JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2011, *17*(3), 242-245

Journal of Agroalimentary Processes and Technologies

Water Extract Viscosities Correlated with Soluble Dietary Fiber Molecular Weight in Cereals

Adrian Căpriţă[1*], Rodica Căpriţă[1], Vasile Octavian Simulescu[2], Raluca Mădălina Drehe[2]

[1]*Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technology, Food Quality Department, 300645-Timişoara, C. Aradului 119, Romania*
[2]*Romanian Academy Institute of Chemistry, 300223-Timişoara, Bd. Mihai Viteazul 24, România*

Received: 12 August 2011; Accepted: 14 September 2011

Abstract

Dietary fiber (DF) is a group of food components that pass undigested through the stomach and small intestine and reach the large intestine virtually unchanged. Although poor in caloric or nutritional value, food fiber has significant health benefits. Whole grain cereals are some of the best sources of DF, along with beans, fruits, vegetables and nuts. Cereals contain substantial amounts of both soluble and insoluble DF. Almost all water-soluble polysaccharides produce viscous solutions. The viscous properties of DF are determined by several factors, including their chemical composition, molecular size, and composition of the extraction media. The study had in view the correlation between water extract viscosities and molecular weight of soluble DF in some whole grain cereals. There is a good correlation between the obtained water extracts viscosities and the average molecular weights of soluble DFs from barley, triticale, oat and wheat. The obtained value of the regression coefficient was r = 0.917.

Keywords: dietary fiber, viscosity, molecular weight, barley, triticale, oat, wheat

1. Introduction

Dietary fiber (DF) is a group of food components that pass undigested through the stomach and small intestine and reach the large intestine virtually unchanged. Small amounts of some dietary fiber may be broken down by bacteria normally found in the intestine and absorbed by the body; the remaining components are excreted.

Although poor in caloric or nutritional value, food fiber has significant health benefits and may assist weight control. Fiber-deficiency is linked to a higher risk of digestive conditions, raised cholesterol levels and some intestinal cancers [1,2].

There are two categories of DF: insoluble, and soluble. Soluble fiber includes gums, mucilages, pectin and some hemicelluloses.

Insoluble fibers are cellulose, lignin, and the rest of the hemicelluloses; these fibers provide structure to plants [3,4].

During digestion, soluble fibers turn into gel like substances as, slow down digestion process in the stomach and intestines, stabilizing blood glucose levels, and increasing the uptake of minerals and other nutrients. Insoluble fibers consist of the parts of plants which cannot be digested at all, moving whole through the digestive system; insoluble fibers increase stool volume and stimulate normal bowel contractions thus reducing passage-time through the colon, improving health in the intestinal tract, and reducing digestive complaints [1,2].

Whole grain cereals are some of the best sources of DF, along with beans, fruits, vegetables and nuts.

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

Cereals contain substantial amounts of both soluble and insoluble DF. The predominant water soluble DFs in wheat, triticale and rye are arabinoxylans, while β-glucans are the predominant water soluble DFs in barley and oat.

Water-soluble fiber fractions have opposite effects on water binding capacity and viscosity than the insoluble fractions [5].

Almost all water-soluble polysaccharides produce viscous solutions. The viscous properties of DF are determined by several factors, including their chemical composition, molecular size, and composition of the extraction media.

β-Glucans (Figure 1) are linear polymers of glucose with β-(1,3)(1,4) glycosidic links. Arabinoxylans (Figure 2) consist of long backbone chains of β-(1,4) anhydro-D-xylopyranosyl with single α-L-arabinofuranosyl residues attached at the 2- or 3-position [6,7]. The structure of plant cell wall influences the physical and chemical properties of the individual DF and these vary considerably between different polymers and different molecular weights of the same polymer [8,9].

The study had in view the correlation between water extract viscosities and molecular weight of soluble DF in some wholegrain cereals.

