



DOSSIER · SUBSTANCE

Mineral Binders (Zeolite, Bentonite)

The database includes studies on **zeolite** and **bentonite**, specifically in humans. Controlled trials focus on **safety** and **gut health**, while foundational research and animal studies predominate. The most notable finding: clinical evidence remains limited, despite these substances being investigated for decades in environmental and agricultural research.

1,423

STUDIES IN
TOTAL

93

IN HUMANS

25

OF WHICH
CONTROLLED

423

IN ANIMALS

118

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-16

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Mineral binders (zeolite, bentonite) at a glance

ORIGIN:
Zeolites are crystalline aluminosilicates with a microporous structure, found in volcanic rock or produced synthetically. Bentonite is a clay mineral, primarily composed of montmorillonite, formed through the weathering of volcanic ash. Both substances bind organic and inorganic compounds due to their cation exchange capacity and surface charge, and are processed industrially for use in medicine, agriculture, and environmental technology.

EVIDENCE BASE:
1,423 evaluated studies · 25 controlled human trials · 68 observational studies · 63 review articles · 423 animal studies · 86 cell culture studies

- STRONGEST EVIDENCE:**
- **Safety and tolerability:** Controlled human trials show that calcium montmorillonite (e.g., NovaSil, ACCS100) at dosages of 1.5–3 g/day over 2–8 weeks is well tolerated. Mild gastrointestinal symptoms (bloating, abdominal pain) occurred in 6–8% of participants, with no significant difference from the placebo group.
 - Gut health and toxin binding Montmorillonite (e.g., diosmectite) reduces the duration of acute diarrhoea (mean difference: -23.39 hours) and improves recovery rates. Studies also showed a reduction in urinary aflatoxin M1 metabolites with calcium montmorillonite (ACCS100).
 - Heavy metal binding Purified clinoptilolite tuff (G-PUR) reduces enteral absorption of lead by approximately 90% (²⁰⁴Pb accumulation in blood: 0.073% vs. 0.505% with placebo). However, effects on other heavy metals or long-term tolerability have not been investigated.
 - Anti-inflammatory effects A combination of diosmectite (3 g/day) and mesalazine showed an increased clinical remission rate in ulcerative colitis after 8 weeks (68.3% vs. 52% with mesalazine alone). Data on diosmectite alone or other inflammatory bowel diseases are lacking.
 - Chemotherapy tolerability PMA-zeolite showed improved tolerability of oxaliplatin-based chemotherapy, enabling more treatment cycles (p=0.03) and reducing the incidence of peripheral neuropathy (64.3% vs. 70.6% with placebo).

- LIMITATIONS:**
- The evidence base is heterogeneous: preparations (e.g., NovaSil, ACCS100, PMA-zeolite) differ in purity, particle size, and modification, limiting comparability. Most studies are short-term (2–14 weeks) and conducted in small populations.
 - Long-term data on safety and efficacy with chronic use are lacking. Mechanistic investigations (e.g., impact on the microbiome, cytokine profiles) are insufficient, and the applicability of animal or in vitro studies is questionable.
 - Binding capacity in the laboratory does not necessarily correlate with clinical effects. Selective binding (e.g., aflatoxins vs. fumonisins) and competition for binding sites in the gut (nutrients, toxins) are inadequately studied.

ASSESSMENT:
Zeolites and bentonites are mineral binders with demonstrated short-term safety and efficacy in gut health, toxin binding, and anti-inflammatory effects. However, their long-term effects and mechanistic impacts remain insufficiently investigated.

1. What Zeolite and Bentonite Are

Zeolites are crystalline aluminosilicates with a microporous structure, found in volcanic rock or produced synthetically. Both substances bind organic and inorganic compounds due to their **cation exchange capacity** and **surface charge**. Natural deposits vary widely in purity, particle size, and chemical composition. Industrially processed forms are used in medicine, agriculture, and environmental technology.

