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Beta-glucans in dog food

Beta-glucans are water-soluble plant fibers, comprising chains of up to 2000 glucose units in so-called beta form. Glucose is a simple sugar, existing in solution as mixture of alpha and beta rings. The glucose building blocks of beta-glucans are joined by one of three linkage types. Beta-glucan constructions can differ as to linkage pattern, spatial structure and functionality. Cellulose is a water-insoluble beta-glucan with only one linkage type; this plant fiber is not discussed here.

Corn, rice, barley, wheat and oat contain different amounts of similarly linked beta-glucans. Another type of beta-glucans is found in baker's yeast. The five cereal grains and yeast are commonly used as petfood ingredient. Dog-food labels rarely highlight the beta-glucans in whole cereals and yeast. In contrast, added concentrates of beta-glucans, isolated from the outer layer of baker's yeast, are reputed to strengthen dog's immune system.

Free beta-glucans are recognized by immune cells in the intestinal wall. As a result, certain specialized cells may more efficiently capture and disarm harmful bacteria and viruses, while others produce more offensive antibodies. Such immunostimulation has been shown in dogs challenged with foreign substances (antigens), while ingesting purified beta-glucans derived from yeast or oyster mushroom. The amount ingested was equivalent to 0.08 % in dry food. Similar diet intervention also relieved symptoms in dogs with inflammation in joints, skin or bowel.

In dogs, food with added, purified beta-glucans can stimulate the immune response elicited by antigens. The risk, if any, of overstimulation is unknown. There is no evidence that extra intake of beta-glucans, as purified additives, prevents development of diseases in dogs. Nevertheless, beta-glucans did ameliorate inflammatory diseases.

Sources and chemistry

Beta-glucans in the aleurone layer of cereal grains have linear, bended structures. Their cellulose-like fragments, generally consisting of three or four of glucose units with β-(1, 4) bonds, are interrupted by a single β-(1, 3) linkage. Beta-glucans from yeast (Saccharomyces cerevisiae) comprise β-(1, 3)-linked glucose residues with small numbers of β-(1, 6)-linked branches.

The approximate levels of total beta-glucans in cereal grains are as follows: corn, 1.0%; rice, 0.7%; barley, 3.8%; wheat, 0.8%; oat, 3.7% (1-5). Dried spent brewer's yeast has about 11% total beta-glucans (6-9). Yeast preparations marketed as immune stimulator contain some 60% beta-1,3/1,6-glucans (6, 10). Dry food with 50% of a grain species holds 0.35 to 1.9% cereal beta-glucans. Food with 1% dried brewer's yeast or a derivative, contains 0.1 or 0.6% yeast beta-glucans.

Macronutrient digestibility

Beta-glucans are resistant to the dogs' digestive enzymes, but are degraded by the colonic bacteria. Barley beta-glucans were moderately fermented by dog fecal microflora (11, 12). High intakes of beta-glucans may raise ileal digesta viscosity, thereby impairing digestion. In dogs dosed with oat-derived beta-glucans at a rate of 1% of the dry food offered, apparent digestibility of dry matter was reduced by 4.6 %units, while fecal mass grew larger and loosened up (13).

In dogs, apparent digestion of protein in dehulled barley was 3.5 %units lower than that for wheat (14, 15). Replacement of 35% wheat in dry food by barley decreased protein digestibility by 7 %units and made stools more loose and moist. The effects were partly counteracted by spraying a mixture of beta-glucanase, xylanase and amylase onto the diet (16). Clearly, the diet contrasts in the digestibility trials (14-16) involved more than barley beta-glucans only.

Immunomodulatory concept

Various intestinal, innate immune cells have so-called pattern recognition receptors (PRRs) that may bind diet-derived beta-glucans, just as they do with beta-1,3-glucans in cell walls of certain pathogenic yeasts, fungi and bacteria. Receptor binding signals phagocytosis and pathogen degradation by the leukocytes of the innate immune system. Leukocytes also release cytokines and antigens that stimulate antibody production by the adaptive immune system. The altered cytokine profile may protect against inflammation.

Dietary beta-glucans act as immunomodulator only if quantity and structure are effective on their arrival at the intestinal, innate immune cells. Beta-glucans of higher purity are active, unlike beta-glucans embedded in (partially digested) food ingredients. PPRs are highly specific for pure β-(1,3) backbone structures (17).

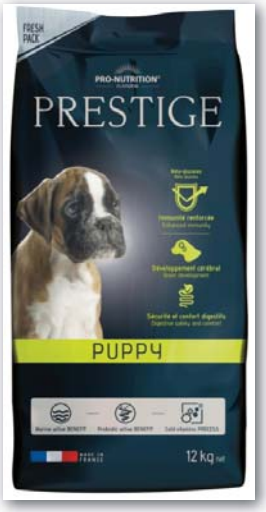
Immune indicators

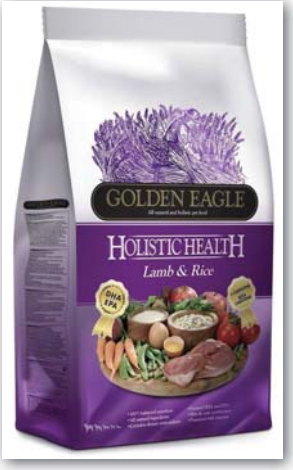
Oral administration of purified beta-glucans from yeast or oyster mushroom enhanced antigen-induced immune responses. Dogs were injected with ovalbumin (10, 18) or vaccinated against rabies plus parvovirus (19-21) and bordetella (22). In-vitro phagocytosis, as index of the innate immune system, was quantified as leukocyte percentages with internalized polystyrene beads. Serum levels of specific antibodies against the antigens served as measure of the adaptive immune system.

The equivalent of 0.08% purified beta-glucans in dry food stimulated phagocytosis by 43% and induced a 3.36-fold increase in specific antibodies. These mean effects concern 3 to 10 weeks post-antigen injection and four studies (10, 18-22).

Inflammatory diseases

In double-blinded, placebo-controlled





trials, lasting 8 weeks, dogs with osteoarthritis (n = 23/group) or atopic dermatitis (n = 15 or 16) received dry food without or with 0.08% of a purified yeast beta-glucan preparation (23, 24). Beta-glucan treatment improved owner-assessed severity scores of arthritis and atopy by 79 and 63%. In dogs (n = 7) with inflammatory bowel disease, feeding dry food without or with 0.05% purified yeast beta-glucan for six weeks changed the clinical index (scale 0-18) from 5.8 to 7.1 or 6.0 to 0.9 (25). Reproducibility is unknown for each trial.

List of references is available on request from the author (beynen@freeler.nl)

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