

# *A brief history of ruminant gut microbiological research*

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**Abstract:** Increasing attention is paying to gut microorganisms, especially gut microflora in ruminants. Here, we explored the literature related to the study of ruminant intestinal microorganisms, in order to answer the questions as follows: (1) what are the distributions of research power in terms of countries, authors, and keywords? (2) what is the frontier research? Our analysis showed ruminant gut microbiological research experienced two stages: germination, and rapid development, GUAN LL, CHAUCHEYRAS-DURAND F, SUEN G were the top three local impact authors and the most relevant authors. USA, China, France and Canada were the main countries. The main keywords were diversity, bacteria, gastrointestinal-tract, rumen, and fermentation. Fungi and bacteria in rumen and intestinal and the evolution of microorganisms in rumen and intestine may need to be strengthened.

## 1. Introduction

With the development of high-throughput sequencing technology and the decrease of cost, more and more attention has been paid to intestinal microorganisms, especially ruminant, whether it is the basic research field or application field. The diversity of ruminant intestinal microorganisms was extensively reported, and the role of intestinal microorganisms in animal growth, production and environmental impact was explored. However, we still don't know what development stages ruminant intestinal microbiological research has gone through, which countries and authors have played a key role in promoting ruminant intestinal microbiological research, and which have become research hotspots. Therefore, based on historical research data, in-depth excavation of the brief history of ruminant intestinal microbiological research will provide us with more information to understand the process of ruminant intestinal microbiological research, and also provide the basis for us to carry out ruminant intestinal microbiological research.

## 2. Methodology

### 2.1 Data source

We studied the articles indexed by the WoS Core Collection database (web of science, www.webofknowledge.com). We selected the articles with topic, title, author's keyword and key

words plus that match our words “gut microbio\*” and “ruminant”). Since the data for 2021 is still being updated, we only focus on the data from 1900 to 2020. Finally, a total of 217 articles were retrieved.

## 2.2 Data analyses

The “bibliometrix” package was used to determine the Annual scientific production, the author local impact and the most relevant authors, identified the main country that the most productive authors came from, and investigated the trend topic, trend keywords [1]. This was performed in R 4.0.0 [2].

## 3. Results and discussions

Annual scientific production (Figure 1) showed ruminant gut microbiological research experienced two stages: Germination, and rapid development.

**Germination stage (1900–2014):** Only 20 publications were found in this 114-year period. Although we focused on 1900 and 2014, there was no relevant literature before 2008. The only 20 papers were published between 2008 and 2014 at the rate of less than five papers per year. The earliest one was published in “Australian Journal of Experimental agriculture” with the title: “Application of rumen microbial genome information to livestock systems in the postgenomic era” [3]. This paper described most of the rumen microorganisms cannot be cultivated, and pointed out that metagenomics and post genomics research can break the ice.

**Rapid development stage (2015–2020):** After exploratory stage, research has entered a new era of booming. In this stage, over ten documents are being published every year with average annual growth rate of 1000%. Microbial diversity of rumen or omasum and reticulum of the giraffe, moose, bovine and kangaroo, lambs, *culicoides sonorensis*, steers, goats, sheep, geese, Muskoxen (*Ovibos moschatus*), yark, camel, Musk Deer (*Moschus berezovskii*), grazing primate, swine, cashmere, cow and elk were reported, and their role in shaping the methane yield, metabolic phenotypes, development and function of gastrointestinal tract, immune response, rumen fermentation, feed intake, growth, efficiency, health and productivity been explored.

