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Nutrition Discussion Forum

Response to Wood and Tosh

Both Wood and Tosh and the editorial that accompanied the original paper[1] raise important issues regarding the characteristics of soluble fibres that affect their efficacy in reducing cholesterol and CVD risk. The potential factors that may influence lipid-lowering effects of soluble fibre include the physico-chemical characteristics of the fibre *per se* (i.e. molecular weight, viscosity, fermentability, binding capacity, dispersability in water) and external factors (e.g. concentration, interaction with other meal components in the digesta, fibre extraction processes, cooking and storage effects). Wood and Tosh note that papers reporting clinical trials with various soluble or viscous fibres rarely include in the methods section or references relevant information about the measurements of the viscoelastic characteristics or molecular weight of the fibre. We agree completely with their recommendation that journals should request this information from authors to help understand possible mechanisms of action and make meaningful comparisons between interventions. This is especially the case when the fibre is extracted or modified from its natural or whole-food state.

We are pleased to share this information regarding the extracted barley β-glucan (BBG) used in the clinical trial that we reported in the June issue of the *BJN*[2]. The process of extraction and modification of molecular weight is described in some detail in a paper reporting a trial of this same fibre in hypercholesterolaemic hamsters[3] and in more detail in a US Patent Application[4]. The extraction process involves hydrating flour from a waxy hulless cultivar of barley and exposing it to high temperature α-amylase to eliminate starches. The residual is centrifuged to remove solids and the remaining liquid is treated with ethyl alcohol to precipitate or flocculate out the BBG. This is then dried and yields a product that is 70 % native or high molecular weight (HMW) BBG. To get the low molecular weight (LMW) product, low temperature β-glucanases are added to the hydrolysed flour with the high temperature α-amylase. The hydrolysis is conducted in a two-staged temperature process, where the first stage is conducted at approximately 65°C and the second stage is run at 95–105°C. Glucanase enzymatic activity can be controlled by raising the temperature of the bath which inactivates the glucanase above 70–75°C. Cargill scientists have developed an extraction process that consistently yields a 70 % concentration of HMW or LMW BBG.

Cargill scientists have used viscosity and molecular weight methods to characterize the fibre materials. Viscosity is measured using Rapid Viscosity Analysis, and Fig. 1 shows the comparative viscosities of 1 % solutions of HMW and LMW BBG and 1 % and 1·3 % Guar. Molecular weight is measured using size-exclusion chromatography coupled with multi-angle laser light scattering and refractive index detectors. Fig. 2 shows the molecular weight distribution of HMW and LMW BBG with the peak HMW at about 1000 kDa and the peak LMW at 175 kDa.

As is evident from the viscosity analysis, lowering the molecular weight substantially reduces the viscosity of LMW BBG. When the probe rotation is dropped from 960 to 160 rpm and the temperature is gradually lowered, the Guar (1 and 1·3 %) and HMW show increasing viscosity and gelling characteristics (centepoise rises from about 220 to 1290 for HMW), whereas the LMW BBG is even less viscous (centepoise drops from 77 to 50). In our study the LMW BBG appeared essentially as effective as HMW in reducing LDL (5 g HMW $= -17$ %, 5 g LMW $= -15$ %, 3 g HMW $= -10$ % and 3 g LMW $= -9{\cdot}5$ %), despite the lower viscosity. As Wood and Tosh suggest, this calls into question the importance of viscosity in the lipid-lowering effect of soluble fibres. Both animal and human studies indicate that at least one mechanism of cholesterol reduction is increased fecal elimination of dietary and biliary cholesterol and bile acids[3,5], but the assumption that that is due to the viscous properties of the fibre may need to be further examined.

Wood and Tosh inquired as to how the dose of BBG fibre was determined for the clinical trial. The goal for the study was to test doses of HMW and LMW BBG that would have efficacy in lipid lowering, yet could still be practically incorporated into a food or beverage with good palatability. Dosing and meta-analysis studies using whole-grain foods suggested that at least 2 g/d is needed to expect an effect on LDL cholesterol and more than 4–6 g/d increase side-effects and palatability problems without much added efficacy[6,7]. There was considerable pre-study experimentation with candidate vehicle foods and beverages and it was especially difficult to get 5 g HMW BBG in a palatable form. Lowering the molecular weight of the BBG greatly improved the food performance of the fibre and allowed greater flexibility in food and beverage use without compromising palatability. As Wood and Tosh note, the ability to lower viscosity without loss of efficacy has important implications for the development of functional foods that incorporate soluble fibres.

