INFLUENCE OF TEMPERATURE ON THE EXTRACTIBILITY OF POLYSACCHARIDES IN WHEAT

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Abstract

Wheat increases the viscosity of contents in the intestine of birds, and consequently decrease the nutrient utilization. The nutritional value of wheat is not related to the amount of insoluble arabinoxylans, but it is correlated with the content of soluble arabinoxylans. Therefore, the viscosity value of the wheat water extract is more important in estimating nutrient composition than the composition of the cell walls. Our experiments had in view the effect of temperature on the soluble fraction of non-starch polysaccharides (NSPs). The heating of the samples at 60°C and 80°C, before extraction, resulted in the decrease of the soluble NSPs, as evidenced by the dynamic viscosity variation. Heating the wheat samples for 15 minutes at 80°C deactivates the endogenous hydrolytic enzymes.

Key words: non-starch polysaccharides, dynamic viscosity, wheat

INTRODUCTION

Wheat increases the viscosity of contents in the digestive tract of birds, and consequently decreases the nutrient utilization. Extract viscosity values of grains could be used as predictors of anti-nutritional properties of non-starch polysaccharides (NSPs) in cereals. The viscous properties of NSPs depend on several factors, including their chemical composition, molecular size, and composition of the extraction media.

The non-starch polysaccharides includ soluble and insoluble forms that depend on the lenghts of the main chain and the number of the branch in the molecule structure.

The NSPs content and type can also vary among grains. The NSPs content relative to dry matter is lower in wheat kernel (11.4%) than in rye (13.2%) and barley (16.7%). Arabinoxylans is are the predominant NSPs in wheat (6-8%) and rye (8.9%), while β-glucans is are the predominant NSPs in barley (7.6%) [9].

The anti-nutritive role of arabinoxylans in wheat is explained by two mechanisms [3,7]. The first mechanism implies that the arabinoxylans in endosperm cell walls and aleurone layers are resistant to enzymatic attack in the small intestine and so prevent access of endogenous enzymes. The second mechanism stipulates that a part of the arabinoxylans in the cell walls dissolve in the small intestine and contribute to environmental viscosity. The increase in the digesta viscosity in monogastric animals, decreases the nutrient diffusion [5], reduces the rate of the feed transit [8] and increases the microbial growth in the small intestine [4].

The nutritional value of wheat is not related to the amount of insoluble arabinoxylans, but it is correlated with the content of soluble arabinoxylans [1]. Therefore, the viscosity is more important in estimating nutrient composition than the composition of the cell walls. Since the viscosity of the pentosans depend on their molecular weight [2,6], better correlation could be obtained between the nutritive value and the soluble arabinoxylans with high molecular weight.

MATERIAL AND METHOD

The experiments had in view the effect of temperature (60°C and 80°C) on the soluble fraction of NSPs, revealed by determination of water extract viscosity.

The wheat samples, milled by a laboratory grinder at a 500 μm sieve, were heated in a forced air oven Froilabo AC60 for 5, 10 and 15 minutes. The soluble NSPs were extracted from the wheat samples, in the

following conditions: extraction temperature 40°C and extraction time 60 minutes. The extract was isolated by centrifugation for 10 minutes at 10.000 rpm, with a Hettich 320R centrifuge. The dynamic viscosity was determined using a cone/plate viscometer (Brookfield Model DVIII Cone CP-40) at 60 rpm and 25°C, at different times after the extract separation: 0, 30 and 60 minutes.

RESULTS AND DISCUSSIONS

The obtained experimental data are presented in Table 1.

The heating of the samples at 60°C and 80°C before extraction induces a decrease in the soluble fraction of polysaccharides, revealed by the variation of the dynamic viscosity.

When heating the wheat samples at 60°C, all viscosity values were lower than the viscosity of the unheated sample (Figure 1). The lower viscosity values suggest that soluble arabinoxylans were hydrolyzed by the endogenous enzymes and consequently their molecular mass reduced.

Heating the wheat samples for 15 minutes at 80°C deactivates the endogenous hydrolytic enzymes. There is no variation of the dynamic viscosities with the time that has elapsed from the centrifugation of the extract till the determination of the dynamic viscosity (Figure 2).

Table 1. Water extract viscosities of wheat samples heated at 60°C and 80°C

No.	Temperature (°C)	Heating time (min.)	Time after centrifugation (min.)	Dynamic viscosity (cP)
1.	60	5	0	2.10
			30	1.92
			60	2.20
		10	0	1.92
			30	1.91
			60	1.82
		15	0	2.00
			30	1.83
			60	1.88
2.	80	5	0	2.18
			30	1.90
			60	1.77
		10	0	2.40
			30	1.86
			60	1.67
		15	0	1.95
			30	2.02
			60	1.82

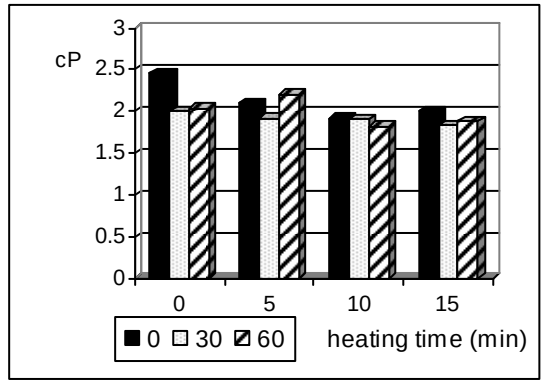

Fig. 1 Water extract viscosities of the wheat samples heated at 60°C, at different times after centrifugation of the extract

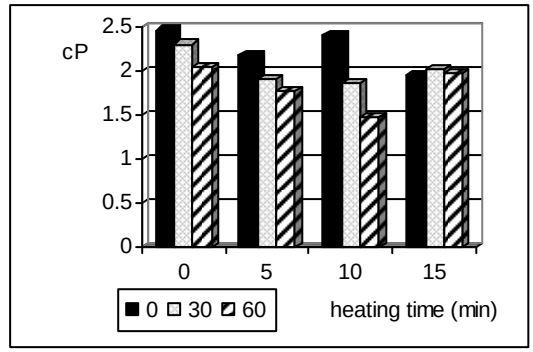

Fig. 2. Water extract viscosities of the wheat samples heated at 80°C, at different times after centrifugation of the extract

CONCLUSIONS

- Elevated temperatures affect polysaccharides solubility.
- Heating the wheat samples at 60°C and 80°C before extraction, has the effect of lowering the soluble fraction of the polysaccharides.
- Heating the wheat samples at 60°C, all viscosity values were lower than the viscosity of the unheated sample when the determinations were made immediately after centrifugation.
- Heating the wheat samples for de 15 minutes at 80°C deactivates the endogenous hydrolytic enzymes and consequently no decrease in the viscosity with the time elapsed after centrifugation was observed.

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