
ALL ABOUT TOXIN BINDERS

Phase III of detoxification is the final step in toxin processing, involving the movement of toxins out of cells in the liver, kidneys, and intestines and into circulation, where the toxins can be prepared for elimination through bile and urine. Dietary supplement strategies that support phase III are distinct from those that aid phases I and II of detoxification.

A critical and often overlooked aspect of successful detoxification protocols is the use of binding agents or 'binders'. Binders are supplements that uniquely support phase III detoxification by helping usher toxins out of the body via the stool, inhibiting their enterohepatic recirculation.

There are several natural binders on the market, however an ideal binder must demonstrate adsorbent properties - the ability to physically attach specific toxins or other molecules to its surface, preventing them from being released and reabsorbed. This is the functional aspect of binding agents. And not all binders attract the same toxins, so it can be beneficial to supplement with multiple binders when detoxifying to capture a broad spectrum of contaminants.

Binders: An Additional Organ of Detoxification

Many environmental pollutants like pesticides and VOCs, and toxins generated endogenously, like endotoxin (lipopolysaccharide), pass through the liver and gut to be excreted in the stool. However, if toxins are not eliminated promptly, they can get recirculated between the intestine, bloodstream, and liver via the enterohepatic circulation.

Intercepting toxins in the intestine using binders helps prevent this unwanted recirculation of pollutants. Essentially, we can think of binders as an additional "organ of detoxification," facilitating the timely elimination of toxins from the body. A few examples of toxin binders include bentonite clay, activated charcoal, chitosan, thiol-functionalized silica, chitosan, zeolite, modified citrus pectin, and acacia gum.

Binders facilitate toxin elimination by adsorbing toxins. Adsorption is the process of attracting, binding, and accumulating particles on a surface; the purpose of adsorbing compounds in the body is to capture these compounds so that they can be eliminated promptly. Adsorption differs from absorption, the process by which substances diffuse or penetrate from one substance into another liquid or solid substance. Ideally, if we are utilizing a binder as part of a detoxification protocol, it must offer adsorbent properties.

By adsorbing toxins, binders play a critical, irreplaceable role in phase III of detoxification. Herbs, vitamins, and minerals can activate enzymes and biochemical pathways involved in Phases I and II of detoxification. However, none can replace the role of binders in Phase III detoxification.

Phase III detoxification consists of transmembrane transporters that draw toxins from the circulation into hepatocytes and renal epithelial tubule cells and then draw the toxins from these cells into either the bile or urine for excretion.¹ When toxins are ushered into the bile, they must subsequently pass through the intestine, where the potential for reabsorption is high. With their adsorbent properties, binders effectively intervene and prevent toxins from being reabsorbed across the intestinal barrier.²

Commonly Used Binding Agents

The use of binding agents dates back to the time of Aristotle, 384-322 BC. These accounts report the ingestion of volcanic mud (aka clay) to quell gastrointestinal ailments.³

Below, we will review several natural binders commonly used in the dietary supplement space to support detoxification.

Activated Charcoal

Activated charcoal contains millions of tiny pores that adsorb ingested toxins within the gastrointestinal tract, preventing the toxins from being systemically absorbed.⁴ Hospitals and emergency rooms have long used activated charcoal to treat cases of poisoning in children and adults. In fact, activated charcoal is so useful as an anti-toxic agent that it is included in the WHO Model List of Essential Medicines.⁵ Supplemental activated charcoal is often derived from bamboo or coconut shells.

Activated charcoal adsorbs many harmful toxins, including pharmaceutical drugs⁶, bacterial endotoxin⁷, volatile organic compounds (VOCs)⁸ which can be derived from outdoor air pollution and indoor environments, pesticides⁹, and mycotoxins,

particularly the mycotoxin deoxynivalenol, mainly produced by *Fusarium* molds.^{10,11} Substances that cannot be bound by activated charcoal include alcohol, organic solvents, and iron.⁴

Oral activated charcoal can also modulate the inflammatory response during infection, acting as a cytokine “mop.”¹²

Chitosan

Chitosan is a water-soluble polysaccharide derived from the outer skeleton of shellfish. It is chemically produced through the deacetylation of chitin, an amino-polysaccharide also found in insects and the cell walls of fungi.¹³

Chitosan's adsorbent properties have even been utilized to decontaminate industrial wastewater.¹⁴ Inside the human body, chitosan binds to bile acids, a major component of bile. Bile, in turn, is a primary excretion route for mycotoxins, arsenic, and lead.^{15,16} Chitosan has also been found to bind to bacterial endotoxin¹⁷ and mycotoxins.¹⁸ Preclinical research suggests that it may also bind to arsenic¹⁹, a heavy metal ubiquitous in several commonly-consumed foods, including rice and poultry.

Furthermore, emerging research suggests that chitosan may also help control the growth of fungi and may thus potentially help inhibit mold colonization and mycotoxin production inside the gut.^{20,21}

Bentonite Clay

Bentonite clay is a creamy gray volcanic ash. Each molecule has a vast surface area capable of binding to numerous harmful substances, including cadmium, lead, and several types of mycotoxins.²² In particular, it has a strong adsorption capacity for aflatoxin, a mycotoxin that commonly contaminates crops such as grains and peanuts.²³

Zeolite

Zeolites are a group of porous minerals naturally found in volcanic rock and ashes. The crystalline structure of zeolite acts as a “cage” that traps positively and neutrally-charged molecules in the gastrointestinal tract. This unique property makes zeolite a powerful adsorbent for heavy metals, including mercury and lead.²⁴ Furthermore, the binding properties of zeolite are impressive: In lead-poisoned mice, zeolite administration reduced intestinal lead absorption by 70 percent.²⁵

