

## Global Research Output on Intestinal Flora and Health from 2000-2023: A Scientometric Analysis

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**How to cite this article:** Keya Ghosh, Dhiraj Sharma, Ashok Kumar Upadhyay (2024) Global Research Output on Intestinal Flora and Health from 2000-2023: A Scientometric Analysis, 44(3), 1247-1260

### ABSTRACT

A Significant number of studies have been made on intestinal flora and health and it has flourished in the last 24 years. In this study we have taken up an initiative to measure the literature outcome in intestinal flora using Scientometric analysis during the period 2000 to 2023 as extracted from SCOPUS interdisciplinary database. Total 6913 numbers of scholarly publications have been fetched which sum up most advanced achievements in this field according to the objectives. This research aims to assess the global research productivity on “Intestinal flora.” In respect of Literature Publications “China” is at the top among the world with publications (TP=4773), followed by “Unites States” (TP=468)”, and “India (TP=75)” is at the 11th position in this field during this time. “Frontiers in Microbiology” is the most prolific journal in the domain of “Intestinal flora” with 119 publications followed by “World Chinese Journal of Digestology” with 111 publications. Mostly Used Keywords are “Intestine Flora” (3947) followed by “article” (3157), then “non-human” (2897), “human” (2701) and so on. In this study Microsoft Excel, and open-source tool VOSviewer is used to study research publications trend, authors productivity, country collaboration the most prolific journals, authors, co-cited references, keywords etc.

**Keywords:** Scientometrics, Intestinal flora, SCOPUS, Research output, Citation Impact, Open access, VOSviewer, Bibliographic coupling

### INTRODUCTION

Bibliometric analysis is quantitative assessment of bibliographic data, and it is used to gauge the impacts of research papers in one or more disciplines. A significant part of the Scientometric analysis involves research output. A quantitative and qualitative technique for assessing several aspects of scientific research is scientometric analysis. Research Output’ means research outcomes or research products presented or published through research papers/articles by faculty, researcher scholars or the scientists of an institution. Bibliometric analysis includes citation counts, journal impact factors, authorship patterns, and co-citation networks. It helps to identify understanding the landscape of academic research, hotspots, and scholarly communication and evaluate the productivity of researchers or institutions,

Bacteria as well as other microorganisms those are live digestive tracts of animals, they help in food digestion and

contribute to our immune system's operation and development. The intestinal flora produces vitamins like vitamin K and biotin. Also known as intestinal microflora, microflora, gut flora, and gut microflora. Intestinal flora, sometimes referred to as gut microbiota or gut flora, affects many facets of diet and nutrition and plays an important role to general health.

The relation between "Intestinal Flora" or "Gut microbiota" and health is becoming more widely acknowledged as it is crucial for overall well-being. It helps in immune system regularization, digestion and nutrient absorption, mental health, metabolism, and weight regulation. Sometimes gut is also referred as "second brain" as it contains extensive networks of neurons. Imbalances in gut microbiota can lead to inflammation, which is also associated with several chronic diseases, like "inflammatory bowel disease (IBD)," "autoimmune disorders," and certain cancers. A healthy gut microbiota supports a variety of body functions and provides protection against disease. This can be achieved by maintaining a balanced diet high in whole, diverse foods.

Microbiome research spurred over the last twenty years providing better understanding of nature of activities of intestinal flora or gut flora and its relation to overall health. Recently intestinal flora had a considerable impact as an agent in maintaining health and resisting diseases.

## 2. Literature Review

Scientometricians often examine scientific literature using both quantitative and qualitative methods. Using statistical and mathematical methodologies Academicians can better understand the research hotspots, development, and current research status in this field by utilising. Few bibliometric studies have been done in the topic of "Intestinal Flora" or "Gut flora" to date, and those that have produced some interesting results. **Lu Zhang et al.** were conducted "a bibliometric study of global trends in diabetes and gut flora research from 2011 to 2021", data extracted from "Web of Science" database. The extracted data (4834 articles) were analysed using the software "Citespace.5.8. R3" and "Vosviewer1.6.17". In this field of study, there was involvement of 23365 authors, 4820 institutions, and 109 countries. In respect of publications United States was at the top with 1262 articles, with 134 articles the "University of Copenhagen" was at the top, and **Patrice, D. Cani** was the most prolific author with 52 publications.

**Cabanillas-Lazo, Miguel et al. (2024)** were carried out a bibliometric study on Effect of Bariatric Surgery on Gut Microbiota, 595 numbers of data extracted from Scopus for the period 2016 to 2022. 47 were excluded due to an inconsistency of the availability of the metadata record. 552 papers were included in this study, data analysed through **SciVal**. **Carel Le Roux** was the most prolific author whereas **Edi Prifti** was most impactful. "National Institute of Health and Medical Research" is the best institution. United States had the highest scientific production in this domain. Articles which having international collaboration had prolific impact. Since 2019 there has been consistent growth in the number of publications.

**Y Chang and et al. (2023)** were carried out a bibliometric study on Global research tendency and connection between colorectal cancer and gut flora for the time 2001 to 2021, The articles and reviews were considered for this study and data extracted from the Web of Science. Data analysed using CiteSpace and VOSviewer for knowledge-map analysis. 2,707 publications were found, there was huge increase in publications in 2015. In this domain major contributors are the "United States" and "China. Jun, Yu. from the Chinese University of Hong Kong was the most productive author. High frequency keywords are "Intestinal flora" and "colorectal cancer,"

**Nie, Kaidi MD et al. (2024)** were conducted a study on "Bibliometric and visual analysis of intestinal flora and immunity," data were extracted from the "Web of Science" database on Gut microbiota and immunity, and data was analysed using Microsoft Excel, Scimago, VOSviewer software etc. 16,611 publications were written in English out of which 10,865 articles and 5746 reviews, time considered 2013 to 2022. University of California System is at the top in with 525 papers. Most productive journals are "Frontiers in Immunology, "Frontiers in Microbiology, and "PLOS ONE".

