National Research Programme NRP 69
Healthy Nutrition and Sustainable Food Prodution

Beta-glucan processing for improved molecular interactions

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Understanding the effects of food processing on beta-glucan

Oats and barley contain beta-glucan, a dietary fibre that helps to reduce cholesterol and to control blood sugar. However, the methods used in food processing may alter cereal beta-glucan and reduce its beneficial health effects. As part of NRP 69, a team of researchers at ETH Zurich analysed the chemical properties of beta-glucan. Their results show the effects of food processing on specific molecular interactions involving beta-glucan.

Foods fortified with cereal beta-glucan are entering the market with ever-greater frequency. These products are believed to be of benefit to individuals suffering from diabetes, cardiovascular disease and obesity. In particular, beta-glucan helps to reduce cholesterol and blood sugar levels. By interacting with the local environment and increasing viscosity in the intestine, this dietary fibre slows the movement of bile acids and sugars towards the intestinal wall, and decreases their absorption by the organism. But food-processing methods such as high-temperature cooking may alter beta-glucan molecules and, consequently, their beneficial effects on health. As part of NRP 69, researchers at ETH Zurich analysed the chemical properties of cereal beta-glucan that had been modified in specific ways, as well as its interactions with other molecules present in food and in the gastro-intestinal tract. Their goal was to understand the effects of food processing on the chemical structure and molecular interactions of beta glucan.

The researchers first subjected beta-glucan extracted from oat and barley flour to various processes in order to modify the structure of the substance in a controlled manner. The modifications included oxidation of the fibre, which occurs during cooking or in the presence of specific chemical components. The researchers characterised the properties of the modified fibres, including molecular weight, viscosity and the chemical structure of modified beta-glucan. These different samples were used to observe the interactions of modified beta-glucan, described below.

Interactions with bile acids

One of the questions the group wished to explore was the nature of the interaction between beta-glucan and bile acids, because of its cholesterol-reducing effect. During digestion, the human organism reabsorbs most of the bile acid secreted by the intestine. But when bound to beta-glucan, bile acids are excreted instead of being

Food processing may alter the chemical structure of cereal beta-glucan and influence its beneficial health effects. The researchers analysed, among others, grain milling processes: the finer and more homogeneous the flour, the easier it was to extract beta-glucan. Image: production of flour in a mill.

absorbed. This mechanism forces the body to make bile acids by tapping into cholesterol. The researchers observed how modified beta-glucan interacts with bile acids. Their in vitro experiments disprove a hypothesis reported in the literature, according to which oxidation or degradation of the fibre increases the bile-acid binding capacity of beta-glucan. Rather, modification of beta-glucan appears to have neither a positive nor a negative effect on the molecular interaction.

Greater bioavailability of iron

A second set of experiments involved the interaction of beta-glucan and iron. Overly strong binding of beta-glucan to iron has the undesirable effect of impairing iron absorption by the organism. The group's analyses shed light on the role of phytic acid, a molecule that is present in cereals. It appeared that native beta-glucan did not directly bind iron, but that the phytic acid contained in the beta-glucan extract was preventing absorption of iron. The experiments showed that certain types of oxidation of beta-glucan affected the equilibrium between this fibre, phytic acid and iron, increasing the amount of available iron. Oxidation of the dietary fibre may thus improve the bioavailability of iron in foods fortified with beta-glucan. The removal of phytic acid was only successful in freeing iron when the contents of minerals that complex phytic acid were reduced first, which has major implications when attempting to increase iron bioavailability through phytase treatments in beta-glucan containing food products.

Further information:
www.nrp69.ch

Effects of processing on flour

Milling grain into flour may affect the structure of beta-glucan. Accordingly, the researchers sought to determine which milling processes preserve the structure and beneficial properties of beta-glucan. They ground oats and barley in different types of mills, using sieves of various sizes and milling for different lengths of time. These experiments showed that slight changes in milling processes have an effect on the molecules and the ability to extract beta-glucan. For example, the finer and more homogeneous the flour, the easier it was to extract beta-glucan.

Interactions with gastric mucin

The researchers also wished to investigate interactions between cereal beta-glucan and gastric mucin. Their objective was to determine whether these interactions aid in regulating cholesterol and sugar absorption. This effect is generally associated with an increase in intestinal viscosity. As a result, low-viscosity dietary fibre is believed to be less beneficial to health. The team's findings point to a paradigm shift in our understanding: beta-glucan interacts actively with gastric mucin, and the mix of beta-glucan and mucin forms a gel that is more viscous and elastic than mucin alone. In some cases, these interactions are intensified by oxidation of beta-glucan. This mechanism suggests that low-viscosity dietary fibre may also have a beneficial effect on health through its molecular interaction with gastric mucin.

Recommendations

Raise consumer awareness and create tailored products

The project aided understanding of some of the beneficial effects of beta-glucan, through its interactions with bile acids, iron and gastric mucin. Additional research is needed to better understand this subject. In the meantime, researchers encourage decision-makers and practitioners to invest more effort in raising awareness among consumers to increase their understanding of the components of food. The researchers also invite industry to apply the knowledge gained from the work on dietary fibre to produce tailor-made foods for individuals suffering from cardiovascular disease, diabetes and obesity.