A colon-targeted delivery system of torularhodin, and its regulation mechanism of gut microbiota

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- Introduction
- Scientific questions
- Results and discussion
- Conclusion

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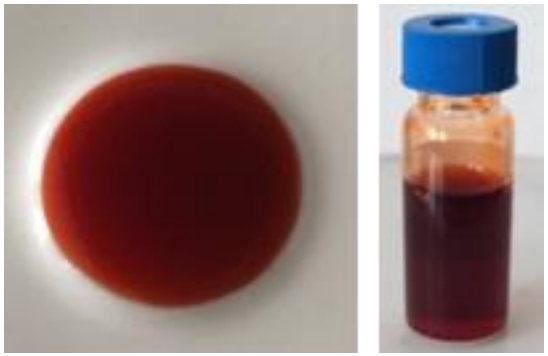
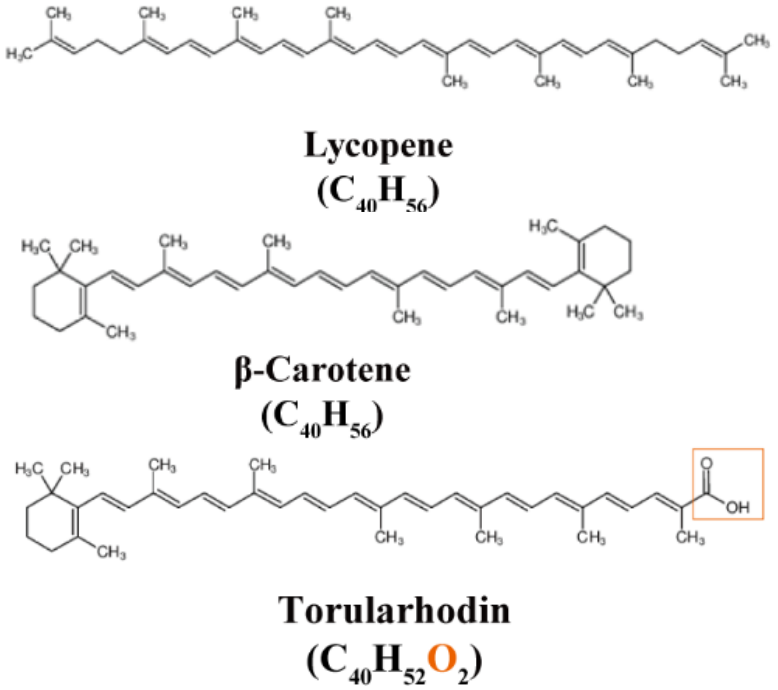
1.1 Torularhodin: One kind of Carotenoids

➢ ***Sporidiobolus pararoseus*** [1]

A facultative aerobic yeast with strong adaptability and wide distribution in nature;

Producing carotenoids , especially torularhodin;





➢ **Torularhodin** [2]

Significant antioxidant;

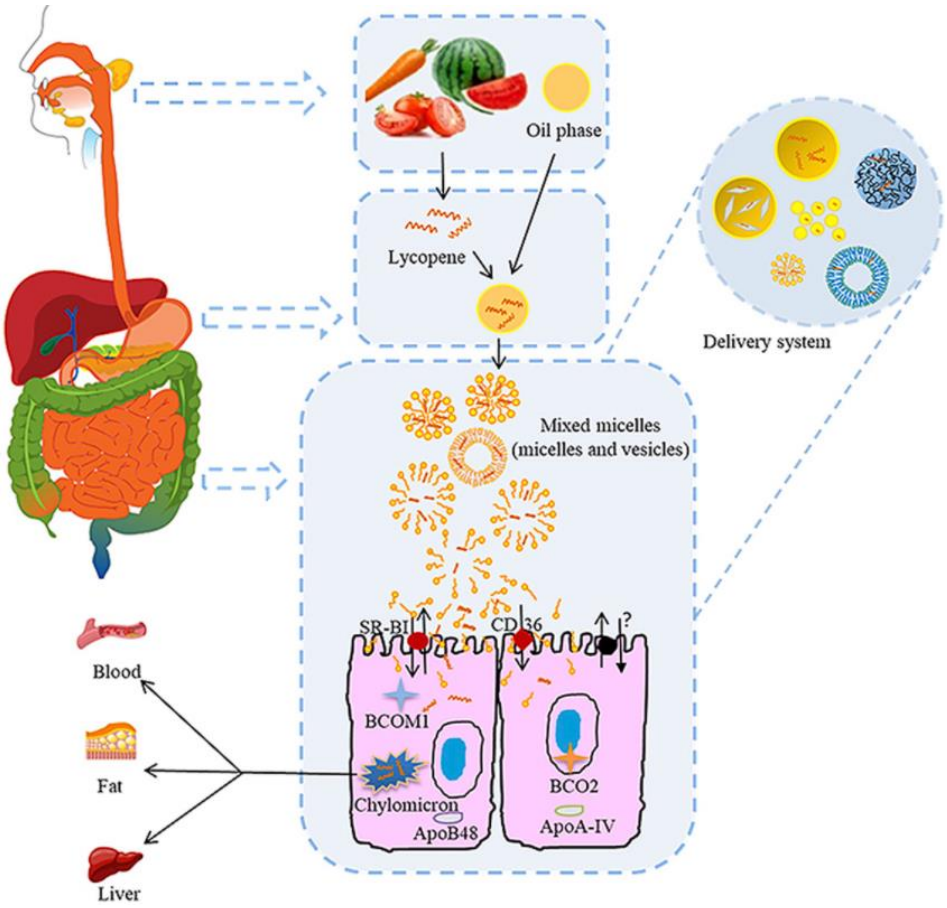
Anti-inflammatory;

Anti-cancer effect;

1. Chang Liu, He Qian., *Bioresource Technol*, 2021.
2. Chang Liu, He Qian., *J. Agric. Food Chem*, 2019.

1.Introduction

1.2 Gut Health Functions of Carotenoids



- **Bioaccessibility** [3. 4]

Small intestine:

Lycopene (40%), beta-carotene (27%);

Colon:

Lycopene (40%), beta-carotene (57%);

- **Health effects** [5]

Carotenoids may improve host health by improving gut microbiome.

3. Isabel Goñi, *Journal of Agricultural and Food Chemistry* , 2006.
4. R. Estévez-Santiago,B, *Food & Function*, 2015.
5. PaulaMapelli-Brahm, *Current Opinion in Food Science*, 2021.

