ARTICLE IN PRESS

Food Hydrocolloids xxx (2016) 1–6

Contents lists available at ScienceDirect

Food Hydrocolloids

journal homepage: www.elsevier.com/locate/foodhyd

Dietary fibre and weight loss: Where are we now?

Iain A. Brownlee [a, *], Peter I. Chater [b], Jeff P. Pearson [b], Matt D. Wilcox [b]

[a] *Human Nutrition Research Centre, School of Agriculture, Food & Rural Development, Newcastle University (Singapore), 567739, Singapore*
[b] *Institute for Cell and Molecular Biosciences, The Medical School, Newcastle University, NE2 4HH, UK*

ARTICLE INFO

Article history:
Received 4 July 2016
Received in revised form
19 August 2016
Accepted 24 August 2016
Available online xxx

Keywords:
Dietary fiber
Weight management
Obesity
Adiposity

ABSTRACT

"Dietary fibre" represents a wide spectrum of polysaccharides that escape digestion in the human gastrointestinal tract. The term has been widely associated with positive health outcomes, with the fibre content of food products being a potential basis for nutritional composition claims in many parts of the world. The current review aims to evaluate the current evidence from human trials on the impact of fibre-rich foods and isolated dietary fibre on body weight management.

Evidence from observational studies consistently demonstrates that habitual increased intake of fruits, vegetables and whole grains is associated with lower body weight increase over time. Adherence to healthier dietary templates (including incorporation of higher amounts of plant-based foods) in intervention studies also tend to evidence greater weight loss than control diets. This further highlights the importance of fruits, vegetables and whole grains as the foundation of positive dietary habit. In contrast, randomised, controlled trials based on increase of fruit/vegetable or wholegrain food intake alone tend to show no impact on body weight or body fat outcomes, suggesting either that the length of previous studies is not long enough to observe measurable effects or that such dietary changes alone do not benefit these outcomes. While individual intervention studies suggest potential benefits of some fibre isolates on weight loss, there only appears to be reproducible evidence of efficacy for glucomannan. The limited amount of available evidence suggests a need for further, well-designed and appropriately targeted intervention studies in the future.

1. Introduction

Observational studies consistently suggest that consumption of plant-based foods appears to be linked to improved long-term health outcomes (Marlett, McBurney, & Slavin, 2002; Rimm et al., 1996; Wolk et al., 1999). Since the phrase was coined in the 1950s (Hipsley, 1953), "dietary fibre" has been considered a candidate causative agent for the positive effects of consuming plant foods. The first issue of Food Hydrocolloids (published in September 1986) contained a range of pioneering articles that presented clear evidence that different sources and types of fibre had varying physicochemical properties (Arrigoni, Caprez, Amado, & Neukom, 1986; Cairns, Morris, Miles, & Brownsey, 1986; Voragen, Schols, & Pilnik, 1986; Watase & Nishinari, 1986) and physiological effects (Anderson, Eastwood, & Brydon, 1986). Despite an additional 30 years of research supporting this divergence of fibre types and sources, the overarching positioning of dietary fibre in relation to human health has remained the same: a homogeneous group of substances that pass through the gut without being altered and the health benefits of which are often associated with a reduction in the amounts or digestibility of macronutrients within natural or manufactured foods.

Nutritional claims for the dietary fibre content of foods are allowed in many parts of the world (Agri-Food & Veterinary Authority of Singapore, 2016; Canadian Food Inspection Agency, 2015; Food Standards Australia New Zealand, 2016; The European Commission, 2016; United States Food and Drug Administration, 2015) and stipulate that food incorporating set amounts of dietary fibre (per weight of food or total energy content of the food) can make equivalent claim based on chemical composition. Current definitions of dietary fibre (Jones, 2014; Macagnan, da Silva, & Hecktheuer, 2016) encompass an enormous range of divergent indigestible carbohydrate entities which are likely to cause different effects in the human body. However, many countries allow nutrient claims to be made based on fibre content (regardless of type) alone. It is also likely that fibre, as an important structural matrix within plants, exerts some of its action as a result of its

* Corresponding author. Human Nutrition Research Centre, #05-01, 172A, Newcastle University (Singapore Campus), Ang Mo Kio Ave 8, 567739, Singapore.
E-mail address: iain.brownlee@ncl.ac.uk (I.A. Brownlee).

http://dx.doi.org/10.1016/j.foodhyd.2016.08.029
0268-005X/

Please cite this article in press as: Brownlee, I. A., et al., Dietary fibre and weight loss: Where are we now?, *Food Hydrocolloids* (2016), http://dx.doi.org/10.1016/j.foodhyd.2016.08.029

compartmentalisation of other compounds and so intake of dietary fibre from plant-based foods may not be entirely comparable to an equal amount of isolated fibre added to a food product or within a supplement (Goodlad & Englyst, 2001).

At a public health level, obesity still remains a major challenge in most parts of the world (World Health Organization, 2016). The increased risk of cardiovascular and metabolic diseases, site-specific cancers and other co-morbidities, drives a strain on healthcare costs and leads to a reduction in quality of life (Dee et al., 2014). Dietary fibre isolates or fibre-rich foods may (among other modes of action) benefit weight management by (i) reducing energy intake in comparison to non-fibre-containing alternatives (ii) by reducing the amount of energy that is absorbed from ingested foods (iii) increasing postprandial energy expenditure (possibly via increased gastrointestinal motility) or (iv) increasing the excretion of bile acids and other factors, thereby putatively driving a mobilization of body fat stores to drive increased hepatic synthesis (Weickert & Pfeiffer, 2008). A recent, well-considered systematic review highlighted that, although there are scientifically accepted tenets on the benefits of dietary fibre intake such as gut transit time and stool bulking, more careful evaluation of data highlights that fibres from different sources did not result in equivocal effects on laxation (de Vries, Birkett, Hulshof, Verbeke, & Gibes, 2016). This spurred the authors to review (in an admittedly non-systematic manner) and summarise the existing evidence linking dietary fibre to improvements in body weight management. This review will consider the impact of consumption of dietary fibres (both as isolates and as "whole" plant-based foods) on adult body weight, with particular consideration of human observational and intervention studies evidence. It was hoped that by doing so, the authors will not only underline the current position of research into dietary fibre and body weight management but also highlight future needs for additional interpretation of existing data and outline where research gaps exist.

