those in the gut. It uses a buffer at 100°C and thermostable amylase to gelatinize and digest the starch. Clearly, treating food at this temperature essentially cooks it and thus alters the solubility of the starch. This dietary fibre method can be made physiologically valid simply by digesting the food in gastro-intestinal conditions to extract the (physiologically) soluble dietary fibre before a further digestion step.

Conclusion

There is a need for several standard objective measures of nutritionally relevant properties of foods, both for food consumers and for manufacturers. The data that food manufacturers currently place on food labels, at some expense, does not provide useful information of food functionality to consumers and for some foods the details may be misleading, although they may be legal and follow the regulations. Further, some studies referred to at the Food and Trade Conference showed that many consumers misunderstand simple information on food labels, suggesting that there is a need for more education of consumers in this area - but that is another story.

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CROP & FOOD RESEARCH

Mana Kai Rangahau

RESEARCH BULLETIN

Flour milling and baking

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Do food labels display useful information on food carbohydrates and dietary fibre and their physiological effects?

Food labels provide consumers with useful health information, helping them to select 'healthy' foods. Information allowed on food labels is carefully regulated and must be measured by standard approved methods. Food labels should also be easy for industry to use and for consumers to understand.

How can science help us to measure the health benefits of foods so that industry can provide this information to guide consumers? Until now, food labels have concentrated on food composition but this gives very little information about physiological effects. The ability to measure the physiological effects of foods will become even more important because of the increasing growth in functional foods and food ingredients. Functional foods are usually defined as foods with health advantages beyond normal nutritional effects. However, promoting and selecting functional foods will be difficult until these properties can be tested according to standards. At present there are few tests for physiological functionality in foods. So how well do food physiological effects relate to food composition and the information currently provided on food labels?

This bulletin is based on a paper John Monro presented to the Crop & Food Research Nutrition and Food Trade Conference in April 1999. John Monro is a C&FR nutrition scientist who specializes in dietary fibre measurement and has developed nutritionally based measures of food functionality.

Carbohydrate information on food labels

Food labels display information on the quantities of carbohydrates (available), complex carbohydrates (starch plus non-starch polysaccharide), sugar, and soluble/insoluble dietary fibre in food. This data is useful for identifying foods that contain little fat and a lot of complex carbohydrates, i.e. are 'healthy'. But the effects of food in the intestine depend on its physio-chemical properties and on the surrounding food matrix.

The physiological functions of food carbohydrates are important because of their various effects on illnesses such as constipation, colo-rectal cancer and heart disease. These are summarised in Table 1. Do food labels assist consumers to select, or manufacturers to promote, healthy foods?

Effect of dietary carbohydrates on blood sugar

The levels of sugars and other carbohydrates are presented separately on food labels because sugars are assumed to have more impact on blood glucose than starch. The impact of carbohydrates on blood glucose is measured by the glycaemic index, GI. Glycaemic index is defined as the blood glucose response to 50 g. of food carbohydrate, relative to the effect of dietary glucose, which has a value of 100. Some starches are digested and absorbed nearly as quickly as glucose, as shown by the GIs of the starch in rice bubbles, 97, and in baked potatoes, 85. However, cane sugar only has a GI of 61 so sugar content is not a reliable guide to the effect on blood glucose.

GI measures the glycaemic effect in response to equal weights of carbohydrates so it doesn't take account of the different carbohydrate levels in foods. Figure 1 shows that parsnip has a GI almost equal to that of glucose. However, this doesn't tell us much about its glycaemic effect because parsnip's carbohydrate content is much lower (it is mostly water). This shows that consumers requiring information about the glycaemic effects of whole foods get little help from GI values.

Table 1: Links between food carbohydrate properties and health

Carbohydrate property							Disorder
Digestibility							
Low	Carbohydrate substrate for fermentation.	➜	Colonic protein converted to bacterial protein	➜	Ammonia and nitrogenous mutagens low	➜	↓Colorectal cancer
Medium	Sustained sugar uptake.	➜	Blood sugars maintained	➜	Appetite suppression	➜	↓Obesity
High	Low colonic carbohydrate. release.	➜	Protein used as carbon source.	➜	Nitrogenous mutagens Insulinaemia.	➜	↑Colo-rectal cancer. ↑Multiple diabetes complications.
	Rapid sugar	➜	Glycaemia.	➜	Protein glycosylation.	➜	
Colonic Fermentability							
Low	Faecal bulk retained.	➜	Colorectal stimulation.	➜	Defaecation. Little mutagen accumulation	➜	↓Colo-rectal cancer.
Medium	Ferments distally.	➜	Butyrate in colorectal region.	➜	Rejection of abnormal cells.	➜	↓Colo-rectal cancer.
High	Ferments proximally.	➜	Loss of faecal bulk.	➜	Carcinogens concentrated.	➜	↑Constipation. ↑Cancer
Solubility, viscosity							
High	Delayed absorption.	➜	↓Plasma lipids + cholesterol. ↓Bile acid recycling.	➜	Decreased Plasma cholesterol	➜	↓Heart disease.

