The MOSS NUTRITION REPORT

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Product Review

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PROBIND SELECT™: MORE INFORMATION ON THE IMPACT OF PROBIOTIC ORGANISMS ON HEAVY METAL DETOXIFICATION

INTRODUCTION

As I first mentioned in the August 2024 product newsletter where I first wrote about our new binder product, **Probind Select™**, one of the most unique and interesting aspects of the product, which contains classic binders such as activated charcoal, bentonite clay, and chlorella, is that it also contains the following probiotic organisms:

- Lactobacillus rhamnosus
- Lactobacillus casei
- Lactobacillus plantarum
- Saccharomyces boulardii

In that August 2024 newsletter I presented highlights from a paper that gave a broad overview of how probiotic organisms can be useful for the detoxification of a broad range of environmental toxins, including heavy metals. In this newsletter I would like to highlight some quotes from the paper "Guardians of the gut: Harnessing the power of probiotic microbiota and their exopolysaccharides to mitigate heavy metal toxicity in human for better health" by Dahiya et al (Dahiya P et al. *Probiotics and Antimicrobial Proteins*, published online May 11, 2024) which, as the title suggests, focuses on the role of probiotic organisms in the detoxification of heavy metals.

GUT MICROBIOTA AND HEAVY METALS: A BIDIRECTIONAL RELATIONSHIP

One of the foundational concepts emphasized by the authors is that there is a bidirectional interaction between heavy metals and gut microflora in that heavy metals can, on one hand, adversely affect microflora populations and, on the other hand, gut microflora can be a powerful force for the detoxification of heavy metals:

"Heavy metals…disrupt the gut's microbial balance, leading to dysbiosis characterized by a decrease in beneficial microorganisms and proliferation in harmful ones, ultimately exacerbating health problems. Probiotic microorganisms have demonstrated their ability to adsorb and sequester heavy metals, while their exopolysaccharides (EPS) exhibit chelating properties."

However, as you might expect, this relationship can be influenced by a number of environmental factors:

"The bidirectional relationship between heavy metals and the gut microbiota is influenced by various factors including dietary constituents and environmental conditions such as temperature and pH, as well as the age and gender of the host."

In the next few quotes, the authors provide much more specific detail on the bidirectional relationship:

"Exposure to heavy metals, particularly chronic exposure, alters the phylogenetic diversity and

trajectory of the gut microbiome, potentially disrupting the metabolic and physiological functions of the gut microbiota and leading to the onset of various pathological conditions and toxic symptoms. Conversely, by influencing the absorption and metabolism of intestinal heavy metals and enhancing fecal heavy metal excretion, the gut microbiota acts as the body's primary defense against heavy metal poisoning. Gut microbiota possesses extensive enzymatic capacities capable of metabolizing various heavy metals and reducing their toxicity to mammalian hosts. Furthermore, heavy metals can also affect the function and composition of gut microbiota negatively."

Before continuing, please notice again in the above quote the authors' comment that gut microflora are not just another method of coping with heavy metal exposure along the more well-known defenses such as glutathione and selenium. Rather, gut microflora is "***…the body's primary defense…"***

The next quote provides still more detail on the negative impact of heavy metals on gut microflora:

"Exposure to heavy metals affects the growth and modifies the phyla that make up the gut microbiome. The gut microbiomes are excellent candidates for heavy metal-induced side effects as they cause modification in the composition of the gut microbiome, which may be an active indicator of the harmfulness and bioavailability of heavy metals. The recently emerging consensus that heavy metal exposure may possibly lead to dysbiosis emphasizes a crucial mutualistic connection between heavy metal exposure and intestinal microecology. Previous research has demonstrated that exposure to gut microbiota directly affects the heavy metal metabolism and absorption that may lead to a loss of specific health-promoting bacteria, or an increase in the pathogenic microbiome. The relative amount of *Lactococcus, Enterohabdus,* and *Caulobacterales* was dramatically reduced in Pb-exposed people, whereas the *Desulfovibrionaceae, Barnesiella,* and *Clostridium* families were overrepresented in the gut microbiome. Treatments with Cd, Pb, Cu, and aluminum (Al) in mice resulted in a metal-specific and time-dependent decrease in the relative abundance of the species *Akkermansia muciniphila*. Following exposure to heavy metals, the gut microbiota undergoes digestion and biotransformation of amino acids, polysaccharides, and bile acids, resulting in the formation of toxic metabolites like cresol and indole. Significant alterations in the levels of these bacterial metabolites may be linked to slight compositional changes in the gut microbiota induced by heavy metals. Recent research has revealed a close association between changes in the composition and structure of the colonic microbiome and variations in the levels of various metabolic components. These include fatty acids, bile acids, amino acid derivatives, and compounds such as indoles, glucuronides, isoflavones, and carnitine conjugates, which exhibit noticeable changes following heavy metal exposure."

THE USE OF PROBIOTICS TO NEGATE THE ADVERSE IMPACT OF HEAVY METALS ON THE GUT MICROBIOME

What can be done to negate the dire scenario depicted above given that heavy metal exposure is not going away anytime soon? To answer this question, Dahiya et al expansively discuss the role of probiotics. First, consider the following:

"The use of gut microbes as probiotics holds great promise for the removal of heavy metal toxicity. In short, research conducted in Tanzania, for instance, pregnant women who consumed yogurt fortified with *Lactobacillus rhamnosus*, had reduced levels of arsenic and mercury in their blood."

Please note again that **ProBind Select™** contains *Lactobacillus rhamnosus.*

The next quote provides a fascinating discussion on how gut microflora function in a complementary manner along with other detoxification pathways:

"Heavy metals can be metabolized by the gut microbiota either immediately after consumption or after the liver has conjugated them with lipids.