2. Plant-based foods and body weight

Observational studies, particularly those of a prospective design, allow a means to evaluate the association of habitual dietary intake with health outcomes, potentially over long periods of follow-up. Such studies form the cornerstone of public health messaging around the world (World Health Organization, 2003). The absolute benefit of such studies is that the length of time the study can cover is perhaps more appropriate to the development trajectory of non-communicable diseases than it is realistic to study in randomized, controlled trials (Scientific Advisort Committee on Nutrition, 2012). A number of estimates of excess body weight exist (e.g. body mass index, waist circumference, body fat percentage estimated by a number of means)and changes in which can be assessed over time. Throughout early to mid-adulthood, a tendency for increased BMI and body fat deposition is seen at a population level (Whitaker et al., 2016). Thus, the body weight of a large proportion of working adults would be expected to increase over a number of years. Previous observational evidence tends to highlight that higher consumption of plant-based foods is linked to reduced weight gain in adults over the course of a number of years, as opposed to reduction in body weight *per se*. While this evidence would support following a diet that helps you manage body weight over time, it would certainly be inappropriate to suggest that this equates to a strategy for weight loss.

A recent systematic review of observational findings noted that increased fruit and vegetable consumption was consistently associated with curtailed increase in body weight, BMI or waist circumference; over periods of follow up of less than one year to over 20 years. The most recent meta-analysis at the time of writing (to the authors' knowledge) has considered three existing, large, US-based, prospective studies with up to 24 years of follow-up in a total of 133,468 men and women in the US (Bertoia et al., 2015). Intake of one serving of fruit or vegetables per day was associated with a small, yet significant, unadjusted reduction in mean weight gain over 4 years of 0.24 (95% confidence intervals 0.28, 0.20) kg and 0.11 (0.16, 0.06) kg respectively. Therefore, an increase in intake of fruit and vegetables from 0 to 5 servings of fruits and vegetables a day would be rather unlikely to lead to a biologically important effect on body weight management unless maintained over decades. However, this study also highlighted that intake of individual type of fruit and vegetables could also be significantly associated with reduced weight gain over 4 years, with blueberries 0.62 (0.76, 0.49) kg and tofu/soy 1.12 (1.40, 0.84) kg having the most pronounced effect (Bertoia et al., 2015). This degree of effect in a non-consumer subsequently meeting food-based dietary recommendations (equating to weight reduction of over 1 kg a year) would seem more likely to benefit long-term health outcomes. It must be noted that there were relatively few fruit and vegetable item that had such a large impact (Bertoia et al., 2015). There is also a potential that other confounding factors (such as an overall healthier dietary or lifestyle habit in the highest consumers) could lead to an over-representation of the impact of high intake of single fruit and vegetable items.

However, randomized controlled trials based on whole grains or fruit and vegetables alone tend not to evidence improvements in body weight parameters. The two largest and longest wholegrain food intervention studies to date have demonstrated no benefit of increasing whole grain intake by high amounts on body weight, body fat percentage or waist circumference (Brownlee et al., 2010; Tighe et al., 2010). These two studies were both parallel by design which helps to ensure that any change in body weight during the treatment is not affected by previous treatment arms of the study. Crossover studies benefit from reduced intra-individual variability but tend to add participant burden from extended involvement in the study. As body weight and body fatness take a relatively long time to change, the between-treatment wash-out period has to be long enough to avoid timing of treatment potentially affecting outcome measures. A number of well-designed crossover studies with wholegrain foods have also tended to demonstrate a lack of effect of whole grains on body weight or body fatness (Andersson et al., 2007; Hajihashemi et al., 2014; Jackson et al., 2014). Even within energy-restriction intervention studies, inclusion of whole grains did not improve weight or fat loss outcomes more than energy restriction alone (Rave, Roggen, Dellweg, Heise, & tom Dieck, 2007; Saltzman et al., 2001), while reduction of abdominal fat (but no other parameter of body weight of body fat) was noted in one study (Katcher et al., 2008). A previous study that has evaluated the impact of increased fruit and vegetable consumption on cardiovascular health have both noted no change in body weight following increasing consumption of potassium via higher fruit and vegetable intake across 4 treatment groups lasting six weeks each (Berry, Mulla, Chowienczyk, & Sanders, 2010).

A recent systematic review of prospective observational evidence suggested that comparison of the highest and lowest percentile of cereal fibre, whole grains and bran/whole grains appeared to consistently lead to small but significant improvements in long-term body weight management (Cho, Qi, Fahey, & Klurfeld, 2013). However, additional systematic reviews assessing evidence from randomized controlled trials on whole grain or fruit and vegetables intake and body weight have all noted a consistent lack of effect. This is despite a range of experimental designs, with interventions of varying doses and across varying time lengths (Kaiser et al., 2014; Mytton, Nnoaham, Eyles, Scarborough, & Ni Mhurchu, 2014; Pol et al., 2013; Schwingshackl et al., 2015).

Please cite this article in press as: Brownlee, I. A., et al., Dietary fibre and weight loss: Where are we now?, *Food Hydrocolloids* (2016), http://dx.doi.org/10.1016/j.foodhyd.2016.08.029