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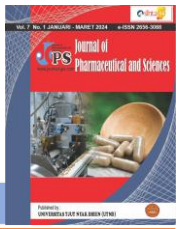

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Current Trends and Future Directions in *Camellia sinensis* Research on Weight Management and Obesity Related Outcomes: A Twenty-Year Overview and Bibliometric Analysis

Tren Terkini dan Arah Masa Depan Penelitian *Camellia sinensis* tentang Manajemen Berat Badan dan Luaran Terkait Obesitas: Tinjauan Dua Puluh Tahun dan Analisis Bibliometrik

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Abstract

Camellia sinensis (tea) is widely consumed and has been extensively investigated for its potential to support weight management, particularly because of the bioactive catechin epigallocatechin-3-gallate (EGCG). We conducted a bibliometric analysis to map the scope, productivity, collaboration patterns, citation impact, and thematic evolution of research on *Camellia sinensis* and obesity-related outcomes. We retrieved records indexed in Scopus for 2005–2024 using terms for *Camellia sinensis*, major tea types, and obesity. After excluding non-original publications, we analysed 897 original research articles with VOSviewer (version 1.6.20) and the Biblioshiny R package, including co-occurrence, collaboration, and citation networks. Annual output increased from 21 articles in 2005 to a peak of 80 in 2020. China produced the most publications (n = 182), while the United States achieved the greatest total citation impact. The leading sources were Nutrients, Journal of Nutritional Biochemistry, and Food & Function; the most prolific authors were Wang Y, Liu Z, and Zhang Y; and Anhui Agricultural University was the most productive institution. Keyword analysis identified four interconnected themes: green tea catechins and lipid metabolism, oxidative stress and polyphenols, gut microbiota and thermogenesis, and obesity-related metabolic syndrome. Recent research increasingly emphasises multi-omics, microbiota interactions, and precision nutrition. These bibliometric findings indicate expanding scientific interest in the potential contribution of *Camellia sinensis* to weight management and obesity-related metabolic health, while underscoring the need for standardised clinical trials, improved EGCG bioavailability, and cautious translation into clinical and policy settings.

Keywords: Camellia sinensis, epigallocatechin-3-gallate (EGCG), weight management, obesity, bibliometric analysis.

Abstrak

Camellia sinensis (teh) banyak dikonsumsi dan telah banyak diteliti karena potensinya dalam mendukung manajemen berat badan, terutama melalui katekin bioaktif epigallocatechin-3-gallate (EGCG). Kami melakukan analisis bibliometrik untuk memetakan cakupan, produktivitas, pola kolaborasi, dampak sitasi, dan perkembangan tematik penelitian mengenai *Camellia sinensis* serta luaran terkait obesitas. Kami memperoleh rekaman yang terindeks Scopus pada periode 2005–2024 dengan menggunakan istilah yang mencakup *Camellia sinensis*, berbagai jenis teh, dan obesitas. Setelah mengecualikan publikasi nonasli, kami menganalisis 897 artikel penelitian asli menggunakan VOSviewer versi 1.6.20 dan paket Biblioshiny pada R, yang mencakup jaringan ko-kemunculan, kolaborasi, dan sitasi. Jumlah publikasi tahunan meningkat dari 21 artikel pada tahun 2005 menjadi 80 artikel pada tahun 2020. Tiongkok menghasilkan publikasi terbanyak (n = 182), sedangkan Amerika Serikat memiliki dampak sitasi tertinggi secara keseluruhan. Sumber publikasi terkemuka adalah Nutrients, Journal of Nutritional Biochemistry, dan Food & Function; penulis paling produktif adalah Wang Y, Liu Z, dan Zhang Y; sedangkan Anhui Agricultural University merupakan institusi yang paling produktif. Analisis kata kunci mengidentifikasi empat tema yang saling berhubungan, yaitu katekin teh hijau dan metabolisme lipid, stres oksidatif dan polifenol, mikrobiota usus dan termogenesis, serta sindrom metabolik terkait obesitas. Penelitian terkini semakin menekankan pendekatan multiomik, interaksi mikrobiota, dan nutrisi presisi. Temuan bibliometrik ini menunjukkan meningkatnya minat ilmiah terhadap kemungkinan kontribusi *Camellia* sinensis dalam mendukung manajemen berat badan dan kesehatan metabolik terkait obesitas, sekaligus menegaskan perlunya uji klinis terstandardisasi, peningkatan bioavailabilitas EGCG, serta penerjemahan hasil secara hati-hati ke dalam praktik klinis dan kebijakan.

Kata Kunci: Camellia sinensis, epigallocatechin-3-gallate (EGCG), manajemen berat badan, obesitas, analisis bibliometrik.

