

Viscosity of water and buffer extract as a new tool in selection of oat genotypes for specific end-uses



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INTRODUCTION

Oat is recognized as a beneficial dietary component that protects against cardiovascular diseases, diabetes and obesity. Besides lower content of starch, high amount of valuable protein and lipids, oat is rich source of dietary fibre, especially of β -glucan, in human diet. In epidemiological study it has been proved the lowering effect of β -glucan on blood cholesterol level and postprandial glucose response (Braaten et al., 1995; Jenkins et al., 2002; Queenan et al., 2007; Granfeldt et al., 2008). Oat is also used for livestock feeding, but its amount in the feed is often limited, depending on the animal species, due to a high content of hulls and fibre, that have negative effect on nutrient density and digestibility (Aimonen and Nasi, 1991). Taking into account significant variability in chemical composition, it indicates therefore, that the same cultivars might have different usefulness either for food or feed purposes and the content of β -glucan is crucial in this respect. For these reasons, selection of oat breeding materials with either high or low content of β -glucan, depending on their future use, is a necessity nowadays.

In order to attain better utilization of existing cultivars and also to achieve substantial progress in breeding, it is necessary to provide appropriate tool to facilitate selection of the appropriate genotypes for these two major end-uses of oat. Such tool seems to be a viscosity assay, which needs modification and validation adapted for specificity of oat and conditions of their processing and it was the purpose of our study.

MATERIALS AND METHODS

Material comprised of two hulled (Bingo, Krezus) and one naked (Siwek) oat cultivars, grown at the same location in 2013 harvest year. Optimization of the viscosity assay was performed using intact as well as dehulled grains. Extracts were prepared from finely ground whole grain with distilled water and HCl-KCl buffer of pH 1.5, used as a solvent. The following factors were examined: dilution rate of grain to solvent (1:3w/v, 1:5w/v, 1:10w/v, 1:20w/v), extraction temperature (30°C, 35°C, 40°C, 45°C, 50°C, 60°C), centrifugation speed of resultant suspension (1000 rpm, 6000 rpm). These factors were examined at the same time of extraction (1h) and were measured on Brookfield Cone/Plate Digital Viscometer, with a 0.8° cone spindle and shear rate of 225 sec applied at 30°C. Components, such as β -glucan, protein, lipids and starch, which might have a significant influence on the viscosity value were also determined.

Effect of dilution rates on viscosity of water extract of oat (w/v)

Cultivar/form	1/3	error	1/5	error	1/10	error	1/15	error
Siwek n+imp.	4,67	9,7	2,71	5,0	1,46	0,5	1,2	1,2
Bingo h	2,00	11,7	1,39	1,6	1,08	1,3	0,96	1,5
Krezus h	1,62	6,7	1,22	1,2	1,00	1,4	0,95	0,7
Siwek n	14,1	11,1	5,29	0,9	1,96	1,1	1,47	1,0
Bingo d	8,25	14,9	3,11	2,0	1,67	0,4	1,31	1,1
Krezus d	4,98	14,0	2,1	1,7	1,47	0,5	1,2	1,7
Mean value	5,94		2,64		1,44		1,18	
CV	79		57		25		17	

Effect of dilution rates on viscosity of acid extract of oat (w/v)

Cultivar/form	1/5	error	1/10	error	1/20	error
Siwek n+imp	ool	-	18,1	13,3	3,45	4,1
Bingo h	ool	-	6,2	0,7	2,14	3,0
Krezus h	ool	-	6,3	1,4	2,07	0,7
Siwek n	2800	5,7	20,3	20,2	4,59	0,6
Bingo d	2050	12,9	11,8	5,4	3,00	7,0
Krezus d	1885	5,4	10,5	6,0	3,00	1,9
Mean value	2245	-	12,2		3,0	
CV	21,7		48,1		30,5	

Chemical composition of water and buffer extracts (mg/ml)

