Journal of Food Composition and Analysis 71 (2018) 36–43

Contents lists available at ScienceDirect

Journal of Food Composition and Analysis

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

Original research article

Creation of a fibre categories database to quantify different dietary fibres

Stacey Fuller*, Linda C. Tapsell, Eleanor J. Beck

School of Medicine, Faculty of Science, Medicine and Health and Illawarra Health and Medical Research Institute, University of Wollongong, NSW, 2522, Australia

ARTICLE INFO

Keywords:
Dietary fibre
Fibre methods
Soluble fibre
Insoluble fibre
Food composition
Health benefits
Food analysis
Food composition database

ABSTRACT

Foods rich in dietary fibre have long been consumed for their known health benefits. Fibre represents a complex group of substances, with diverse physicochemical properties and therefore varied physiological effects. To be able to fully understand the clinical benefit of consuming dietary fibre, it is important to look at the components and their physiological roles. Evidence suggests that soluble fibres contribute to health effects such as blood glucose attenuation and cholesterol lowering, while insoluble fibres play a role in health effects such as laxation. Most countries have a food composition database that includes dietary fibre, however further details on categories of fibre are not included. This lack of information is problematic for research, for example dietary effects may be attributed to total fibre, rather than the type of fibre. A Fibre Categories Database (FCD) was developed to include data on total, soluble and insoluble fibre from a range of common foods. Fibre data was collected from a variety of sources including the scientific literature, food industry and national databases and calculations from recipe files were used. The creation of the Fibre Categories Database provides a useful tool to analyse the intake of types of fibre and relate this to health outcomes in the context of a whole diet.

1. Introduction

Foods rich in dietary fibre have long been consumed for their known health benefits. While there is no universally accepted definition of dietary fibre, all existing definitions recognise dietary fibre to be a group of carbohydrate polymers or oligomers that escape digestion in the small intestine, passing into the large intestine, where they are either partially or completely fermented by gut microbiota. Many definitions also recognise the range of health benefits that can be attributed to dietary fibre including increased faecal bulk/laxation; reduced total and/or low density lipoprotein (LDL) serum cholesterol levels; and attenuation of postprandial glycaemia/insulinaemia (Jones, 2013; Mudgil and Barak, 2013). Dietary fibre has been extensively studied due to its beneficial physiological effects. Studies have shown that diets high in dietary fibre, especially fibre from cereal or vegetable sources, are significantly associated with lower risk of coronary heart disease and cardiovascular disease (Threapleton et al., 2013); and that cereal fibre, and to a lesser extent vegetable fibre, are significantly associated with lower total mortality (Kim and Je, 2014).

Evidence suggests that soluble fibres, such as β-glucan, play a role in certain health effects such as blood glucose attenuation and cholesterol lowering, while insoluble fibres play a role in health effects such as laxation (Fuller et al., 2016). The most widely accepted ways in which dietary fibres have been classified is to differentiate them based on (1) their solubility in a buffer at a defined pH, and/or (2) their fermentability in an *in vitro* system, using an aqueous enzyme solution representative of human alimentary enzymes (Tungland and Meyer, 2002). Since most fibre types are at least partially fermented, it may be appropriate to refer to fibre as partially or poorly fermented, and well fermented. Generally, well fermented fibres are soluble in water, while partially or poorly fermented fibres are insoluble. There are other classification systems such as those based on the role of fibre in the plant, the type of polysaccharide, the degree of simulated gastrointestinal fermentability, the site of digestion, and others based on products of digestion and physiological classification (Tungland and Meyer, 2002). Classification of dietary fibre based on molecular weight is also common (Westenbrink et al., 2013). For any classification system, it is important to understand that, as these are not mutually exclusive systems, fibre types may fit into more than one category. In addition, foods are likely to contain many different types of fibres, so individual foods that contain fibre will not fit into a single category, but rather be categorised into a group representing the predominant type of fibre in those foods. It is also important to recognise that particular types of fibre belonging to a functional category (e.g. soluble fibre) may not attribute the same health benefits, and it is therefore essential to recognise which fibres possess specific health-promoting properties (McRorie and McKeown, 2017).

Current research has made it clear that dietary fibre represents a complex group of substances, with diverse physiological properties (McRorie and McKeown, 2017). To be able to fully understand the

* Corresponding author.
E-mail address: sf964@uowmail.edu.au (S. Fuller).

https://doi.org/10.1016/j.jfca.2018.05.004
Received 25 April 2017; Received in revised form 8 March 2018; Accepted 4 May 2018
0889-1575/

clinical benefit of dietary fibre, it is important to look at the individual components or properties and their physiological role, rather than considering dietary fibre as a single nutrient (Jew et al., 2015).

Most countries, including Australia, have a nutrient composition database that includes details for a range of nutrients, including dietary fibre (Food Standards Australia and New Zealand, 2014a). Food composition databases tend to only include details for total fibre in foods rather than specific types or categories. Further details on fibre types, including categorisation of fibre types as soluble and insoluble fibre, are not included. This lack of detailed information regarding fibre is problematic for research for example, attributing positive effects to total fibre, rather than type of fibre or even a broader group of fibre categories. However, sourcing information on different fibres is also difficult potentially requiring multiple approaches to analysis to determine fibre type. In addition there are limited publications providing useful reference data.