## 3. Objectives

Present study objectives are –

- ❖ Year wise publication output from 2000 to 2023, open access vs non-open access publications, type of documents published.
- ❖ To discover top articles and journals and most prolific authors based on citations received.

- ❖ Find out most productive countries and country collaboration analysis
- ❖ Detect patterns in authorship, co-occurrence of keywords and Bibliographic Coupling analysis co-authorship within publications related to Intestinal Flora during the period of 2000 to 2023.

#### 4. Methodology

In the present study we considered 6913 documents published within the globe from 2000 to 2023. We accumulated the data from the Scopus multidisciplinary database and then tabulated and analysed the data importing it into Microsoft Excel. Visualization analysis of retrieved data was done by Version 1.6.19VOSviewer software. Our field of study is knowledge mapping or research output on “Intestinal flora “. This area was preferred due to its vast literature coverage. Only Scopus indexed publications were considered from 2001 - 2023 and there was no language barrier if the term “Intestinal flora” is included in titles, abstracts, and keywords. The search query performed was - TITLE-ABS-KEY (“Intestinal flora”) AND PUBYEAR>1999 AND PUBYEAR<2024 and here considers publication output throughout the globe. As the citations might change on daily basis and so the bibliometric indicators, we retrieved all the data at once and on the same day, 27th May, 2024 we collected the other necessary bibliometric information and prolific data such as – mostly cited documents, most prolific authors, best journals, top institutions, leading countries, and top sponsors, to avoid any difference in data. We considered all the retrieved articles to analyse the several types of document and subject facets of Intestinal flora literature. A bibliometric data visualization tool like VOSviewer (version 1.6.19) has been used in this study for visual representation of the relationship among various authors, organizations, Nations, key terms. The relation between items based on their repetitions, co-authorships and co-citations is highlighted. Bibliographic coupling (*Eck & Waltman, 2009*) was used to realize the connection between repetitions and terms along with most co-authorship of authors and Nations. VOS viewer is a free bibliographic tool used for data mapping. The collected data were imported to VOSviewer v.1.6.19 (<https://www.vosviewer.com/>), for data analysis This tool has been used to present visual network maps which demonstrate research collaboration and research hotspots (*Eck & Waltman, 2009*)

#### 5. Data Collection and Analysis

| Table: 1 Main Information about Intestinal Flora publication data |           |
|---|-----------|
| Description   | Results   |
| Time span   | 2001:2023 |
| Sources   | 2010      |
| Documents   | 6913      |
| Total Citation  | 147868    |
| Annual Growth Rate %  | 15.50     |
| Document Average Age  | 5.94      |
| Average Citations Per Doc.  | 21.38     |
| Type of documents   | 13        |
| Index Keywords  | 27960     |
| Author's Keywords (DE)  | 14525     |
| References  | 147780    |
| Authors   | 6800      |
| Single author   | 303       |
| Single-authored Docs.   | 343       |
| Multi –authored Docs.   | 6570      |
| Degree of Collaboration   | 0.948     |
| Average Number of Co-authors per Document                         | 0.989     |

The table 1 summarizes the key data extracted from the Scopus on “Intestinal flora” research from 2000 to 2023, Data extracted 6913. A total of 2010 sources, including all types of documents as part of the research. A total number of 147868 number of citations were made throughout the documents, which proves the extensive use of

previous research and literature to support the study. A total 147780 number of references were used in the analysis of documents. The annual growth rate is calculated at 15.50 %. The average age of the documents analysed is 5.94. Index Keywords 27960 4774 and author keywords are 14525 in this study. Single authored documents are 343 and multi-authored documents are 6570. Degree of Collaboration 0.95 %. It proves that there is maximum Collaboration among authors. The positive annual growth rate suggests a potential increase in the number of documents or citations over the years.

**5.1 Publications (NP) Vs Citations (CT)**

Table 2 shows the distribution of number of publications chronologically on "Intestinal Flora" from 2000 to 2023. It is observed from the data set, Publications on "Intestinal flora" is on the top in the year 2023 with 1412 publications (20.425%) and in the first year (2000) of observation there are 82 number of Scopus indexed Journal in this field. It is also observed that the publications productivity of this subject domain "Intestinal Flora" had slowly increased from 2000 to 2012 and steadily increased after 2013. In respect of citations 2021 received highest citations 12090, followed by the year 2020 with citations 10203. Year wise Average Citations per Paper (ACPP) it is reflected that 2003 record is the highest with 98.13(ACPP) followed by 2002(ACPP=95.97) and Average citations per paper during the time span (2000-2023) is 21.389.

