Review Article

Benefits for Post Prandial Glucose, Lipid Metabolism, and Immune Modulation: A Mini-Review on Barley Beta-Glucan

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ABSTRACT

Beta-glucan in barley has been reported as the key ingredient that promotes beneficial health effects. These benefits may extend to as far as lowering cholesterol, modulating the immune system, and preventing cancer. The goal of this mini-review is to perform an analysis of available literature and determine the mechanism of action of high molecular weight barley and roasted barley in addressing the above listed disease states. The review has implications for health educators, public health professionals, nutritionists, alternative health practitioners, and the research community involved in food science. It serves as a base to build upon for seeking further solutions.

Key Words: Barley beta glucan, Immune modulation, Lipid metabolism, Post prandial glucose, High molecular weight barley, Nutrition, Public health, Cancer prevention, Roasted barley, Disease prevention, Chronic disease, Alternative healing, Food science

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INTRODUCTION

Beta-glucan is a water-soluble dietary fiber found in barley. Many more foods such as mushrooms and oats also contain beta-glucan. It is a water-soluble polysaccharide with linked units of glucose. The structure of beta-glucan differs according to the source from which it is obtained and determines its water solubility. Insoluble beta-glucan has a high degree of polymerization and beta linkages.

Barley has high molecular weight beta-glucan, and generates viscosity in the gastrointestinal tract, producing a cholesterol-lowering effect [1]. Roasting puffs the barley grain, which absorbs more water and has higher solubility in water. Experimental evidence indicates that roasting decreases the total beta-glucan and increases the insoluble beta-glucan [2]. This has beneficial effects such as lowering LDL serum cholesterol, influencing postprandial glucose metabolism, and boosting immunity as explained below.

HIGH MOLECULAR WEIGHT BETA-GLUCAN CONTRIBUTES TOWARDS BETTER CHOLESTEROL CONTROL AND BETTER CARDIOVASCULAR OUTCOMES

The insolubility of beta-glucan allows its interaction with water and between glucan molecules. Its water solubility and molecular weight are relevant to hypercholesterolemia. According to scientific literature, the viscosity of beta-glucan (which is related to molecular weight, molecular structure, and solubility) is responsible for its cholesterol-lowering effect [3]. Beta-glucan with high solubility and high molecular weight can reduce serum cholesterol better than its counterpart with low solubility and low molecular weight. An explanation is that higher beta-glucan viscosity reduces bile acid reabsorption, higher bile acid excretion, enhances bile acid synthesis from cholesterol, increases cholesterol uptake, and reduces LDL serum cholesterol.

Wang and team studied possible cholesterol-lowering mechanisms in detail to identify whether the underlying process was cholesterol synthesis, cholesterol absorption, or bile acid synthesis [4]. The participants included in the study had mild hypercholesterolemia and consumed High Molecular Weight (HMW) and Low Molecular Weight (LMW) barley beta-glucan as part of their diet. Participants in the control group consumed LMW beta-glucan. In this controlled cross-over study, they found that bile acid synthesis increased after consuming high-molecular-weight barley beta-glucan [4].

Researchers also found the impact of a specific gene variation that may have influenced the cholesterol-lowering effect [4]. Individuals with the CYP7A1 gene involved in cholesterol metabolism showed a greater response to HMW barley beta-glucan when they had a single nucleotide polymorphism in the gene (G allele in the SNP rs3808607). Greater gene expression was linked to the G-allele when compared to its counterpart, the T-allele. Researchers explained that this could be due to increased transcriptional activity, which in turn, increased bile acid synthesis.

Researchers also tested whether roasted barley flour improved lipid metabolism and fermentation of beta-glucan in the gut. The molecular weight of roasted barley flour decreased by 16% to 49%, but there was no change in the beta-glucan content. Roasted barley also contained a higher level of resistant starch and damage starch. Scientists confirmed that the roasting process decreased the molecular weight of barley [5]. However, lipid metabolism may have been affected by the presence of short-chain fatty acids, which produced a prebiotic effect.

Aoe, et al, also investigated the effect of Low Molecular Weight (LMW) barley on lipid metabolism and a few other parameters [6]. They compared these values with High Molecular Weight (HMW) barley. They explored the absorption of fat, biomarkers in the serum, and the genes involved in the metabolism of lipids and glucose. After analysis of the different parameters, scientists found that there was a reduction in serum leptin levels and the total LDL cholesterol concentration [6]. They also observed mRNA expression of *SREBP-1c* (sterol regulatory element-binding protein 1c). They concluded that LMW beta-glucan affected lipid and glucose metabolism on account of a prebiotic effect. This prebiotic effect may promote the gut immune system and protect the pro-inflammation of the organs. The other effects could be attributed to the viscosity of HMW barley beta-glucan in the digestive tract.

