

Effects & Benefits of Beta-Glucan



KEY POINTS

- ▶ Beta (1-3)/(1,6) Glucan (glucan) belongs to a group of physiologically active compounds called *biological response modifiers* and is found in the cell walls of yeast, mushrooms, and grains.
- ▶ Glucan is recognized by multiple specific receptors expressed on membranes of effector cells, such as macrophages, monocytes, dendritic cells, leukocytes, and NK cells.
- ▶ Activity of glucan has been demonstrated in every species tested, including dogs, cats, humans, fish, pigs, and chickens.¹
- ▶ Recent studies demonstrate glucan's significant immunomodulating effects in dogs.²⁻¹⁰ Research has focused on use with vaccine potentiation, IBD, OA, and atopy.^{2,4-8}

Overview

Glucans have the potential to play a significant role in the care of companion animals. They are cost effective, possess very low risk for negative side effects, and offer considerable promise for protection against and potential management of multiple conditions.¹

Definition

Beta (1/3)/(1,6) Glucan (glucan) belongs to a group of physiologically active compounds called *biological response modifiers* and is found in the cell walls of yeast, mushrooms, and grains. It is important, whatever the source, that the glucan undergoes a controlled extraction process to ensure quality of the ingredient.

Immunomodulators are substances capable of interacting with the immune system resulting in up- or downregulation of specific immune responses. Immunomodulators represent diverse synthetic, natural, and recombinant molecules, and some are already used in veterinary medicine. Included in these natural molecules are curcumin, resveratrol, ginseng, and *Echinacea* spp; however, limited scientific studies exist for effects of these molecules. Direct comparisons of individual immunomodulators, if available, are limited, but glucan has consistently shown the best immunomodulatory effects¹¹ in more than 20 000 published studies.

Mechanisms of Action

Glucan is recognized by multiple specific receptors expressed on membranes of effector cells (eg, macrophages, monocytes, dendritic cells, leukocytes, NK cells). In one series of studies, glucans had pleiotropic effects on various facets of the immune system including cytokine production¹² and antibody response.¹³

Original glucan studies focused on its effects on the immune system of mice, but subsequent studies have shown glucan's strong immunomodulatory effects in multiple other species, including earthworms, bees, shrimp, fish, chickens, rats, rabbits, guinea pigs, dogs, sheep, pigs, goats, cows, monkeys, and humans.¹ The well established biological effects of glucans, shown in several species, range from reduced stress and cholesterol to immune stimulation and to potentiated cancer defense.¹⁴ The mechanisms of stress and cholesterol effects may be the result of the physicochemical properties of glucans, including antioxidant effects involved in the scavenging of reactive oxygen species, as well as their role as dietary fiber.

Administration of glucan with vaccines increased both cellular and humoral immune responses.

Much attention has been focused on glucan's effects on various animals—including companion and food animals. Glucan-supplemented feed was found to improve growth and overall health in pigs¹⁵; glucan in chicken feed showed significant immunomodulating effects and natural growth stimulation¹⁶; and glucan-enriched food has been successfully used in aquaculture for decades.¹⁷

Glucan & Companion Animals

In one study, glucan helped dogs with acute radiation sickness.³ In another study, glucan increased efficacy of canine parvovirus and rabies vaccines in puppies⁴; similar results were achieved when glucan was used with DHLPP vaccine in dogs 6 to 12 months of age. In all cases, administration of glucan with vaccines increased both cellular and humoral immune responses.⁵ Glucan was also evaluated in dogs with inflammatory bowel disease (IBD); its dietary addition resulted in significant histopathologic and immunologic improvements. Glucan supplementation offered the highest level of treatment efficacy by producing the quickest therapeutic effect, lowering the canine IBD activity index (CIBDAI) values to below 3 (ie, clinically insignificant disease), improving histopathologic parameters, decreasing IL-6 levels, increasing IL-10 concentrations, and producing remission periods longer than six months.⁶

Recent research measured changes in phagocytosis, IL-2 levels in blood, antibody formation, and blood glucose levels to demonstrate glucan's significant immunomodulating effects

in dogs; findings indicated feed supplementation with these glucans can result in biological and immunological improvements.² Among other effects, beta-glucan supplementation decreased blood glucose levels in dogs with hyperglycemia but had no effect on blood glucose levels in normoglycemic dogs. Beta-glucan also increased white blood cell phagocytosis. Subsequent studies found that a 3-week daily oral glucan supplementation (either 15 or 25 mg/kg/day, based on different purities of the glucan material) strongly potentiated production of IL-2 and proliferation of T cells, showing the pleiotropic effects of glucan reaching all facets of immune defense reactions. Immunogenic capacity of glucans clearly lies in their molecular structure, which enables them to be recognized as pathogen-associated molecular patterns (PAMPs) by immune cell receptors on neutrophils, macrophages, and dendritic cells. These interactions trigger intracellular signaling activation with subsequent expression of immune molecular factors regulating non-specific natural and specific adaptive immune responses.

