

Evaluation of emmer wheat genetic resources aimed at dietary food production

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Genus *Triticum* L.

- Over 30 different species with large interspecific variability.
- Bread wheat (*Triticum aestivum* L.) and durum wheat (*T. durum* Desf.) - important role in human nutrition.
- Spelt wheat (*T. spelta* L.) and emmer (*T. dicoccon* Schrank) - rarely used, so called minor wheat species.
- Other species - used for human consumption very rarely or not at al.

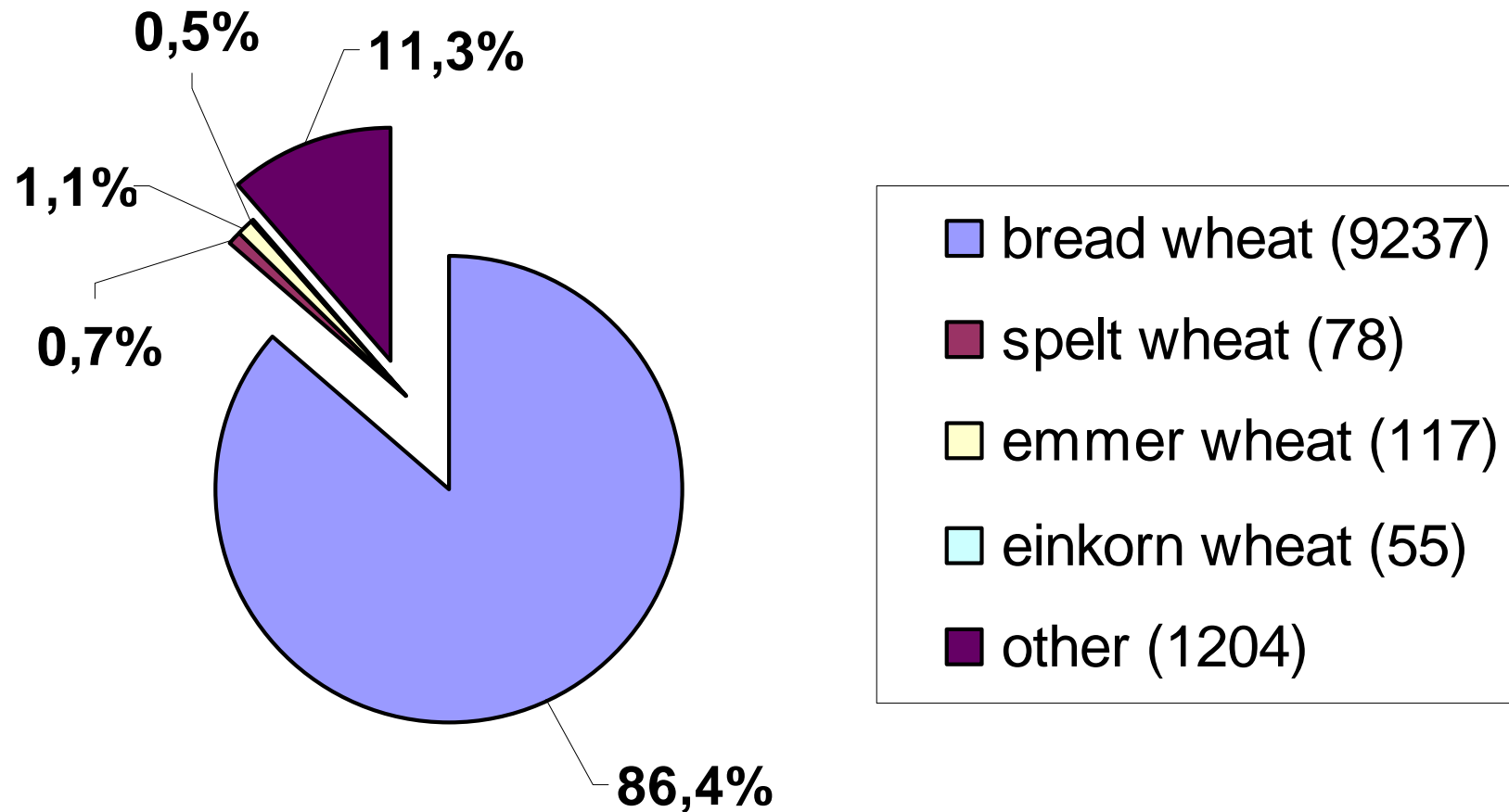
Wheat genetic resources

- *Source of variability for breeding*
 - Main wheat species varieties
 - Minor wheat species varieties for special use
 - High product quality
 - Components to standard dishes as bread etc.



