GUT DYSBIOSIS UNCOVERED

How gut diversity & gut barrier function play a crucial role in maintaining your health

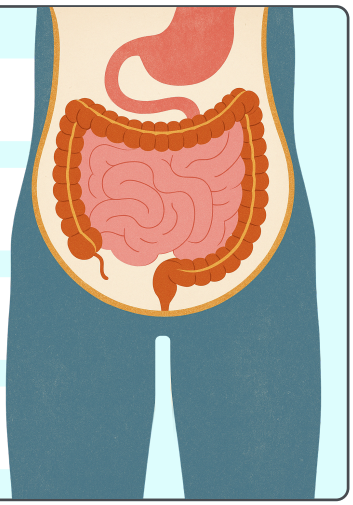
Microbial imbalance and immune disruption

The human gut microbiota plays a pivotal role in maintaining overall health. When the composition and function of this microbial ecosystem become imbalanced, we talk about gut dysbiosis. This imbalance contributes to a dysregulated gut-immune axis, referring to impaired communication and feedback loop between the gut microbiota, intestinal barrier, and the immune system [1].

Although the exact prevalence of gut dysbiosis in the general, asymptomatic population is scarce, studies have shown an association between gut microbiota imbalances and various pathological conditions such as irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), obesity, and allergic disorders [2].

Gut health and immunity facts

- **Up to 70% of your immune system lives in your gut, making microbial resilience your frontline defense**
- **Your gut barrier is your internal firewall.** When weakened ("leaky gut"), unhealthy metabolites (i.e toxins) slip through, triggering inflammation and symptoms such as diarrhea, bloating, and constipation
- A diverse and balanced gut microbiome makes it harder for even potent pathogens to take hold. Low microbiota diversity is linked to a higher risk of gut issues
- **A single course of antibiotics can wipe out up to 30% of your gut bacteria,** with some species never recovering, leading to long-term vulnerabilities



The importance of microbiota diversity

A key indicator of gut health

A diverse gut microbiota is a hallmark of gut health. The human gut harbors trillions of microorganisms, predominantly bacteria, but also fungi, protists, archaea, and viruses. This microbial ecosystem plays a crucial role in human physiology and health, collectively aiding digestion, synthesizing essential nutrients, and regulating immune responses [3].

External stress factors, such as extreme dietary changes, infections, or antibiotic use, can disrupt this microbial ecosystem. Several human intervention studies have shown that dietary fiber intake increases gut microbiota diversity [4]. Conversely, other studies have found that antibiotic administration decreases microbiota diversity, often leading to incomplete restoration of microbial composition [5].

Decrease of microbiota diversity can cause alteration in the abundance of bacterial-produced metabolites such as short-chain fatty acids (SCFAs). SCFAs are one of the most important metabolite categories involved in the regulation of several biological functions, playing a key role in supporting a resilient and diverse gut microbiota. To promote SCFA production, the diet should be rich in dietary fibers found in plant-based foods such as fruits, vegetables, legumes, and whole grains.

The gut barrier

A critical defense system

The intestinal mucosal barrier, also referred to as the gut barrier, is widely recognized as a critical player in the gut-immune axis as it ensures the complex crosstalk between the gut microbiota (both commensals and pathogens) and the host immune system. The gut barrier is a physical and biochemical barrier that regulates the selective permeability of the gut.

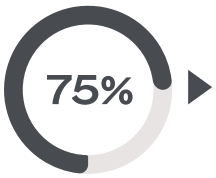
The gut barrier acts like a smart gatekeeper for your intestines. It helps keep your gut balanced by letting in the good stuff, like nutrients and blocking out harmful substances such as bacteria and toxins. This careful control helps maintain a healthy gut environment, which is called gut homeostasis [7].

One important factor that affects the gut barrier is the gut microbiota. An *in vivo* study has shown that the gut microbiota can directly influence how "leaky" the gut barrier becomes. The study showed that high abundance of unhealthy bacteria, such as Proteobacteria (incl. *E. coli*), was associated with a disrupted gut barrier. This suggests that shifts in microbiota composition can compromise the gut barrier function [8] In contrast, certain good bacteria, like *Bifidobacterium*, have been shown to reduce inflammation and help strengthen the gut barrier [9].

Key consequences linked to reduced microbiota diversity and a disrupted gut barrier

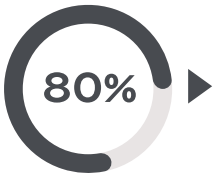
1	Reduced microbiota diversity can decrease the production of essential metabolites like SCFAs, leading to gut dysbiosis.
2	Dysbiosis can increase the presence of pathogenic bacteria in the gut and reduce gut resilience.
3	Reduced microbiota diversity and disrupted gut barrier integrity are associated with various pathological conditions such as irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and food allergies.
4	Disrupted gut barrier function allows harmful substances (e.g., microbial toxins, dietary antigens or heavy metals) to pass into the bloodstream. Once in the blood, these substances can trigger the body's immune system and cause widespread inflammation, which over time may lead to long-term diseases.

