JAP&T
TPA-Timişoara

Available on-line at www.japt.tpa.usab-tm.ro

Journal of Agroalimentary Processes and Technologies 2009, *15*(1), 122-125

Journal of Agroalimentary Processes and Technologies

Influence of soluble dietary fiber extract procedure on the dynamic viscosity coefficient

A. Căpriță*, Rodica Căpriță

Banat's University of Agricultural Sciences and Veterinary Medicine Timişoara, Romania

Abstract

Dietary fiber includes all non-starch polysaccharides resistant to digestion in the small intestine and fermentable in the large intestine. The viscosity of dietary fiber depends on their solubility and molecular weights. Solubility, in turn, depends on their chemical structure and their association with the rest of the cell wall components. The arabinoxylans not bound to the cell walls can form highly viscous solutions and they can absorb about ten times their weight of water. The viscosities of aqueous extracts of different wheat concentrations were investigated. Two extraction procedures were experimented: with (procedure 1) and without (procedure 2) deactivating the endogenous enzymes. The viscosity of aqueous wheat flour extracts is concentration dependent. A higher positive correlation (r = 0.9827) was observed in procedure 1 than in procedure 2 (r = 0.9288).

Keywords: dietary fiber, wheat, viscosity.

1. Introduction

Several different classification systems have been used to classify the components of dietary fiber: based on their role in the plant, based on the type of polysaccharide, based on their simulated gastrointestinal solubility, based on site of digestion, and based on products of digestion and physiological classification. However, none is entirely satisfactory, as the limits cannot be absolutely defined. The most widely used classification for dietary fiber has been to differentiate dietary components on their solubility in a buffer at a defined pH, and/or their fermentability in an in vitro system using an aqueous enzyme solution representative of human alimentary enzymes.

However, there is still debate regarding the most appropriate means to define and classify dietary fiber.

At the American Association of Cereal Chemists (AACC) Annual Meeting in Seattle, in November 1999, the AACC concluded the definition of dietary fiber: the remnants of the edible part of plants and analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the human large intestine.

Dietary fiber includes all non-starch polysaccharides (NSP) resistant to digestion in the small intestine and fermentable in the large intestine.

The principal components (approximately 90%) of plant cell walls are polysaccharides that do not have □-glucosidic linkages and therefore collectively are termed NSP [1,2].

Indigestible polysaccharides (fiber components) consist of all NSP resistant to digestion in the small intestine and fermentable in the large intestine. These polysaccharides are typically long polymeric carbohydrate chains containing up to several hundred thousand monomeric units. The polysaccharides differ by the number and type of monomeric units linked together, the order in the chain, the types of linkages between the various monomers, the presence of branch points in the backbone of the molecule, and by presence

* Corresponding author: *e-mail address*: adrian.caprita@gmail.com

of acidic groups (for example, uronic acids in pectins).

Examples of these NSP compounds are cellulose with β-glycosidic bonds, nonglucose sugars (hemicelluloses such as arabinoxylans and arabinogalactans), sugar acids (pectins), gums, and mucilages.

Resistant oligosaccharides, such as the fructans (oligomers and polymers of fructose, i.e. inulin and fructooligo-saccharides (FOS)), are characterized as carbohydrates with a relatively low degree of polymerization (DP), as compared to the NSP. FOS differs from fructo-polysaccharides (inulin) only in chain length. The strict definition of an oligosaccharide is a chain of monomer units with a DP of 3-10 [3].

Oligosaccharides, such as oligofructans, include the lower molecular weight analogues of the digestion-resistant polysaccharides. Analogous carbohydrates, i.e. polysaccharides having the digestion resistance, fermentation, and physiological properties of naturally sourced dietary fibers, are also included.

Lignin and the plants substances associated with the non-starch polysaccharides are an integral part of the fibrous portion of plants.