| <b>Year</b> | <b>NP</b> | <b>P</b> | <b>CT</b> | <b>ACPP</b> | <b>Citation sum within h-core</b> | <b>h-index</b> |
|-------------|-----------|----------|-----------|-------------|-----------------------------------|----------------|
| 2000        | 82        | 1.186    | 6123      | 74.67       | 5692                              | 33             |
| 2001        | 81        | 1.171    | 4976      | 61.43       | 4403                              | 32             |
| 2002        | 79        | 1.142    | 7582      | 95.97       | 7030                              | 37             |
| 2003        | 72        | 1.041    | 7066      | 98.13       | 6609                              | 36             |
| 2004        | 101       | 1.461    | 6141      | 60.80       | 5420                              | 35             |
| 2005        | 101       | 1.461    | 6849      | 67.81       | 6223                              | 41             |
| 2006        | 93        | 1.345    | 6032      | 64.86       | 5540                              | 30             |
| 2007        | 111       | 1.605    | 7056      | 63.56       | 6429                              | 38             |
| 2008        | 106       | 1.533    | 5581      | 52.65       | 4894                              | 33             |
| 2009        | 95        | 1.374    | 4430      | 46.63       | 3826                              | 29             |
| 2010        | 107       | 1.547    | 3586      | 33.51       | 2975                              | 29             |
| 2011        | 92        | 1.330    | 4098      | 44.54       | 3658                              | 31             |
| 2012        | 94        | 1.359    | 3479      | 3701        | 3053                              | 30             |
| 2013        | 134       | 1.938    | 4554      | 33.98       | 743                               | 13             |
| 2014        | 146       | 2.111    | 5984      | 40.98       | 4943                              | 34             |
| 2015        | 157       | 2.2710   | 4654      | 29.64       | 1717                              | 15             |
| 2016        | 153       | 2.213    | 4588      | 29.98       | 3772                              | 32             |
| 2017        | 182       | 2.632    | 5091      | 27.97       | 1021                              | 22             |
| 2018        | 231       | 3.3415   | 5727      | 24.79       | 3792                              | 43             |
| 2019        | 394       | 5.699    | 8169      | 20.73       | 4573                              | 46             |
| 2020        | 638       | 9.228    | 10203     | 15.99       | 4005                              | 52             |
| 2021        | 884       | 12.787   | 12090     | 13.67       | 3663                              | 47             |
| 2022        | 1368      | 19.788   | 9974      | 7.29        | 1839                              | 34             |
| 2023        | 1412      | 20.425   | 3836      | 2.71        | 480                               | 19             |

**NP=Number of Publications, CT=Citations Count, P=Percentage, ACPP=Average Citations Per Paper**

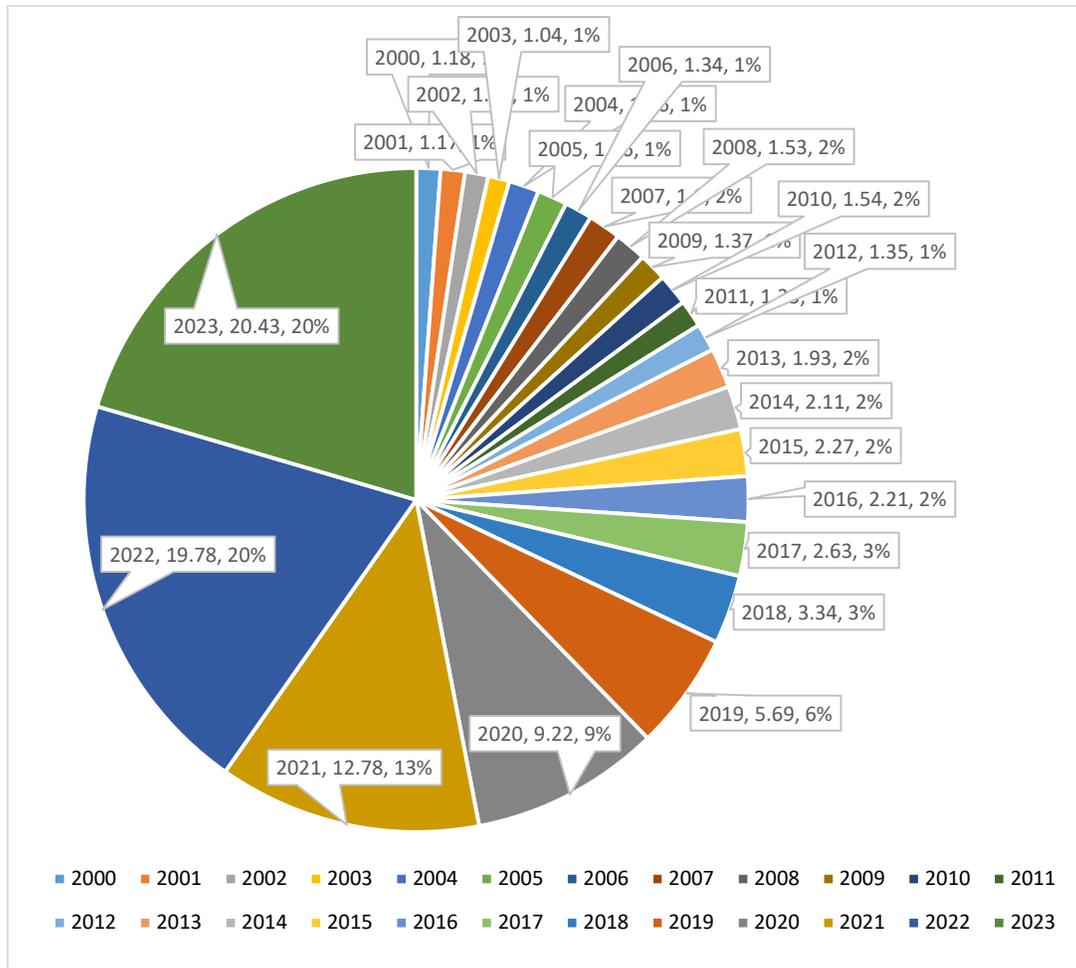


Fig. 1 Year wise Publication Percentage

### 5.2 Open Access Vs Non-open access Publications

Scholarly publications are either open access or non-open access. Any publication will be called as free access if no barriers is there in terms of financial and legal aspects for accessing it. Without any constraints such type of research publications can be downloaded, read, or distributed freely. In open access research contributions get more visibility and can be easily accessible among masses in research community. In Gold Open access the content related to publications of articles is made available free of cost on the website of journal immediately after completing their production stage, usually authors are required to pay article processing charges and bear all cost of publications instead of readers. In case of green open access publisher usually places manuscripts of authors into the repository making it available at free of cost for all readers