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Introduction

The global prevalence of obesity continues to rise, making it a major public health challenge of the twenty-first century. Obesity reduces quality of life and increases the risk of type 2 diabetes, cardiovascular disease, and several cancers; therefore, effective management requires integrated nutritional, behavioural, and pharmacological strategies [1,2]. Within this context, *Camellia sinensis*—the source of green, black, oolong, and white tea—has garnered considerable attention as a dietary source of bioactive compounds that may support weight management. Studies have particularly examined catechins such as EGCG in relation to energy expenditure, fat absorption, gut-microbiota modulation, and lipid and glucose homeostasis [3–5].

In this bibliometric study, we operationally define research on weight management and obesity-related outcomes as studies that investigate the effects of tea or tea-derived compounds on at least one obesity-related endpoint, including body weight, adiposity or body composition, energy expenditure, lipid or glucose metabolism, inflammatory or oxidative markers, gut microbiota, or related metabolic profiles in animal models or humans. This definition encompasses prevention and management research but does not imply that *Camellia sinensis* has established therapeutic efficacy for obesity. Over the past two decades, a burgeoning body of literature has examined *Camellia sinensis* in this context. However, systematic assessments of publication growth, research collaboration, influential contributors, and the field's conceptual evolution remain limited [6,7]. This study provides a comprehensive bibliometric review of research on *Camellia sinensis* and obesity-related outcomes from 2005 to 2024. By analysing scientific articles indexed in Scopus, we aimed to identify key publication trends, prominent authors, institutions and countries, influential sources and publications, collaboration patterns, and emerging themes to guide future investigations.

Methods

Data Resource Strategy

We retrieved bibliometric records from the Scopus database on May 4, 2025. Scopus is a comprehensive, widely recognised source of peer-reviewed abstracts and citation data, making it appropriate for bibliometric analysis. We searched titles, abstracts, and keywords using the following conceptual combination: ("*Camellia sinensis*" OR "black tea" OR "green tea" OR "oolong tea" OR "white tea" OR "herbal tea" OR "herbal teas") AND "obesity," and limited the publication period to 2005–2024 and the language to English.

We retrieved 1,471 records and excluded reviews, book chapters, editorials, letters, conference publications, and other non-original document types. The final validated dataset comprised 897 original research articles, and we based all subsequent analyses on this dataset. We used VOSviewer (version 1.6.20) and the Biblioshiny interface of the bibliometrix R package to map and visualise bibliometric relationships. As this study is a bibliometric analysis of publicly available published literature and does not involve human participants or animal subjects, ethical approval was not required.

Data Analysis

We analysed annual publication output, citation impact, leading authors, productive countries and institutions, publication sources, and highly cited documents using VOSviewer (version 1.6.20) and Biblioshiny. In the network visualisations, nodes represent authors, terms, sources, countries, or cited references; node size indicates frequency or weight; link thickness reflects link strength; and shorter distances indicate stronger relationships. Colours distinguish clusters or, in overlay maps, the average publication period [8,9].

We exported Scopus records in CSV format for VOSviewer and RIS format for Biblioshiny. We then generated co-authorship, citation, co-citation, and keyword co-occurrence networks and examined their major thematic clusters [10,11].

Term Map

We extracted terms from article titles, abstracts, and author keywords with VOSviewer and Biblioshiny [12,13]. In the resulting maps, bubble size represents term frequency, spatial proximity indicates co-occurrence strength, and overlay colour represents the average publication year or citation influence, depending on the visualisation. We manually removed generic, duplicate, and contextually irrelevant terms before interpreting the networks [14].

Results and Discussion

Global Publication Trends

Using the predefined strategy, we retrieved 1,471 Scopus records published between 2005 and 2024. After excluding non-original document types, we retained 897 original research articles for analysis (Figure 1). We used this validated dataset for all analyses of publication trends, geographic and institutional productivity, authorship, citation impact, collaboration, and thematic development. Applying one consistent dataset throughout the study improves the transparency and reproducibility of the analysis. [15].