Lignin is a phenylpropane polymer, and not a carbohydrate that is covalently bound to the fibrous polysaccharides (cellulose) of plant cell walls. Lignin has a heterogeneous composition ranging from 1 or 2 units to many phenyl propanes that are cyclically linked. Lignin, a polyfunctional polymer is intimately formed with and infiltrates the cellulose of plant cell walls and is very resistant to digestion, even with strong acid. Lignin is also included as a dietary fiber Likewise, waxes and cutin, found as waxy layers at the surface of the cell walls, are made up of highly hydrophobic, long chain hydroxy aliphatic fatty acids and are resistant to digestion and probably render the associated tissues resistant to digestion [4]. Suberin, while not well characterized, is hypothesized to be a highly branched and cross-linked combination of polyfunctional phenolics, polyfunctional hydroxyacids, and dicarboxylic acids [5] that are likely linked to the cell wall with ester linkages. Evidence of its intimate interaction with other dietary fiber components is the fact that only suberin-enriched fractions, but never purified suberin, have been prepared. And finally, phytate (phytic acid), tannins and saponins that are part of the dietary fiber complex are included.

Cereal grains are major sources of dietary fiber, an important contributor to human health. Dietary fiber fractions, such as nonstarch polysaccharides, have the potential to lower cholesterol and the glycaemic response of food as well as to promote regularity and improve bowel health.

Experiments were carried out to study the influence of extraction conditions on the viscosity values of cereal water extracts.

2. Materials and Method

The viscosities of aqueous extracts of different wheat concentrations were investigated. The samples were milled by a laboratory grinder at a 600 μm sieve.

Two extraction procedures were experimented. In procedure 1 we incubated the sample with 80% (v/v) ethanol at 80°C, and than added water to the pellet and incubated at 40°C for 2 h with constant stirring. In procedure 2 we skipped the incubation step with ethanol.

Following the centrifugation of the water extract, an aliquot of 0.5 mL supernatant was taken and its viscosity determined using a cone/plate viscometer (Brookfield Model DVIII Cone CP-40) at a constant temperature of 25°C.

3. Results and Discussion

In the present study significant differences between the viscosities of two procedures used for aqueous extracts were found.

The water-soluble, nonstarch polysaccharides of wheat are mainly pentosans. Wheat soluble NSP give rise to

highly viscous aqueous solutions even at low concentrations.

In aqueous solutions, water molecules penetrate the amorphous regions of soluble NSP. These water molecules bind to available sites, which reduce inter-polysaccharide associations. The increase in viscosity of the polysaccharide molecules is explained by formation of Ca2+ bridges and hydrogen bonds, resulting in a loose network that can hold considerable amounts of water [6,7].

The viscosity values obtained with procedure 2 are lower than those obtained with procedure 1.

When we compare the percentage increase of viscosity with the percentage increase in wheat concentration, we observe that in procedure 1 the viscosity increase is up to 167.41% while in procedure 2 is only 129.21%, for 20% wheat concentration (Figure 1).

There are two possible explanations for these results: a) in procedure 1 we added ethanol to deactivate the endogenous enzymes present in the grain, while in procedure 2 a part of the soluble nonstarch polysaccharides were hydrolyzed and consequently their molecular mass reduced; b) Elevated temperatures affect polymer solubility by increasing enzymatic degradation of water-insoluble pentosans to a water-soluble form via transarabino-sylation.

Extract viscosity determined using water extraction correlated well with the wheat concentrations as presented in Figures 2 and 3. A higher positive correlation (r = 0.9827) was observed in procedure 1 than in procedure 2 (r = 0.9288).

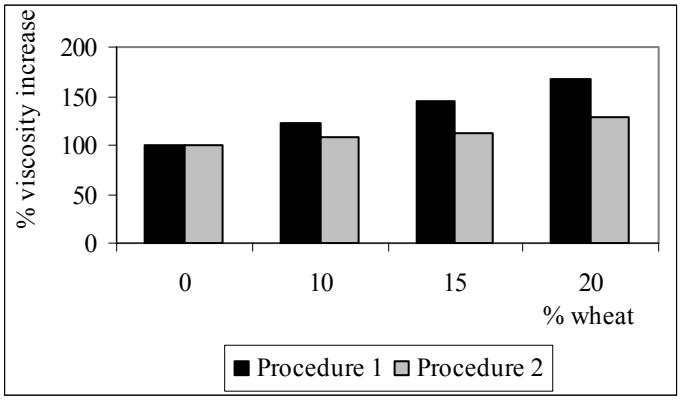

Figure 1: The percentage increase of water extract viscosity obtained by procedures 1 and 2