Cultivar/ form	Lipids		Starch		β -glucan		Protein	
	WE	AE	WE	AE	WE	AE	WE	AE
Siwek n+imp	3,5	6,9	0,014	0,069	4,4	0,3	4,8	8,7
Bingo h	2,1	5,3	0,021	0,048	3,3	0,2	4,0	7,1
Krezus h	1,8	5,4	0,021	0,059	3,5	0,3	3,1	5,7
Siwek n	2,7	7,7	0,009	0,070	4,5	0,3	5,3	8,7
Bingo d	3,2	5,3	0,011	0,052	3,8	0,1	5,5	8,8
Krezus d	2,4	4,9	0,011	0,055	3,7	0,1	5,1	8,7
Mean value	2,6	5,9	0,015	0,059	3,9	0,22	4,6	8,0
CV	24,8	18,8	36,4	15,3	12,5	45,4	19,8	16,1
Correlation with EV	0,48	0,83	-0,84	0,75	0,84	0,30	0,70	0,73

CONCLUSION

The study will be continuing to validate these two assays on a greater number of oat samples. We assume, that at the end of our study we will be able to propose two viable protocols, appropriate for selecting oat genotypes for food or feed uses.

RESULTS

Extraction of grain with water at a dilution of 1: 5w/v and with acid buffer at a dilution 1:20w/v gave the lowest error between replicates and a very wide variation between samples. In these conditions the resultant extract was also sufficiently watery, and seemed to guarantee a maximum extractability of components responsible for viscosity. The optimum temperature of extraction, that gave the best repeating and high values of viscosity of water extracts was 30°C. In the case of acid extraction, the best temperature was 35°C. Higher temperature, in range 35-45°C and 50-60°C, indicated the involvement of endo-enzymes and starch gelatinization on measured viscosity of water extracts, respectively. Starch gelatinization in 1,5pH buffer was not observed, what was probably connected with starch granules degradation and hydrolyses. Centrifugation speeds did not have any significant effect (Tukey test) on viscosity of both types of extract. Extract produced from every grain sample of oat was very cloudy, thus differed significantly from extract prepared from the other cereals. The overall finding demonstrated that β -glucan provided the major contribution to viscosity of either extract, moreover lipids and protein evidently participated significantly at it as well.

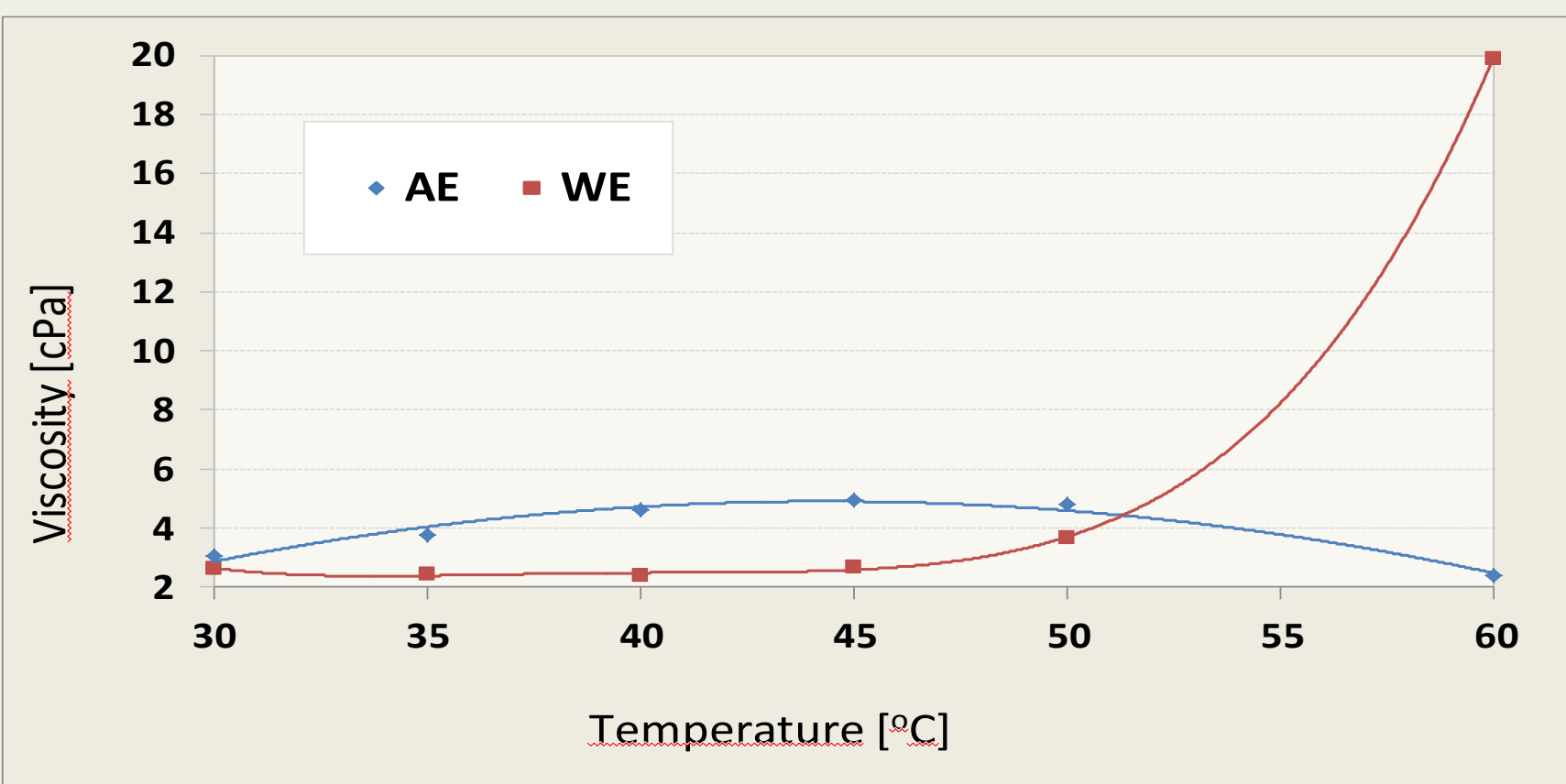
Abbreviations: h – hulled, n with impurities, n – naked, d - dehulled

