

**Raw fibre and inulin content in roots of different
scorzonera cultivars (*Scorzonera hispanica* L.)
depending on cultivation method**

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ABSTRACT

The study was conducted in the years 2002 and 2003. The object of analysis were the roots of seven scorzonera cultivars: 'Einjährige Riesen', 'Meres', 'Prodola', 'Lange Jan', 'Maxima', 'Westlandia', and 'Duplex' growing on ridge tillage and in flat tillage plots. The content of inuline and raw fibre fractions, i.e. acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADL) was analysed. The tillage method significantly affected the inulin content, which was most pronounced in 'Meres' and 'Westlandia'. The inulin content in the roots of most scorzonera cultivars growing in flat tillage plots was significantly higher in both study years. The raw fibre content was affected by the tillage method and, probably, by the amount of precipitation in the second half of vegetation period. The highest content of this component was determined in 'Prodola' and 'Meres', depending on the year of study. Only the ADL content was significantly affected

by the tillage method, whereas each assayed fraction content was significantly affected by a cultivar.

INTRODUCTION

Scorzonera is used in prophylaxis and treatment of alimentary and cardiovascular system diseases and also in treating diabetes. The reasons for this are the glycosides compounds, inulin, vitamins and easily assimilated mineral elements it contains. Inulin activity manifests itself among others in reducing blood sugar and cholesterol levels. It can be used as a natural bioactive element enriching food products and a prebiotic, which stimulates intestinal flora growth and activity (Hofer and Jenewein 1999). Roberfroid (1993) indicates the similarity of inulin and dietary fibre activity.

Dietary fibre, among others, limits absorption of cholesterol, bile and fatty acids, water and other harmful substances in alimentary system. Additionally, it causes a decrease of blood sugar level and lowers blood pressure by binding sodium ions (Berger 1998, Cichoń and Wądołowska 2003).

The quality of roots, determined by a chemical content, depends on their physical traits such as shape, size or embranchment degree. These traits depend not only on a cultivar, but also on the place and method of cultivation and on weather conditions during the vegetation period (Vulsteke and Biston 1979, Stompor-Chrzan and Pisarek 1999).

The aim of the present study was to evaluate chemical content, namely the content of inulin and fibre (both raw and its fractions), in the roots of seven scorzonera cultivars growing under conditions of two tillage methods – flat tillage and ridge tillage.

MATERIAL AND METHODS

The object of study conducted in the years 2002 and 2003 in a horticulture farm near Warsaw were seven cultivars of scorzonera, i.e. 'Einjährige Riesen' (W. Legutko – Poland), 'Lange Jan' (Bejo Zaden – Holland), 'Prodola' (Rijk Zwaan – Holland), 'Westlandia' and 'Maxima' (Bakker Brothers – Holland), 'Meres' (Flora Frey – Germany), and 'Duplex' (Thomas Ety Esq. – England). The experiments were conducted with the random blocks method in three replicates, on podzolic soil, with pH 6.8. Each year, broad bean crop ploughed-under in autumn was used as a forecrop. In the spring the plots were deeply ploughed and fertilized with mineral fertilizer to adjust the soil content to the nutritional requirements of scorzonera. In flat cultivation a spacing of 40 × 5-6 cm was used and in ridges a spacing of 67.5 × 5-6 cm. The seeds were sown in the middle of April in the

amount of 10 kg ha^{-1} and harvest was made in the end of October. In the roots obtained, the content of inulin was assayed using Jermakow technique (Jermakow et al. 1952), and the content of raw fibre and its fractions: ADF, NDF, and ADL using Henneberg and Stohmann technique (Pijanowski 1954) on the devices System M 1020 Hot Extractor and Fibertec System M 1021 Cold Extractor provided by the Swedish company Tecator Fibertec.

Meteorological data was worked out on the basis of the records from the nearest meteorological station (Plant Breeding and Acclimatization Institute in Radzików). The results were statistically processed with the use of ANOVA software.

RESULTS AND DISCUSSION

Precipitation distribution was more favourable to scorzonera cultivation in the year 2003. Temperature conditions were similar in both years. A minimal difference occurred only in the second half of April and in the first half of May, which is a period of germination and emergence (Fig. 1).