GI microbiota has been linked to metabolism, demonstrating the capacity to metabolize heavy metals through a variety of chemical changes on medications. These metabolic processes encompass reduction, hydrolysis, succinate group removal, dihydroxylation, acetylation, deacetylation, N-oxide bond cleavage, proteolysis, denitration, deconjugation, thiazole ring opening, and deglycosylation. Acting as a secondary endocrine system, the host's gut microbiota plays a crucial role in regulating the immune system and secreting hormones to maintain normal biological function. Within the host, heavy metals undergo metabolism by the gut microbiota, with the chemical form of the heavy metals influencing their absorption, excretion, and tissue distribution, ultimately impacting their biological effects."

The next quote features specifics on the impact of gut microflora on arsenic:

"Studies demonstrated that human colonic bacteria may methylate arsenic in soils contaminated with the metal in a lab setting. Mice with natural gut microbiota expelled more arsenic in their stool and collected less of it in their organs, demonstrating the probable significance of the gut microbiota in regulating the toxicity of heavy metals."

Next, consider how specific probiotic organisms function in the gut to negate the adverse effects of heavy metals:

"The fundamental process of probiotic detoxification involves the adsorption of metal ions onto the cell wall followed by their accumulation with the bacteria via membrane transport. Previous studies suggest that certain *Lactobacillus* strains may enhance fecal excretion of heavy metals by facilitating intestinal metal sequestration and peristalsis, thereby reducing heavy metal uptake in the gut and reversing alterations in the intestinal microbiota induced by heavy metals."

Furthermore:

"Consequently, probiotic strains such as *Lactobacillus* and *Bifidobacterium* species possess more robust metal-binding capacities. Numerous studies have demonstrated that the lactic acid bacteria's cell wall's negative charge enhanced its capacity to bind metals."

In addition:

"The probiotic *Pediococcus pentosaceus* GS4 was found to reduce Cd excretion and restore *Lactobacillus* concentration in the gut microbiome, preventing Cd poisoning in mice. Additionally, *L. plantarum* CCFM8610 and *Bacillus cereus* were previously utilized against Cd toxicity."

Next, the authors provide some interesting comments on the development of probiotics specifically designed to reduce heavy metal toxicity:

"Some engineered probiotics show promise for heavy metal detoxification. Among the most effective microbial strains is *Akkermansia muciniphila*, known for its ability to enhance colon mucin production and improve gut barrier function. Studies in mice have demonstrated that *Lactobacillus plantarum* strains CCFM8610 and CCFM8661 can significantly enhance hepatic bile acid synthesis and fecal bile acid excretion, leading to increased biliary and fecal excretion of lead. This process aids in heavy metal excretion by regulating enterohepatic circulation."

Dahiya et al then comment on the ability of probiotics to sequester heavy metals:

"The potential of *Lactobacilli* to detoxify additional dietary poisons, as well as their capacity to minimize oxidative stressors brought on by metal toxicity in vitro, is significant. The resistance mechanisms a strain possesses determine how well it can bind and sequester metals. The primary mechanism of resistance against arsenic and mercury involves actively removing these toxic metals from the cytosol."

Exopolysaccharides produced by gut microflora.

The next section of the Dahiya et al paper discusses the little known products of probiotic metabolism termed "exopolysaccarides" (EPS). As you will see, these probiotic metabolites can

also play a powerful role in heavy metal detoxification. Consider the following:

"Exopolysaccharides (EPS) are extracellular (homo- or hetero-) polysaccharides that are secreted by many bacteria including probiotics."

What organisms produce EPS? Please note:

"The most widely recognized EPS-producing lactic acid bacteria include *Weissella* sp., *Pediococcus, Lactobacillus, Lactococcus, Bifidobacterium, Leuconostoc, Streptococcus, and Enterococcus."

How exactly does EPS function concerning heavy metals?

"EPS exhibits notable properties such as water binding and retention, along with impressive swelling and gelation abilities. Serving as a protective shield, EPS like xanthan, alginate, and cellulose promote the development of biofilms on bacterial cell surfaces. Recent studies have demonstrated that certain bacteria and their EPS possess significant potential in mitigating heavy metal exposure. They achieve this by delaying the absorption of these substances into bodily fluids and facilitating their excretion through feces."

Furthermore:

"Exopolysaccharides play a crucial role in the bacterial adsorption of heavy metals and may improve their removal ability by bacterial cells. Some *Lactobacilli* that produce EPS had greater tolerance for the ability to adsorb heavy metals than non-EPS-generating *Lactobacilli."*

CONCLUDING COMMENTS BY DAHIYA ET AL

In closing their outstanding, informative paper, Dahiya et al make the following key summation points:

"In the ever-evolving landscape of health and well-being, the 'Guardians of the Gut' have emerged as silent sentinels, protecting us from the lurking threat of heavy metal toxicity."

And lastly:

"The power of the gut, harnessed through probiotics, prebiotics, synbiotics, and exopolysaccharides, is a testament to the extraordinary resilience and adaptability of our bodies."

SOME FINAL THOUGHTS

As I mentioned in the August 2024 product newsletter, Moss Nutrition owes a great debt of gratitude to Dr. Joe Mather for not only introducing the critical need for Moss Nutrition to develop a binder product but for Dr. Mather's sage advice to make sure **ProBind Select™** contains key probiotic organisms in addition to the usual binders such as activated charcoal, bentonite clay, and chlorella. As Dahiya et al have convincingly demonstrated, when considering heavy metal detoxification, the probiotic components of **ProBind Select™** are every bit as important, if not more so, as the usual binders mentioned above.

ProBind Select™ 120 Vegetarian Capsules