The rise of consumer demand for gut-supporting solutions



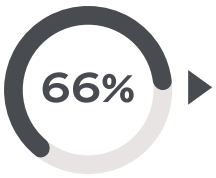
A global consumer survey revealed that 75% of respondents are interested in food products that improve gut health.

TASTE TOMORROW SURVEY (2024)



Focusing on European consumers in the UK, France, Germany, the Netherlands, and Poland, this survey reported that 80% of respondents were concerned about gut health

SENSUS CONSUMER SURVEY (2023)



Additionally, 66% expressed interest in consuming products containing prebiotics, associating them with benefits like digestive health (47%), immune system support (32%), and mental well-being (21%).

SENSUS CONSUMER SURVEY (2023)

Enter Binding Proteins

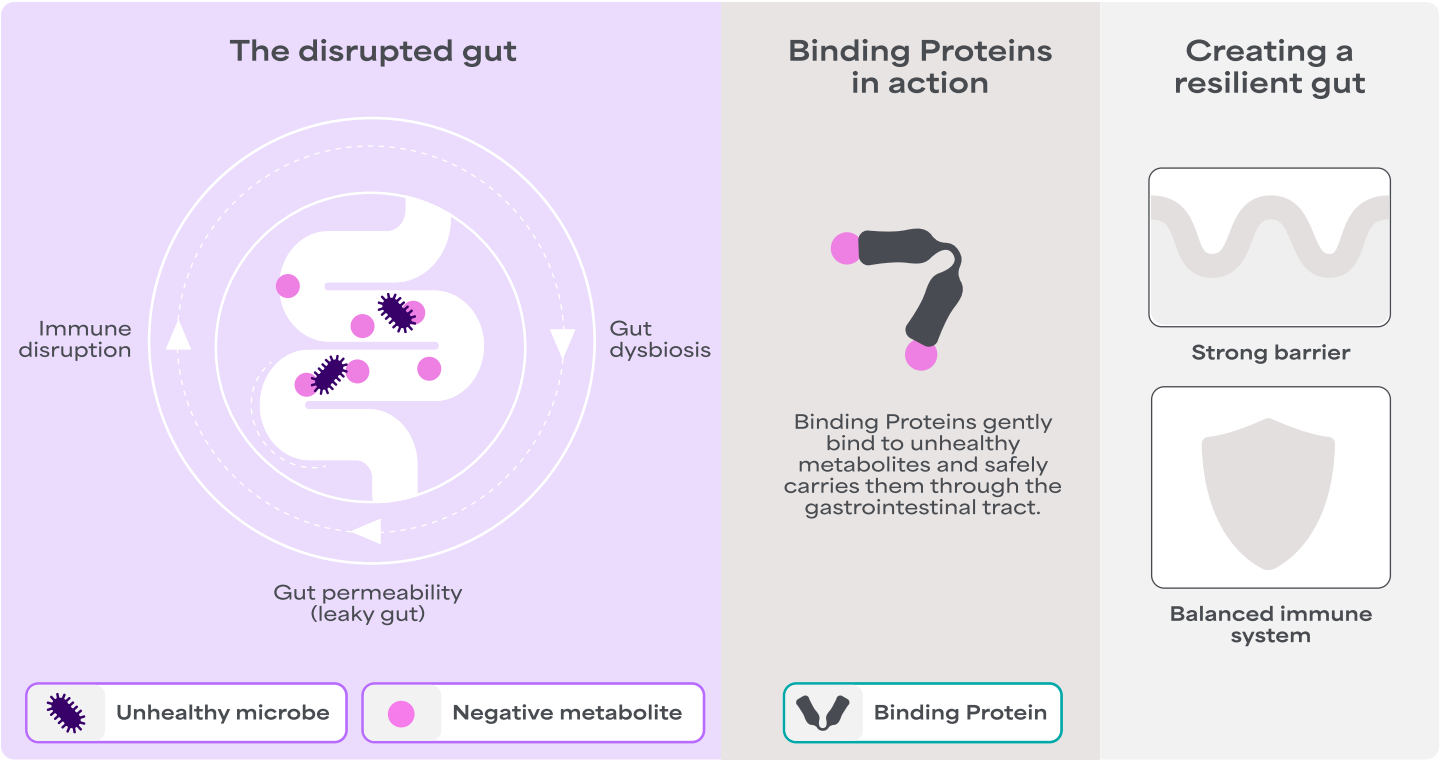
The next frontier in gut health

Binding Proteins

Innovative gut-stabilizing ingredients that leverage natural mechanisms for enhanced gastrointestinal support