Acacia Gum

Acacia gum is a gum exuded from the Acacia Senegal tree, native to the Sudan region of Africa. It is rich in soluble fiber, which dissolves in water, forming a viscous gel that traps bile acids and other substances, facilitating their elimination via the stool.^{26,27}

Acacia gum also offers prebiotic properties and may help counteract gut dysbiosis, improving the health of the gut microenvironment. A healthy gut microenvironment is critical for successful detoxification as it is a significant route of excretion for numerous toxins.²⁸ Acacia gum supplementation can also enhance intestinal zinc absorption by increasing levels of beneficial gut bacteria involved in zinc metabolism.²⁹ Zinc sufficiency, in turn, protects against heavy metal toxicity.^{30,31}

Thiol Resins

Mercury is perhaps the most well-recognized toxic heavy metal in our environment and perhaps the most complex one. Industrial plants, coal burning, incinerators, and chlor-alkali facilities have historically released copious amounts of mercury into our atmosphere, resulting in widespread contamination of our oceans, soil, and air. Mercury is also a primary component of dental amalgams, which reside in the teeth of more than 100 million Americans.

Thiol resins, such as thiol-functionalized silica, are highly specific mercury binders. Thiol resins optimize the natural elimination of metals through the intestine while quenching metal-induced free radicals, providing multifaceted support for heavy metal detoxification.³²

Modified Citrus Pectin

Modified citrus pectin is a soluble dietary fiber derived from the white fleshy inner portion of citrus peels. Supplementation with modified citrus pectin reduces the body burden of several toxic metals, including lead, arsenic, and cadmium. In addition, it alleviates inflammation, an important barrier to effective detoxification.³³

Beyond its binding properties, modified citrus pectin also inhibits the growth and metastasis of abnormal cells and may thus be a useful addition to cancer treatment protocols.³⁴ It also reduces liver fibrosis, thereby supporting the proper function of our primary organ of detoxification.³⁵

Toxin Removal Through Binders May Enhance Lifespan

By removing toxins with pro-aging effects on the body, referred to as “gerontogens,” the consumption of binders may extend lifespan.³⁶ In an animal study, ingestion of a charcoal binder delayed the rate of biological aging and increased mean and maximal lifespan by 43% and 34%, respectively.³⁷



Binders in Practice

Dietary supplement binders are important multi-purpose health tools to help reduce the body's toxic burden and maintain a healthy gut microenvironment. There are several important considerations to make when selecting and ingesting binders. Let's discuss each of these considerations in turn.

Constipation

Constipation may occur when supplementing with certain binders, namely activated charcoal and bentonite clay, in the absence of adequate water intake. Constipation contributes to the recirculation of toxins between the gastrointestinal tract, blood circulation, and liver. Therefore, preventing constipation is key during any detoxification protocol.

Constipation can be alleviated by drinking half of one's body weight in ounces of water a day, eating a fiber-rich diet, and exercising daily. If these measures are insufficient to resolve constipation on their own, either the dosage of the binder can be reduced or a magnesium supplement can be added to the patient's regiment. Magnesium citrate and magnesium oxide are the best forms of magnesium for alleviating constipation because of their osmotic laxative effects in the gut.^{41,42}

Potential Interference with Medications and Supplements

Binders should be taken on an empty stomach either one hour before or two hours after taking any medications or supplements to avoid interfering with the absorption of these substances in the gastrointestinal tract. Of course, patients should also check with their doctors before incorporating any binder into their routine, since some medications with delayed-release technology may require additional consideration regarding the timing of binder intake.

Binders and Food

It is possible that binders may inhibit the absorption of some food-based nutrients, such as fat-soluble vitamins and calcium, if consumed in close proximity to meals. Ideally, it is best to take binders one hour before or two hours after meals. However, if this isn't feasible, then the best option is to take binders close to meals and to maintain the ideal 1-hour-before or 2-hours-after spacing of binders from other medications and supplements.

Additional Considerations

It is best to look for products that contain multiple binding agents to support phase III detoxification and the effective removal of multiple contaminants. Multiple studies show that combinations of binders are more effective than single binders at adsorbing contaminants and mitigating toxin-induced damage inside the gut.^{43,44}

Finally, some people have the misconception that binders can be absorbed from the gut into the bloodstream. However, other than modified citrus pectin, binders are not absorbed across the gut into the bloodstream.^{33,4} Rather, binders "catch" toxins that are passing through the intestine so that the toxins can be excreted via stool.

What Is Not a Binder?

Several natural substances are currently being marketed by supplement companies as "binders" when, in fact, they are not binders in the traditional sense.

Serum Bovine Immunoglobulins (SBIs)

SBIs are currently being marketed as a binding agent for bacterial toxins.³⁸ SBIs are a specially formulated protein preparation containing 60 percent immunoglobulins, including IgG, IgA, and IgM.

However, SBIs technically use the immune system and antibody-antigen binding to "flag" toxins as threats, resulting in the immune system clearing those toxins rather than using adsorbent mechanisms. SBIs can offer beneficial effects for gastrointestinal health but are not suitable for comprehensive detoxification since they only target toxins that can be eliminated through a narrow range of antigen-antibody-based mechanisms.

Fulvic and Humic Acids

Similarly, fulvic and humic acids are often included in binder formulas but do not offer the same binding properties as binders like activated charcoal, bentonite clay, and zeolite. Rather, fulvic and humic acids are organic compounds found in humus, the part of the soil that is richest in decayed plant and animal matter. In other words, these substances are decomposed organic matter. Although humic and fulvic acids have been shown to adsorb the herbicide glyphosate³⁹, and humic acid weakly binds some heavy metals, their binding capabilities are limited, making them unsuitable for use in broad-spectrum toxin binding.⁴⁰



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