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Short Communication

Analysis of dietary fibre of boiled and canned legumes commonly consumed in the United Kingdom

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ABSTRACT

The use of different analytical methods to measure the dietary fibre content of foods complicates the interpretation of epidemiological studies. The aim of this study was to determine the total (TDF) and insoluble (IDF) fibre content of 14 boiled and canned legumes commonly consumed in the UK using the Association of Official Analytical Chemists (AOAC) enzymatic gravimetric method. The fibre values obtained were compared to non-starch polysaccharide (NSP) values. The results showed that mean values for TDF (2.7–11.2 g/100 g) were higher than NSP (2.6–6.7 g/100 g), with a mean NSP:TDF ratio of 1:1.43. TDF was correlated with NSP ($r = 0.6$; $p = 0.02$). Canning significantly reduced TDF and IDF by an average of 30% and 26% compared to boiling respectively. However, IDF represented at least 60% of the TDF in both boiled and canned samples. In conclusion, fibre values are affected by the processing and analytical method used.

1. Introduction

Legumes are a rich source of dietary fibre and provide a good source of energy from starch and protein as well (Trinidad et al., 2010). The beneficial effects of legumes have been reported in the results of a pooled analysis which showed an improvement in fasting blood glucose concentration in both diabetic and non-diabetes subjects (Sievenpiper et al., 2009). The hypoglycaemic effects of legumes have been attributed to their high content of dietary fibre (Trinidad et al., 2010).

The health benefits of a diet rich in dietary fibre have been reported (Lunn and Buttriss, 2007). Prospective studies were inconclusive regarding the protective effect of high dietary fibre intake on the risk of type 2 diabetes mellitus (Hopping et al., 2010; Barclay et al., 2007). Inconsistency in the results may be explained partly by differences in the analytical method used to estimate the dietary fibre intake and to errors arising from the dietary assessment tool that is commonly used in the prospective studies.

There are two analytical methods that are commonly used for dietary fibre analysis: the enzymatic chemical method developed by Englyst et al. (1982) and the enzymatic gravimetric methods (985.29 and 991.43) (Lee et al., 1992) endorsed by the Association of Official Analytical Chemists (AOAC). Both methods have been used to generate fibre data for food composition tables (Food Standard Agency, 2002; DeVries and Rader, 2005). The Englyst method (Englyst et al., 1982) is based on the chemical analysis of alcohol-insoluble cell wall polysaccharides remaining after the enzymatic degradation of starch. Some residual starch glucose may also be included in the Englyst NSP values, and the acid hydrolysis step may result in the loss of some acid-labile cell wall sugars (Wolters et al., 1992). Alternatively, the AOAC method is based merely on the gravimetric measurement of the alcohol-insoluble solid residue remaining after enzymatic degradation of starch and protein. Not only does the AOAC method provide a measure of plant cell wall polysaccharides, but it also includes other indigestible substances such as digestion-resistant starch and protein, lignin and high molecular weight polyphenols (Englyst et al., 2007).

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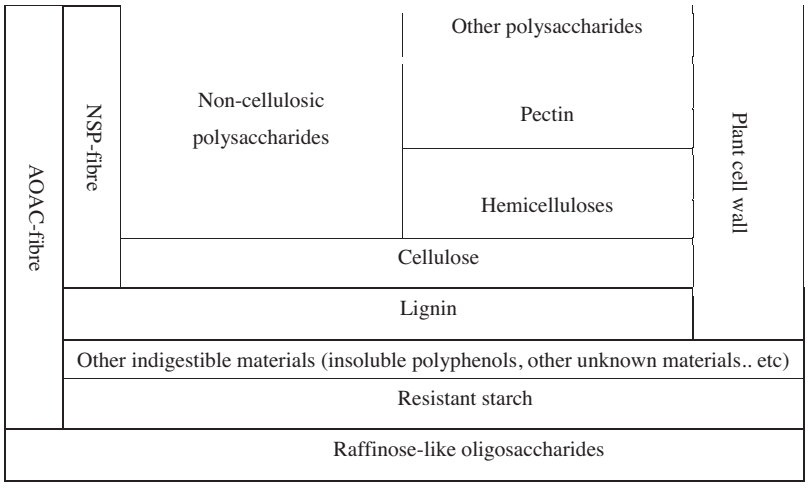

Fig. 1. Constituents of total dietary fibre measured by the Association of Organic Analytical Chemists (AOAC) method and non-starch polysaccharides (NSP) measured by Englyst method.
Adapted from British Nutrition Foundation (1990).

