

DIETARY FIBRE ROLE IN GLUTEN INTOLERANCE

Can dietary fibre help provide safer food products for sufferers of gluten intolerance? A well-established biophysical probe may help towards providing an answer.

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INTRODUCTION

There is growing interest in the use of traditional food-type of large carbohydrate molecules such as galactomannans, glucomannans and arabinoxylans for therapeutic biopharmaceutical purposes ranging from blood plasma substitutes to mucoadhesive drug delivery systems. There has been a suggestion that these molecules may also offer a protective role for the mucosal epithelia for sufferers of gluten protein intolerance, by interacting with the gluten proteins. A well established biophysical technique - sedimentation velocity in the analytical ultracentrifuge - may provide an answer to the important question as to whether these interactions would be strong enough for gluten proteins passing through the gastrointestinal tract.

GLUTEN INTOLERANCE

Gluten intolerance is a T-cell mediated autoimmune condition (as distinct from an allergic IgE mediated immune response) of the small intestine that occurs when an individual with a genetic predisposition to the condition ingests the proteins of wheat, barley and rye and possibly oats (1). The ingestion of gluten and related proteins leads to damage of the mucosal lining and the flattening of the villi of the small intestine, resulting in the malabsorption of nutrients from the diet. The condition is permanent and damage to the small intestine will occur

every time gluten is consumed regardless of whether symptoms are present or not (2). The only current treatment is a total exclusion of gluten and related proteins from the diet - a gluten-free diet.

PREVALENCE OF GLUTEN INTOLERANCE

Over the past two decades, the perception of gluten intolerance has transformed from the concept of a rare disease affecting primarily children of northern European ancestry with gastrointestinal symptoms, to a very common condition of people of all ages worldwide. Indeed, the condition has recently received high profile coverage in the media following the improved performances of top sports stars after moving to gluten-free diets (7).

CONTROL OF GLUTEN INTOLERANCE

The only known effective treatment for gluten intolerance is a life-long gluten-free diet (GFD). There are few systematic studies in the literature on the factors affecting an individual's ability to adhere to a GFD, but a number of factors have been identified. These include compliance, particularly among adolescents, where dietary diaries indicate compliance levels between 50 to 95 percent; however, serological/intestinal biopsy studies on the same subjects indicate different degrees of intestinal damage (10). Poor product information is another contributing factor relating to the

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gluten content of foods and the fact that gluten products can be 'hidden' in foods where they would not be expected to form part of a particular product. Individuals differ in their sensitivity to gluten so that an activating dose of gluten for one individual may not elicit a response in another (11). The availability and price of gluten-free (GF) foods is another factor, often there are limited ranges of GF food products available and these are considerably more expensive than conventional products and can place an economic burden on the individual and their family. The conclusion is that in patients attempting to adhere to a GFD, mucosal damage can occur from the ingestion of gluten due to a number of factors that may be outside the control of the individual.

There is also a problem with the acceptability to consumers of GF products. The unique properties of wheat gluten make it difficult to replace and currently many GF products available on the market are of low attraction, exhibiting poor mouth feel and flavour. The use of starches, gums and hydrocolloids represent the most widespread approach used to mimic gluten in the manufacture of GF bakery products, due to their structure-building and water binding properties. Novel approaches, including the application of dietary fibres and alternative protein sources combined with response surface methodology, are also emerging (12). Preparation of GF pasta is also difficult, as the gluten contributes to a strong protein network that prevents dissolution of the pasta during cooking.

GF foods can be prepared from gluten containing ingredients, where the gluten component has been removed. In the USA and Canada food labelled GF must be devoid of wheat, whereas in Europe, products labelled as 'gluten-free' are permitted to contain wheat starch (12). The threshold amounts of gluten

that activate gluten intolerance have produced conflicting results and it has been concluded that it is the total amount of gluten ingested over time rather than the concentration of gluten in the food product that is important. It is recommended that the ingestion of gluten should be kept at less than 50mg gluten per day in the treatment of gluten intolerance (14). The recently revised recommendations of the WHO/FAO (15) indicate that products only be called 'gluten free' if there is less than 20ppm of gluten in the finished product. In Europe new legislation requires that products labelled 'gluten free' (usually made from foods that do not naturally contain gluten) must contain less than 20ppm gluten.