For interpreting the studies, it is crucial to recognise that **zeolites** and **bentonites** are not uniform substances. Even within a mineral group (e.g., clinoptilolite for zeolites or calcium montmorillonite for bentonites), samples differ in **crystal structure**, **impurities**, and **surface modifications**. **Bioavailability** depends on particle size and formulation: coarse powders pass through the gut largely unchanged, while nanoscale or chemically activated variants may be absorbed. Measurement methods often capture only **binding capacity in the laboratory**, not the actual effect in the organism.

2. What the Studies Show in Detail

The key human studies and most important reviews — by application area, with population, duration, preparation, outcome measures, and results, as reported in the original publications. Numbers are included only where the study provides them.

Distribution of **controlled human trials** by application area — the numbers are not additive, as one study may be assigned to multiple areas:

APPLICATION AREA	CONTROLLED STUDIES
Safety and tolerability	17
Gut and microbiome	5
Fatigue and stress	5
Absorption and bioavailability	5
Oncology	4
Immune system	4

APPLICATION AREA	CONTROLLED STUDIES
Inflammatory processes	3
Oxidative stress	1

Gut and Microbiome

In a randomised, double-blind Phase I study involving 50 healthy adults (23 men, 27 women, aged 20–45 years), the tolerability of NovaSil clay (NS, a calcium montmorillonite) was investigated over two weeks. Participants received either 1.5 g/day (low dose) or 3.0 g/day (high dose) of NS in capsule form, divided into three doses. Primary endpoints included laboratory parameters in blood and urine, as well as the assessment of gastrointestinal side effects. Compliance was 99.1%. Mild gastrointestinal symptoms occurred in 6–8% of participants (e.g., bloating: 8%, 4/50; abdominal pain: 6%, 3/50), with no statistically significant differences between the groups. There were no serious adverse events or abnormal laboratory findings. The study demonstrates that NS is safe in the tested dosages in the short term but provides no data on its effects on the microbiome or the gut barrier¹.

The experimental group (n=28) received montmorillonite in addition to standard therapy, while the control group (n=30) received only standard therapy. Prior to treatment, both groups showed comparable plasma levels of diamine oxidase (DAO), D-lactate, and endotoxin. The study suggests that montmorillonite may improve surrogate markers associated with intestinal barrier function in HSP; however, clinical outcomes, its influence on the microbiome, or sustained effects were not assessed. Additionally, the study was not blinded, which increases the risk of bias⁷.

The ZeOxaNMulti study, a randomised, double-blind, placebo-controlled trial involving 120 patients (primarily with colorectal cancer), investigated the effect of PMA-zeolite (Multizeo Med) on chemotherapy-induced side effects, particularly peripheral neuropathy (CIPN). Patients received either PMA-zeolite (dosage not explicitly stated) or placebo during oxaliplatin-based chemotherapy. After six months, 70.6% of the placebo group and 64.3% of the PMA-zeolite group developed CIPN. Patients receiving PMA-zeolite were able to complete significantly more chemotherapy cycles (p=0.03), suggesting improved tolerability. The study provides a preliminary indication for a potential role of PMA-zeolite in supporting chemotherapy adherence, but lacks detailed data on dose-response relationships, its influence on the microbiome, or robust CIPN diagnostics beyond nerve conduction studies¹⁰.

HYPOTHESIS The studies suggest that mineral binders such as montmorillonite and zeolite may stabilise the intestinal barrier and bind toxic substances. However, whether these effects lead to sustained modulation of the microbiome remains unclear, as none of the studies conducted microbiological analyses (e.g., 16S rRNA sequencing). Additionally, long-term data on safety and efficacy with chronic use are lacking.

Safety and Tolerability

A randomised, controlled study involving 524 patients with irritable bowel syndrome (IBS) examined the symptomatic efficacy of beidellite-montmorillonite (3 g/day over 8 weeks). Participants were stratified by IBS subtype (diarrhoea-predominant, constipation-predominant, or mixed). The primary endpoint was the improvement of abdominal pain or discomfort by at least one point on a 4-point Likert scale. Tolerability was good, with similar rates of side effects in both groups. However, the study was not fully blinded, and the use of rescue medications (e.g., phloroglucinol) may have influenced the results⁴.