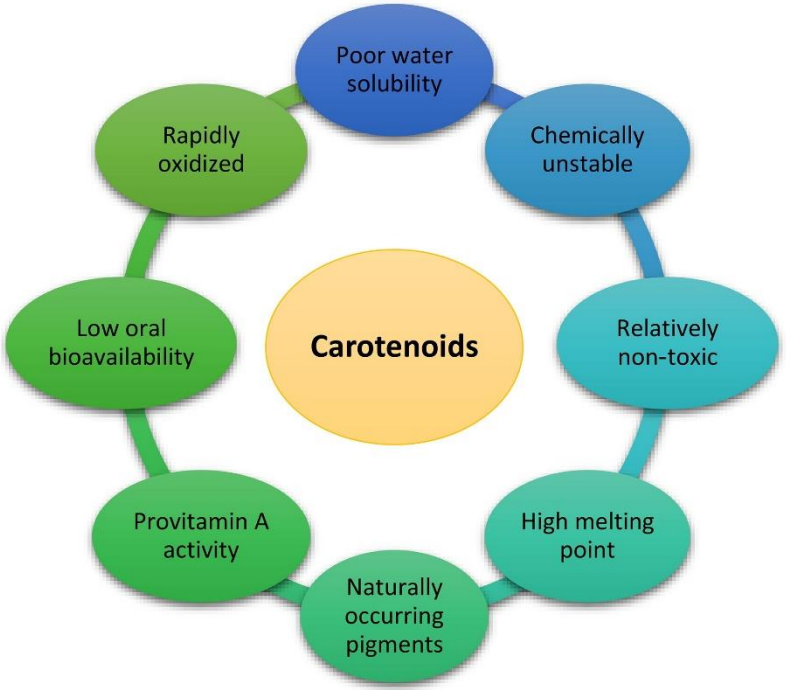
1.3 Carotenoids and colon-targeted delivery systems

- **Difficulties in the application of carotenoids** [6]

Poor water solubility;

Poor stability;

Photo degradability;

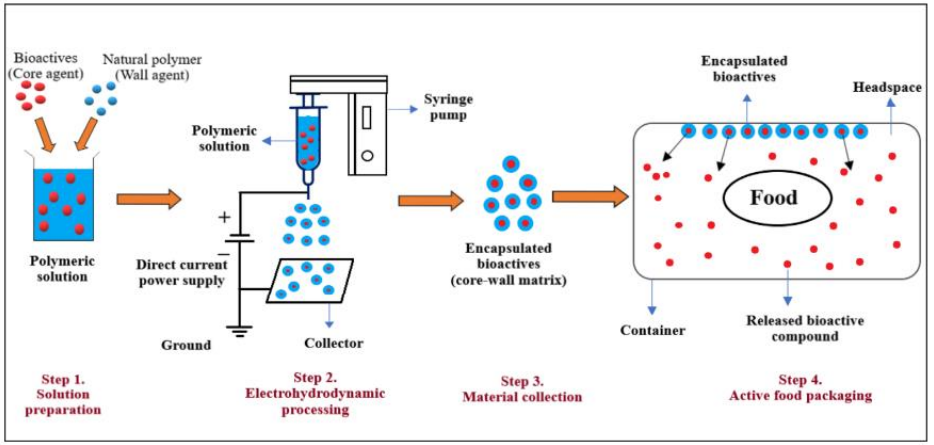


- **Electrospinning technology** [7]

Natural polymers for active food packaging;

Natural, safe;

Biodegradable;



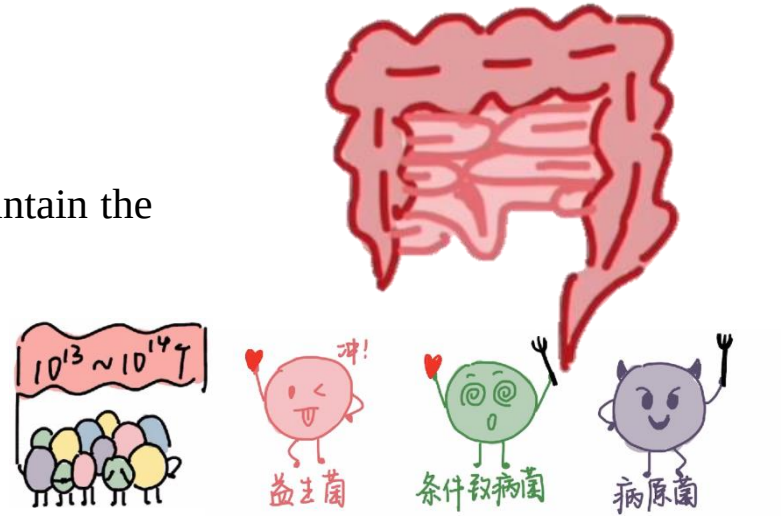
6. Saeid Maghsoudi, *Critical Reviews in Food Science and Nutrition*, 2022.
7. Charles, A, *Compr Rev Food Sci Food*, 2021.

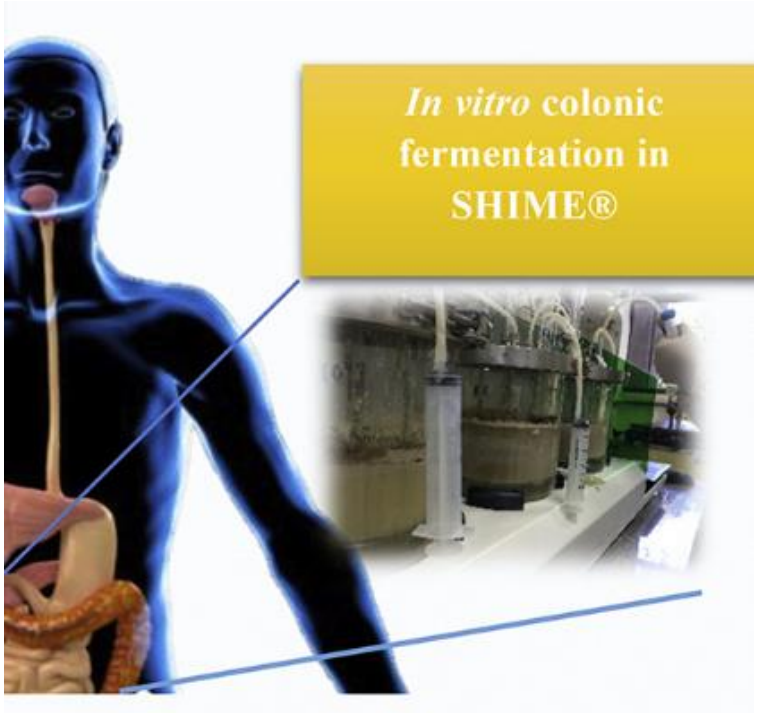
1.4 Gut microbiome and *In vitro* fermentation

➢ **Gut microbiome** [8]

Exceed 100 trillion;

Multiple functions: energy supply, immune regulation, maintain the integrity of the intestinal barrier, inhibit intestinal pathogens;





➢ ***In vitro* fermentation** [9]

Simple and have **no ethical constraints**;

