trends, identify leading contributors and collaboration networks, reveal thematic clusters and emerging application domains, and highlight translational opportunities and research gaps to guide future scientific and industrial advancement.

Rationale Although hydroxypropyl cellulose (HPC) has well-established physicochemical advantages and diverse applications, the research landscape is fragmented. Most studies focus narrowly on specific uses—such as H-HPC in drug delivery and functional materials or L-HPC in tablet disintegration—without providing a cohesive, data-driven overview of the field. Moreover, reliance on commercially available grades has constrained innovation, leaving greener synthesis strategies, functionalization for next-generation devices, and industrial scale-up underexplored. Despite a rapid increase in publications over the past two decades, no comprehensive bibliometric synthesis exists to map global research trends, key contributors, and thematic clusters. This gap motivated the present study, which applies systematic bibliometric methods to reveal the intellectual structure, collaborative networks, and translational opportunities in HPC research.

Condition being studied Bibliometric data were retrieved from the Scopus database, covering publications from 2005-2024. The Scopus database was systematically searched on 7 July 2025 using predefined keywords. The screening and reporting of this bibliometric review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020

guidelines. A completed PRISMA checklist is provided in the Supplementary Materials (Table S1) to ensure the transparency and reproducibility of the study.

All compatible results in each predefined outcome domain were included in this study. Specifically, bibliometric indicators (publication counts, annual growth rates, citation trajectories, geographic distributions, co-authorship, co-citation, bibliographic coupling, and keyword co-occurrence networks) were extracted from the final dataset of 1,273 publications for H-HPC and 92 publications for L-HPC, obtained after screening, and analyzed without selective exclusion. In addition, other variables, such as top au-thors, journals, institutions, and countries, were collected from Scopus metadata to characterize the research landscape. Funding information was recorded when it was available in the database. When metadata fields were missing or unclear, these were treated as 'not reported,' and no assumptions were made beyond the information available. As this was a bibliometric review, no formal risk-of-bias tool was applied. Potential bias was minimized through duplicate removal and the use of standardized bibliometric indicators, without reviewer-level or automation-based bias assessment. Because the data source was limited to the Scopus database, potential reporting bias due to non-indexed or unpublished studies could not be excluded.

METHODS

Search strategy Bibliometric data were retrieved from the Scopus database, covering publications from 2005-2024. The Scopus database was systematically searched on 7 July 2025 using predefined keywords. The screening and reporting of this bibliometric review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [22], as shown in Figure 2. A completed PRISMA checklist is provided in the Supplementary Materials (Table S1) to ensure the transparency and reproducibility of the study. First, data were collected from the Scopus database, covering publications from 2005 to 2024, with search settings restricted to article titles, abstracts, and keywords. The dataset was divided into two categories based on the keyword strategies: one targeting the H-HPC group and the other targeting the L-HPC group. For H-HPC, search strings included "hydroxypropyl cellulose" or "hydroxypropylcellulose" and "HPC," while explicitly excluding terms related to low substitution. For L-HPC, combinations of "low-substituted hydroxypropyl cellulose," "low-substituted hydroxypropylcellulose," "low substituted hydroxypropyl cellulose," "low substituted hydroxypropylcellulose," and "L-HPC" were applied.

Following keyword-based retrieval, only research articles and conference pro-ceedings explicitly addressed HPC research. From this, the resulting data found 1,281 publications (1,201 research articles and 80 conference proceedings) for H-HPC and 92 research articles for L-HPC. The data screening was performed using Microsoft Excel to eliminate duplicate entries. This step refined the datasets, yielding 1,273 publications for H-HPC (1,197 research articles and 76 conference proceedings) and 92 publications for L-HPC. Furthermore, abstract and/or full-text assessments were employed as secondary screening, and no excluded publications were found both H-HPC and L-HPC. Subse-quently, bibliometric analysis was performed using Microsoft Excel for statistical assessment and VOSviewer for visualizing collaboration networks, co-citation patterns, and keyword co-occurrences.

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Participant or population This review does not involve patients or clinical participants. Instead, the population of interest is the body of published research indexed in Scopus between 2005 and

2024 that investigates hydroxypropyl cellulose (HPC), including both its highly substituted form (H-HPC) and low-substituted form (L-HPC). The included publications encompass research articles and conference proceedings across disciplines such as pharmaceutical sciences, materials science, nanotechnology, biotechnology, and sustainable functional materials.

Intervention Application of bibliometric analysis methods (publication counts, citation analysis, co-authorship networks, keyword co-occurrence, and thematic mapping) to systematically evaluate the global HPC research landscape.

Comparator Comparative analysis between H-HPC and L-HPC research trends, including differences in publication output, citation impact, geographic distribution, collaboration networks, and thematic applications.

Study designs to be included This review includes original research articles and conference proceedings indexed in the Scopus database that address hydroxypropyl cellulose (HPC), including both highly substituted (H-HPC) and low-substituted (L-HPC). No restrictions were applied regarding study design (e.g., experimental, applied, or computational), provided the publication directly related to HPC. Non-research documents such as reviews, editorials, notes, short surveys, book chapters, and errata were excluded.

