COMPARISON OF DIETARY FIBRE CONTENT IN DIFFERENT FIBRE SOURCES

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Abstract

Dietary fibre is an important component of human's nutrition. It is the common name for all carbohydrate components occurring in foods that are non-digestible in the human small intestine. It is known that deficiency of dietary fibre in food, provoke disturbance of intestinal tract, for example, constipation and that different fibre sources have different composition and quantities of dietary fibre. Therefore the task of research was to investigate the content of total, soluble and insoluble dietary fibre in different fibre sources such as wheat and rye bran, defatted flaxseeds, chicory and Jerusalem artichoke powder.

The results of research showed that total dietary fibre content in different fibre sources ranged between 41.76% and 59.42%, where the lowest TDF content was determined for wheat bran and the highest for Jerusalem artichoke powder. The content of TDF in defatted flaxseeds and Jerusalem artichoke powder was significantly higher comparing with other samples ($p<0.05$). Whereas dried chicory and Jerusalem artichoke powder were important sources of soluble dietary fibre, which significantly differed from other analysed samples ($p<0.05$). The significant part of SDF content made inulin, which contain in dried chicory was 94.3% of total SDF and in Jerusalem artichoke powder – 97.7%. The significantly higher amount of IDF was determined in wheat and rye bran, defatted flaxseeds ($p<0.05$) comparing with dried chicory and Jerusalem artichoke powder.

Keywords: bran, flaxseeds, chicory, Jerusalem artichoke, soluble and insoluble fibre.

Introduction

The food industry is facing the challenge of developing new food products with special health – enhancing characteristics, since the beneficial effects of healthy diet on the quality of life are wildly recognized. These functional materials come from a wide variety of plant sources which provide important nutraceutical components that may be used in food systems (Lee et al., 2004). Dietary fibre is an important component of human's nutrition. These health benefits include reduction in bowel transit time (Gear et al., 1981; Brennan, Cleary, 2005), prevention of constipation (Odes et al., 1993), reduction in risk of colorectal cancer in vitro (Rowland, 1995; Verghese et al., 2002), production of short chain fatty acids (Wasan, Goodland, 1996; Scharlau et al., 2009) and promotion of the growth of beneficial gut micro flora (Brennan, Cleary, 2005; Bosaeus, 2004). Fibre is naturally present in cereals, fruits, pulses, vegetables; it can be produced from sources that might otherwise be considered waste products. For example, soy hulls, defatted flaxseeds, oat hulls, spent brewer's grain and waste portions of fruits and vegetables (Katz, 1997). Dietary fibre is the common name for all carbohydrate components occurring in foods that are non-digestible in the human small intestine. These components include non-starch polysaccharides, resistant starch, and resistant oligosaccharides with three or more monomeric units, and other non-digestible, but quantitatively minor, components when naturally associated with dietary fibre polysaccharides, especially lignin. Dietary fibre components consist of two major classes: (1) water soluble polymers (SDF), such as pectins and gums, and (2) water insoluble materials (IDF), in which cellulose, hemicelluloses and lignin are included (Lebesi, Tzia, 2011). The Institute of Medicine (USA) recommends that children and adults consume 14 g of fibre for every 1 000 calories of food they eat each day. That means a person who eats 2 500 calories each day should get at least 35 g of fibre daily, while a person who eats 1 700 calories each day needs somewhat less fibre – about 24 g. Here are general fibre intake recommendations for different age groups and genders. These recommendations are based on the average daily calorie intake for people in these age and gender groups. Individuals who consume more or fewer calories than this average should adjust their fibre intake accordingly (Institute of Medicine, Food and Nutrition Board, 2005). In 2010 EFSA set European dietary reference values for nutrient intakes, where is written that a daily intake of 25 g of dietary fibre is adequate for normal bowel function in adults. In Latvia man consumes 20.2 g per day, women 15.8 g per day (Joffe et al., 2009). It is less than recommended daily intake of fibre. The part of nutritionists and diet experts suggest that 20–30% of daily fibre intake should come from soluble fibre (Institute of Medicine, Food and Nutrition Board, 2005).

Bran represents the outer parts of grains including the pericarp and surrounding cuticle, the testa and the aleurone layer. Depending on the milling process, commercial bran preparations also contain variable amounts of starchy endosperm and germ (Kamal-Eldin et al., 2009). Wheat bran are widely commercially available, are well characterised with respect to their composition and properties, especially with regard to their fibre components (Luhaloo et al., 1998). Wheat bran is the best known source of insoluble dietary fibre which helps to prevent and control bowel problems and to lower cancer risk (Verma, Banerjee, 2010). Whereas rye consumption inhibits breast and colon tumour growth in animal models, lower glucose responses in diabetics, and lowers the risks of death from coronary heart diseases (Verma, Banerjee, 2010).