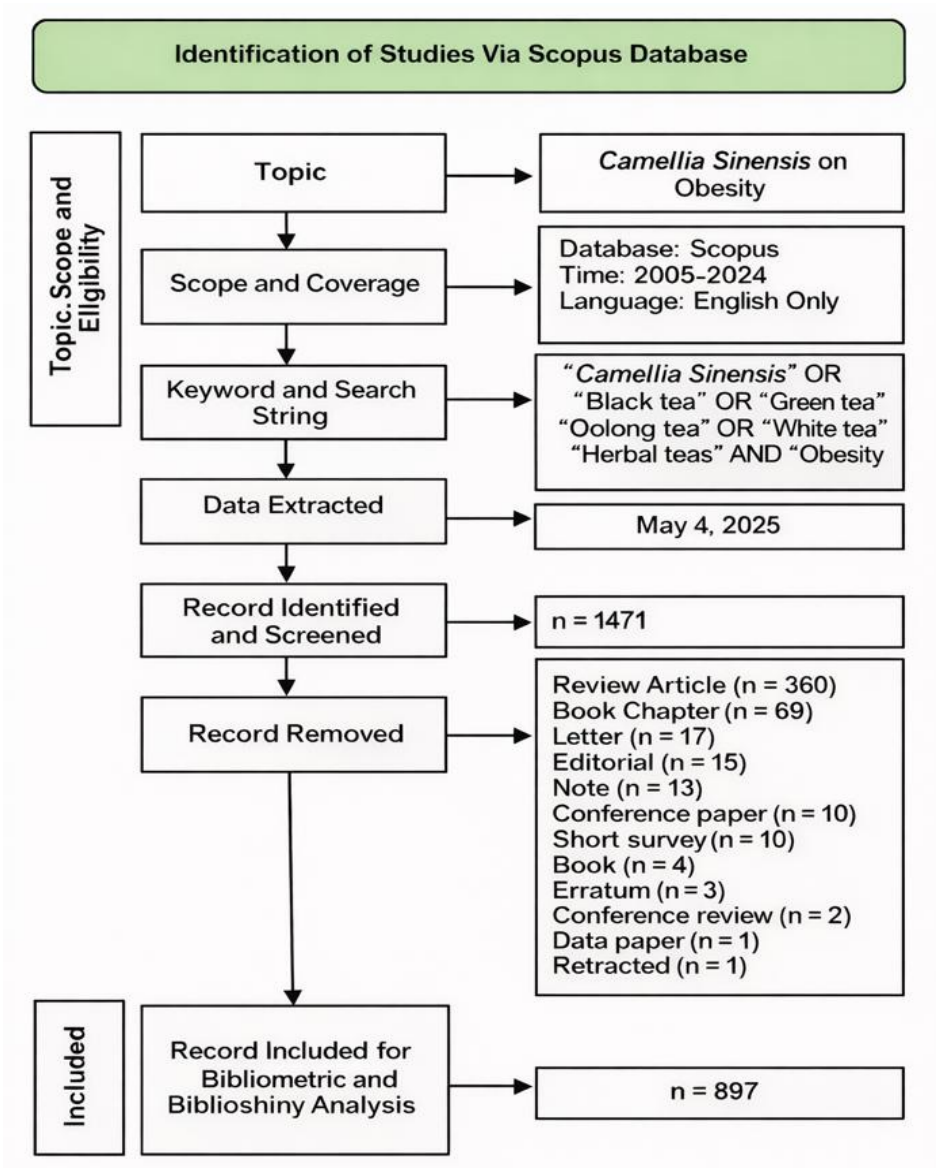

Figure 1. Flow Diagram of the Search Strategy

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Analysis of Global Publication Trends

Within the validated corpus of 897 articles, annual publication output showed sustained long-term growth. The field expanded particularly after 2011 and reached its highest annual output in 2020 (Figures 1 and 2) [16].

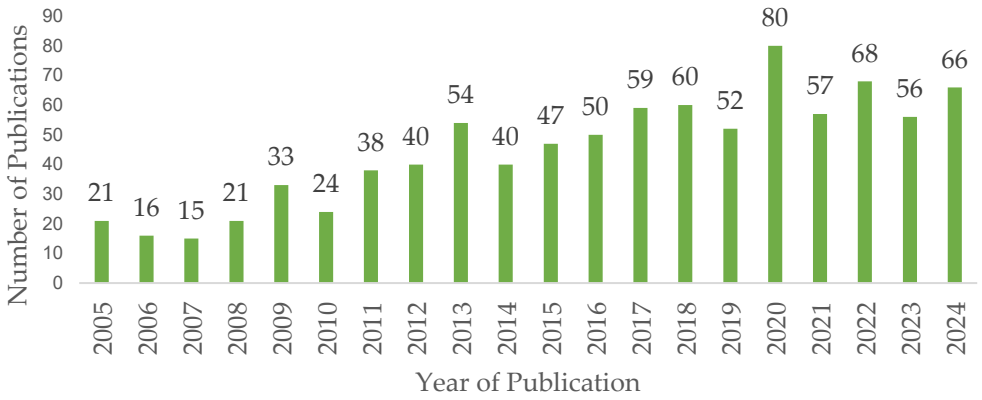

Figure 2. Publishing trends in *Camellia sinensis* research on weight management and obesity-related outcomes

Annual output increased from 21 articles in 2005 to 80 in 2020, representing an approximately 3.8-fold increase. Publications from 2005 to 2010 accounted for 130 articles (14.5% of the dataset), whereas the remaining 767 articles (85.5%) were published from 2011 onward. The 2020 peak represents the culmination of a sustained growth trajectory rather than evidence of a specific external cause. Although output declined to 57 articles in 2021, it increased again to 68 in 2022 and 66 in 2024, indicating continued scholarly engagement [17-21].