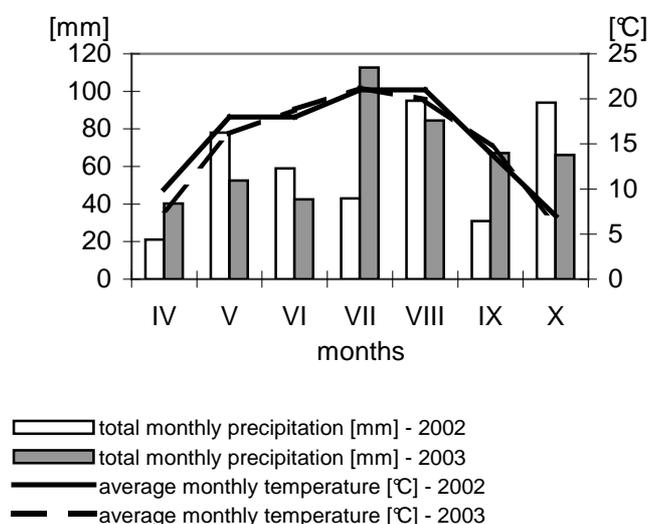


Figure 1. Meteorological conditions in vegetation seasons 2002 – 2003

In both study years, the inulin content (Table 1) in most cultivars was significantly affected by the tillage method (except 'Duplex' in 2003); namely, the significantly higher inulin content was the effect of the flat tillage. In 2002 the highest difference in the inulin content, dependent on the chosen tillage method,

was determined in ‘Meres’, whereas in 2003 the similar result was found in ‘Westlandia’ and ‘Meres’.

Table 1. Inulin content in the roots of some scorzonera cultivars depending on cultivation method in 2002 – 2003 (g 100 g⁻¹ f.w.)

Cultivar (A)	Cultivation method (B)					
	2002		mean	2003		mean
	flat	ridges		flat	ridges	
‘Einjährige Riesen’	11.04	9.85	10.44 d*	9.19	9.72	9.45 c
‘Lange Jan’	9.49	8.51	9.00 f	9.15	9.92	9.53 c
‘Prodola’	8.40	7.92	9.71 g	10.28	9.70	9.99 b
‘Westlandia’	10.72	9.89	10.30 e	7.00	11.93	9.47 c
‘Maxima’	10.01	11.04	10.52 c	11.93	9.57	10.75 a
‘Meres’	8.01	14.29	11.15 b	9.87	6.44	8.15 d
‘Duplex’	11.93	11.19	11.56 a	10.30	9.85	10.07 b
mean	9.94 b	10.38 a		9.59 a	9.67 a	

* Values designated with the same letters within columns do not differ significantly at p = 0.05

The content of raw fibre and its fractions was generally lower in 2003, which was probably the result of the amount of precipitation in the second half of vegetation period. The higher diversity among cultivars in the fibre content (Table 2) was noted in 2002 than in 2003. The highest fibre content in 2002, irrespectively of the tillage method, was determined in ‘Prodola’, whereas in 2003 the same concerned ‘Meres’. In both years the chosen tillage method significantly affected the fibre content only in ‘Maxima’ and ‘Einjährige Riesen’.

Table 2. Raw fibre content in the roots of some scorzonera cultivars depending on cultivation method in 2002 – 2003 (% f. w.)

Cultivar (A)	Cultivation method (B)					
	2002		mean	2003		mean
	flat	ridges		flat	ridges	
‘Einjährige Riesen’	1.05	1.03	1.04 e*	1.05	1.01	1.03 b
‘Lange Jan’	1.08	1.07	1.07 d	1.01	1.00	1.00 cd
‘Prodola’	1.41	1.40	1.40 a	0.97	1.00	0.99 de
‘Westlandia’	1.05	1.05	1.05 e	0.88	0.87	0.88 f
‘Maxima’	1.34	1.30	1.32 b	0.94	1.09	1.02 bc
‘Meres’	1.14	1.10	1.12 c	1.15	1.14	1.15 a
‘Duplex’	0.92	0.90	0.91 f	0.99	0.98	0.98 e
mean	1.14 a	1.12 b		1.00 b	1.01 a	

* Values designated with the same letters within columns do not differ significantly at p = 0.05

According to dieticians (Berger 1998, Cichoń and Wądołowska 2003), fibre fraction content is crucial, since some of these fractions (e.g. NDF) determine chyme consistence and alimentary tract action, whereas others play an important role in adjusting chyme viscosity or in binding bile acids, or act as ion removers. The data of statistical analysis of results concerning the content of fibre fractions are shown in Tables 3 and 4. In 2002 the significant effect of the chosen tillage method was determined for the content of NDF and ADL fractions, and in 2003 for ADF and ADL. The effect of cultivar was significant in the case of every fraction in both years.

Table 3. ADF, NDF and ADL content in the roots of some scorzonera cultivars depending on cultivation method in 2002 (% f.w.)