Effect of extraction temperature on viscosity of water extract of oat (°C)

Cultivar/ form	30	error	35	error	40	error	45	error	50	error	60	error
Siwek n+imp.	2,71	6,3	2,28	5,0	2,31	2,4	2,44	1,2	3,28	2,6	10,61	33,2
Bingo h	1,39	1,0	1,28	6,6	1,26	5,1	1,33	3,2	1,58	3,1	2,98	11,9
Krezus h	1,22	3,6	1,18	3,6	1,13	3,8	1,25	4,5	1,31	2,7	2,40	18,0
Siwek n	5,29	7,0	4,64	1,8	4,62	1,2	5,28	2,0	8,02	4,0	71,20	69,1
Bingo d	3,11	6,1	3,09	2,7	2,95	2,2	3,49	1,2	4,87	13,9	24,90	50,0
Krezus d	2,10	6,2	2,13	4,6	2,08	2,4	2,23	4,8	2,99	16,3	7,22	26,2
Mean value	2,64		2,43		2,39		2,67		3,67		19,88	
CV	57		53		54		57		68		133	

Effect of extraction temperature on viscosity of acid extract of oat (°C)

Cultivar/ form	30	error	35	error	40	error	45	error	50	error	60	error
Siwek n+imp.	3,45	4,1	4,56	0,5	5,40	2,1	5,17	0,8	4,68	2,3	2,79	5,8
Bingo h	2,15	3,0	2,49	1,7	3,48	4,9	3,76	1,1	3,86	2,0	1,99	4,3
Krezus h	2,07	0,7	2,12	1,0	2,87	2,0	2,88	1,5	2,62	1,9	1,86	1,5
Siwek n	4,59	0,6	6,18	2,9	6,04	1,4	7,34	0,8	5,24	2,2	2,69	6,8
Bingo d	3,05	7,0	3,59	0,4	5,00	2,8	5,56	0,2	7,01	0,8	2,71	5,0
Krezus d	3,00	1,9	3,78	0,7	4,81	2,6	5,08	0,8	5,37	0,8	2,31	0,3
Mean value	3,05		3,78		4,60		4,97		4,79		2,39	
CV	30		39		26		31		31		17	



Viscosity of water and buffer extracts after extraction in different temperatures