China was the most productive country (n = 182), followed by the United States (n = 115), Japan (n = 75), Korea (n = 64), Brazil (n = 40), and Iran (n = 33). The United States recorded the highest total citation count among these countries (n = 8,995), whereas the Netherlands had the highest average citations per publication (108.93). We report only countries for which the publication and citation values were internally consistent in the available dataset (Table 1). This pattern demonstrates strong East Asian leadership alongside substantial contributions from North America, Europe, and other regions [22].

Table 1. Leading productive countries with verified citation data

Country	Total Publication	Total Citation	Average Citations Per Publication
China	182	7005	38.49
Usa	115	8995	78.22
Japan	75	3996	53.28
Korea	64	1665	26.02
Brazil	40	1012	25.30
Iran	33	674	20.42
Netherlands	14	1525	108.93

Figure 3 shows that Nutrients published the largest number of articles (n = 47), followed by the Journal of Nutritional Biochemistry (n = 34) and Food & Function (n = 31). Other prominent sources included the British Journal of Nutrition, Journal of Medicinal Food, Journal of Nutrition, Journal of Agricultural and Food Chemistry, PLOS ONE, Journal of Functional Foods, and American Journal of Clinical Nutrition. This distribution confirms that the field spans nutrition, biochemistry, food science, and natural-products research [17].

Authorship analysis (Figure 4) showed concentrated productivity within several research networks. Wang Y authored 22 articles, followed by Liu Z (18), Zhang Y (17), Wang S (15), and Zhang X (15), with many high-output groups based in East Asia [18]. Broader international and cross-disciplinary collaboration could improve methodological comparability and accelerate the translation of mechanistic findings into well-designed human studies [19,20].

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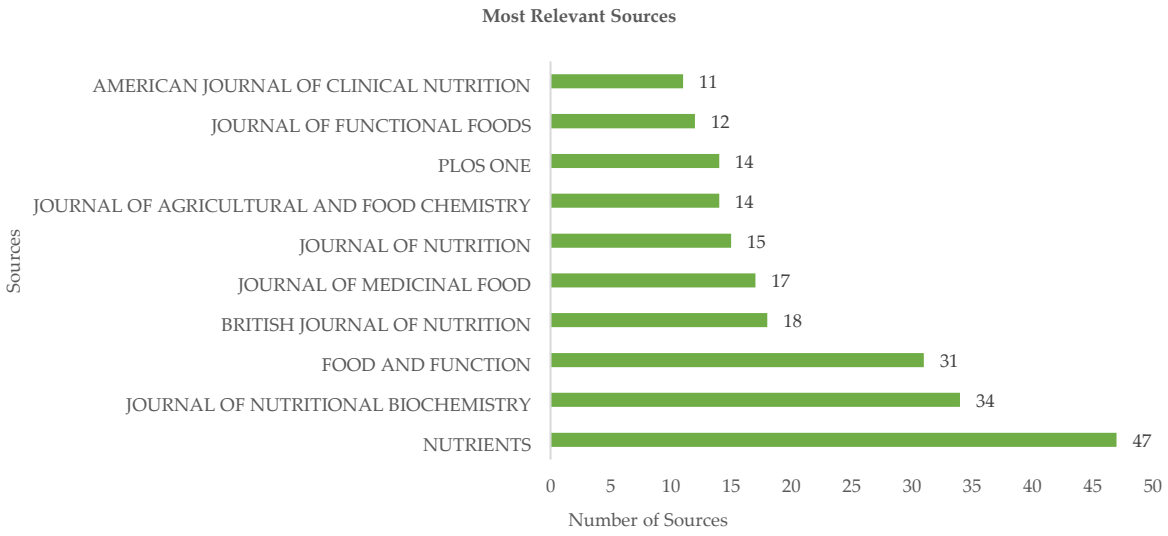

Figure 3. Top ten publication sources for *Camellia sinensis* research on weight management and obesity-related outcomes

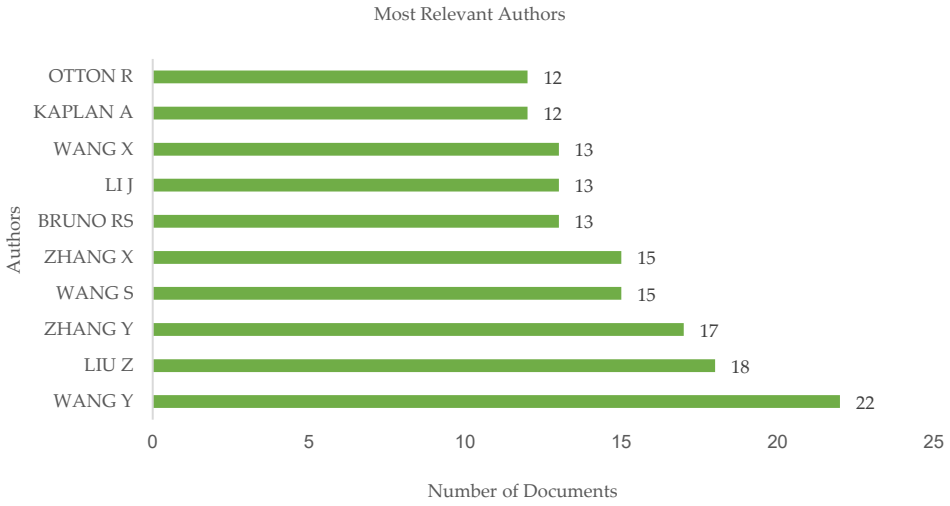

Figure 4. Leading authors in *Camellia sinensis* research on weight management and obesity-related outcomes