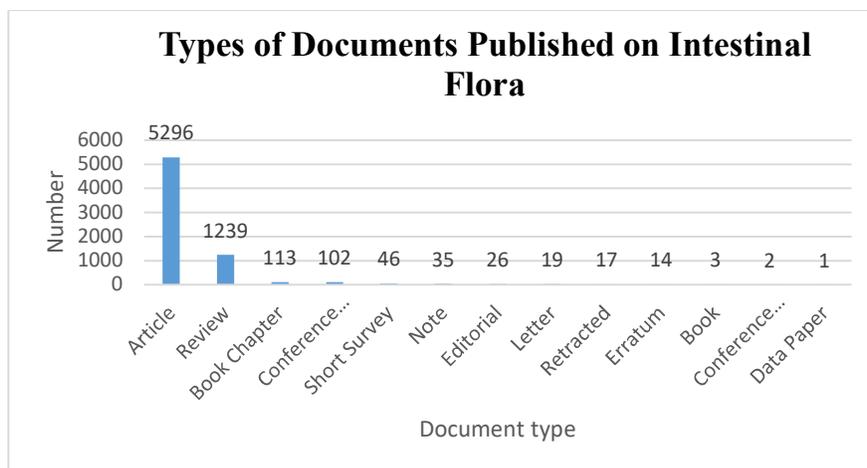
Table 3 shows Open Access and Non-Open Access publications year wise in respect of citation received. Here Number of citations received denoted by CT. Average Citations per paper denoted by ACPP. Comparing both the type of publications contributions in the field of “Intestinal Flora” number of non-open access Publications (3907) are higher as compared to the open access publications (3006) during the period 2000 to 2023, but open access publications received more citations compared to non-open access.

| YEAR | Open Access |       |      |       | Non-Open Access |       |      |       |
|------|-------------|-------|------|-------|-----------------|-------|------|-------|
|      | NP          | P     | CT   | ACPP  | NP              | P     | CT   | ACPP  |
| 2023 | 731         | 51.77 | 2242 | 3.06  | 681             | 48.22 | 1594 | 2.34  |
| 2022 | 714         | 52.19 | 5985 | 8.38  | 654             | 47.80 | 3989 | 6.09  |
| 2021 | 398         | 45.02 | 6729 | 16.90 | 486             | 54.97 | 5361 | 11.03 |

|           |      |       |       |        |      |       |       |       |
|-----------|------|-------|-------|--------|------|-------|-------|-------|
| 2020      | 259  | 40.59 | 5688  | 21.96  | 379  | 59.40 | 4515  | 11.91 |
| 2019      | 144  | 36.54 | 4909  | 34.09  | 250  | 63.45 | 3260  | 13.04 |
| 2018      | 103  | 44.58 | 3108  | 30.17  | 128  | 55.41 | 2619  | 20.46 |
| 2017      | 85   | 46.70 | 3636  | 42.77  | 97   | 53.29 | 1455  | 15.00 |
| 2016      | 52   | 33.98 | 3098  | 59.57  | 101  | 66.01 | 1490  | 14.75 |
| 2015      | 58   | 36.94 | 3177  | 54.77  | 99   | 63.05 | 1477  | 14.91 |
| 2014      | 58   | 39.72 | 3437  | 59.25  | 88   | 60.27 | 2547  | 28.94 |
| 2013      | 44   | 32.83 | 3081  | 70.02  | 90   | 67.16 | 1473  | 16.36 |
| 2012      | 28   | 29.78 | 1888  | 67.42  | 66   | 70.21 | 1591  | 24.10 |
| 2011      | 30   | 32.60 | 1936  | 64.53  | 62   | 67.39 | 2162  | 34.87 |
| 2010      | 29   | 27.10 | 1144  | 39.44  | 78   | 72.89 | 2442  | 31.30 |
| 2009      | 24   | 25.26 | 2164  | 90.16  | 71   | 74.73 | 2266  | 31.91 |
| 2008      | 40   | 37.73 | 3443  | 86.07  | 66   | 62.26 | 2138  | 32.39 |
| 2007      | 33   | 29.72 | 3213  | 97.36  | 78   | 70.27 | 3843  | 49.26 |
| 2006      | 22   | 23.65 | 4009  | 182.22 | 71   | 74.34 | 2023  | 28.49 |
| 2005      | 31   | 30.69 | 2578  | 83.16  | 70   | 69.30 | 4271  | 61.01 |
| 2004      | 28   | 27.72 | 3258  | 116.35 | 73   | 72.27 | 2883  | 39.49 |
| 2003      | 20   | 27.77 | 3025  | 151.25 | 52   | 72.22 | 4041  | 77.71 |
| 2002      | 20   | 25.31 | 2577  | 128.85 | 59   | 74.68 | 5005  | 84.83 |
| 2001      | 27   | 33.33 | 2144  | 79.40  | 54   | 66.66 | 2832  | 52.44 |
| 2000      | 28   | 34.14 | 3560  | 127.14 | 54   | 65.85 | 2563  | 47.46 |
| 2000-2023 | 3006 | 43.48 | 80029 | 26.62  | 3907 | 56.51 | 67840 | 17.36 |

**5.3 Type of Document Published**

From the collected dataset of 6913 documents on “Intestinal flora” from Scopus, major documents are Journal articles (n=5296, 76.61%), followed by review articles (n=1239, 20.95%), book chapter (n=113,1.634%), Conference paper (n=102,1.475%), short survey (n=46,0.665%), Note (n=35,0.506 %), Editorial (n=26,0.376. %), Letter (n=19,0.2748%), Retracted (n=1,0.026%), Erratum (n=14,0.2025%), Book (n=3,0.043%), Conference review (n=2,0.0289%) & Data paper (n=1,0.014%).