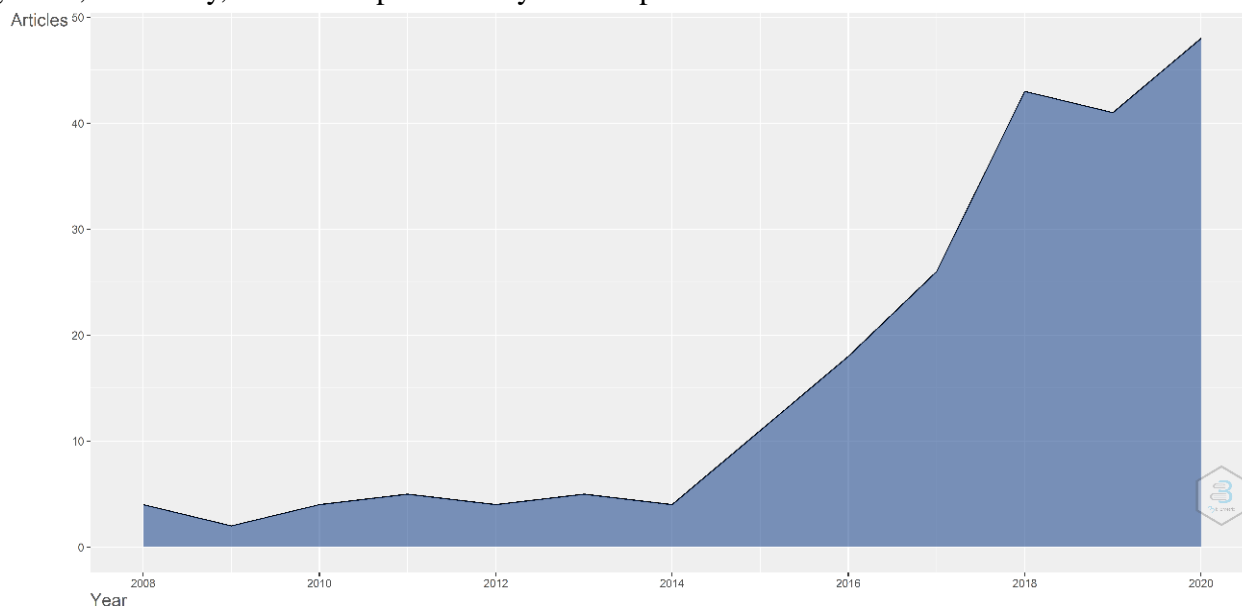


Figure 1: Annual distribution of publications of ruminant gut microbiological research.

We identified the author local impact and the most relevant authors, results showed that GUAN LL, CHAUCHEYRAS-DURAND F, SUEN G were the top three local impact authors and the most relevant authors (Figure 2). GUAN LL and their coauthors established relationships of rumen microbial structure to host phenotypical traits, that is, they built the correlation of rumen microbial ecology with cattle’s feed efficiency. This study enhanced the understanding of livestock–microbial interactions [4]. CHAUCHEYRAS-DURAND F and their coauthors explored the effect of probiotic Yeast on rumen cellulolytic bacteria, fibrolytic bacteria and fungi, development of fermentative activities, fibre degradation [5-8]. These studies enhanced the understanding of probiotic roles. SUEN G and their coauthors reported the complete genome of the cellulolytic ruminal bacterium, and provided novel insights into cellulose degradation [9, 10].