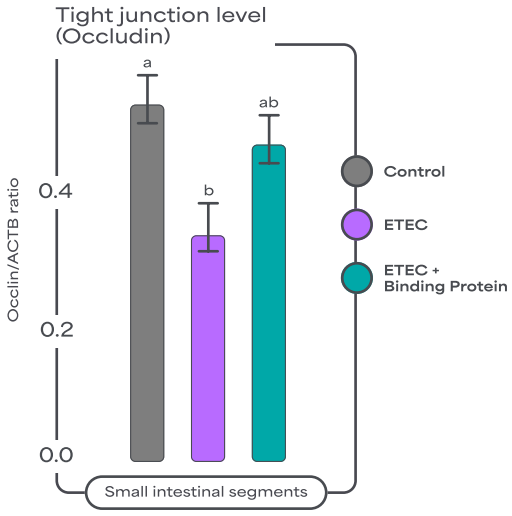
Binding Proteins: A novel class of functional ingredients derived from camelid immunoglobulin G (IgG) binding domains, inspired by the protective properties of immunoglobulins naturally found in colostrum and raw milk that has a long history of safe use. They are very target specific, designed to selectively bind and neutralize microbial-derived risk factors [10,11].

Binding Proteins can also foster a balanced microbial environment, helping to reduce the need for antibiotics, which, although effective, can negatively impact the gut microbiota diversity.



Supports a healthy gut barrier

Binding Proteins help maintain the normal function of the gut lining. An *in vivo* study has demonstrated that they significantly contribute to the gut defense system by enhancing gut integrity under challenges, such as an ETEC infection. This without inducing inflammation and preserving small intestinal tight junction levels [15].

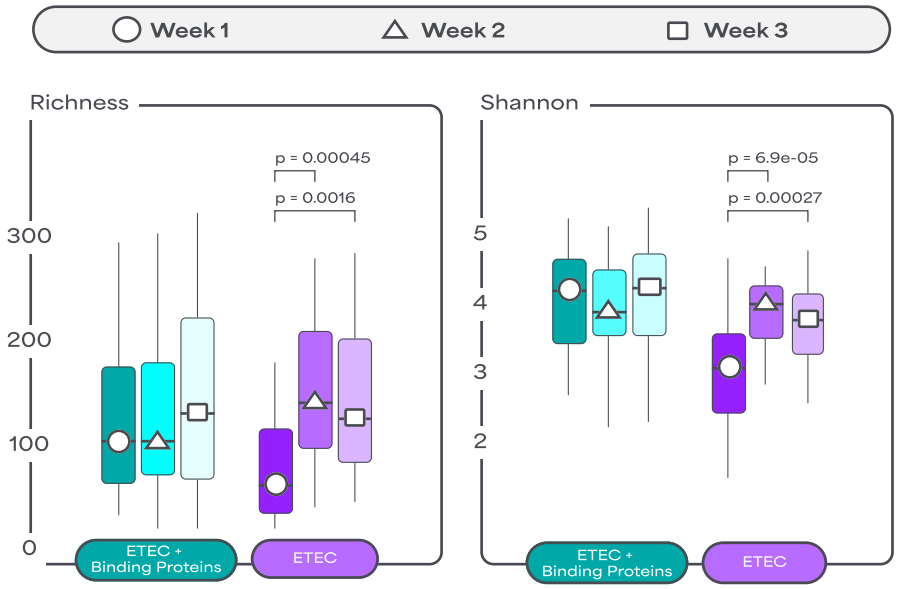


Occludin levels in the small intestine from an *in vivo* challenge study, comparing a control group, a group challenged with unhealthy *E. coli* (ETEC), and a group challenged with ETEC and given Binding Proteins. Occludin levels in the Binding Protein group remained comparable to those in the control group, indicating that Binding Proteins contribute to the gut defense system, improving gut barrier function as evidenced by maintaining occluding level [15].

a, b indicate statistical significance ($P < 0.05$) between groups based on pairwise comparisons (Holm-Bonferroni adjustment).