Neither method takes into account low molecular weight or ethanol-soluble indigestible oligosaccharides such as the raffinose-like oligosaccharides. For practical reasons, both methods use microbial enzymes for the degradation of starch, which may not give a true representation of starch digestibility *in vivo*. Fig. 1 shows the relationship between the main components of dietary fibre that are measured by the Englyst and AOAC methods. Updated dietary fibre definitions include components other than non-starch polysaccharides and therefore the AOAC analytical methods may more closely estimate the dietary fibre content of foods and have been adopted in many countries to provide fibre values for food composition tables and food labelling purposes (DeVries and Rader, 2005).

In the UK, the Englyst method has been used to determine non-starch polysaccharides (NSP) for food composition tables and remained the recommended method for nutrition and food labelling until 1999 (Food Standard Agency, 2002). After that, the Food Standard Agency (FSA) accepted the role of resistant starch and lignin as being part of dietary fibre and adopted the use of the AOAC method to generate fibre values for labelling purposes. The sixth edition of *McCance and Widdowson's The Composition of Foods* (Food Standard Agency, 2002) lists total dietary fibre (TDF) derived by AOAC values for 47 food items, including 27 values for the cereal group, 13 for the milk group, 4 for meat group, 2 for the fish group and a single item from vegetable dishes. There are no TDF values listed for any legume consumed in the UK.

Most epidemiological studies undertaken in the UK still use NSP values, and it is therefore difficult to compare UK studies to those conducted in the rest of the world. In order to address this issue, a mean ratio of TDF:NSP of 1:1.3 was generated for all food groups (Lunn and Buttriss, 2007). However, the legumes were not highly represented in this ratio. A study by Reistad and Frolich (1984) suggested a ratio between 1.1 and 1.4 for vegetables, but this study did not include legumes in the analysis. A ratio that includes legumes may be useful to convert NSP to TDF values for populations with high consumption of legumes, such as Asian ethnic minorities and vegetarians.

The aim of the current work was to determine TDF by the AOAC enzymatic gravimetric method for selected legumes commonly consumed in the UK. The study aimed to investigate the effects of common cooking methods (boiling and canning) on the TDF and IDF content of legumes. The second aim was to establish a NSP:TDF ratio for the legume group which would be of interest to nutritional epidemiologists.

2. Materials and methods

2.1. Materials

The tested samples were selected based on commonly consumed legume products listed in the National Diet and Nutrition Survey (NDNS) (Henderson and Swan, 2002) and frequency data derived from the UK Women Cohort Study (Cade et al., 2004). A descriptive analysis of a Food Frequency Questionnaire (FFQ) was used as part of the UKWCS showed that 88% of women in the cohort reported some legume consumption. The most frequently consumed pulses (at least once a week) were green beans (62%), peas (60%), baked beans (39%), lentils (15%), and mung and red kidney beans (12%), butter beans (9%) and chickpeas (8%). The women in the UKWCS reported eating legumes both in the boiled and canned forms, and therefore raw samples were not analysed.

Fourteen pooled samples of legumes were derived from different brands purchased from UK supermarkets and retailers (Tables 1 and 2). Composite samples were obtained according to the sampling protocol used in the UK food composition table (Food Standard Agency, 2002). Six types of legumes were included, namely yellow chickpeas (*Cicer arietinum* L.), red kidney beans (*Phaseolus vulgaris*), red lentils and green and brown lentil (*Lens culinaris*), butter beans (*Phaseolus lunatus* L.), green peas (*Pisum sativum*), and green beans (*Phaseolus vulgaris*), baked bean in tomato sauce (haricot or navy beans; *Phaseolus vulgaris*) and mung beans (*Vigna mungo*). All chemicals were of analytical grade and were purchased from Sigma–Aldrigh (Dorset, UK) unless otherwise stated.

2.2. Sample preparation

Dried legumes were processed prior to analysis. Processing included soaking overnight in tap water (1:5 w/v) at room temperature, followed by draining and then cooking in tap water at boiling temperature according to the UK food composition description in *McCance and Widdowson's The Composition of Foods* (Food Standard Agency, 2002). When cooking instructions were not available in the aforementioned book, packet instructions were followed as per normal domestic practice. Then, samples were drained and homogenised prior to analysis. Canned samples were drained and homogenised prior to analysis.