Whereas untreated coeliac disease can result in inadequate nutrition for the individual, there is evidence that strict adherence to a GFD can also result in nutritional inadequacies. Few gluten-free products are enriched or fortified, adding to the risk of nutrient deficiencies. Poor vitamin status has been reported for 50 percent of patients adhering to GFD for 10 years, an increased incidence of obesity and poor nutrient intakes (17).

USE OF DIETARY FIBRE (DF) POLYSACCHARIDES

It would be very useful if people who suffer from gluten intolerance could consume a limited number of low gluten based products without suffering from the consequence, or if the trace amounts of gluten in 'gluten free' foods (which can still cause severe problems) could be taken out by another non-digestible food ingredient. To achieve this would mean preventing coeliac activating peptides from coming into contact with the mucosal epithelia and its receptors. Could the addition of a natural ingredient or combination of ingredients be the answer? ▶

A particular group of complex carbohydrate substances which are used as dietary fibre may hold the key here. Dietary fibre carbohydrates, sometimes referred to as 'non-digestible carbohydrate' or NDC, are all essentially polysaccharides and associated lignins in the diet that are not digested by the endogenous secretions of the human digestive tract and are of considerable physiological importance (28). They influence the digestion of food in general and in particular reduce the insulin needs of people with diabetes, influence bile acid metabolism, alter lipid digestion, cholesterol absorption and protect against colonic cancer (29). Byrnes et al (30) found that meals which included bread containing partially depolymerized guar galactomannan, gave a reduction in postprandial insulin resistance in healthy middle aged men at risk of coronary heart disease. Addition of partially hydrolyzed guar gum to the diet reduced laxative dependence in a nursing home population. It also reduced the incidence of diarrhoea in septic patients receiving total enteral nutrition, reduced symptoms of irritable bowel syndrome and increased production of Bifidobacterium in the gut (31).

CONCLUSION

Although promising, the goal now is to see if there exists a non-toxic biopolymer combination providing not only a strong interaction with the form that gliadins present themselves to mucosal epithelia - the pepsin-trypsin digested form - but an interaction which will withstand the physiological stresses in the alimentary tract and the bioprocessing stresses during food preparation. The value of the ultracentrifuge as an assay procedure is it involves no columns or membranes - as required by chromatographic or field flow fractionation procedures - or any immobilisation onto surfaces as is required by techniques such as surface plasmon resonance. It may well turn out that there may be no polysaccharide which gives an interaction that is strong enough - and resistant enough to external effects, but at least there is now another methodology to explore the interactions.

The authors declare that they have no competing interests. We thank Professor Arthur Rowe and Dr. Gordon Morris for helpful discussions. The electronic version of this article is the complete one and can be found online with references at www.biomedcentral.com/2046-1682/5/10 ■

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Questions relating to: *Dietary fibre role in gluten intolerance*

Type your answers below and then **print for your records** or print and complete answers by hand.

Q.1 What is gluten intolerance and when does it occur?

A

Q.2 Outline the prevalence of gluten intolerance.

A

Q.3 What are the risks of ingesting gluten in those who suffer from gluten intolerance?

A

Q.4 What is the treatment for gluten intolerance and what are the related guidelines on gluten ingestion?

A

Q.5 What factors influence the long-term compliance of patients to a gluten-free diet?

A

Q.6 What are the nutritional risks involved in a long-term gluten-free diet?

A

Q.7 What are dietary fibre carbohydrates?

A

Q.8 Why are these carbohydrates of considerable physiological importance?

A

Q.9 State at least two large carbohydrate molecules and describe their therapeutic biopharmaceutical purposes.

A

Please type additional notes here . . .