**Fig. 2 Types of Documents**

**5.4 Language type of Literature Published on Intestinal Flora**

Maximum number of articles are published in English (n=4991, 72.19 %), Chinese (n=1558, 22.537%), followed by German language (n=91, 1.316%), French (n=70, 0.010%), Russian (n=40, 0.578%), Japanese (n=35, 0.506%) Spanish (n=31, 0.448%) and 97 are in other language.

### 5.5 Top 15 articles in the domain of Intestinal Flora

Table 4 depicts the top fifteen articles based on most citations received. The article “Sex and virulence in *Escherichia coli*: An evolutionary perspective” is the best article based on highest citations (1573) received during the time 2000-2023, followed by “Inflammatory bowel disease: clinical aspects and established and evolving therapies” with citations (1528).

| Rank | Title of the article   | Year of Publication | No. of Citations | Source  | ISSN (online) | Cite Score |
|------|--|---------------------|------------------|---|---------------|------------|
| 1.   | “Sex and virulence in <i>Escherichia coli</i> : An evolutionary perspective”   | 2006                | 1573             | “Molecular Microbiology”                              | 1365-2958     | 7.2        |
| 2.   | “Inflammatory bowel disease: clinical aspects and established and evolving therapies”  | 2007                | 1528             | “Lancet”  | 0140-6736     | 148.1      |
| 3.   | “A human colonic commensal promotes colon tumorigenesis via activation of T helper type 17 T cell responses”                             | 2009                | 1318             | “Nature Medicine”                                     | 1546-170X     | 100.9      |
| 4.   | “Analysis of intestinal flora development in breast-fed and formula-fed infants by using molecular identification and detection methods” | 2000                | 1128             | “Journal of Pediatric Gastroenterology and Nutrition” | 0277-2116     | 5.3        |
| 5.   | “Vancomycin-resistant enterococci”   | 2000                | 951              | “Clinical Microbiology Reviews”                       | 0893-8512     | 54.2       |
| 6.   | “Probiotics and antibodies to TNF inhibit inflammatory activity and improve non-alcoholic fatty liver disease”                           | 2003                | 848              | “Hepatology”  | 0270-9139     | 27.5       |
| 7.   | “Probiotic functional foods: Survival of probiotics during processing and storage”   | 2014                | 833              | “Journal of Functional Foods”                         | 1756-4646     | 9.6        |
| 8.   | “Probiotics, prebiotics, and Synbiotics”   | 2008                | 824              | “Advances in Biochemical Engineering/Biotechnology”   | 0724-6145     | 5.7        |

|     |   |      |     |   |           |       |
|-----|---|------|-----|---|-----------|-------|
| 9.  | “Communicable Ulcerative Colitis Induced by T-bet Deficiency in the Innate Immune System”                                     | 2007 | 793 | “Cell”  | 1097-4172 | 110.0 |
| 10. | “Probiotics, prebiotics and Synbiotics- a review”   | 2015 | 764 | Journal of Food Science and Technology  | 0975-8402 | 7.7   |
| 11. | “Commensal microbiota affects ischemic stroke outcome by regulating intestinal $\gamma\delta$ T cells”                        | 2016 | 737 | “Nature Medicine”   | 1078-8956 | 100.9 |
| 12. | “Intestinal domination and the risk of bacteraemia in patients undergoing allogeneic hematopoietic stem cell transplantation” | 2012 | 714 | ‘Clinical Infectious Diseases’  | 1537-6591 | 25    |
| 13. | “Innate and adaptive immunity in inflammatory bowel disease”  | 2014 | 686 | ‘Autoimmunity Reviews’  | 1873-0183 | 24.7  |
| 14. | “Stress responses in lactic acid bacteria”  | 2002 | 661 | “Antonie van Leeuwenhoek International Journal of General and Molecular Microbiology” | 1572-9699 | 5.6   |
| 15. | “Effect of antimicrobial agents on the ecological balance of human microflora”  | 2001 | 639 | “Lancet Infectious Diseases”  | 1473-3099 | 60.9  |

### 5.6 Top 10 Journals based on citations

Table 5 reveals the top 10 Journals based on citations received. The “Frontiers in Microbiology” is the most prolific journal based on citations (1115) received during the study time, followed by “World Chinese Journal of Digestology” with 102 citations. It is observed that although “Food and Function” has only 92 publications in this subject area during this period but still it managed to gain most citations (1834) in this field. The article “Sex and virulence in Escherichia coli: An evolutionary perspective” having highest citations (1573) is also published in Molecular Microbiology.