Nurturing microbiota diversity

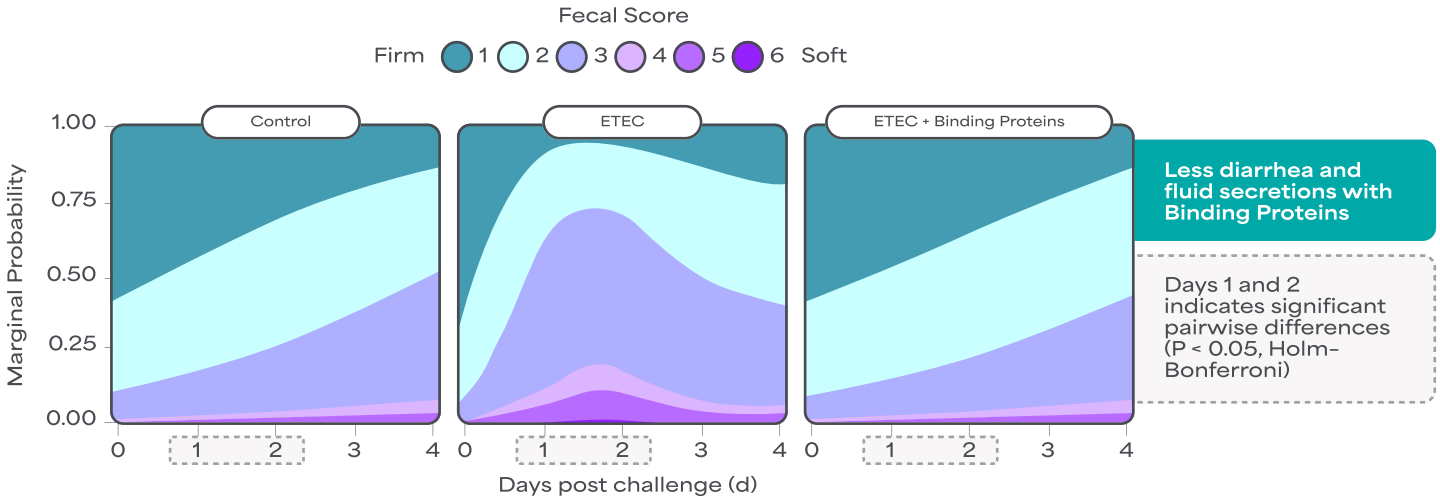
Binding Proteins have been shown to positively impact the gut microbiota by accelerating the recovery of microbiota diversity and induce lower abundance of unhealthy bacteria in vivo [12].



Alpha-diversity (Richness and Shannon indices) of the gut microbiota in a group challenged with unhealthy E. coli (ETEC) and a group receiving Binding Proteins over a 3-week period during an *in vivo* challenge study with unhealthy *E. coli*. Binding Proteins support the maintenance of microbiota diversity and promote a stable gut microbial community [12].

Maintains hydration & electrolyte levels

Binding Proteins contribute to the gut defense system. Both *in vitro* and *in vivo* data demonstrate that they prevent the entry of harmful metabolites, such as bacterial toxins, into intestinal cells by binding to harmful metabolites. This binding neutralizes the destructive activity. Data further shows that Binding Proteins help maintain intestinal integrity and contribute to the regulation of gut fluid and electrolyte balance. This regulation supports the reduction of diarrhea and excessive fluid secretion, highlighting their capacity to promote fluid and electrolyte homeostasis [13,14].



Less diarrhea and fluid secretions with Binding Proteins

Days 1 and 2 indicates significant pairwise differences ($P < 0.05$, Holm-Bonferroni)

Fecal scores from an *in vivo* challenge study comparing a control group, a group challenged with unhealthy *E. coli* (ETEC), and a group challenged with ETEC and given Binding Proteins. Fecal scores in the Binding Protein group followed a similar pattern to the control group, suggesting that Binding Proteins help maintain fluid balance and electrolyte regulation [15].

References

1. Stolfi, C. et al. (2022) Biomedicines 10.
2. Duan, H. et al. (2022) Critical Reviews in Food Science and Nutrition 62.
3. Qin, J. et al. (2010) Nature 464.
4. Cronin, P. et al. (2021) Nutrients 13.
5. Patangia, D. V. et al. (2022) Microbiology Open 11.
6. Dogra, S. K. et al. (2020) Frontiers in Microbiology 11.
7. Wells, J. M. et al. (2017) American Journal of Physiology - Gastrointestinal and Liver Physiology 312.
8. Jakobsson, H. E. et al. (2015) EMBO Rep 16.
9. Ruiz, L. et al. (2017) Frontiers in Microbiology 8.
10. Fiil, B. K. et al. (2022) iScience 25.
11. Petersson, M. et al. (2024) Trends in Biotechnology 41.
12. Jenkins, T. P. et al. (2024) NPJ Biofilms Microbiomes 10.
13. Rodriguez Rodriguez, E. R. et al. (2024) Protein Science 33.
14. Petersson, M. et al. (2025) Nature Communications 16.
15. Xu et al. (2025) Journal of Animal Science and Biotechnology 16:78.