In a double-blind, placebo-controlled crossover study involving 50 healthy adults in Kenya, the safety and efficacy of ACCS100 (a calcium montmorillonite clay) in reducing aflatoxin exposure were investigated. Participants received either 3 g/day of ACCS100 or placebo for 7 days, followed by a 5-day washout phase and subsequent crossover to the other treatment. The primary endpoint was the reduction of the aflatoxin M1 metabolite (AFM₁) in urine. ACCS100 significantly reduced AFM₁ compared to placebo (β=0.49, 95% CI: 0.32–0.75). There were no significant differences in tolerability or taste of the preparations. The study demonstrates that ACCS100 is safe and reduces aflatoxin bioavailability, but lacks data on long-term effects or potential interactions with other dietary components².

A randomised, controlled study involving 60 children (aged 3–9 years) investigated the safety of Uniform Particle Size NovaSil (UPSN), a calcium montmorillonite clay, over 14 days. Children received either 0.75 g/day, 1.5 g/day of UPSN, or 1.5 g/day of calcium carbonate as placebo. Primary endpoints included haematological and serum biochemical parameters, as well as the reduction of the aflatoxin M1 metabolite in urine. There were no significant differences in laboratory parameters between the groups, and no serious adverse events were reported. The high dose of UPSN significantly reduced AFM₁ compared to placebo. The study confirms the short-term safety of UPSN in children but provides no data on long-term tolerability or its influence on the microbiome⁵.

The dosage was 3–6 g/day for 3 days until recovery. Diosmectite significantly reduced the duration of diarrhoea (mean difference: -23.39 hours, 95% CI: -28.77 to -18.01) and increased the recovery rate by day 5 (OR: 4.44, 95% CI: 1.66–11.84). There was no increased rate of side effects. However, most studies were open-label, and the quality of evidence was rated as 'low'. The meta-analysis shows that diosmectite is safe and effective but lacks data on its effects in specific pathogens (e.g., rotavirus vs. bacterial infections)⁶.

Absorption and Bioavailability

A randomised, placebo-controlled, double-blind study involving 42 healthy adults investigated the effect of purified clinoptilolite tuff (G-PUR) on the enteral absorption of lead. Participants received either 2.0 g of G-PUR, 2 × 2.0 g of G-PUR, or placebo along with 2.5 µg of the stable lead isotope ²⁰⁴Pb. The primary endpoint was the enrichment of ²⁰⁴Pb in blood and urine. The maximum ²⁰⁴Pb enrichment in blood was 0.505% in the placebo group, compared to 0.073% (2.0 g G-PUR) and 0.057% (2 × 2.0 g G-PUR), corresponding to a reduction in bioavailability of approximately 90% (p<0.0001). The study demonstrates that G-PUR effectively reduces the enteral absorption of lead but lacks data on its effects on other heavy metals or long-term tolerability¹².

HYPOTHESIS The ability of zeolites and montmorillonites to bind heavy metals and toxins could be harnessed therapeutically, e.g., in chronic heavy metal exposure. However, clinical studies testing this hypothesis in patients with confirmed exposure (e.g., lead, cadmium) are lacking. Furthermore, it remains unclear whether the binding capacity is equal for different metals or if there are unintended interactions with essential minerals (e.g., zinc, iron).

Inflammatory Processes

A randomised, double-blind, placebo-controlled pilot study involving 25 patients with endoscopy-negative gastro-oesophageal reflux (ENGORD) investigated the effect of potentially activated clinoptilolite (Absorbatox™ 2.4D, 750 mg twice daily for 14 days). Primary endpoints included improvement in clinical symptoms (e.g., heartburn, regurgitation) and endoscopic findings. The study showed that clinoptilolite may reduce symptoms and endoscopic signs of inflammation, but lacks data on underlying mechanisms (e.g., cytokine profiles) or its effects in other gastrointestinal conditions ¹³.

A randomised, controlled study involving 120 patients with mild to moderate ulcerative colitis examined the effect of diosmectite (3 g/day) in combination with mesalazine. After 8 weeks, the combination group showed a significantly higher clinical remission rate. After 52 weeks, the remission rate in the diosmectite group was 61.7% vs. 40% in the placebo group. The study suggests that diosmectite may enhance the anti-inflammatory effect of mesalazine but lacks data on diosmectite's standalone effects or its long-term tolerability ¹⁵.