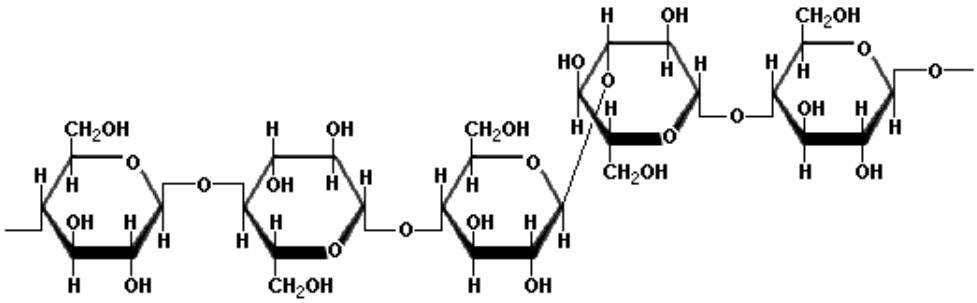

Figure 1. Structure of β-glucan [6]

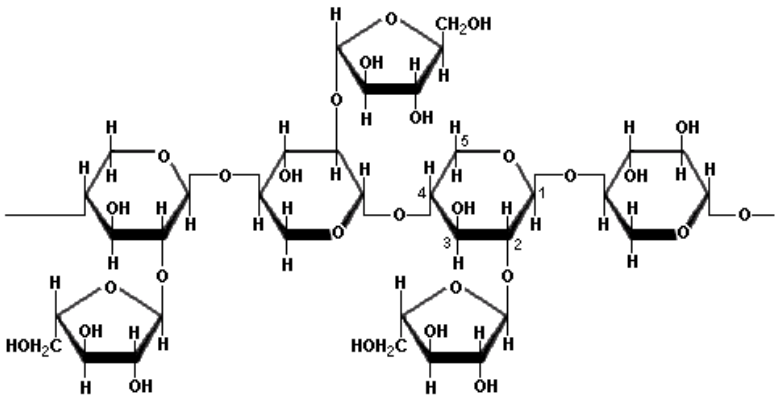

Figure 2. Structure of arabinoxylan [6]

Table 1. Properties of soluble DFs from cereals [10]

Property	Wheat	Triticale	Barley	Oat
Soluble DFs content (%)	0.6	0.7	1.2	1.0
Average molecular weight	255 000	569 000	665 000	446 000

2. Materials and Method

Wheat, triticale, oat and barley samples were milled to 500 μm granulation.

The water-soluble fractions were obtained by a single extraction at a ratio 1/2 (flour/water), by shaking the tubes at 150 rpm, for 60 minutes at 40ºC, using a LabTech LSB-015S water bath.

The extracts were centrifuged for 10 minutes at 5,000 rpm and 25°C, using a Hettich 320R centrifuge.

The dynamic viscosity was determined using a cone/plate viscometer Brookfield Model DVIII Cone CP-40, at 100 rpm and 25°C. The relative viscosity was calculated.

3. Results and Discussion

DFs from cereals have a wide distribution of the molecular weights. The molecular weights of water extracts obtained from cereals are of 10^6 magnitudes (Table 1).

The molecular characteristics of β-glucans and arabinoxylans are important both for their physical properties, e.g. water solubility, viscosity, freezing behavior, and for their physiological role in the gastrointestinal tract.

In terms of functional food properties, the best soluble DFs are β-glucans. β-Glucans (which are the predominant water soluble DFs in barley and oat) consist of long cylindrical molecules containing up to about 250,000 glucose units. Soluble DFs having high molecular weights increase the digesta viscosity and are supposed to play beneficial role in reducing heart diseases by lowering cholesterol and reducing the glycemic response. They are used in food technology as fat substitutes and to adjust food texture.

Arabinoxylans (which are the predominant water soluble DFs in wheat and triticale) are important in the baking industry. They are used to adjust the texture of baked products due to the property of the arabinose units to bind water and produce viscous compounds that influence the consistency of dough, and the retention of gas bubbles from fermentation in gluten-starch films.

There is a good correlation between the obtained water extracts viscosities and the average molecular weights of soluble DFs from barley, triticale, oat and wheat (Figure 3)

The obtained value of the regression coefficient (Figure 4) was r = 0.917, in accordance with literature data [11,12].