Figure 5 shows that the ten most productive institutions collectively contributed 672 articles. Anhui Agricultural University led with 104 articles, followed by Ben-Gurion University of the Negev (89), Kyushu University (75), Hunan Agricultural University (74), and the University of São Paulo (68). This pattern highlights strong institutional capacity in Asia, particularly China and Japan, while also demonstrating important contributions from Israel, Brazil, and the United States [23-27].

Table 2 identifies the most highly cited publications in the dataset. Collectively, the ten listed publications accumulated 7,317 citations at the time of data export and include foundational work on tea polyphenols, adiposity, metabolic regulation, and cardiometabolic outcomes [28].

The co-citation network (Figure 6) shows a central intellectual structure linking clinical nutrition, obesity and metabolic research, and dietary-intervention studies. Central nodes such as Shai, Blüher, Rinott, and Kaplan indicate shared attention to energy balance, insulin resistance, and metabolic regulation. However, the clinically oriented blue cluster appears less densely connected to the newer, mechanistically oriented yellow cluster. This separation suggests a translational gap between emerging evidence on molecular, microbiome, and multi-omics mechanisms and their evaluation in controlled human trials. Relatively sparse links involving detailed phytochemical characterisation, long-term safety, and herb–drug interactions further identify priorities for future research [8,9,27].

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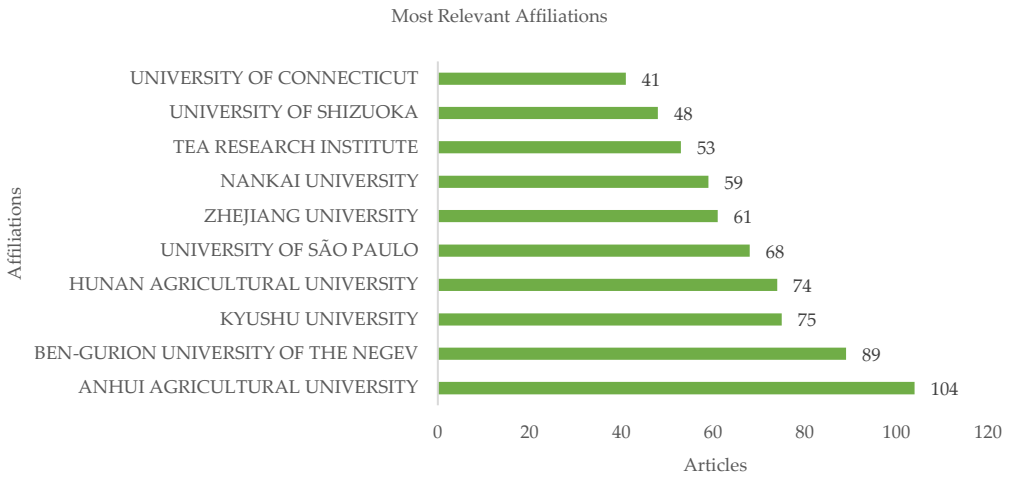

Figure 5. The most productive institutions

Table 2. Top ten most-cited publications in the dataset

Rank	Authors	Title	Year	Journal	Cited b	Reference
1	McAlindon, T. E., Bannuru, R., Sullivan, M. C., Arden, N. K., Berenbaum, F., Bierma-Zeinstra, S. M., & Underwood, M.	OARSI guidelines for the non-surgical management of knee osteoarthritis	2014	Osteoarthritis and cartilage	2299	[28]
2	Cabrera, C., Artacho, R., & Giménez, R.	Beneficial effects of green tea review	2006	Journal of the American College of Nutrition	1590	[29]
3	Musial, C., Kuban-Jankowska, A., & Gorska-Ponikowska, M.	Beneficial properties of green tea catechins	2020	International journal of molecular sciences	547	[30]
4	Bose, M., Lambert, J. D., Ju, J., Reuhl, K. R., Shapses, S. A., & Yang, C. S.	The major green tea polyphenol, (-) epigallocatechin-3-gallate, inhibits obesity, metabolic syndrome, and fatty liver disease in high-fat–fed mice.	2008	The Journal of Nutrition	547	[31]
5	Nagao, T., Hase, T., & Tokimitsu, I.	A green tea extract high in catechins reduces body fat and cardiovascular risks in humans.	2007	Obesity	433	[32]
6	Zhai, F. Y., Du, S. F., Wang, Z. H., Zhang, J. G., Du, W. W., & Popkin, B. M.	Dynamics of the Chinese diet and the role of urbanicity	2014	Obesity reviews	429	[33]
7	Klaus, S., Pültz, S., Thöne-Reineke, C., & Wolfram, S.	Epigallocatechin gallate attenuates diet-induced obesity in mice by decreasing energy absorption and increasing fat oxidation.	2005	International journal of obesity	388	[34]
8	Nagao, T., Komine, Y., Soga, S., Meguro, S., Hase, T., Tanaka, Y., & Tokimitsu, I.	Ingestion of a tea rich in catechins leads to a reduction in body fat and malondialdehyde-modified LDL in men.	2005	The American journal of clinical nutrition	387	[35]
9	Amiot, M. J., Riva, C., & Vinet, A.	Effects of dietary polyphenols on features of metabolic syndrome in humans: a systematic review.	2016	Obesity reviews	357	[36]
10	Potenza, M. A., Marasciulo, F. L., Tarquinio, M., Tiravanti, E., Colantuono, G., Federici, A., & Montagnani, M.	EGCG, a green tea polyphenol, improves endothelial function and insulin sensitivity, reduces blood pressure, and protects against myocardial I/R injury in SHR	2007	American Journal of Physiology-Endocrinology and Metabolism	340	[37]