Wang, et al. identified that high molecular weight beta-glucan alters gut microbiota composition and reduces cardiovascular disease markers [4]. Given the detrimental effects of gut microbiota in the manifestation of obesity, cardiovascular disease, diabetes, and metabolic disorders, manipulating the gut microbiota could also be the answer to the prevention and treatment of metabolic disorders. The research study indicated that gut microbiota modification depended on the molecular weight of barley beta-glucan. Scientists identified that the consumption of higher molecular weight beta-glucan increases the viscosity of food undergoing digestion in the gastrointestinal tract to slow down the process of digestion. Slow digestion exposes fermentable compounds to the microbes in the stomach for a longer period, altering the gut

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microbiota. These changes in the microbiota are linked to improved cardiovascular outcomes [7].

HIGHER BETA-GLUCAN VISCOSITY AND BETTER POST-PRANDIAL GLUCOSE METABOLISM

Since the viscosity of beta-glucan is dependent on its concentration consumed and molecular weight, the glycemic response is related to these parameters. Viscosity also affects postprandial glucose metabolism. The processing and conversion of beta-glucan into food products influences its extractability, molecular weight, and viscosity. Fiber consumption is widely known to prevent chronic cardio metabolic disease. Beta-glucan has also been found to be most effective in preventing cardiovascular disease and Type II diabetes due to improvement in long-term blood cholesterol levels and lowering of the postprandial glucose response.

Beta-glucan has high viscosity. After a specific concentration, there is an exponential increase in viscosity as molecular weight varies. Higher concentrations cause a greater increase in viscosity. Researchers believe that the presence of aggregate particles or molecular associations modifies molecular entanglements. The viscosity of beta-glucans results in a slow rate of gastric emptying and causes a delay in the delivery of chyme to the intestine. Beta-glucan found in cereals including barley, are resistant to digestion, remain in the intestine, and increase the viscosity of the alimentary bolus. This causes a delay in the digestion and absorption of carbohydrates, due to the thick layer around the food bolus that restricts access to intestinal enzymes. Other factors that slow down carbohydrate absorption are decreased mixing of luminal content and reduced glucose transport to the absorption surface. When the bloodstream receives lower glucose at a slow pace, insulin concentrations are adjusted accordingly. This reduced insulin concentration is dependent on the dose of beta-glucan as well as its extractability and molecular weight.

Processing beta-glucan in the cooking process affects its sensory and physiological properties. Both molecular weight and extractability are influenced due to structural changes in the form of polymer size and the amount of polymer released from the food matrix respectively. Cooking increases extractability and reduces large molecular weight [8]. Beta-glucan with high molecular weight has often been found to affect postprandial glucose.

HIGH MOLECULAR WEIGHT WITH LOW CONCENTRATION HAS AN IMPACT ON IMMUNITY AND CANCER

Furthermore, beta-glucan with high molecular weight and low concentration forms viscous solutions, and one with low molecular weight forms a soft gel. Beta-glucan in the small intestine is trapped by macrophage receptors in the intestinal wall. The glucan molecule is activated by glucan receptors and generates oxides, reactive oxygen radicals, lysozyme, and bactericidal compounds. Subsequently, the surrounding cells release cytokines to activate leukocytes and phagocytes, leading to immunity [3].

Murphy and Carmichael investigated the ability of beta-glucan as a protective agent against infections and cancer [9]. They stated that beta-glucan has an immune-modulating effect as it can bind to the pattern recognition receptors such as scavenger receptors, complement receptor 3, dectin-1, and lactosylceramide. This process leads to the activation of different parts of the immune system. The immune-modulatory effects of beta-glucan may also be involved in protecting against cancer [9].

DISCUSSION

Beta-glucans are known to modulate both the innate and adaptive responses of the immune system [10]. They also enhance non-opsonic and opsonic phagocytosis. The effect of beta-glucans on the immune system is a complex process. Animal studies demonstrated that when administered orally, certain parts of the beta-glucan remain undigested (beta glycosidic chain). The beta-glucans enter the proximal small intestine and some parts are captured by macrophages. Here, they are fragmented in the cell, and the macrophages transport them to the endothelial reticular system and the marrow. When these beta-glucan fragments are released by the macrophages, the other immune system cells take them up, and several types of immune responses occur. The immune potency of beta-glucans depends on their branching patterns and size.