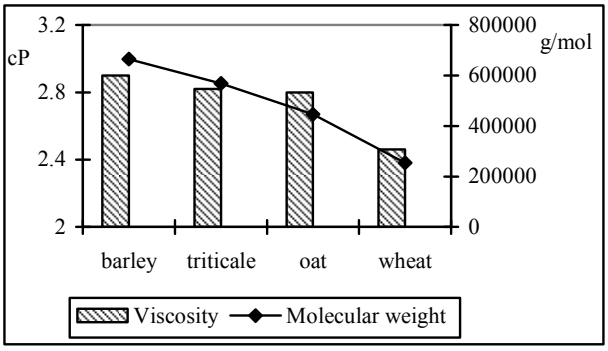

Figure 3. Water extracts viscosities and average molecular weight of soluble DFs from barley, triticale, oat and wheat

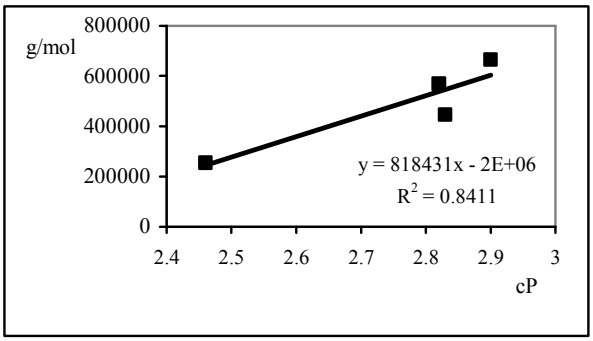

Figure 4. Correlation between water extracts viscosities and average molecular weights of soluble DFs from barley, triticale, oat and wheat

4. Conclusion

The viscous properties of dietary fiber are determined by several factors, including their chemical composition, molecular size, and composition of the extraction media.

The viscosities of water extracts obtained from barley, triticale, oat and wheat are correlated with soluble dietary fiber molecular weights. The obtained value of the regression coefficient is r = 0.917.

Acknowledgements

This work was supported by CNCSIS–UEFISCSU, project number 1055/2009 PNII–IDEI code 898/2008.

References

1. American Heart Association, Whole grains and fiber, http://www.americanheart.org/presenter.jhtml?identifier=4574, **2011**.

2. Anderson, J.W.; Bridges, S.R., Dietary fiber content of selected foods, *American Journal of Clinical Nutrition*, **1988**, *47*(3), 440-447.
3. Henley, S.; Misner, S., Dietary fiber, http://ag.arizona.edu/pubs/health/az1127.html, **1999**.
4. Anderson, J.; Perryman, S.; Young, L; Prior, S., Dietary fiber, http://www.ext.colostate.edu/pubs/foodnut/09333.html, **2011**.
5. Sasaki, T.; Yasui, T.; Matsuki, J., Effects of amylose content on gelatinization, retrogradation, and pasting properties of starches from waxy and nonwaxy wheat and their F1 seeds, *Cereal Chemistry* **2000**, *77*(1), 58-63, doi: 10.1094/CCHEM.2000.77.1.58
6. Zamora, A., Carbohydrates - chemical structure, http://www.scientificpsychic.com/fitness/carbohydrates2.html, **2005**.
7. Lineback, D.R.; Rasper, V.F., *Wheat Carbohydrates*, In: *Wheat: Chemistry and Technology, vol. 1*, Pomeranz, Y. (ed.), Am. Assoc. Cereal Chem., St. Paul, 1998, 277-371
8. Căpriţă, R.; Căpriţă, A.; Julean, C., Biochemical aspects of non-starch polysaccharides, *Scientific Papers: Animal Science and Biotechnologies*, **2010**, *43*(1), 368-374.
9. Chawla, R.; Patil, G.R., Soluble dietary fiber, *Comprehensive Reviews in Food Science and Food Safety* **2010**, *9*(2), 178–196, doi: 10.1111/j.1541-4337.2009.00099.x
10. Girhammar, U.; Nair; B.M., Certain physical properties of water-soluble non-starch polysaccharides from wheat, rye, triticale, barley and oats, *Food Hydrocolloids*, **1992**, *6*(4), 329-343, doi:10.1016/S0268-005X(09)80001-5
11. Goncharenko, A.A.; Timoshchenko, A.S., Analysis of the correlation potential of traits determining the viscosity potential of a water extract of winter rye grain, *Russian Agricultural Sciences*, **2010**, *36*(3), 151-155, doi: 10.3103/S1068367410030018
12. Yao, N; Jannink, J.-L.; White, P., Molecular weight distribution of (1→3)(1→4)- β -glucan affects pasting properties of flour from oat lines with high and typical amounts of β -glucan, *Cereal Chemistry*, **2007**, *84*(5), 471–479, doi:10.1094/CCHEM-84-5-0471