Interpretation of citation impact requires caution. Several of the most-cited publications are reviews or guidelines, which generally have greater citation opportunities because they synthesise broad evidence and

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are frequently used as reference points. High citation counts therefore do not necessarily indicate stronger primary evidence or closer topical specificity. Nevertheless, primary studies by Bose et al., Nagao et al., Klaus et al., and Potenza et al. also appear in the top ten, demonstrating their foundational role in developing this research area [28–37].

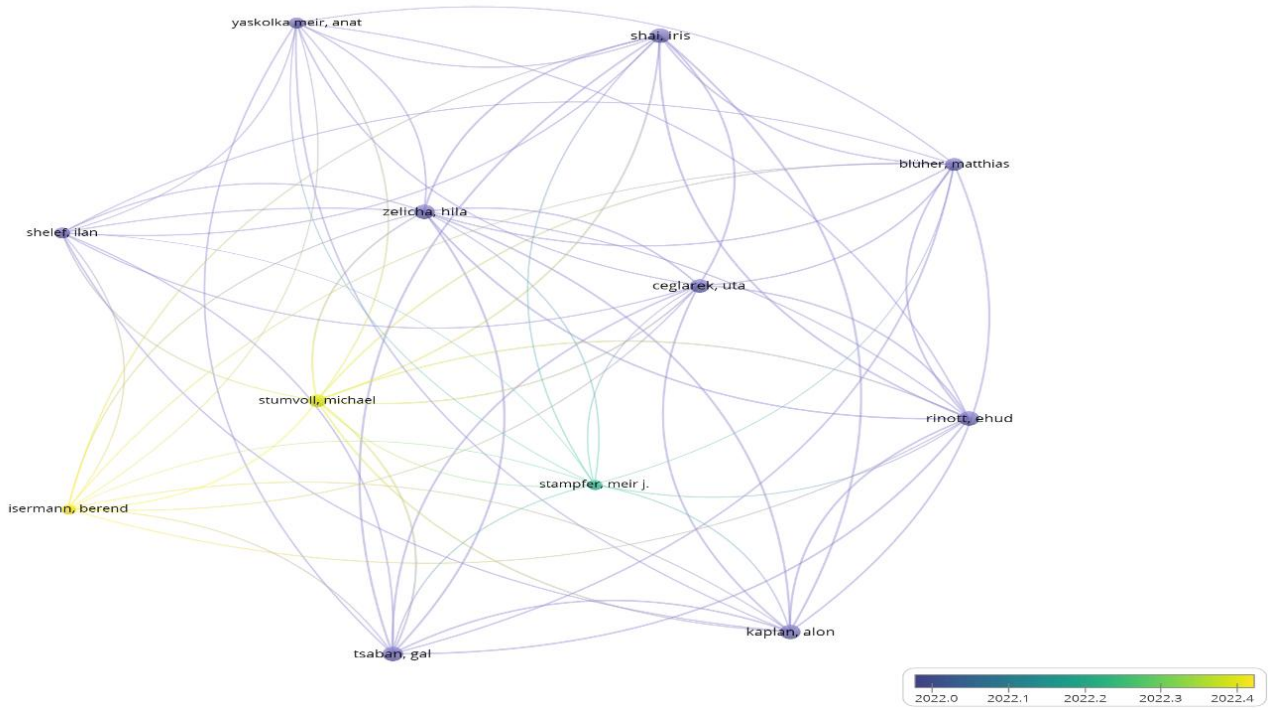

Figure 6. Co-citation network of cited references

The four keyword clusters represent interconnected levels of the proposed biological pathway rather than independent themes. The polyphenol and oxidative-stress cluster reflects upstream bioactive compounds and redox mechanisms. Because a substantial proportion of tea polyphenols reaches the intestine, these compounds can interact with the gut-microbiota and thermogenesis cluster by altering microbial composition and metabolite production. These microbial and molecular changes may subsequently influence lipid absorption, fat oxidation, energy expenditure, and gene regulation within the catechin and lipid-metabolism cluster. The metabolic-syndrome cluster represents downstream clinical and physiological outcomes, including insulin resistance, dyslipidemia, and adiposity. Thus, the network suggests a conceptual progression from tea-derived compounds, through redox and microbiome-mediated mechanisms, to metabolic and weight-related outcomes [38–42].