Bone and Joints

A randomised, placebo-controlled, double-blind study involving 100 patients with osteoporosis investigated the effect of PMA-zeolite over 5 years. Primary endpoints included bone quality, fracture risk, and quality of life. The PMA-zeolite group showed a reduction in fracture risk compared to baseline before the study. The study showed that PMA-zeolite may improve bone stability but lacks data on underlying mechanisms (e.g., effects on bone metabolism or calcium absorption) or its effects in other bone diseases (e.g., osteomalacia) ¹⁴.

Overall Picture

The available studies demonstrate that some mineral binders, including montmorillonite, zeolite, and clinoptilolite, are safe and partially effective in various clinical contexts. Their ability to bind toxins (e.g., aflatoxins, heavy metals) and stabilise the intestinal barrier is particularly well documented among these agents. Some studies also suggest anti-inflammatory and bone-stabilising effects. However, most studies are short-term (2–14 weeks), and long-term data on safety and efficacy with chronic use are lacking. Furthermore, the underlying mechanisms (e.g., influence on the microbiome, cytokine profiles) are often insufficiently investigated.

A central limitation in the current evidence base is the lack of standardised preparations and dosages. Most controlled human trials use different formulations (e.g., NovaSil, ACCS100, PMA-zeolite), which complicates comparability. Additionally, these trials are often conducted in small populations, and endpoints vary widely (e.g., symptom improvement vs. laboratory parameters). Systematic investigations into interactions with medications or nutrients are largely absent in the controlled human trials.

Methodology of the Evidence Base

["Controlled human trials on mineral binders include randomised, controlled trials (RCTs) with a duration of 2–14 weeks. Typical endpoints include laboratory parameters (e.g., toxin metabolites, inflammatory markers), clinical symptoms (e.g., duration of diarrhoea, pain), or tolerability data. Some studies use placebo controls, while others employ active comparator groups (e.g., diosmectite vs. probiotics). Weaknesses in some studies include the lack of long-term studies (>1 year), insufficient characterisation of the preparations (e.g., particle size, purity), and often small sample sizes. Furthermore, mechanistic investigations (e.g., influence on the microbiome or immune response) that go beyond mere symptom improvement are frequently lacking in these trials."]

Binding Is Not Equivalent to Effect: Why Laboratory Results Are Often Overestimated

The

BINDING CAPACITY

of zeolites and bentonites for toxins, heavy metals, or pathogens is frequently interpreted as **proof of efficacy**. However, **in vitro binding** does not necessarily correlate with **in vivo effects**. Studies show that mineral binders act **selectively** in the gut: they effectively bind, for example, **aflatoxins**, while other mycotoxins (e.g., fumonisins) are barely adsorbed. Moreover, in the gut, **nutrients**, **microbiome metabolites**, and **other toxins** compete for binding sites. Even if a substance is bound in the laboratory, its **bioavailability** in the organism can be influenced by **pH**, **gut motility**, or **microbiome interactions**. Most human studies therefore measure **surrogate parameters** (e.g., toxin excretion in stool) rather than **clinical endpoints** such as disease progression or mortality.

Another issue is the

LACK OF STANDARDISATION

. Even in controlled studies, **different mineral forms** (e.g., clinoptilolite vs. mordenite in zeolites) or **processing methods** (e.g., thermally activated vs. untreated) are used. **Particle size** varies from **micrometres** to **nanoparticles**, which affects **absorption** and **toxicity**. Some studies employ **synthetically modified** variants (e.g., loaded with organic cations), whose **safety profile** cannot be extrapolated to natural forms. While the **most frequently cited review papers** highlight **potential risks** (e.g., nutrient deficiencies due to non-specific binding), systematic investigations into **long-term effects** or **drug interactions** are lacking. Without clear **quality criteria** for the materials used, the **comparability** of studies remains limited.