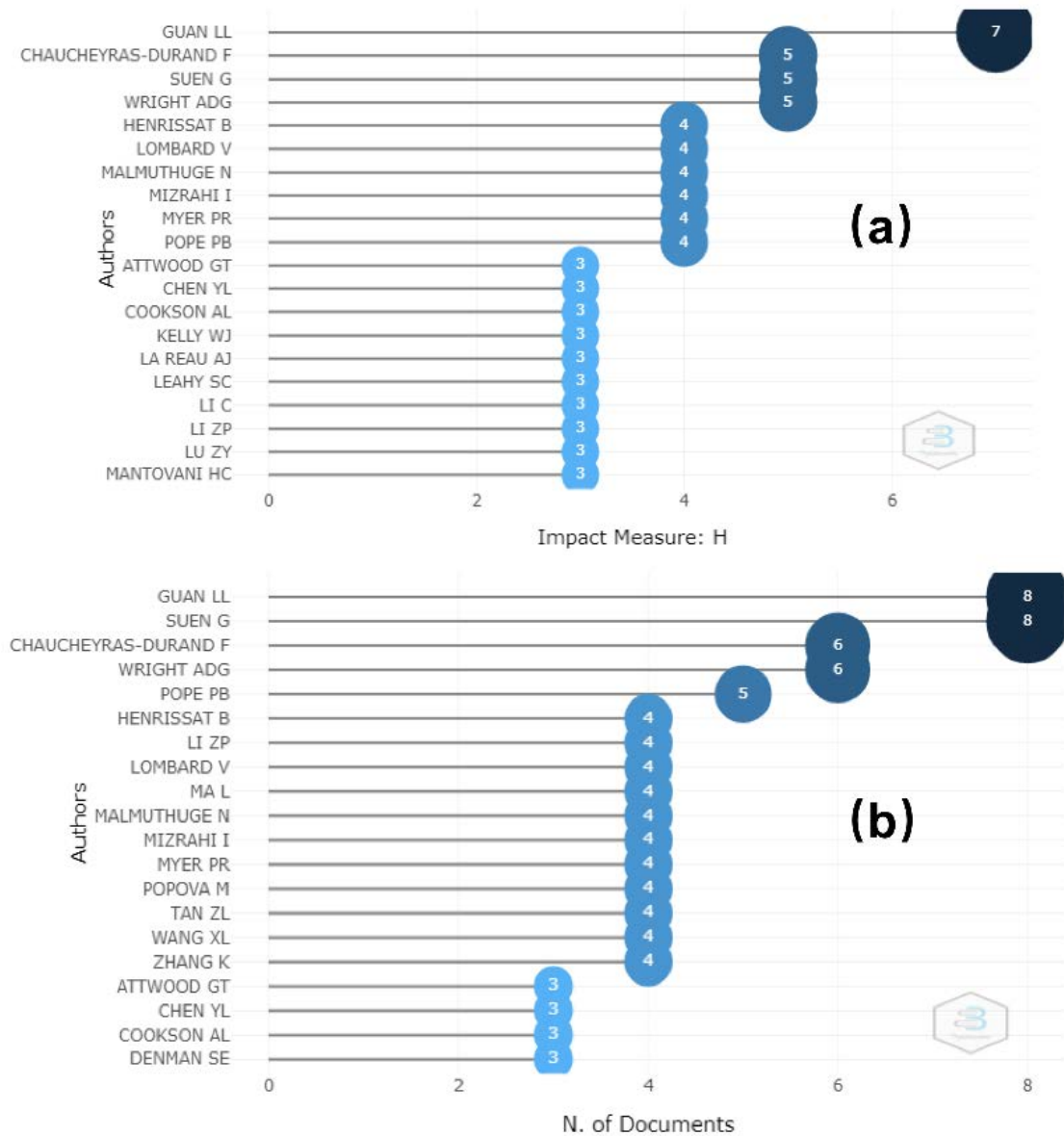


Figure 2: The author local impact (a) and the most relevant authors (b)

We identified the main country that the most productive authors came from (Figure 3). Results showed that USA, China, France and Canada were the main countries. the three-field plot and world could plot showed that the main keywords were diversity, bacteria, gastrointestinal-tract, rumen, and

fermentation. These results indicate that rumen and intestinal bacterial communities have been well studied. However, there are still many fungi and bacteria in rumen and intestinal, which have not been fully studied. The evolution of microorganisms in rumen and intestine has not been fully studied.

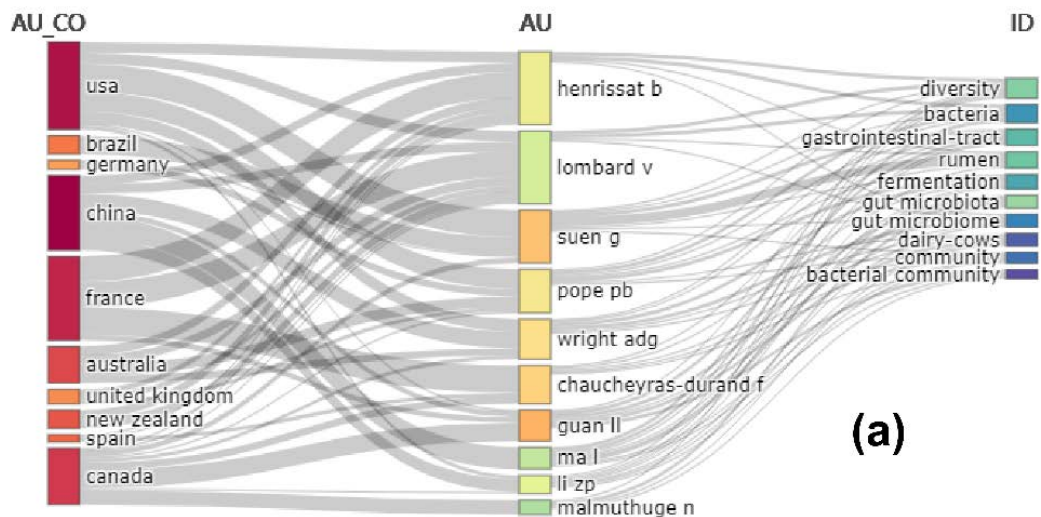


Figure 3: The three-field plot (a) and world cloud plot (b)

We investigated the trend topic, keywords (Figure 4). Results showed that rumen microbiome has always been the focus of research in 2018 and 2019, however, the yak and goat were the objective of research in 2020, the health, protein and fatty acids were the most keywords in 2020. These may be the main trends in the next few years.