The keyword overlay map (Figure 8) further illustrates the field's chronological evolution. Earlier studies emphasised biochemical pathways, oxidative stress, diabetes, and animal models, whereas more recent studies increasingly focus on gut microbiota, thermogenesis, metabolomics, and gene regulation. This shift reflects a move from relatively isolated mechanistic explanations toward integrated, systems-level research.

These network gaps support several methodological priorities. Researchers should conduct preregistered multicenter randomised controlled trials using well-characterised tea extracts with verified catechin profiles, standardised doses, consistent obesity-related endpoints, and adequate follow-up. Integrating metabolomics, lipidomics, and microbiome profiling may help identify responder subgroups and clarify thermogenic and lipid-regulatory mechanisms. Long-term studies should also evaluate hepatotoxicity, chronic exposure, and drug interactions. Living systematic reviews and meta-analyses could compare tea-based interventions with established dietary strategies and strengthen evidence-to-policy translation [38,39].

Taken together, the thematic networks identify five recurring domains: EGCG and other polyphenols in lipid metabolism and intestinal absorption; antioxidant and inflammatory pathways; gut-microbiota modulation and brown-adipose thermogenesis; metabolic comorbidities; and molecular regulation of adipogenesis, gene expression, and lipid storage [40]. The field has therefore progressed beyond a simple antioxidant narrative toward a multidimensional model that links dietary bioactives, host metabolism, microbial ecology, and clinically relevant outcomes.

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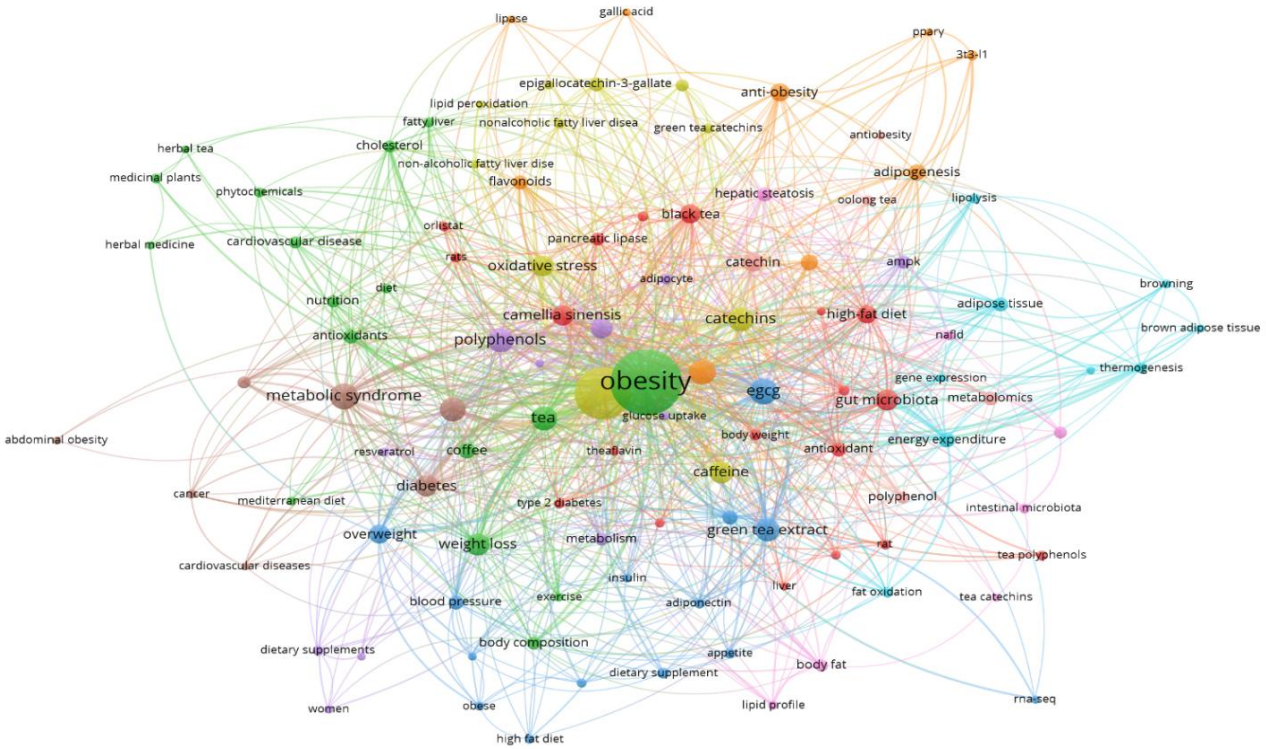