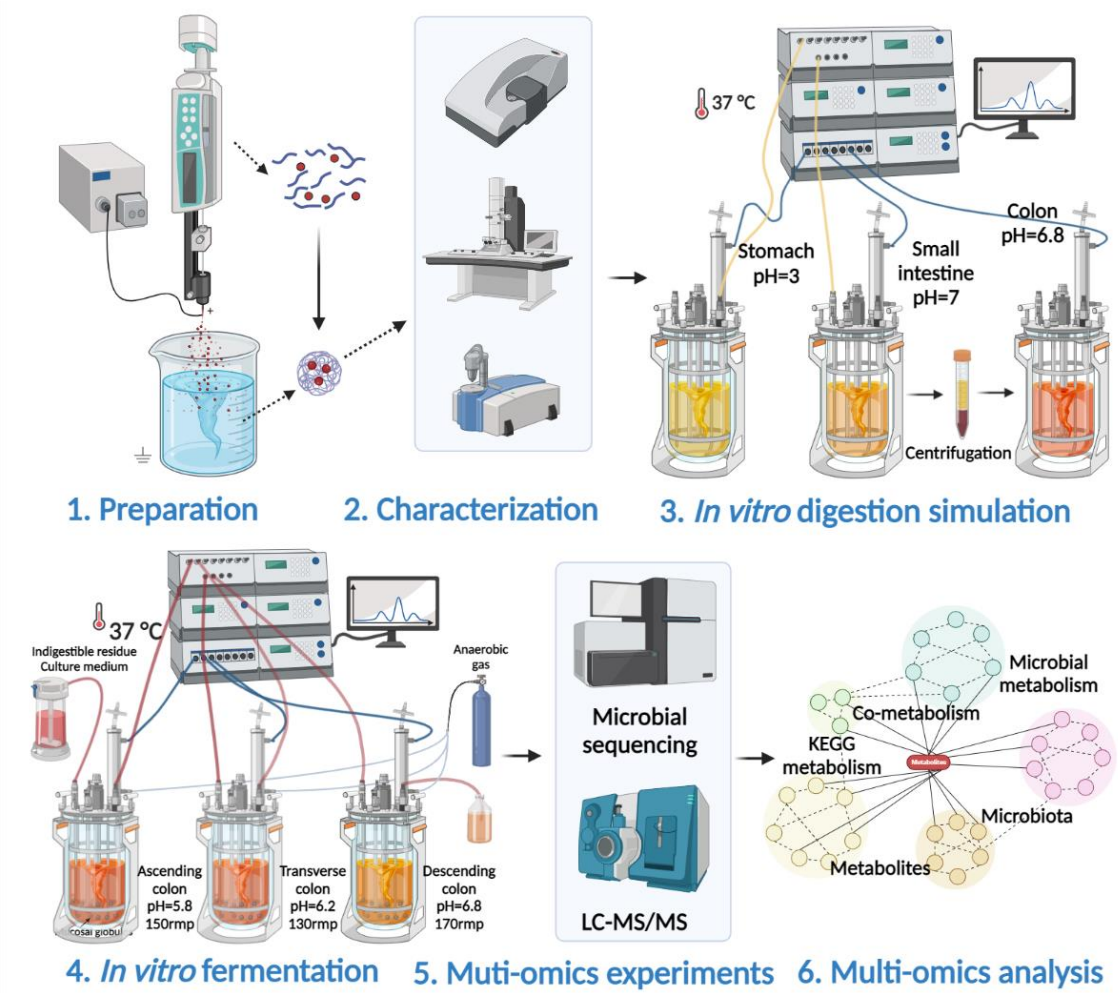
Test the ability of the human gut microbiota to metabolize foods with different structures;

Formulate healthy, functional foods ;

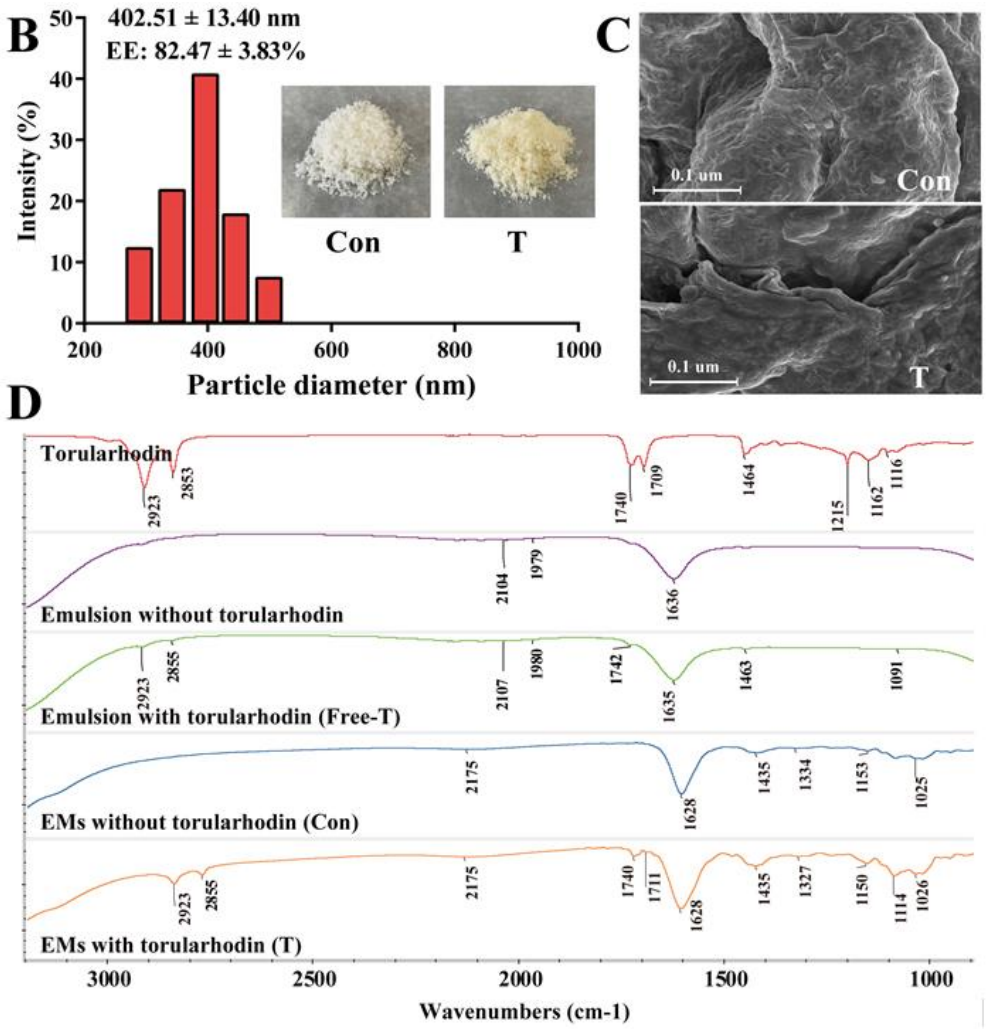
8. Schroeder, *Nature Medicine*, 2016.
9. Sayago-Ayerdi, S. G, Food Research International, 2021.