| Rank | Name of the Journals   | No. of Documents | No. of Citations | ISSN (Online) | Cite Score |
|------|--|------------------|------------------|---------------|------------|
| 1    | “Frontiers In Microbiology”                                    | 119              | 1115             | 1664-302X     | 7.7        |
| 2    | “World Chinese Journal of Digestology”                         | 111              | 102              | 1009-3079     | 0.2        |
| 3    | “Frontiers In Pharmacology”                                    | 100              | 1313             | 1663-9812     | 7.8        |
| 4    | “Chinese Journal of Experimental Traditional Medical Formulae” | 93               | 113              | 2042-6496     | 0.7        |

|    |  |    |      |           |      |
|----|--|----|------|-----------|------|
| 5  | “Food And Function”                                | 92 | 1834 | -         | 10.1 |
| 6  | “Frontiers In Cellular and Infection Microbiology” | 81 | 1197 | 2235-2988 | 7.9  |
| 7  | “Chinese Traditional and Herbal Drugs”             | 75 | 175  | 2296-861X | 1.1  |
| 8  | ‘Frontiers In Nutrition’                           | 75 | 647  | -         | 5.2  |
| 9  | “Chinese Journal of Animal Nutrition”              | 73 | 113  | 1006-267X | 0.8  |
| 10 | “Shipin Kexue/Food Science’                        | 71 | 89   | 1002-6630 | 1.4  |

### 5.7 Top 10 Prolific Author

Table 6 shows the productivity of author and citations received during study period on “Intestinal Flora” domain. Tan, B. and Zhang, X. of China are the most prolific author with 30 publications and 377 citations and 691 respectively followed by Chi, S. with 20 publications and 299 citations.

| Sl. No. | Author Name | TP | TC  | H-Index | ACPP  | Institution  | Country |
|---------|-------------|----|-----|---------|-------|--|---------|
| 1       | Tan, B.     | 30 | 377 | 12      | 12.56 | “Aquatic Animals Precision Nutrition and High Efficiency Feed Engineering Research Center of Guangdong Province, Zhanjiang,” | China   |
| 2       | Zhang, X.   | 30 | 691 | 12      | 23.03 | “Ningbo University, Ningbo,”   | China   |
| 3       | Chi, S.     | 20 | 299 | 8       | 14.95 | “Ministry of Agriculture of the People's Republic of China, Beijing,”  | China   |
| 4       | Chen, W.    | 19 | 340 | 9       | 17.89 | “Info Jiangnan University, Wuxi”   | China   |
| 5       | Wu, Z.      | 19 | 257 | 9       | 13.52 | “Ningbo University, Ningbo,”   | China   |
| 6       | Yang, Q.    | 19 | 294 | 9       | 15.47 | “Guangdong Ocean University, Zhanjiang,”   | China   |
| 7       | Duan, J.A.  | 15 | 204 | 9       | 13.6  | “Animal-Derived Chinese Medicine and Functional Peptides International Collaboration Joint Laboratory, Nanjing”              | China   |
| 8       | Jiang, S.   | 14 | 369 | 11      | 26.35 | “Nanjing University of Chinese Medicine, Nanjing”  | China   |
| 9       | Liu, Y.     | 14 | 125 | 6       | 8.92  | “Ningbo University, Ningbo”  | China   |
| 10      | Tan, Z.J.   | 13 | 15  | 3       | 1.15  | “Hunan University of Chinese Medicine, Changsha”   | China   |

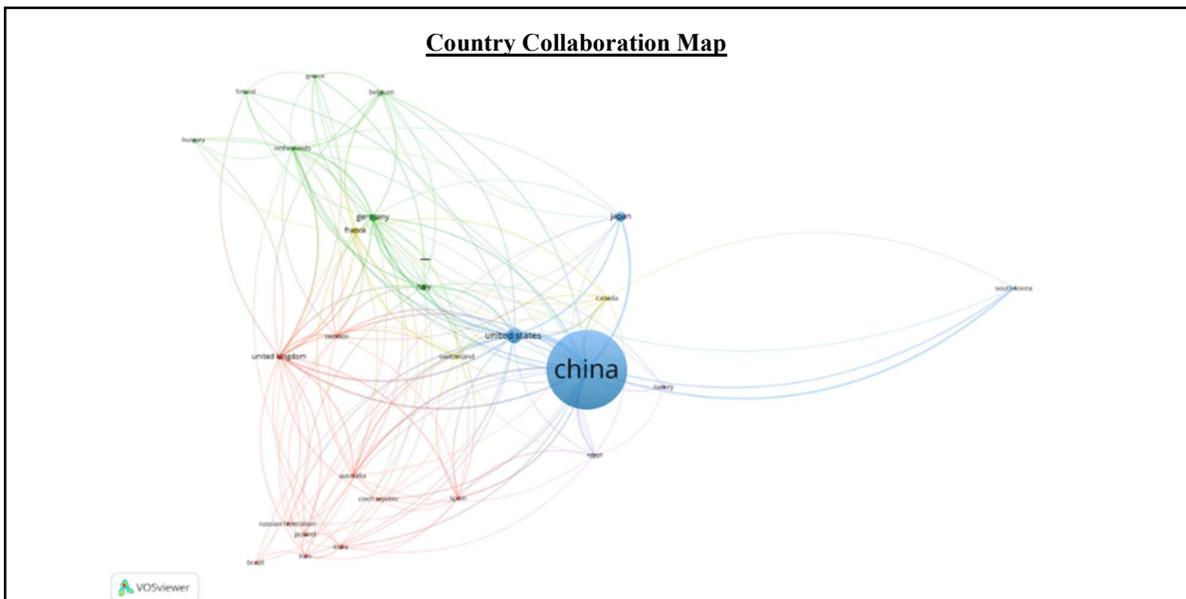
### 5.8 Top 10 productive countries with citations

Table 7 Shows that China is most prolific country with publications (TP=4773, TCC=51487), followed by United States (TP=468, TCC=34197), Japan (TC=268, TCC=9950), then Germany (TP=200, TCC=15144), Italy (TP=153, TCC=9138), France (TP=148, TCC=7360), then followed by United Kingdom, Poland, Netherlands and Turkey.