Defatted flaxseeds contain circa 30% dietary fibres of which of one third is viscous and the majority of the flaxseed water-extractable dietary fibre (the mucilage) belongs to heterogenic polysaccharides. Viscous dietary fibre has been shown to induce an increased sensation and lowered energy intake at the following meal (Archer et al., 2004). Defatted flaxseeds are commercially available as the product rich in fibre, proteins, and polyunsaturated fatty acids. This dietary source is from oil pressing, using cold pressing method. Defatted flaxseeds are dietary fibre source, which are primarily recognised as a rich source of alfa linolenic acid and plant lignin and have as such been proposed to play a role in cardiovascular disease prevention (Bloedon, Szapary, 2004).

Chicory (*Chicorium intybus*) is one of the earliest known and most widely used raw materials for the manufacture of coffee substitutes (Pazola, 1987). The major component of chicory root is inulin which is a polymer of fructose with (2-1) glycoside linkages. Inulin is soluble in water and not hydrolyzed by human digestive enzymes, it is expected to behave like a soluble (Gibson et al., 1995). Inulin is used in the food industry not only as a source of dietary fibre (Flamm et al., 2001), but also as a functional food ingredient since it affects biochemical and physiological processes resulting in better health and reduction in the risk of many diseases in humans beings (Kaur, Gupta, 2002).

Jerusalem artichoke (*Helianthus tuberosus* L.) is cultivated mainly for use as green or ensiled forage, as a cover crop in marginal areas and to produce sugars (especially fructose) and fructans (inulin), which are used as food or for various chemical, electronicand pharmaceutical applications (Bosticco et al., 1989; Maijer, Mathijssen, 1991). Jerusalem artichoke is one of the most important candidates for use as a raw material for the industrial production of biological fructose and inulin. It is a particularly interesting and suitable crop, for southern European countries and especially in low-requirement environments (Paolini et al., 1998; D'Egidio et al., 1998).

It is known that deficiency of dietary fibre in food, provoke disturbance of intestinal tract, for example, constipation and that different fibre sources have different composition and quantities of dietary fibre. Therefore the task of research was to investigate the content of total, soluble and insoluble dietary fibre in different fibre sources such as wheat and rye bran, defatted flaxseeds, chicory and Jerusalem artichoke powder.

Materials and Methods

The research was performed at the Food technology laboratory of the Department of Food Technology of Latvia University of Agriculture and at the laboratory of Microbiology and Biotechnology Department of the Faculty of Biology of Latvia University.

Materials used in the research were wheat bran (Farm "Paukulnieki", Latvia), rye bran (Farm "Paukulnieki", Latvia), defatted flaxseeds with fat content less than 10% ("Iecavnieks and Co", Latvia), dried chicory ("RA5", Latvia) and Jerusalem artichoke ("Herbe", Latvia). Wheat and rye bran as well dried chicory were milled for analysis.

The content of total, soluble and insoluble dietary fibre was determined by AOAC Official Method: 991.43; Total, Soluble and Insoluble Dietary Fiber in Foods Enzymatic-Gravimetric Method (Phospate buffer) and using the FOSS Analytical Fibertec E 1023 System.

The content of inulin was determined by AOAC Official Method 999.03 and by AACC Official Method 32.32.

The analyses were performed in triplicate. The differences in the content of total, soluble and insoluble dietary fibre were analyzed using the analysis of variance (ANOVA). t-test was applied to compare the mean values, and p-value at 0.05 was used to determine the significant differences.

Results and Discussion

The total dietary fibre (TDF) content in different fibre sources such as wheat and rye bran, defatted flaxseeds, dried chicory and Jerusalem artichoke powder is given in Table 1. The obtained results were compared with literature data for analysis.