2. Scientific questions

- **1. Constructing the colon-targeted delivery system of torularhodin?**
- **2. The effects of torularhodin targeting the colon on the gut microbiome?**
- **3. The interaction mechanisms of gut microbiome-metabolites-host metabolism?**



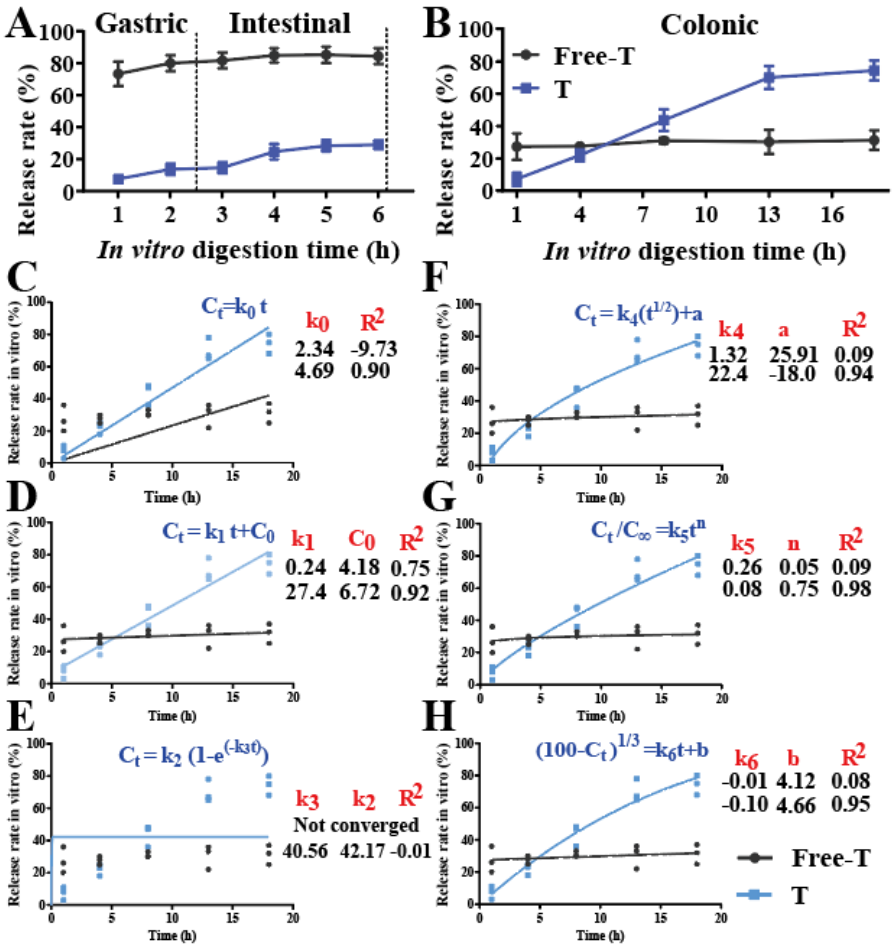
3.1 Electrospinning microspheres



Torularhodin helps to relieve the microspheres and maintain structure.

Electrospinning microspheres could wrap torularhodin to form a stable system.

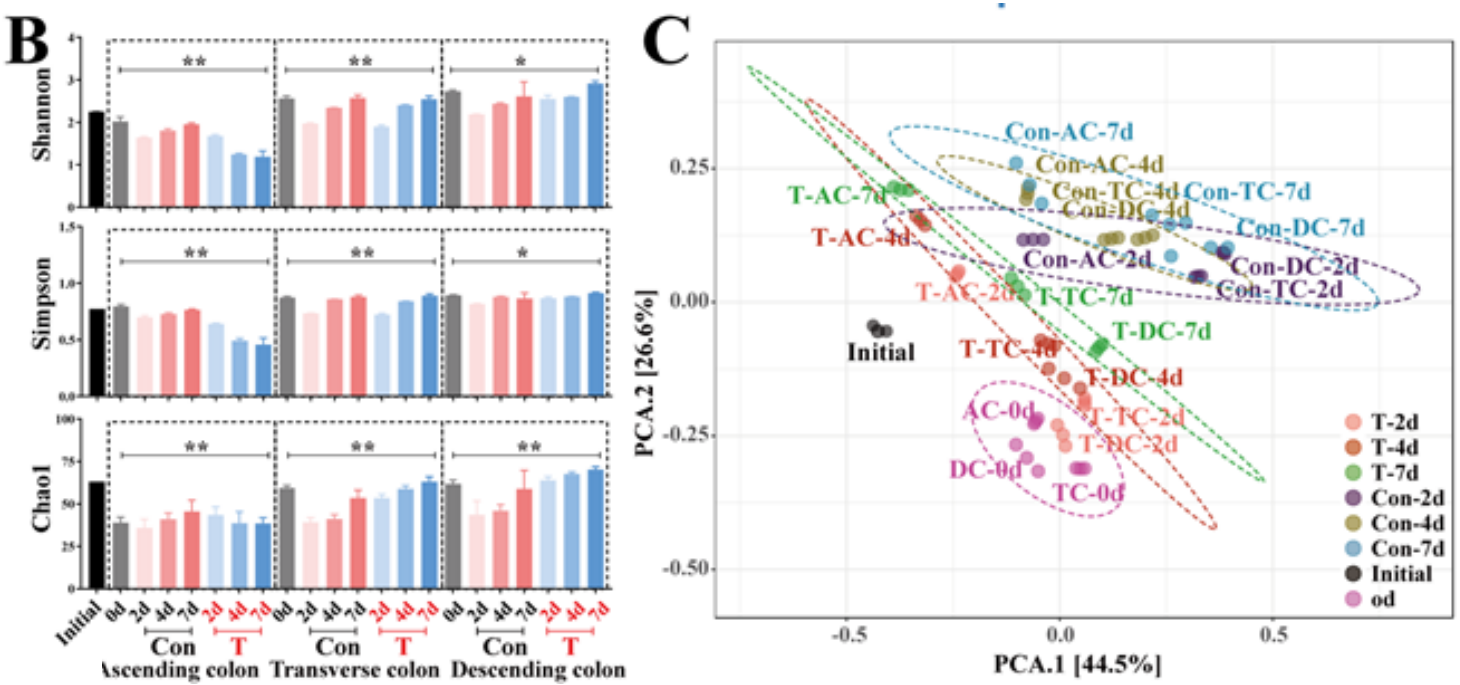
3.2 *In vitro* digestion



The release of torularhodin is a Korsmeyer-Peppas model owing to non-Fickian transport (n = 0.75).

