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Manipulating dietary fibre: Gum Arabic making friends of the colon and the kidney

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ABSTRACT

There is an appreciation that the incidence of chronic renal disease is increasing worldwide. This is a health issue, which carries significant morbidity and mortality for patients. Furthermore treatment of patients with renal failure is expensive and therefore represents a significant financial burden to health economies. This review provides an overview of the in vitro, in vivo and clinical evidence supporting the potential therapeutic benefit of manipulating dietary fibre intake and specifically supplementation of the diet with Gum Arabic in patients with progressive renal disease.

Contents

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1. Dietary fibre and disease

Dietary interventions have been an important cornerstone of medicine since its early days. Epidemiological evidence suggests that a high intake of dietary fibre is associated with numerous health benefits, with reduced mortality documented in those consuming a diet rich in whole grain (Jacobs, Meyer, & Solvoll, 2001). High intake of fibre from cereals and high consumption of wholegrain foods is significantly associated with a reduced risk of colorectal cancer (Aune et al., 2011). Observational studies also suggest that a diet high in fibre may confer protection from the risk of cancers beyond the colon (La Vecchia, Chatenoud, Negri, & Franceschi, 2003), which suggests systemic beneficial effects. This is further supported by evidence of the potential favourable effect of whole-grain foods on cardiovascular disease (Truswell, 2002), and the risk of myocardial infarction (Rimm et al., 1996). Studies on the consumption of whole grains and the risk of type 2 diabetes together with observational studies demonstrating an inverse association between fibre intake and the occurrence of type 2 diabetes also suggest a role for fibre supplementation in the prevention of type 2 diabetes, possibly associated with a lower incidence of obesity (Cho, Qi, Fahey, & Klurfeld, 2013). More recent studies suggest that a high dietary fibre intake may also provide clinical benefit for patients with chronic kidney disease (Krishnamurthy et al., 2012). Chronic renal disease represents an expensive and rapidly growing health issue. Its incidence is increasing with current estimates that up to 10% of the population have impaired renal function (Coresh et al., 2007).

2. Regulatory definition of dietary fibre

The Codex Committee on Nutrition and Foods for Special Dietary Users finally agreed an internationally acceptable definition of dietary fibre in 2009 (Phillips & Cui, 2011). The question was – should it be defined according to its chemical category or its physiological function. The following chemical definition was finally adopted:

"Dietary fibre means carbohydrate polymers with 10 or more monomeric units which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories:

- edible carbohydrate polymers naturally occurring in the food as consumed;
- carbohydrate polymers, which have been obtained from food raw material by physiological, or chemical means and which have been shown to have a physiological effect or benefit to health as demonstrated by generally accepted scientific evidence to competent authorities; and
- synthetic carbohydrate polymers which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities" (Cummings & Stephen, 2007).

It is not clear whether it is the chemical characterisation or its physiological action which are the critical factors. Conversion in the colon to short-chain fatty acids is a necessary requirement if the material is to be accepted as a dietary fibre. But to make a health claim it also needs biological, physiological and clinical evidence and chemical characterisation of the test material. Therefore while the general identification of dietary fibre can be made on a chemical basis, any specific health claim must be based upon its physiological and clinical performance (Phillips, 2013).

3. Dietary fibre and renal disease

In patients with chronic kidney disease (CKD), dietary advice currently focuses on the intake of salt, phosphate, potassium and protein. The role of dietary fibre is less well defined. Fruits and vegetables, often restricted in CKD to prevent or correct hyperkalaemia, are an important source of dietary fibre. In patients with CKD dietary fibre intake is therefore known to be well below the recommended daily intake of 25–30 g/day (Kalantar-Zadeh, Kopple, Deepak, Block, & Block, 2002; Krishnamurthy et al., 2012). There are studies which date back over 25 years which suggest that modification of fibre intake may have beneficial effects on renal function. In an animal model of diabetic renal disease a high fibre diet was associated with amelioration of the pathological changes within the kidney (Lee, 1982). In human studies, locust bean gum, a non-digestible polymer of mannose and galactose derived from the seeds of the *ceratonia siliqua* tree, has been demonstrated to be an efficient sorbent which binds to many of the potential toxic substances found in patients with chronic renal failure (Yatzidis, 1977). In a study of only two patients, it was also suggested that dietary supplementation with locust bean gum improved both blood pressure control and also reduced serum creatinine (Yatzidis, Koutsicos, & Digenis, 1979). These observations, which have not been investigated further, and if confirmed would suggest a mechanism other than that related to its "sorbent" properties by which locust bean gum may influence progressive renal disease. In addition, a case report of a single patient, using dietary supplementation with the hemicellulosic ispaghula husk also suggested a beneficial effect on renal function beyond increased faecal bacterial loss (Rampton et al., 1984). A recent landmark study however has reignited interest in the role of dietary fibre in renal disease demonstrating in a large observational study using the Third National Health and Nutritional Examination Survey (NHANES III), a data base over 14,500 participants, which identifies a positive association between fibre intake and mortality in patients with kidney disease (Krishnamurthy et al., 2012).