Fraction	ADF			NDF			ADL		
	flat	ridges	mean	flat	ridges	mean	flat	ridges	mean
Cultivation method (B)									
Cultivar (A)									
'Einjährige Riesen'	1.53	1.53	1.53 d*	1.55	1.58	1.56 d	0.15	0.19	0.17 ab
'Lange Jan'	1.56	1.57	1.56 c	1.82	1.83	1.82 c	0.17	0.18	0.17 ab
'Prodola'	1.85	1.85	1.85 a	2.21	2.24	2.22 a	0.14	0.14	0.14 c
'Westlandia'	1.43	1.44	1.44 e	1.57	1.59	1.58 d	0.14	0.17	0.15 bc
'Maxima'	1.73	1.73	1.73 b	2.03	2.07	2.05 b	0.11	0.18	0.15 bc
'Meres'	1.41	1.41	1.41 e	1.50	1.52	1.51 e	0.11	0.11	0.11 d
'Duplex'	1.24	1.23	1.23 f	1.40	1.41	1.40 f	0.17	0.21	0.19 a
mean	1.53 a	1.54 a		1.72 b	1.75 a		0.14 b	0.17 a	

* Values designated with the same letters within columns do not differ significantly at $p = 0.05$

Table 4. ADF, NDF and ADL in the roots of some scorzonera cultivars depending on cultivation method in 2003 (% f. w.)

Fraction	ADF			NDF			ADL		
	flat	ridges	mean	flat	ridges	mean	flat	ridges	mean
Cultivation method (B)									
Cultivar (A)									
'Einjährige Riesen'	1.54	1.49	1.51 a*	1.59	1.58	1.58 a	0.12	0.14	0.13 b
'Lange Jan'	1.20	1.20	1.20 e	1.25	1.25	1.25 f	0.27	0.26	0.26 a
'Prodola'	1.41	1.37	1.39 c	1.44	1.44	1.44 e	0.14	0.12	0.13 b
'Westlandia'	1.13	1.09	1.11 g	1.44	1.45	1.44 de	0.00	0.11	0.06 c
'Maxima'	1.36	1.00	1.18 f	1.46	1.46	1.46 d	0.12	0.16	0.14 b
'Meres'	1.46	1.46	1.46 b	1.90	1.86	1.88 a	0.13	0.13	0.13 b
'Duplex'	1.25	1.21	1.23 d	1.59	1.58	1.53 c	0.13	0.13	0.13 b
mean	1.34 a	1.26 b		1.51 a	1.51 a		0.13 b	0.15 a	

* Values designated with the same letters within columns do not differ significantly at $p = 0.05$

CONCLUSIONS

1. The inulin content in the roots was significantly diverse in all examined cultivars and depended on the chosen tillage method, irrespectively of the study year. In 2002, the tillage method effect was the strongest in 'Meres', whereas in 2003 the effect was the strongest in 'Westlandia' and 'Meres'.
2. In both years for most cultivars the significantly higher inulin content in the roots was determined in the plants growing in flat tillage plots.
3. In 2002, as compared to 2003, the content of raw fibre and its fractions and the diversity of the fibre content in cultivars were higher, which probably resulted from amount of precipitation in the second half of vegetation period.
4. In the year with lower amount of precipitation in the second half of vegetation period (2002), for both tillage methods, the highest raw fibre content was found in 'Prodola', whereas in the year with higher amount of precipitation at this time – in 'Meres'. In both years the significant effect of the tillage method was determined only in 'Maxima' and 'Einjährige Riesen'.
5. In both study years the effect of cultivar was significant in each fraction content, whereas effect of tillage method was significant in 2002 for the NDF and ADL, and in 2003 for the ADF and ADL content.

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ZAWARTOŚĆ WŁÓKNA SUROWEGO I INULINY W KORZENIACH
RÓŻNYCH ODMIAN SKORZONERY (*SCORZONERA HISPANICA* L.)
W ZALEŻNOŚCI OD METODY UPRAWY

Streszczenie: Badania przeprowadzono w latach 2002 i 2003. Korzenie siedmiu odmian skorzonery: 'Einjährige Riesen', 'Meres', 'Prodola', 'Lange Jan', 'Maxima', 'Westlandia' i 'Duplex' z uprawy na płask i na redlinach, poddano analizie pod względem zawartości inuliny oraz błonnika pokarmowego i jego frakcji: ADF, NDF i ADL. Na zawartość inuliny w sposób istotny wpłynęła metoda uprawy, a najbardziej zareagowały na nią odmiany 'Meres' i 'Westlandia'. Większość badanych odmian wykazywała wyższą zawartość inuliny z uprawy na płask. Na zawartość błonnika miała wpływ odmiana oraz metoda uprawy, a także prawdopodobnie suma opadów atmosferycznych w drugiej połowie okresu wegetacji. Największą zawartością tego składnika zależnie od roku wykazały się odmiany 'Prodola' i 'Meres'. W roku 2002 stwierdzono istotność metody uprawy dla frakcji NDF i ADL, a w roku 2003 dla frakcji ADF i ADL, natomiast istotny wpływ odmiany stwierdzono dla wszystkich trzech oznaczonych frakcji w obydwu latach badań.

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