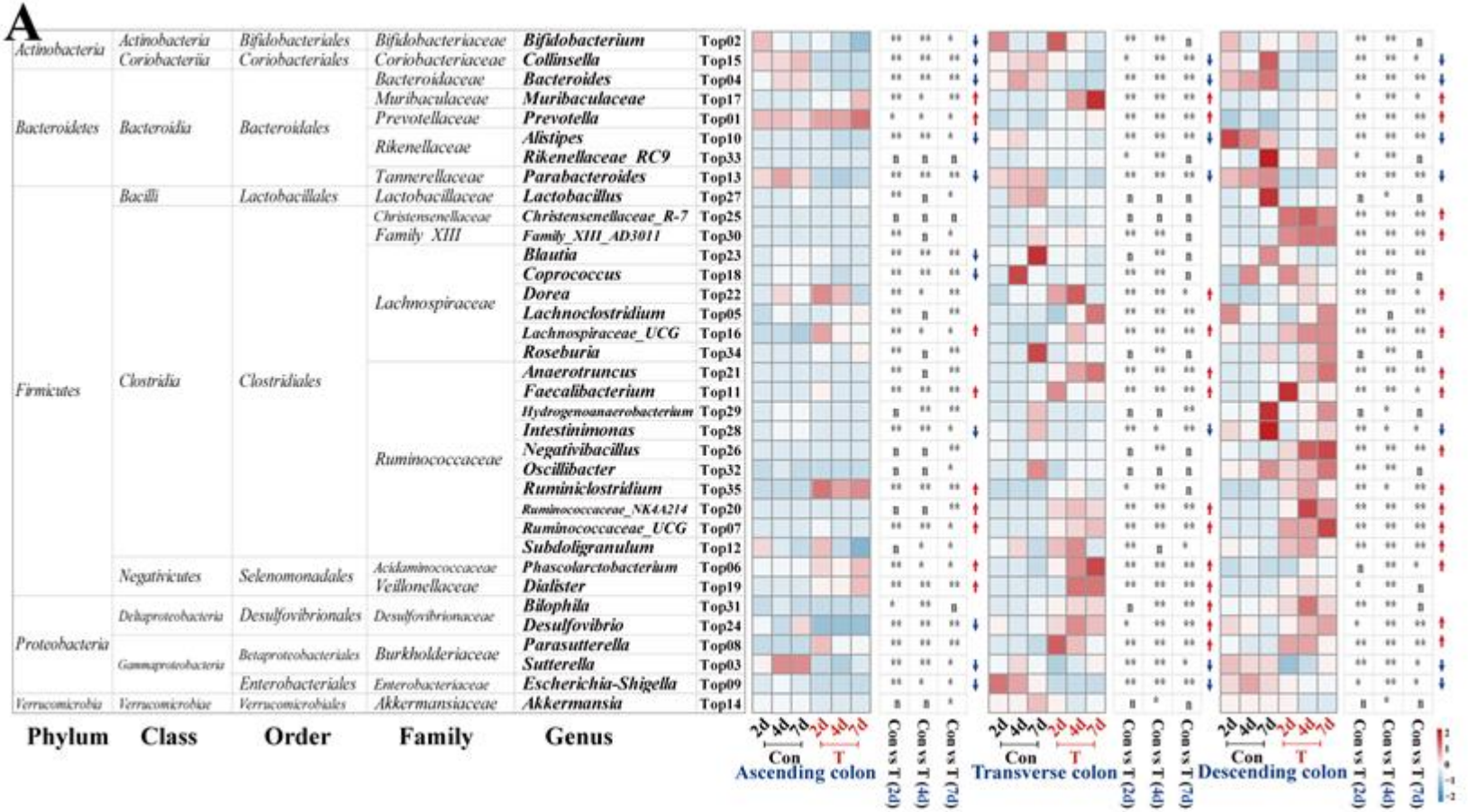
Electrospinning microspheres can be used as carriers for torularhodin in the food industry.

3.3 Gut Microbiome



1. The addition of torularhodin can regulate the diversity and abundance of gut microbiota.
2. The change of the gut microbiota in the transverse colon and descending colon is not obvious, and the diversity composition is more stable.

3.3 Gut Microbiome



1. There were more gut microbiome with significantly increased abundance in the descending colon than transverse colon.
2. Significantly increased in *Prevotella* (Top01), *Phascolarctobacterium* (Top06), *Ruminococcaceae UCG* (Top07), *Faecalibacterium* (Top11), *Lachnospiraceae UCG* (Top16), *Muribaculaceae* (Top17) .
3. Significantly decreased included *Sutterella* (Top03), *Bacteroides* (Top04), *Escherichia-Shigella* (Top09), *Alistipes* (Top10), *Parabacteroides* (Top13), *Collinsella* (Top15), and *Intestinimonas* (Top28).

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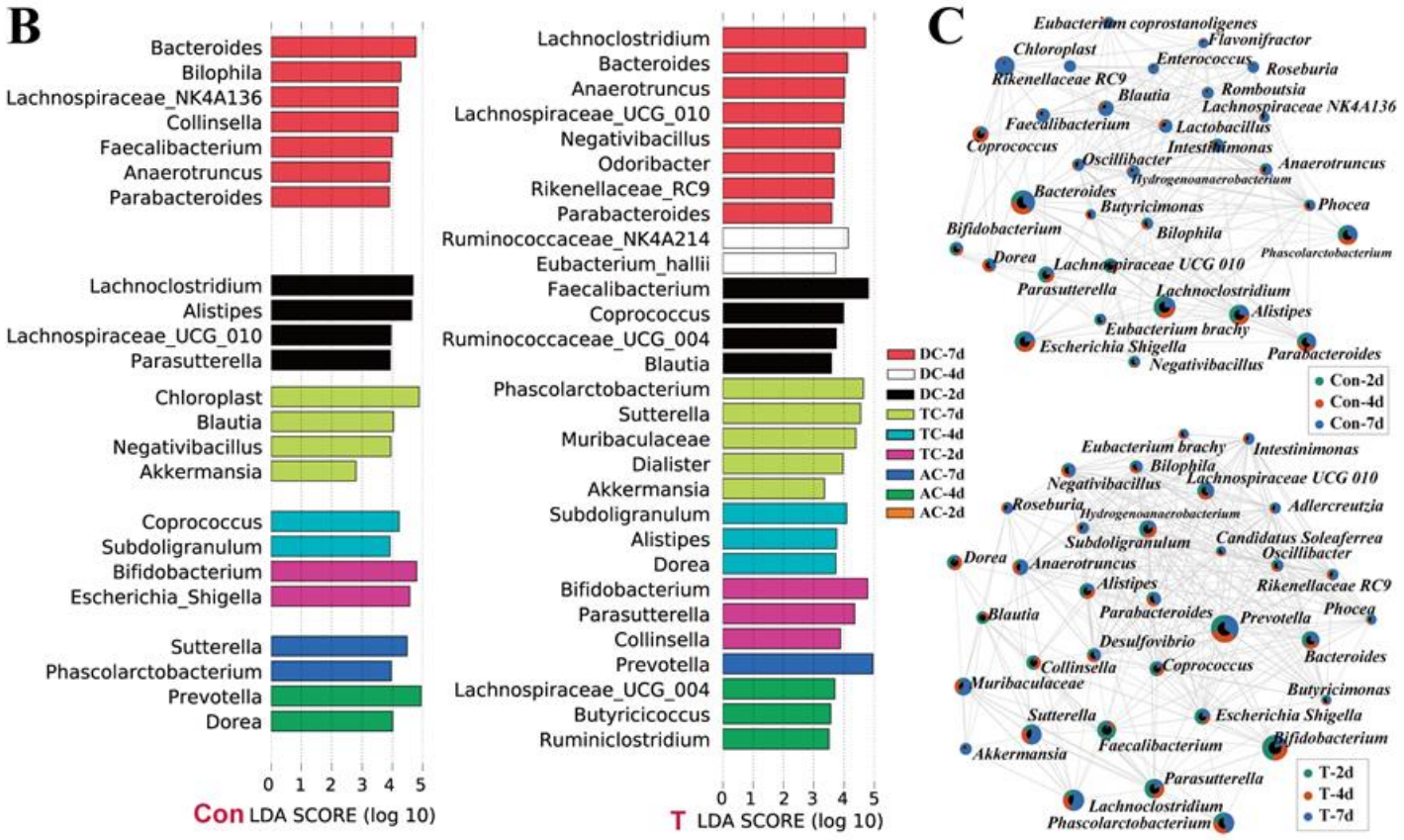
3.3 Gut Microbiome