Being able to measure dietary fibre has important implications for research, regulation and labelling purposes. Quantification to determine health effects is particularly relevant, and although fibre labelling is not mandatory in Europe, it is required in countries such as Australia and the United States. As previously stated, the definition and analysis of dietary fibre components are intimately related. Both the definition of dietary fibre and the analytical methods used to measure dietary fibre have evolved over time (McCleary, 2007; Westenbrink et al., 2013). Since dietary fibre is a multicomponent mixture, it is essential that there are methods that allow measurement of all known components.

Given that fibre is indigestible and there is chemical diversity of dietary fibre, a number of different methods have evolved to estimate the quantity of these materials in foods. All methods use a dried, defatted food sample, but they measure different chemical fractions (Lunn and Buttriss, 2007). Several methods are available for the measurement of dietary fibre in plant and food products. The Codex Alimentarius defines four types of methods for the measurement of dietary fibre; type I (defining methods), type II (reference methods), type III (alternative approved methods) and type IV (tentative methods), each with its own range of applicability. The Codex Committee on Methods of Analysis and Sampling have approved 14 methods for the measurement of dietary fibre: eight as type I methods, five as type II and one as type III (McCleary et al., 2013). A summary of these methods is given in Table 1.

Of these methods, the Association of Official Analytical Chemists (AOAC) methods 985.29 and AOAC 991.43 have been the main methods for dietary fibre analysis for many years. The AOAC 985.29 method measures the total high molecular weight dietary fibre (HMWDF) directly, while the AOAC 991.43 method distinguishes between insoluble and soluble HMWDF. The drawback of these methods is that they are inappropriate for the measurement of low molecular weight dietary fibre (LMWDF), such as inulin, fructo-oligosaccharides (FOS), galacto-oligosaccharides (GOS) and polydextrose, and they only measure RS3 category of resistant starch. Specific AOAC methods have therefore been developed to differentiate between different dietary fibre constituents. However, the large number of available methods makes it difficult to select an appropriate method for an unknown sample, and applying the broad classical and specific methods would be inappropriate since there is considerable overlap between these methods (Westenbrink et al., 2013). Table 1 shows the components measured by various methods of dietary fibre analysis and highlights the significant crossover between methods which can be problematic.

As a result, in 2007, a new method for the integrated measurement of total HMWDF, LMWDF and resistant starch was described (McCleary, 2007). This method is known as the AOAC 2009.01 total DF method. This method has eliminated the need for both AOAC 985.29 for total dietary fibre and the specific methods for measuring LMWDF and RS1, 2 and 4 (Westenbrink et al., 2013). The AOAC 2011.25 method was developed as an extension of AOAC 2009.01 and enables differentiation between the soluble HMWDF and insoluble HMWDF part, of which the sum equals the HMWDF fraction as measured with the AOAC 2009.01 method (McCleary et al., 2012; Westenbrink et al., 2013). Therefore, of the approved methods, only AOAC Method 2009.01 and AOAC Method 2011.25 measures the total content of dietary fibre as defined by the Codex Alimentarius, with no double counting of any components (McCleary et al., 2013) (Fig. 1). Further refinement of these latter methods is currently occurring in interlaboratory testing. The application of these methods has provided the dietary fibre databases available today.

Given the lack of information on the type of fibre in Australian Food Composition Databases (Food Standards Australia and New Zealand, 2014a), this project aimed to develop a database that included information for soluble fibre, insoluble fibre, and where possible resistant starch (RS), that could be applied to the analysis of dietary data. AUSNUT 2011–2013 Food Composition Database (Food Standards Australia and New Zealand, 2014a), which contains 5740 foods relevant to the Australian food supply, was used as a basis to establish a fibre categories database (FCD) thereby providing an expanded number of foods to potentially include.

Table 1
Summary of Association of Official Analytical Chemists (AOAC) and American Association of Cereal Chemists International (AACCI) Approved Dietary Fibre Analysis Methods [1].

Codex Alimentarius Method Type	AOAC Method	AACCI Method	Fibre fraction measured
I	985.29	32–05.01	Total HMWDF (IDF + HMWSDF)
I	991.42	32–20.01	IDF in foods
I	993.91	–	HMWSDF in foods
I	991.43	32–07.01	IDF and HMWSDF separately
I	994.13	32–25.01	Total HMWDF; provides sugar composition and Klason lignin
I	2001.03	32–41.01	HMWDF and LMWSDF in foods devoid of resistant starch
I	993.21	–	Total HMWDF in samples with > 10% fibre and < 2% starch
I	2009.01	32–45.01	HMWDF and LMWSDF in all foods
[a]	2011.25	32–50.01	IDF, HMWSDF, and LMWSDF in all foods
II	995.16	32–23.01	(1 → 3) (1 → 4)-β-Glucan in cereals, feeds, and foods
II	997.08	32–31.01	Fructans and FOS
III	999.03	32–32.01	Fructans and FOS (underestimates highly depolymerized FOS)
II	2000.11	32–28.01	Polydextrose
II	2001.02	32–33.01	Trans galacto-oligosaccharides
II	2002.02	32–40.01	Resistant starch (RS2 and RS3)

HMWDF = higher-molecular-weight DF; IDF = insoluble DF; HMWSDF = higher-molecular weight soluble DF; LMWSDF = lower-molecular-weight soluble DF; and FOS = fructooligosaccharides.
[a] No decision has yet been made by Codex concerning this method.