3. How Robust the Research Is

Research on **mineral binders** is unevenly distributed: a significant portion of the work comes from **basic research**, **animal studies**, or **environmental/agricultural sciences**. Only a fraction of studies have been conducted in humans, with controlled trials representing a minority. The **controlled human trials** focus on **safety** and **gut health**. A few studies have examined effects on **fatigue**, **immune system**, or **bone metabolism**, though these provide initial insights with small sample sizes and short observation periods. The most frequently cited studies date from the 2000s and primarily investigate **montmorillonite clays** (e.g., NovaSil, diosmectite).

The **methodological robustness** of human studies is limited. Many are **open-label** or **single-blinded**, with heterogeneous endpoints and short durations. **Safety studies** typically assess only **acute tolerability**, while long-term data are lacking. **Gut-related studies** show consistent effects on **stool consistency** and **diarrhoea duration**, but without clear differentiation between **symptomatic relief** and **causal therapy**. The **applicability** of animal and cell culture studies is limited to preclinical insights, as these often use **high dosages** or **synthetic modifications** that may not reflect human applications. Environmental studies on **toxin binding** (e.g., aflatoxins, heavy metals) provide mechanistic insights but do not establish clinical relevance in humans.

4. Common Claims—and What the Data Actually Show

CLAIM	EVIDENCE
Mineral binders bind heavy metals and detoxify the body.	Controlled human studies demonstrate reduced enteral absorption of lead within the examined dosage ranges, but no data on systemic detoxification or clinic
Zeolites and bentonites strengthen the immune system.	Investigated for the modulation of the immune system; controlled results are inconsistent. Most studies originate from cell cultures or animal models using high
These substances have antioxidant and anti-inflammatory effects.	Antioxidant effects have been investigated; the controlled results are inconsistent. In-vitro studies demonstrate radical-scavenging properties , but the relevan
Zeolites and bentonites improve bone health.	Investigated for its impact on bone health; controlled results are inconsistent. Animal studies demonstrate heterogeneous outcomes , depending on mineral for

5. The Most Robust Studies

Ranked by strength of evidence, not by prominence. The full evaluation includes significantly more studies; only the most reliable are listed here.

Controlled Human Trials

- ¹ Short-term safety evaluation of processed calcium montmorillonite clay (NovaSil) in humans (2005)
- Xyloglucan for the treatment of acute diarrhoea: results of a randomised, controlled, open-label, parallel-group, multicentre, national clinical trial (2015)
- ² Evaluation of the efficacy, acceptability and palatability of calcium montmorillonite clay used to reduce aflatoxin B1 dietary exposure in a crossover study (2017)
- ³ Oral diosmectite reduces stool output and duration of diarrhoea in children with acute watery diarrhoea (2009)
- ⁴ Symptomatic efficacy of beidellitic montmorillonite in irritable bowel syndrome: a randomised, controlled trial (2005)
- ⁵ Short-term safety and efficacy of calcium montmorillonite clay (UPSN) in children (2014)
- ⁶ Efficacy and safety of diosmectite in acute childhood diarrhoea: a meta-analysis (2015)
- ⁷ Effect of montmorillonite powder on the intestinal mucosal barrier in children with abdominal Henoch-Schönlein purpura: a randomised controlled study (2018)
- ⁸ Intervention trial with calcium montmorillonite clay in a South Texas population exposed to aflatoxin (2016)
- ⁹ Double-blind, randomised, controlled clinical trial of the effects of diosmectite and basic fibroblast growth factor paste on the treatment of minor recurrent aphthous stomatitis (2013)
- ¹⁰ ZeOxaNMult Trial: A randomised, double-blinded, placebo-controlled trial of oral PMA-zeolite to prevent chemotherapy-induced side effects, in particular oral mucositis (2020)
- ¹¹ Topically administered purified clinoptilolite-tuff for the treatment of cutaneous wounds: a prospective, randomised phase I clinical trial (2022)
- ¹² Concomitant oral intake of purified clinoptilolite tuff (G-PUR) reduces enteral lead uptake in healthy humans (2021)
- ¹³ Potentiated clinoptilolite: artificially enhanced aluminosilicate reduces symptoms associated with endoscopically negative gastro-oesophageal reflux disease (2014)
- Paediatric Tui Na for acute diarrhoea in children under 5 years old: a systematic review and meta-analysis of randomised clinical trials (2018)
- ¹⁴ Clinical Parameters in Osteoporosis Patients Supplemented With PMA-Zeolite at the Conclusion of a 5-Year Double-Blind Clinical Trial (2022)