1. The key to the gut ecosystem was explained by the LDA and co-occurrence network.
2. Microorganisms with greater relevance weights included *Prevotella*, *Bifidobacterium*, *Faecalibacterium*, and *Phascolarctobacterium*.

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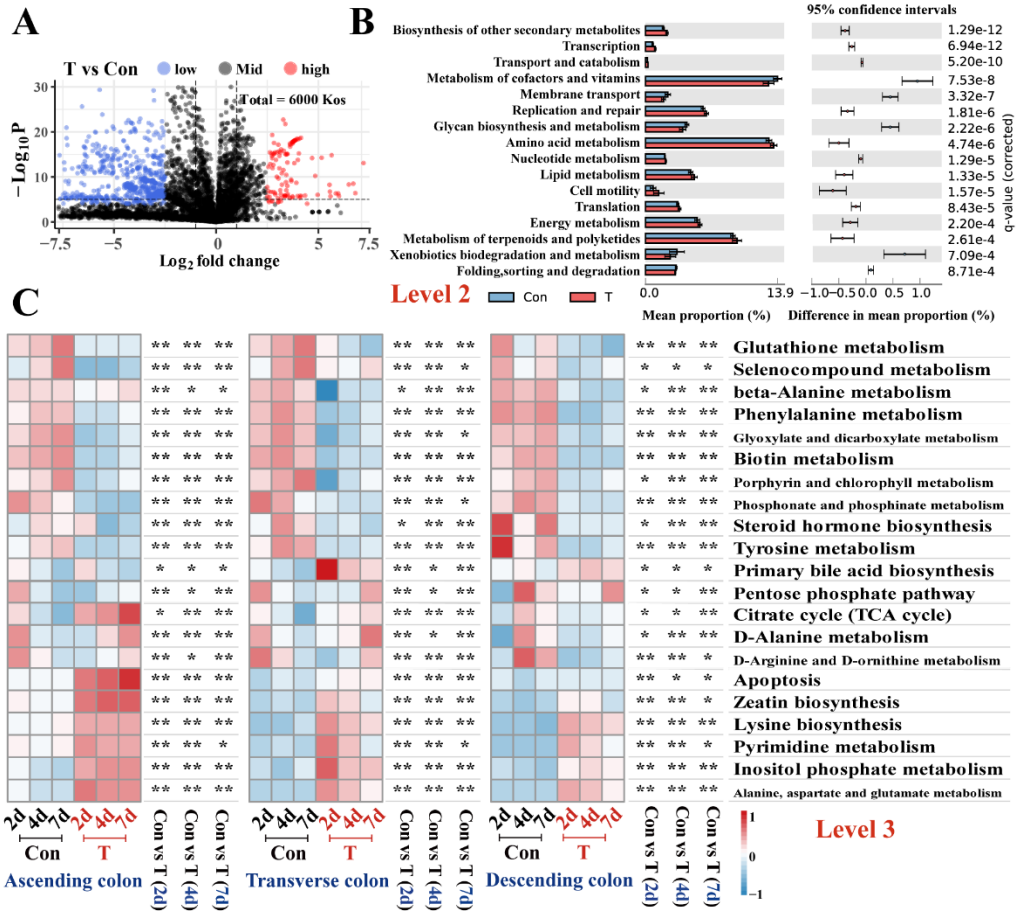
3.3 Gut Microbiome