Additional studies reported improvement of clinical signs in dogs suffering from osteoarthritis and atopy.^{7,8} Improvements in diabetic dogs and dogs recovering after surgery have also been reported, showing improved defense reactions, reduced C-reactive protein levels, anti-inflammatory effects, and faster recovery of leukocyte levels.^{9,10}

Research in cats with periodontal disease showed administration of glucan lowered systemic expression of the inflammatory mediators NF-kappaB and IL-1beta and decreased alveolar bone loss.¹⁸ Research in horses has also evaluated effects of glucan supplementation. One study found glucan modulated the immune suppression caused by glucocorticoid administration.¹⁹ Another showed that IM glucan administration prior to parturition in pregnant mares stimulated innate immunity in their foals.²⁰

Glucan & Humans

In addition to its use as a food supplement, glucan is the subject of more than 100 current clinical trials in humans. Specific research has focused on children with chronic respiratory diseases. A series of clinical, placebo-driven

DEFINITION

- ▶ PAMPs: Pathogen-associated molecular patterns. These are molecules essential for the survival of groups of related microbes and are not found associated with mammalian cells.*

*From Kaiser G. Pathogen-associated molecular patterns (PAMPs) and danger-associated molecular patterns (DAMPs). [https://bio.libretexts.org/TextMaps/Microbiology/Book%3A_Microbiology_\(Kaiser\)/Unit_5%3A_Innate_Immunity/11.4%3A_Early_Induced_Innate_Immunity/11.3A%3A_Pathogen-Associated_Molecular_Patterns_\(PAMPs\)_and_Danger-Associated_Molecular_Patterns_\(DAMPs\)](https://bio.libretexts.org/TextMaps/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_5%3A_Innate_Immunity/11.4%3A_Early_Induced_Innate_Immunity/11.3A%3A_Pathogen-Associated_Molecular_Patterns_(PAMPs)_and_Danger-Associated_Molecular_Patterns_(DAMPs)). Accessed 10 August 2018.

trials examined the effect of short-term glucan supplementation on immune parameters in children with chronic respiratory problems. Results showed that short-term supplementation improved levels of salivary IgM, IgG, and IgA²¹; decreased exhaled nitrous oxide (eNO) levels; and improved physical endurance.²² Improved eNO levels were suggestive of improved pulmonary functions.

There is increasing attention on glucan supplementation and possible regulation of metabolism, obesity, and metabolic syndrome. Adding glucan to food may help prevent or treat metabolic syndrome and decrease insulin resistance, dyslipidemia, hypertension, and obesity.²³ Studies of diabetic retinopathy patients showed that dietary supplementation with glucan and vitamin D can offer a simple, safe, and cost-effective way of increasing leptin levels. In combination with current suggestions of

leptin for treatment of diabetic retinopathy, glucan use might begin a new future for human medicine.^{24,25}

How to Use

The daily oral dose for dogs is approximately 25 mg/50 lb. Glucan is apparently nontoxic and has no known adverse effects.¹ Contraindications for glucan are limited to patients receiving immunosuppressive therapy or those recovering from transplantation. Stimulating or modulating the immune system should be avoided at this time to avoid counteracting the desired immunosuppression.

Conclusion

The positive effects of glucan in a variety of diseases—including infections, arthritis, diabetes, immunosuppression, and neoplastic growth—have been investigated and provide support for glucan's increased prominence as an effective therapeutic immunomodulator.

Adding glucan to food may help prevent or treat metabolic syndrome and decrease insulin resistance, dyslipidemia, hypertension, and obesity.²³

IMUQUIN™ from Nutramax Laboratories Veterinary Sciences, Inc. contains glucan (yeast extract), the omega-3 fatty acids eicosapentaenoic acid and docosahexaenoic acid, and a mix of vitamins and minerals. The glucan has been evaluated in the author's laboratory and was shown to increase T-cell proliferation in dogs. Imuquin was also evaluated in dogs, as was glucan in horses. Results in dogs found modulation of the immune system with significant effects on IL-2, IL-6, and IgA. A similar trend was seen in horses for IL-2 and IL-6, although effects did not reach significance. These results may explain the clinical results seen in IBD, OA, and atopy.

Imuquin is available in 3 powder formulations: one for puppies up to 6 months of age, one for dogs 6 months and older, and one for cats.



BEST USES OF GLUCAN

SUPPORTED BY RESEARCH IN COMPANION ANIMALS

- ▶ Potentiation of vaccine response
- ▶ Inflammatory conditions:
 - Inflammatory bowel disease
 - Atopy
 - Osteoarthritis
 - Periodontal disease
- ▶ Stimulation of innate immunity in neonates

POTENTIAL

- ▶ Compromised immune system:
 - Recurrent/chronic infections (eg, skin, respiratory)*
 - Demodex* spp and other external or intestinal parasites
 - Failure to thrive
 - Abuse, neglect
 - Immunosenescence
 - Undergoing chemotherapy*

*Supported by studies in other species and/or in vitro research

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