- Allogenic Faecal Microbiota Transplantation for Antibiotic-Associated Diarrhoea in Critically Ill Patients (FEBATRICE)—Study Protocol for a Multicentre Trial (2024)
- ¹⁵ Combined Diosmectite and Mesalazine Treatment for Mild-to-Moderate Ulcerative Colitis: A Randomised, Placebo-Controlled Study (2015)
- ¹⁶ Safety and Efficacy of Purified Clinoptilolite-Tuff in Patients with Diarrhoea-Predominant Irritable Bowel Syndrome: A Randomised Controlled Trial (2022)
- ¹⁷ Survival Analyses of the ZeOxaNMulti Trial: Follow-Up Randomised, Double-Blind, Placebo-Controlled Trial of Oral PMA-Zeolite to Prevent Chemotherapy-Induced Toxicity (2022)
- Effectiveness of Xielikang Capsules in Treating HIV-Related Diarrhoea by Increasing Plasma Interleukin-17 Concentration (2017)
- ¹⁸ Oral Zeolite Therapy for the Management of Mild to Moderate Lead Poisoning: A Randomised Clinical Trial (2025)
- Efficacy and Safety of Modified Sishen Decoction for Tyrosine Kinase Inhibitor-Induced Diarrhoea in Hepatocellular Carcinoma: A Randomised Controlled Trial (2026)
- ¹⁹ *Saccharomyces boulardii* CNCM I-745 and Smectite Treatment for Paediatric Acute Gastroenteritis in China: A Systematic Review and Meta-Analysis (2026)

6. Summary

Short-term safety and tolerability of zeolites and bentonites (primarily montmorillonite) at dosages of 1.5–3 g/day are indicated in studies. Clinical effects are primarily observed in gut health: reduction in diarrhoea duration and stabilisation of stool consistency. Some studies report binding of toxins (e.g., aflatoxins, lead) in laboratory settings. Anti-inflammatory effects (e.g., in ulcerative colitis) and improved tolerance to chemotherapy are suggested by small, short-term studies with heterogeneous endpoints and preparations.

Additionally, preclinical studies suggest stabilisation of the gut barrier, which may be relevant for inflammatory bowel diseases or leaky gut syndrome. However, whether these effects lead to sustained modulation of the microbiome or reduction in systemic inflammation in humans remains unclear, as microbiological analyses (e.g., 16S rRNA sequencing) are lacking. **Hypothesis:** The bone-stabilising effects of PMA-zeolite may stem from improved mineral absorption or anti-inflammatory mechanisms, though the underlying mechanisms are not yet elucidated.

Future studies should employ standardised preparations and dosages to enhance comparability. Long-term studies (>1 year) are necessary to assess safety and efficacy with chronic use. Mechanistic investigations should clarify the impact on the microbiome, cytokine profiles, and interactions with nutrients (e.g., zinc, iron). Furthermore, clinical trials are lacking for specific indications such as heavy metal exposure or inflammatory bowel diseases (e.g., Crohn's disease). The selectivity of binding capacity (e.g., for different toxins or pathogens) should be systematically investigated.

7. Broader Context

Effects of mineral binders measured in humans focus on gut health, particularly stool consistency and duration of diarrhoea. Controlled studies demonstrate that bentonite (primarily montmorillonite) and zeolites (e.g., clinoptilolite) bind organic and inorganic substances in the intestinal lumen, leading to symptomatic relief. The cation exchange capacity and surface charge of these substances enable the adsorption of toxins, bile acids, or pathogenic microbes, which correlates in human studies with reduced frequency of diarrhoea. However, it remains unclear whether these effects are causally linked to improved barrier function or merely result from physical binding. The evidence base is heterogeneous, as variability in sample purity and particle size, along with methodological differences in dosage and administration, complicates direct comparisons. Long-term data are lacking, and the applicability of animal models to humans is limited, as absorption behaviour and systemic effects are insufficiently characterised.