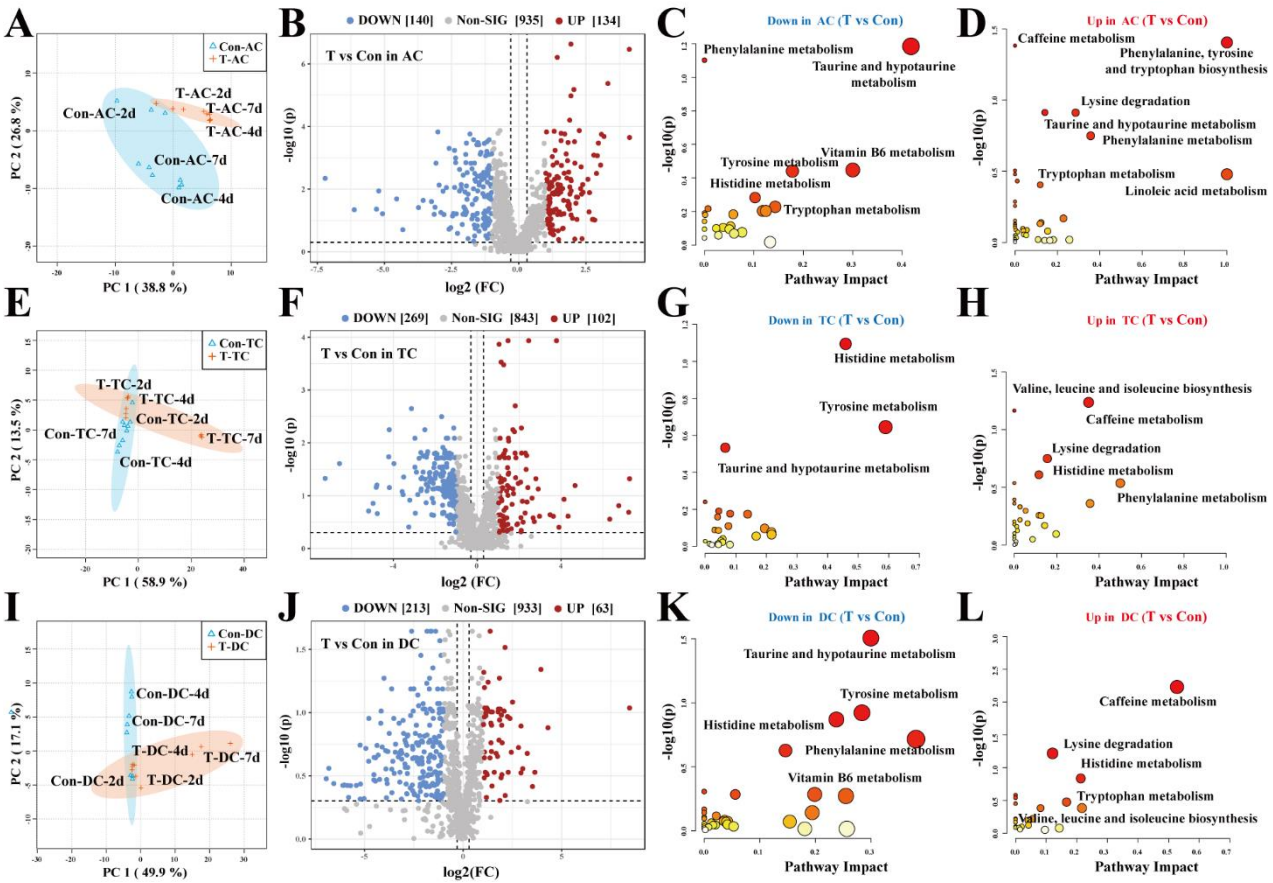


Predictive functional results from KEGG database:

Enhanced lysine biosynthesis and inositol phosphate metabolism;

Decreased phenylalanine and tyrosine metabolism;

3.4 Metabolome

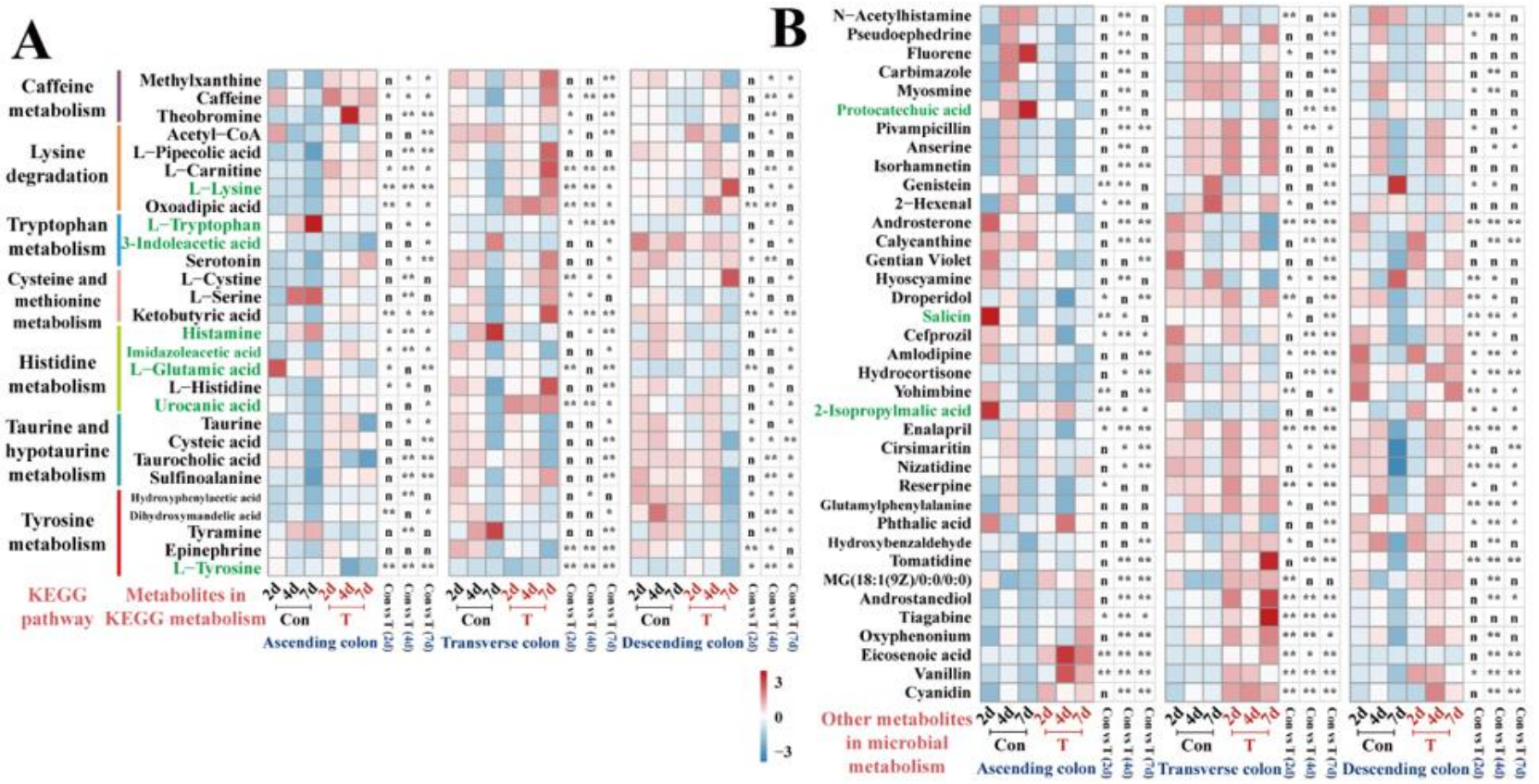


Significantly downregulated:
taurine and hypotaurine; histidine and tyrosine metabolism;

Significantly up-regulated:
lysine degradation, and tryptophan metabolism;

It is relatively consistent with the prediction function of the gut microbiome.

3.4 Metabolome



The marked metabolites were lysine, tyrosine, tryptophan, 3-indoleacetic acid, glutamic acid, and histamine.