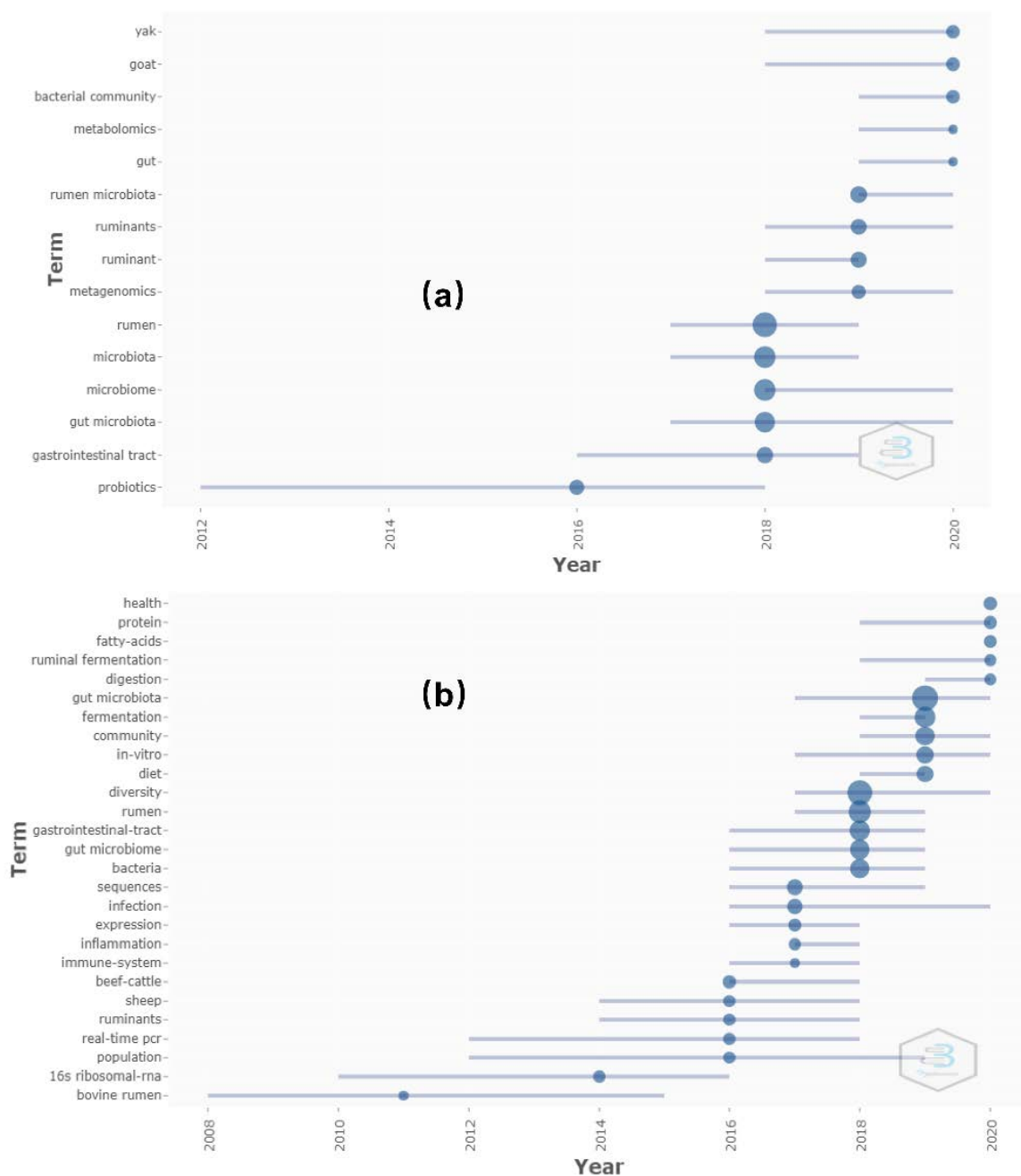


Figure 4: The trend topic or keywords

#### 4. Conclusion

Fungi and bacteria in rumen and intestinal and the evolution of microorganisms in rumen and intestine may become the focus of future research.

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