| Table 7: Top 10 Productive Countries based on Citations |                     |                              |                           |  |                                    |                              |                           |
|---|---------------------|------------------------------|---------------------------|--|------------------------------------|------------------------------|---------------------------|
| Sl. No.   | Name of the Country | Total no. Publications (TPs) | Total no. Citations (TCs) | Percentage against total citation received | Average Citations per publications | Total Publication Rank (TPR) | Total Citation Rank (TCR) |
| 1   | China               | 4773                         | 51487                     | 34.82                                      | 10.79                              | 1                            | 1                         |
| 2   | United States       | 468                          | 34197                     | 23.12                                      | 73.07                              | 2                            | 2                         |
| 3   | Japan               | 268                          | 9950                      | 6.73                                       | 37.13                              | 3                            | 4                         |
| 4   | Germany             | 200                          | 15144                     | 10.24                                      | 75.72                              | 4                            | 3                         |
| 5   | Italy               | 153                          | 9138                      | 6.18                                       | 59.72                              | 5                            | 6                         |
| 6   | France              | 148                          | 7360                      | 4.97                                       | 49.72                              | 6                            | 7                         |
| 7   | United Kingdom      | 109                          | 9577                      | 87.86                                      | 6.47                               | 7                            | 5                         |
| 8   | Poland              | 84                           | 1895                      | 22.56                                      | 1.28                               | 8                            | 9                         |
| 9   | Netherlands         | 81                           | 7105                      | 87.71                                      | 4.80                               | 9                            | 8                         |
| 10  | Turkey              | 79                           | 1158                      | 14.65                                      | 0.78                               | 10                           | 10                        |

**5.9 Country Collaboration:**

Here, we examined the participation of countries in the field of “Intestinal Flora” publications and the result has been showed in Fig. 3. To achieve such conclusions, among 6913 articles those having author collaboration, when performed the analysis taking minimum number of documents of a country 25 out of 166 countries 26 meets the requirement evaluated the adequacy of the co-authorship links with other Countries for each of 26 countries. The countries having substantial link strength has been picked. “China” is the colonizer in the field of “Intestinal Flora” with 4773 documents with 51487 citations. There are 5 clusters for 26 items, cluster 1(n=10), cluster 2(n=7), cluster 3(n=4), cluster 4(n=3), cluster 5(n=2). Here we consider n as the number of items in cluster



**Fig. 3: Country Collaboration based on authors**

**5.10 Degree of Collaboration**

According to K. Subramanyam (1983) Degree of Collaboration is a measure used in bibliometric to assess that how much research is done in collaboration within a scholarly community or a field of study during a certain period.

$$DC = Nm / (Ns + Nm)$$

DC = Degree of Collaboration  
 N<sub>s</sub> = Number of single Authored papers  
 N<sub>m</sub> = Number of Multi authored papers  
 Here N<sub>s</sub> = 343 and N<sub>m</sub> = 6570  
 $DC = 6570 / (343+6570)$   
 $= 6570 / 6913$   
 $= 0.95$

The following table 8 depicts the authorship patterns on “Intestinal Flora “research papers. It shows that single authored papers are 343(4.96%), double authored papers 561(8.11%), Triple authored papers 606(8.77%), Four authored papers are 748(10.82%), Five authored papers 839(12.13%), six authored papers 936(13.54%), 7 authored papers 791(11.44%), Eight authored papers 667(9.64%) nine authored papers are 459(6.63%) and equal or more than ten authored papers are 963(13.93%).

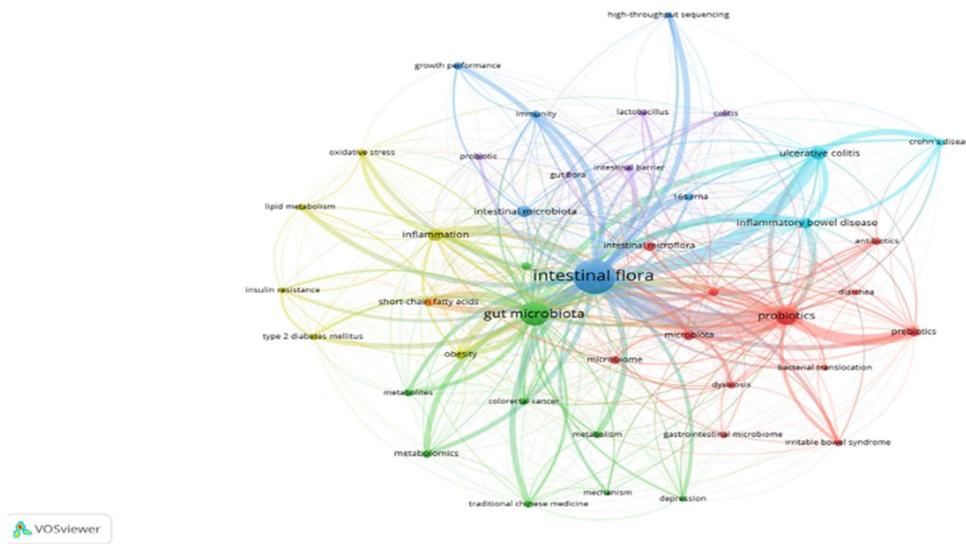
|   | N <sub>s</sub> | N <sub>m</sub> |      |       |       |       |       |      |      |       | Total |
|---|----------------|----------------|------|-------|-------|-------|-------|------|------|-------|-------|
|   | 1              | 2              | 3    | 4     | 5     | 6     | 7     | 8    | 9    | ≥10   |       |
| NP  | 343            | 561            | 606  | 748   | 839   | 936   | 791   | 667  | 459  | 963   | 6913  |
|   | 343            | 6570           |      |       |       |       |       |      |      |       |       |
| P   | 4.96           | 8.11           | 8.77 | 10.82 | 12.13 | 13.54 | 11.44 | 9.64 | 6.63 | 13.93 | 100   |
| <b>N<sub>s</sub>=Single Authored papers, N<sub>m</sub>=Multi Authored Papers, NP=Number of Publications, P=Percentage</b> |                |                |      |       |       |       |       |      |      |       |       |

It shows that out of 6913, considerable number of publications in this domain are by multi-authored (6570, 95%) and Single author publications are 343 (4.96%).