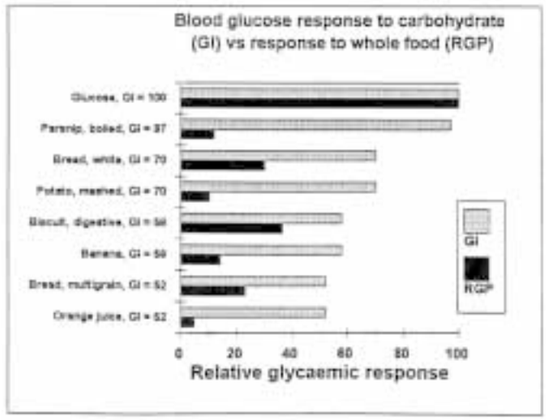

Figure 1: Relative glycaemic response to carbohydrate in foods (GI) versus relative glycaemic response to whole foods as consumed (RGP)

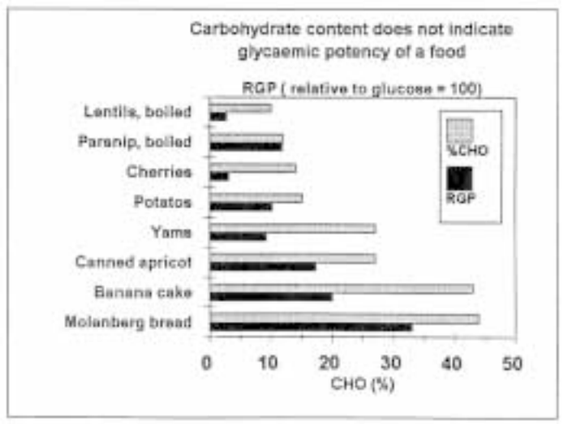

Figure 2: Carbohydrate content (%) compared with relative glycaemic potency (%) of a range of foods

John Monro has proposed a new value, relative glycaemic potency, RGP, to measure and compare the relative effects of different foods on blood glucose, on a whole food weight basis. Figure 1 compares the RGP for various foods to their GI and shows that GI on its own is not a good guide for diabetics and doctors managing blood glucose levels.

Therefore both GI and food carbohydrate contents can be misleading if used alone as guides for dietitians and diabetics.

Dietary fibre/roughage

Dietary fibre is commonly assumed to confer bowel 'regularity', even in publications such as the New Zealand Food and Nutritional Guidelines, and many foods are promoted on the basis of their dietary fibre content. Faecal bulk is also important because it decreases the risk of colon cancer. Does information on the nutrition information panel, or NIP, of food labels help consumers to estimate the effects of food dietary fibre on physiological effects ('regularity')? Does dietary fibre content measure the effects of functional ingredients with laxative effects?

Monro has invented the faecal bulking index (FBI) to measure the contribution of food to faecal bulk compared to the effects of the old standby, wheat bran. The FBI is the volume of moist faecal material and includes food residues from digestion and fermentation, gut secretions, bacterial growth and water.

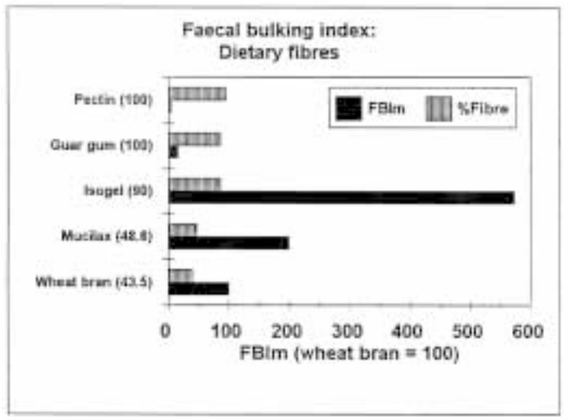

Figure 3: The dietary fibre content (% fibre in brackets) of polysaccharide preparations compared with their faecal bulking indices (FBIm).

Figure 3 compares the faecal bulking effect of a number of fibre-rich materials with their dietary fibre content. It is clear that dietary fibre values are a very poor guide to faecal bulking effects. Wheat bran is largely resistant to fermentation. Pectin is almost 100% fibre but has very little impact on faecal bulk because it is almost completely fermented. Isogel™ or Metamucil™ are resistant to fermentation and also have high water-holding capacity. Therefore, dietary fibre values give a very poor idea of faecal bulk for some types of dietary fibre.

Some breads are boosted with amylase-resistant starch from maize and are sometimes promoted as containing more than 100% more dietary fibre than white bread, for example,"Wonder White". To consumers this means that they can eat it instead of wholemeal with similar effects. However, although the fibre in fibre white resists amylase, it is fermentable so the FBI is much lower than its dietary fibre content suggests.

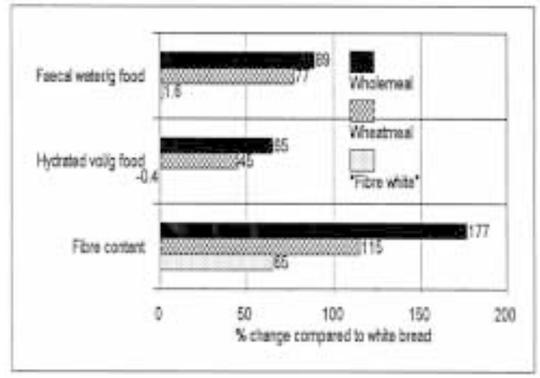

Figure 4: Effects of dietary fibre enhanced breads on faecal characteristics (water content and hydrated faecal volume) relative to white bread.

Figure 4 shows the values for dietary fibre and FBI for Fibre White, wheatmeal and wholemeal breads compared to white bread. Although fibre white contains more dietary fibre, it produces no greater faecal bulk than white bread. However, consumers may choose it instead of wholemeal on the basis of its misleading dietary fibre value. Food manufacturers' food labels can include all types of dietary fibre, irrespective of how they perform in the bowel. In effect, the term dietary fibre masks the differences between the functionality of different types and implies that all dietary fibres are equally effective. The use of the FBI value could help consumers of foods to understand food function and manufacturers to test food functionality.

Soluble fibre

When the term was introduced, soluble fibre was promoted by nutritionists because it was thought to reduce blood cholesterol. The standard method for measuring soluble fibre uses conditions quite unlike