In animal studies, immune modulation was observed in terms of cellular and humoral immune responses. In human studies, beta-glucan can eliminate infectious agents by triggering the production of pro-inflammatory factors and phagocytosis. The activation of several signaling pathways often leads to the release of cytokines including InterLeukin-10 (IL-10), InterLeukin-12 (IL-12), InterLeukin-6 (IL-6), and Tumor Necrosis Factor-alpha (TNF - alpha) [10].

Beta-glucans also have several anti-cancer effects. They are involved in activating cellular immune function and macrophages [11]. They assist in infection control against fungi, parasites, and bacteria. Clinical trials have also recorded the antitumor activity of the beta-glucans. Furthermore, beta-glucans also have a significant effect on the antibodies that occur in cancer naturally. Finally, beta-glucans are used in adjunct therapy, and positively affect the quality of life of patients and their survival.

CONCLUSION

The High Molecular Weight (HMW) beta-glucan in barley produces its characteristic viscosity in the gut. When roasted, the insoluble beta-glucan in barley grains increases, and molecular weight decreases, leading to beneficial effects. Viscosity is related to molecular weight and solubility. HMW beta-x glucan reduces LDL serum cholesterol due to increased bile acid synthesis. Moreover, certain gene variations may have participated in an improved response to HMW barley, further contributing to bile acid synthesis. Even though the prebiotic effects of short-chain fatty acids may have contributed towards lipid metabolism, the viscosity of the beta-glucan was a potential underlying factor in this context. Further, HMW beta-glucan was observed to reduce cardiovascular disease markers. HMW barley also modified gut microbiota with an increase in viscosity and slow digestion, all leading to better cardiovascular outcomes.

Viscosity was also observed to influence post-prandial glucose metabolism due to slow rate of gastric emptying and lower glucose in the bloodstream, leading to adjustment in insulin concentration. Furthermore, beta glucan was observed to have a protective effect on cancer and infection by way of immune modulation. These studies indicate the beneficial effects of barley beta glucan, through an emphasis on its high molecular weight, and the structural changes induced by roasting barley i.e. increase in insoluble beta glucan and a reduction in molecular weight. It is worthwhile to understand these mechanisms in greater depth through high quality randomized clinical trials to determine the potential of roasted barley in the prevention and reversal of metabolic disease, cardiovascular disease, and cancer.

REFERENCES

1. Wilson TA, Nicolosi RJ, Delaney B, et al. Reduced and high molecular weight barley β-glucans decrease plasma total and non-HDL-cholesterol in hypercholesterolemic Syrian golden hamsters. J Nutrition. 2004;134(10):2617-2622.
2. Sharma P, Gujral HS, Rosell CM. Effects of roasting on barley β-glucan, thermal, textural and pasting properties. J Cereal Sci. 2011;53(1):25-30.
3. Mudgil D. Beta-Glucan. 2021.

4. Wang Y, Harding SV, Thandapilly SJ, et al. Barley β-glucan reduces blood cholesterol levels via interrupting bile acid metabolism. Brit J Nutrition. 2017;118(10):822-829.

5. Mio K, Yamanaka C, Kohyama N, et al. Effect of roasted barley flour on lipid metabolism and gut fermentation in mice fed high-fat diets. J Cereal Sci. 2021;102:103351.

6. Aoe S, Mio K, Yamanaka C, et al. Low molecular weight barley β-glucan affects glucose and lipid metabolism by prebiotic effects. Nutrients. 2020;13(1):130.

7. Lozano G, Trenado HP, Fiallo-Olivé E, et al. Characterization of non-coding DNA satellites associated with sweepoviruses (genus Begomovirus, Geminiviridae) definition of a distinct class of begomovirus-associated satellites. Frontiers Micro Bio. 2016;7:162.

8. Henrion M, Francey C, Lê KA, et al. Cereal B-glucans: The impact of processing and how it affects physiological responses. Nutrients. 2019;11(8):1729.

9. Murphy EA, Davis JM, Carmichael MD. Immune modulating effects of β-glucan. Clin Nutri Metabolic Care. 2010;13(6):656-661.

10. Chan GC, Chan WK, Sze DM. The effects of β-glucan on human immune and cancer cells. J hematol oncol. 2009;2(1):1-1.

11. Benlier N, Sayin S, Cetin Z, et al. Dietary Fibers/Beta-glucan and cancer. Food Bioactive Ingredients, 2021;569–590.