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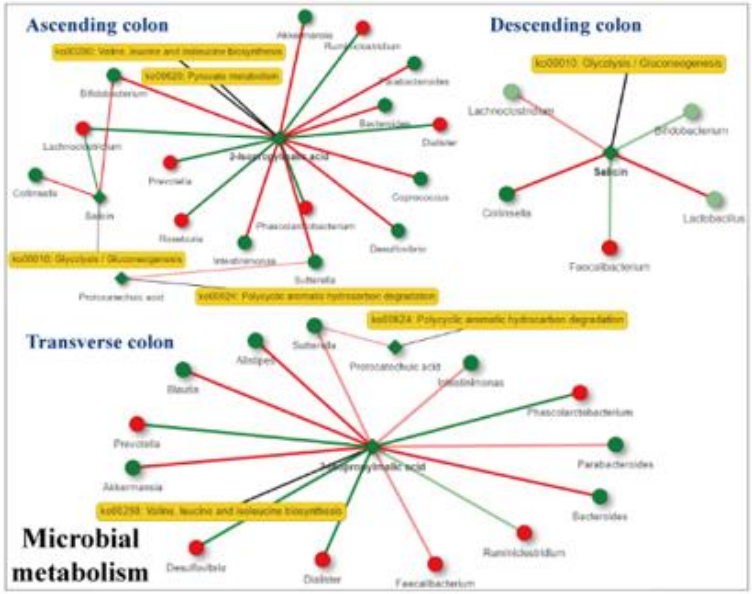
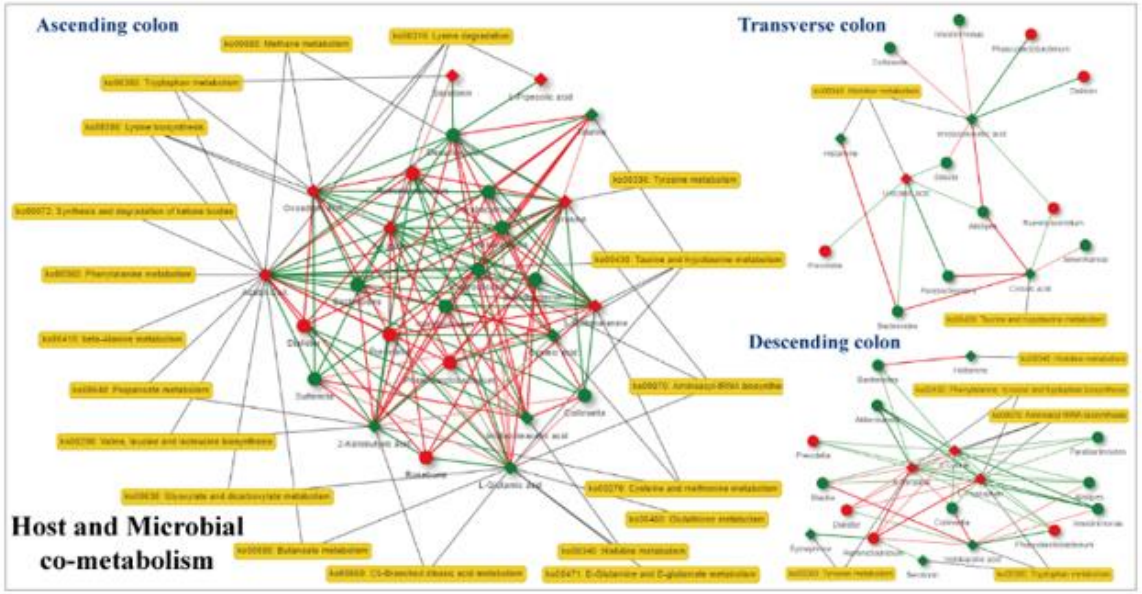
3.5 Combined analysis

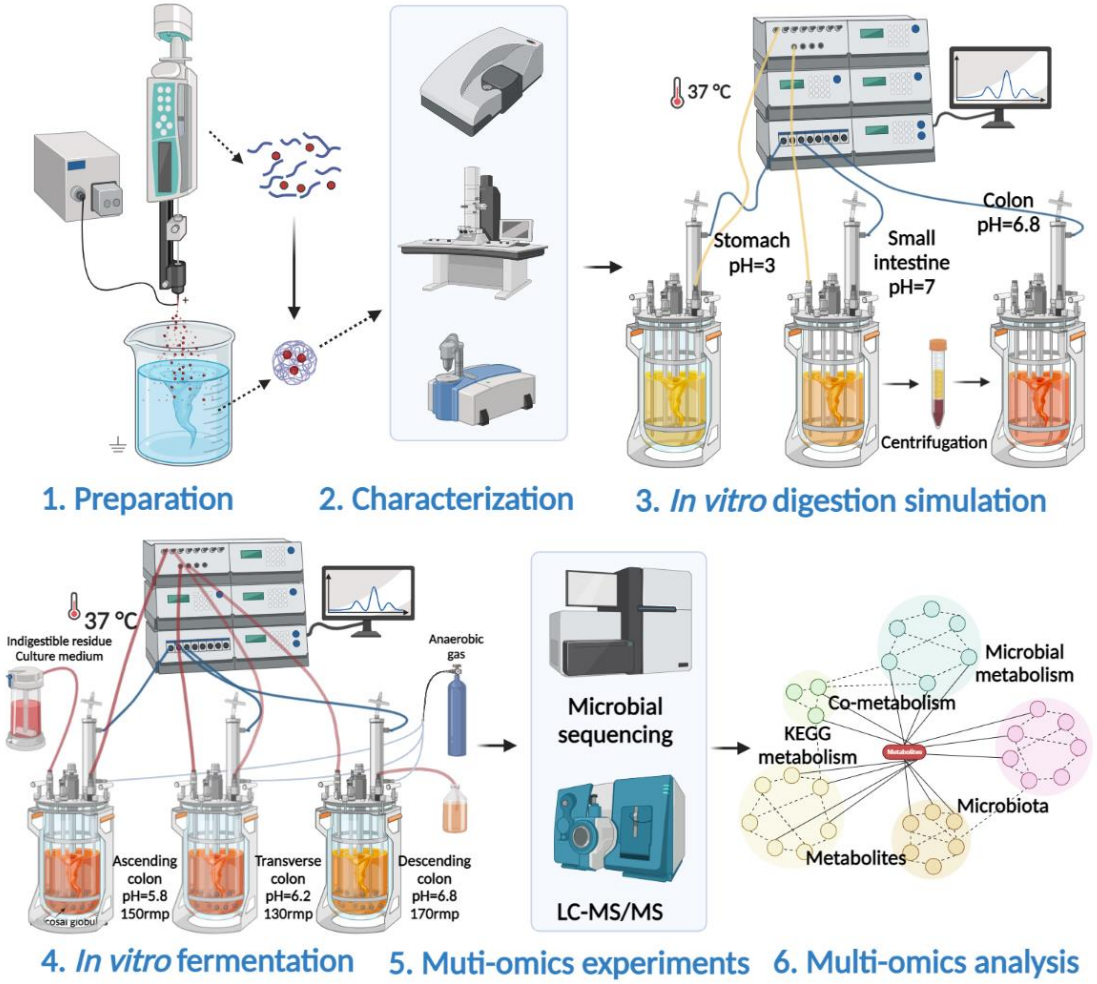




Key metabolites: lysine, tyrosine, tryptophan, 3-indoleacetic acid
Key metabolisms: lysine degradation, tyrosine metabolism, tryptophan metabolism, and histidine metabolism.
Key microbiome: *Prevotella*, *Phascolarctobacterium*, and *Dialister*,

The metabolic functions of the gut microbiome are related to human biological functions through the microbiome-host co-metabolic network.

4.Conslusion



1. Torularhodin electrospinning microspheres are stable and slowly released in the colon;

2. Torularhodin enhanced lysine biosynthesis and decreased tyrosine metabolism;

3. Co-metabolic network clarifies torularhodin enhanced lysine and carnitine;

4. Gut microbiota *Phascolarctobacterium*, *Prevotella*, and *Dialister* were upregulated;

5. Providing new applications for carotenoids-based diets for gut health;

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