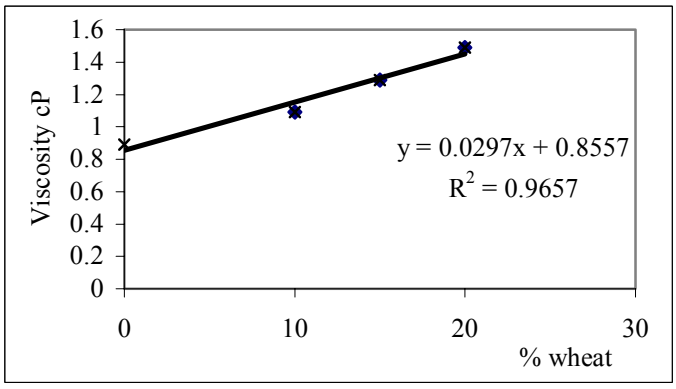

Figure 2: The positive linear relationship between aqueous extracts viscosity values and wheat concentration in procedure 1

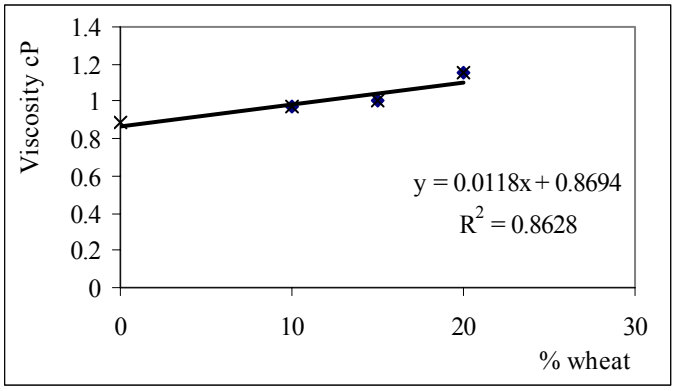

Figure 3: The positive linear relationship between aqueous extracts viscosity values and wheat concentration in procedure 2

4. Conclusion

The viscosity values obtained with procedure 2 are lower than those obtained with procedure 1.

Extract viscosity determined using water extraction correlated well with the wheat concentrations.

A higher positive correlation (r = 0.9827) was observed in procedure 1 than in procedure 2 (r = 0.9288).

Acknowledgements

This work was supported by PN II-IDEI projects, CNCSIS code 898 and 894.

References

1. Trowell, H., *Dietary Fibre; A Paradigm*. In: *Dietary Fibre, Fibre-Depleted Foods and Disease*, Academic Press, London, 1985, pp. 1–20.
2. Englyst**,** H.N.; Cummings, J.H., Digestion Of The Polysaccharides Of Potato in The Small Intestine Of Man, *The American Journal of Clinical Nutrition* **1987**, 45, 423–431.
3. Englyst, H. N.; Kingman, S. M.; Cummings, J. H., Classification and Measurement of Nutritionally Important Starch Fractions, *European Journal of Clinical Nutrition* **1992**, 46 (2), 33-50.
4. Cho, S.S.; DeVries, J.W.; Prosky, L., *The Structure and Chemistry Of Dietary Fiber*. In: *Dietary Fiber Analysis and Applications*, AOAC International, Gaithersburg, MD, 1997, pp. 11-48.
5. Kolattukudy, P.E., Structure, Biosynthesis and Biodegradation of Cutin and Suberin, *Annual Review of Plant Physiology* **1981**, 32, 539-567.
6. Selvendran, R.R.; Stevens, B.J.H.; Du Pont, M. S., Dietary Fibre: Chemistry, Analysis and Properties, *Advances in Food Research* **1987**, 31, 117-209.
7. Choct, M., Feed Non-Starch Polysaccharides: Chemical Structures and Nutritional Significance, *Feed Milling International* **1997**, 6, 13-26.