Figure 7. Keyword co-occurrence network

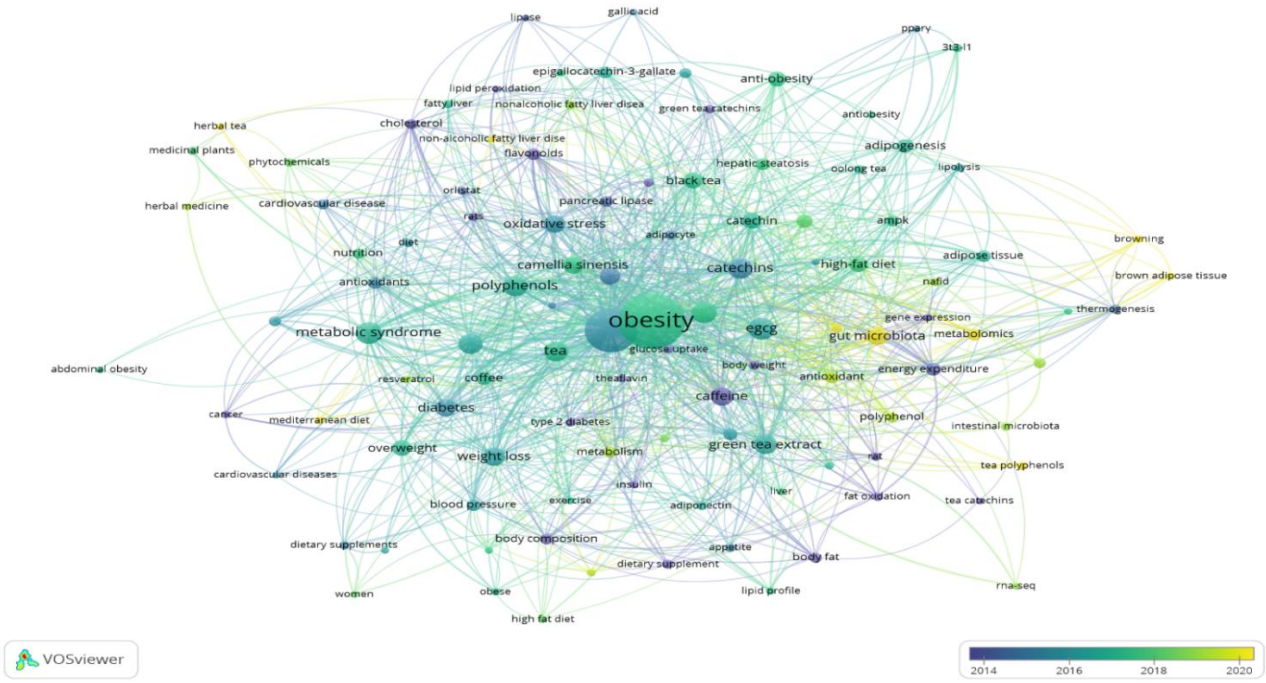

Figure 8. Keyword co-occurrence overlay with a time frame

Despite this expansion, bibliometric prominence should not be interpreted as proof of clinical efficacy. Human studies remain heterogeneous in extract composition, EGCG dose, intervention duration, participant characteristics, and outcome definition. Future syntheses should therefore distinguish preventive, supportive, and therapeutic claims and should separately evaluate preclinical and human evidence. A major translational challenge is EGCG's low and variable oral bioavailability, which is affected by chemical instability, limited intestinal absorption, rapid metabolism, food-matrix effects, and interindividual differences. Future research should evaluate formulation strategies such as EGCG-based nanoparticles and lipid-based delivery systems while carefully assessing safety and dose exposure [19,38]. Precision-nutrition approaches that integrate genetic, metabolic, and microbiome characteristics may further explain variability in response.

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Implementation research should examine real-world effectiveness, cost-effectiveness, adherence, and policy relevance before making broad clinical recommendations.

Conclusions

We found that research on *Camellia sinensis* and weight management has expanded substantially and increasingly integrates metabolic, microbiome, and multi-omics perspectives. The bibliometric evidence identifies growing scientific interest and several plausible biological pathways, but it does not establish *Camellia sinensis* as an effective treatment for obesity. Future work should use standardised formulations and endpoints, improve EGCG bioavailability, conduct adequately powered and long-term clinical trials, and clearly distinguish preclinical findings from clinically meaningful human outcomes. These steps are necessary to determine whether tea-derived interventions can safely support weight management and obesity-related metabolic health in practice.

Conflict of Interest

The authors declare no conflict of interest.

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