Joseph Keenan
Department of Family Medicine
University of Minnesota
Minneapolis, Minnesota, 55455, USA
keena001@umn.edu

Richard Hess
Principal Engineer, Barliv Project
Cargill Inc.
Minnetonka, Minnesota, 55331, USA
Richard_Hess@Cargill.com

Lore Kolberg
Regulatory and Scientific Affairs Manager Barliv Project

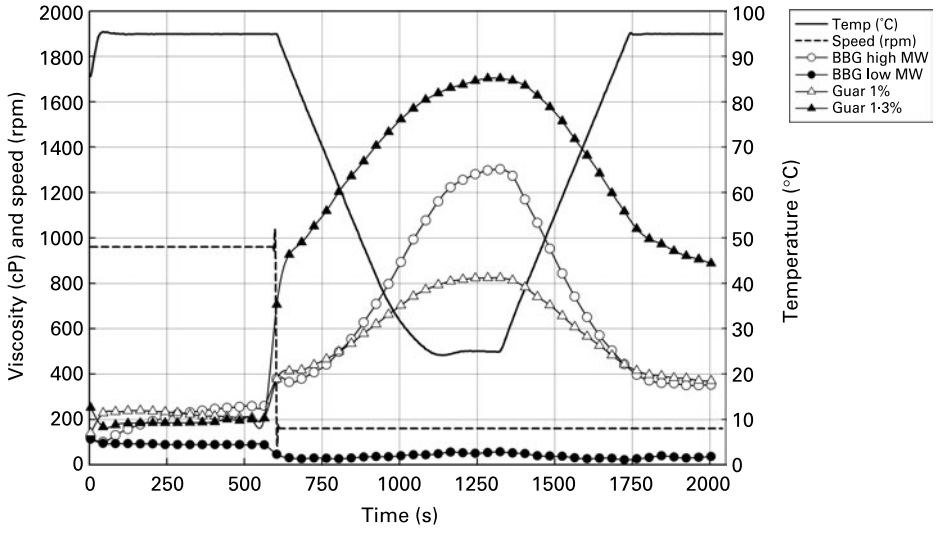

Fig. 1. Comparison of viscosities of Cargill high molecular weight (HMW) and low molecular weight (LMW) products against Guar gum. All samples were run at 1 % by weight of the fibre in water, unless otherwise noted.

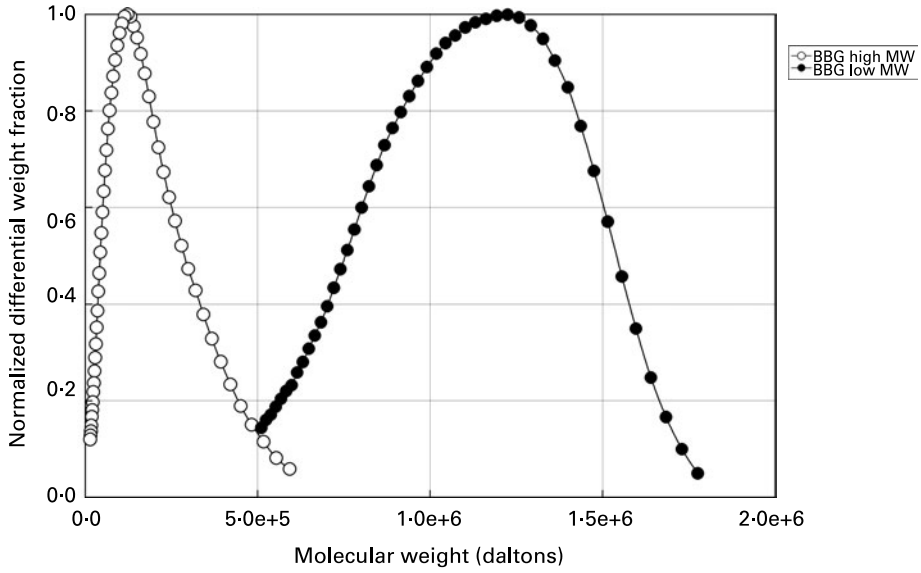

Fig. 2. Normalized differential weight fraction response of the clinical materials.

Cargill Inc.
Minnetonka, Minnesota, 55331, USA
Lore_Kolberg@Cargill.com

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