**5.11 Co-occurrences of Author Keywords**

The following Fig. 4 shows the co-occurring of author keywords in the field of Intestinal flora publications. To get adequate visual map, here we consider minimum number of occurrences of a keyword 50. Then out of 12035 keywords 42 meet the requirements. Top five keywords are “Intestinal flora” (Occurrence=1739 & total link strength 1078), “Probiotics” (Occurrence=469 & total link strength 574), “Gut Microbiota” (Occurrence=822 & total link strength 540), “Ulcer Colitis” (Occurrence=232 & total link strength 299), “Inflammation” (Occurrence=208 & total link strength 298). There are 7 clusters for 42 items.

**Network Visualization Map of Author Keywords**



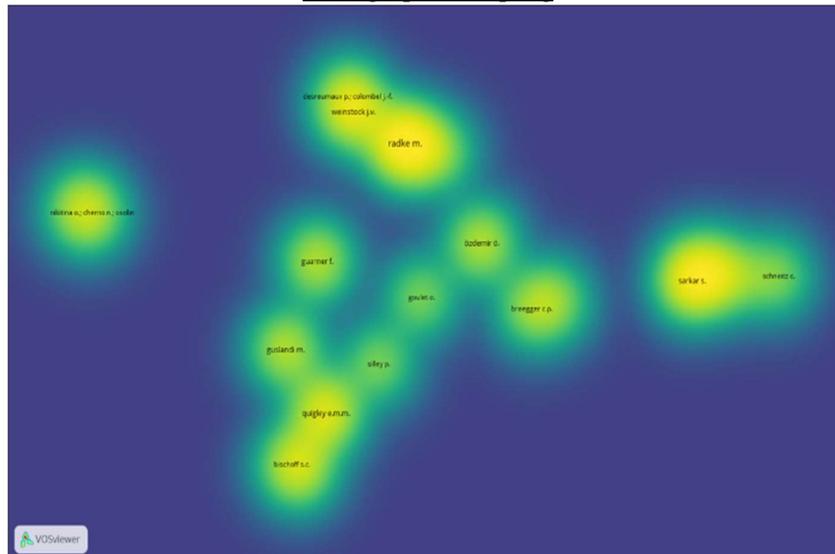
**Fig. 4: Visualization Networks of Co-occurrences of Author Keywords**

**5.13 Bibliographic Coupling of Authors**

When two works use the same third work in their bibliographies, this is known as bibliographic coupling. It implies that there is a possibility of two articles are on the same subject domain. If two documents cite the same document or research papers together, they are considered as bibliographically linked.

Fig. 5 depicts the bibliographic coupling of authors. Here, we considered the minimal quantity of papers written by an author is 2, out of 6806 authors 57 meets the standards. For each of the largest set of related things, with 20 items out of 57, is as follows. There are 6 clusters for 20 items

**Bibliographic Coupling**



**Fig.5 Density Network of Bibliographic Coupling of authors**

**6. Limitations & Scope:**

Aims of this study is to measure the global research outcome in the domain of intestinal flora during the study period, 24 years by retrieving data from the Scopus database. However, it has been noted that many research

papers on Intestinal Flora are not included in Scopus. This limitation suggests that additional databases such as “PubMed”, “Web of Science”, and “Google Scholar”, which are significant in this field to data extraction to accurately capture the breadth and depth of research in this area were not considered in this study.

The present study on Intestinal flora has significant impact on public health policies, clinical practice, research advancement, and promotion of outreach and education initiatives in the domain of science of microbiome. The research on intestinal flora or Gut microbiota is interdisciplinary and has a major impact on human health and disease with the aim of developing targeted medicine or therapies. Identifying key researchers and institutions in the field of Intestinal Flora or gut microbiota that can help in interdisciplinary collaborations. The Scientometric analysis in this field identify the research gaps in this domain that received less attention, and this will help new researchers in this field in prioritizing research efforts and allocating resources effectively.

## 7. Conclusion

Many studies have been conducted on diabetes and intestinal flora and many researchers are associated in this domain. Intestinal flora come up with a key research direction for the treatment of diabetes. In near future, gut flora will remain the core of the diabetes field. This study finds out the research productivity in the field of “Intestinal Flora” The present study analysed a total 6913 publications retrieved from Scopus database during the time 2000 to 2023. China, United States, Japan, Germany, Italy have published more research paper in the domain of “Intestinal Flora.” India is at the 11<sup>th</sup> position with 75 publications based on research productivity. “Frontiers in Microbiology” is the most prolific journal based on citations. **Tan, B. and Zhang, X.** are the most prolific author with maximum no. of publications 30 with citations 377 and 691 respectively followed by Chi, S. with 20 publications and 299 citations both the authors are from China. All the top 10 authors of this field are from China. Highest cited article Sex and virulence in *Escherichia coli*: An evolutionary perspective is published in Molecular Microbiology with citations 1573. Substantial number of publications are multi- authored (6570, 95%) and only 4.96 % articles single authored (343). Out of 6913 publications 5296 (76.60%) were articles. Maximum number of articles are in English (4991, 72.19%). Open access publications have gained more citations (26.62.5%) than non -open access publications (17.36%).

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