The mechanistic plausibility of mineral binders arises from their ability to act as 'molecular sponges' in the intestinal lumen. Animal studies and in vitro models show that bentonite and zeolites can bind not only toxins but also pro-inflammatory cytokines or bacterial endotoxins (e.g., LPS). This may alleviate stress on the gut barrier by reducing exposure to pro-inflammatory substances. Additionally, preclinical data suggest that these substances could indirectly support mucus production or tight junction integrity—by binding bile acids, for instance, which would otherwise damage the barrier. However, human data on interactions with the microbiome are lacking: it is unclear whether mineral binders selectively inhibit pathogenic microbes or also impair beneficial bacteria (e.g., butyrate producers). The translation of these mechanisms to humans is further complicated by the variability of natural deposits, as impurities (e.g., heavy metals) or structural differences may alter binding properties.

Existing data suggest that mineral binders may serve as a bridging factor in the chain *gut barrier – inflammation – stress*: by binding luminal stressors (toxins, LPS), they could reduce the inflammatory burden and thus stabilise barrier function under chronic stress. However, it remains untested whether this effect acts synergistically with barrier-nourishing substances (e.g., butyrate, polyphenols)—for example, by reducing the 'toxin load' while simultaneously strengthening the mucus layer. It also needs to be investigated whether the binding capacity of zeolites or bentonites is sufficiently specific to neutralise pathogenic substances without impairing essential nutrients (e.g., trace elements) or microbiome metabolites. Long-term studies must clarify whether the observed acute effects on gut health also have systemic consequences—such as on the hypothalamic–pituitary–adrenal axis or immune regulation. A critical question is whether nanoscale or chemically activated variants are absorbed and could thus trigger undesirable systemic effects.

8. Unresolved Questions

- **Long-term safety:** Data on chronic use are lacking, particularly regarding **nutrient interactions** and **microbiome effects**.
- **Absorption:** It remains unclear whether and to what extent **nanoparticles** or **modified forms** are systemically absorbed.

- **Clinical relevance:** Most studies measure **surrogate parameters** (e.g., toxin excretion) rather than **hard endpoints** such as disease progression or mortality.

9. Further Paths

Topics, mechanisms and chains in which this substance appears — for those who want to look beyond the substance.

- From Exclusion to Inflammation: Stress, Cortisol, Gut
- Gut Barrier and Binding: Mineral Binders, Zeolite, Butyrate, Probiotics

Frequently Asked Questions

Can mineral binders be used for irritable bowel syndrome or chronic diarrhoea?

Controlled studies demonstrate **symptomatic effects** in **acute diarrhoea** (e.g., shortened duration, improved stool consistency), particularly with **diosmectite** (montmorillonite clay). For **chronic diarrhoea** or **irritable bowel syndrome**, data are still emerging, often involving small sample sizes. The **mechanistic basis** involves the **binding of toxins and pathogens**, but whether this acts **causally** or merely provides **symptomatic relief** remains unclear. **Interactions** with medications (e.g., impaired absorption) have not been systematically investigated in human studies.

Are zeolites and bentonites safe for long-term use?

Safety studies have primarily examined **short-term use** and reported no severe adverse effects. However, **long-term data** are lacking. **Animal studies** suggest **potential risks**, such as **nutrient deficiencies** due to non-specific binding of vitamins or trace elements. **In vitro studies** indicate that some mineral forms may exhibit **cytotoxic effects**, particularly at the doses investigated. **Clinical recommendations** for long-term use cannot be derived from the current evidence base.

Can mineral binders help with chemotherapy-induced side effects?

Investigated for the prevention of **chemotherapy-induced peripheral neuropathy**; controlled results are inconsistent. **Animal studies** show **heterogeneous effects** on **toxicity** and **tumour growth**, depending on mineral form and dosage. **Clinical recommendations** cannot be derived from the current evidence base. **Interactions with chemotherapeutic agents** (e.g., impaired absorption) have not been sufficiently studied.

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Research, put in context. Every statement leads to the original paper; the decision in the individual case rests with the treating professional.
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