Eligibility criteria Following keyword-based retrieval, only research articles and conference pro-ceedings explicitly addressed HPC research. From this, the resulting data found 1,281 publications (1,201 research articles and 80 conference proceedings) for H-HPC and 92 research articles for L-HPC. The data screening was performed using Microsoft Excel to eliminate duplicate entries. This step refined the datasets, yielding 1,273 publications for H-HPC (1,197 research articles and 76 conference proceedings) and 92 publications for L-HPC. Furthermore, abstract and/or full-text assessments were employed as secondary screening, and no excluded publications were found both H-HPC and L-HPC.

Information sources The primary information source was the Scopus database, which was systematically searched on 7 July 2025 to retrieve publications from 2005 to 2024. The search was conducted using predefined keywords applied to article titles, abstracts, and author keywords. Only documents indexed in Scopus were considered, as the database provides extensive coverage of multidisciplinary literature and allows export of complete metadata required for bibliometric analysis. No additional databases, trial registers, or grey literature sources (e.g., theses, preprints, or institutional reports) were included, and no direct contact with authors was undertaken.

Main outcome(s) Identification of global publication and citation trends, leading contributors (countries, institutions, authors, journals), thematic clusters, and research gaps. The outcomes also highlight future translational opportunities, including greener synthesis, functionalization for next-generation devices, and industrial scalability.

Additional outcome(s) In addition to publication and citation trends, the review also assessed:
1. Geographic distribution of research output, highlighting leading countries and regional patterns.
2. Authorship dominance factors to evaluate intellectual leadership and first-author contributions.
3. Global co-authorship and collaboration networks at both country and institutional levels.
4. Keyword co-occurrence mapping to identify thematic clusters, niche applications, and emerging research domains.
5. Comparative analysis between H-HPC and L-HPC in terms of scope, applications, and scientific influence.

Quality assessment / Risk of bias analysis This study did not perform a traditional risk of bias assessment of primary studies, as is common in systematic reviews of clinical trials, because the present work is a bibliometric review. Instead, quality assurance was ensured by:
a. Using Scopus, a comprehensive and validated bibliographic database, as the sole information source.
b. Applying structured keyword strategies to minimize retrieval bias.
c. Screening and removing duplicates to ensure dataset accuracy.
d. Using objective bibliometric indicators (publication counts, citation data, co-authorship networks, and keyword co-occurrence) that reduce subjective interpretation.

No further risk of bias assessment was required, since the study evaluates the published research landscape rather than outcomes from experimental or clinical studies.

Strategy of data synthesis Data synthesis will be performed using a quantitative bibliometric approach. First, descriptive analyses (annual

publication and citation trends, document types, and geographic distributions) will be conducted in Microsoft Excel. Next, VOSviewer software (v1.6.20) will be applied to construct and visualize bibliometric networks, including co-authorship, co-citation, bibliographic coupling, and keyword co-occurrence. Cluster analysis will be used to identify thematic structures and research frontiers. Comparative synthesis will be undertaken to contrast highly substituted HPC (H-HPC) and low-substituted HPC (L-HPC) in terms of research volume, citation impact, and application domains. The integrated results will provide a comprehensive map of the intellectual structure, collaboration networks, and emerging trends in HPC research.

Subgroup analysis Subgroup analyses will be conducted to enable comparative insights across different dimensions of HPC research. Specifically:
1. H-HPC vs. L-HPC: Comparative analysis of publication volume, citation impact, and thematic applications.
2. Research domains: Stratification by subject categories (e.g., pharmaceuticals, chemistry, materials science, engineering).
3. Geographic distribution: Analysis of leading countries and regions contributing to HPC research.
4. Authorship dynamics: Examination of dominance factors and co-authorship patterns by author and institution.
5. Temporal trends: Comparison of early (2005–2014) vs. recent (2015–2024) publications to capture thematic evolution.

Sensitivity analysis Formal sensitivity analysis of primary studies was not applicable, as this is a bibliometric review. Instead, robustness of the findings was ensured by:
1. Duplicate removal and validation of search results to avoid data distortion.
2. Cross-checking keyword strategies (e.g., "hydroxypropyl cellulose" vs. "hydroxypropylcellulose," "H-HPC" vs. "L-HPC") to confirm consistency in dataset retrieval.
3. Testing alternative thresholds in VOSviewer (e.g., minimum keyword co-occurrence set at 5 vs. 10) to verify stability of thematic clusters.
4. Comparing results across timeframes (early vs. late periods) to ensure observed trends were not driven by a single peak year.

Country(ies) involved Indonesia.

Other relevant information PRISMA checklist is available as a supplementary material of the submitted manuscript.

Keywords hydroxypropyl cellulose; bibliometric analysis; systematic review; drug delivery; thermochromic; hydrogels.

Contributions of each author

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