Table 1

Comparison of total dietary fibre content in analyzed samples with literature data, %

Samples	Total dietary fibre (TDF)		Authors
	Research data	Literature data	
Wheat bran	41.76±1.54	39.9–53.1	Kamal-Eldin et al., 2009
Rye bran	42.28±0.98	41.1–47.5	Kamal-Eldin et al., 2009
Defatted flaxseeds	57.41±1.03	22.33[b]	Schakel et al., 2001
Dried chicory	46.10±1.09[a]	80.00[c]	Schittenhelm, 1996
Jerusalem artichoke powder	59.42±1.21[a]	62.88[a]	Gedrovica, 2012

[a] Total dietary fibre content with inulin
[b] Total dietary fibre content in raw flaxseeds
[c] There is indicated only inulin

Total dietary fibre (TDF) content in different fibre sources ranged between 41.76% and 59.42%, where the lowest TDF content was determined for wheat bran and the highest for Jerusalem artichoke powder. Comparing the research data with literature it was established that obtained results were close to data given in literature except defatted flaxseeds and dried chicory. The differences of TDF content in flaxseeds could be explained with various used materials: raw flaxseeds (data of literature) and defatted flaxseeds (data of research). The literature data of TDF content in defatted flaxseeds was not available. The differences of

TDF in dried chicory could be chained with various factors such as chicory sort, growing conditions, season, and region as well treatment technology.

The results of dispersion analysis established that there were no significant differences of TDF content among wheat and rye bran as well dried chicory ($p>0.05$). Whereas the content of TDF in defatted flaxseeds and Jerusalem artichoke powder was significantly higher comparing with other samples ($p<0.05$). Evaluating the dietary fibre content there is important the amount of soluble and insoluble dietary fibre in product. Therefore the content of soluble and insoluble dietary fibre in analysed fibre sources is shown in Figure 1.

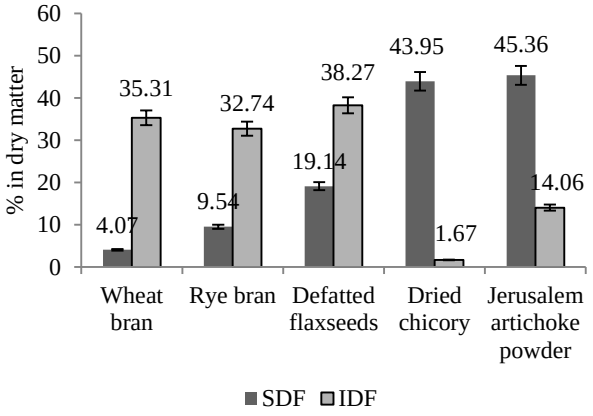

Figure 1. Content of soluble and insoluble dietary fibre in different fibre sources

SDF – soluble dietary fibre, IDF – insoluble dietary fibre

The obtained results showed that dried chicory and Jerusalem artichoke powder were important sources of soluble dietary fibre (SDF), which significantly differed from other analysed samples ($p<0.05$). The significant part of SDF content made inulin, which contain in dried chicory was 94.3% of total SDF and in Jerusalem artichoke powder – 97.7%. Due inulin contain in dried chicory and Jerusalem artichoke powder the both fibre sources have been attempted in different products attributed to their health benefits. Inulin possesses the typical properties of fibre – reduction of transit time in bowel, decreasing of pH in colon, beneficial effect on blood indices (Roberfroid, 1993). The SDF contain in rye bran confirm the conclusions of Åman et al. (1997) research that rye fibre contains soluble fibre 11–12% , i.e., in the form of arabinoxylan (9%) and β-glucan (2–3%).

Evaluating the content of insoluble dietary fibre (IDF) in analysed samples there was determined significantly higher amount of IDF in wheat and rye bran, defatted flaxseeds ($p<0.05$) comparing with dried chicory and Jerusalem artichoke powder. The obtained results correspond to Verma and Banerjee (2010) investigations that wheat bran is the best known source of insoluble dietary fibre.

The present study showed that different fibre sources had various amount of soluble and insoluble dietary fibre. Therefore it is important to mix different fibre sources for producing new functional products with advisable soluble and insoluble dietary fibre correlation.

Conclusions

Total dietary fibre (TDF) content in different fibre sources ranged between 41.76% and 59.42%, where the lowest TDF content was determined for wheat bran and the highest for Jerusalem artichoke powder. The content of TDF in defatted flaxseeds and Jerusalem artichoke powder was significantly higher comparing with other samples ($p<0.05$). Whereas dried chicory and Jerusalem artichoke powder were important sources of soluble dietary fibre, which significantly differed from other analysed samples ($p<0.05$). The significant part of SDF content made inulin, which contain in dried chicory was 94.3% of total SDF and in Jerusalem artichoke powder – 97.7%. The significantly higher amount of IDF was determined in wheat and rye bran, defatted flaxseeds ($p<0.05$) comparing with dried chicory and Jerusalem artichoke powder.

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