Wheat genetic resources in the Czech gene bank

Number of wheat genetics resources



Use of minor wheat species in CR

- Spelt registered cultivars ‚Franckenkorn‘ and ‚Rubiota‘ – organic farming
- Emmer legally protected cultivar ‚Rudico‘ research and organic farming
- Einkorn research and testing

The main aims

Emmer wheat research

- Characterisation of emmer wheat by HMW glutenin markers
- Grain composition
- Bread making parameters
- Grain compounds valuable from dietary viewpoint

Results



Characterisation of emmer wheat by HMW glutenin markers

- ***Methods used:***

- One-dimensional SDS polyacrylamide gel electrophoresis (Laemmli 1970)
- HMW-GSs identification - catalogue (Payne & Lawrence 1983)

- *Results summary:*

- 5 accessions homogeneous (one glutenin line)
- T. dicoccon (Ruzyně),
- Kahler Emmer,
- May-Emmer,
- Weisser Sommer
- T. dicoccon (Tapioszele)

Characterisation of emmer wheat by HMW glutenin markers

<i>T. dicoccon</i> landrace	Origin	<i>Glu</i> lines	<i>HMW-GSs</i>		
			<i>Glu-A1</i>	<i>Glu-B1</i>	<i>Glu-1D</i>
T. dicoccon (Kroměříž)	(CZE)	A	1	7+8	-
		B	1	21	-
		C	1	6+7	-
T. dicoccon (Ruzyně)	(CZE)	A	1	7+8	-
Kahler Emmer	GER	A	1	7+8	-
May-Emmer	CHE	A	1	7+8	-
Weisser Sommer	GER	A	1	(7+8)	-
T. dicoccon (Tapioszele)	(HUN)	A	1	7+8	-
Krajova-Podbranc (Toman)	CSK	A	2*	21	-
		B	2*	6+9	-
Poering Jaarma (Nachitchevan.)	AZE	A	1	22	-
		B	1	7+8	-
		C	0	7+8	-
		D	2*	7+8	-
T. dicoccon (Balkan)	(GER)	A	2*	14+15	-
		B	0	14+15	-
T. dicoccon (Brno)	CSK	A	2*	6+8	-
		B	2*	21	-
Sandra (<i>T. aestivum</i>) - control	CSK	A	2*	7+8	3+12
		B	2*	7+9	3+12
		C	1	7+9	3+12

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 - May-Emmer
 - Weisser Sommer
 - T. dicoccon (Tapioszele)

Grain composition

- ***Used methods:***
 - Standard methods (fat content, fibre content, carbohydrates, crude ash), Kjeldahl method (crude protein content)

- ***Results summary:***
 - + Crude protein content
 - + Fat content (higher than in bread wheat variety ,Vlasta‘)
 - Fibre content – variable
 - + Crude ash

Grain composition

<i>Genotype / variety</i>	<i>Dry matter</i> (%)	<i>Crude protein</i> (%)	<i>Fat content</i> (%)	<i>Fibre</i> (%)	<i>Carbohydrates</i> (%)	<i>Crude ash</i> (%)
Rudico	89.78	14.74	4.00	13.89	55.30	1.85
May-Emmer	89.23	13.35	3.77	9.18	61.03	1.90
Weisser Sommer	89.12	12.15	3.81	8.77	62.51	1.88
T.dicoccon..(Dagestan)	89.25	11.99	3.83	8.68	62.99	1.76
T.dicoccon..(Palestine)	89.37	13.91	4.10	8.90	60.44	2.02
T.dicoccon..(Tapioszele)	89.27	13.10	4.40	10.59	59.20	1.98
T.dicoccon..(Brno)	89.53	13.42	4.19	9.56	60.28	2.08
T.dicoccon..(Tabor)	89.74	14.39	4.38	12.51	56.69	1.77
Vlasta (<i>T. aestivum</i> check)	89.09	11.59	2.76	11.13	62.23	1.38

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 - Fibre content – variable
 - + Crude ash

Bread making parameters

■ **Methods used:**

- Crude protein content: Kjeldahl method according to ČSN ISO 1871
- Wet gluten content and Gluten index (GI): on Glutomatic 2200 according to ČSN ISO 5531
- Sedimentation index – Zeleny test: according to ČSN ISO 5529

■ **Results summary:**

- Quality in all emmer accessions very low
- Gluten of 3 landraces totally flowable
 - T. dicoccon..(Dagestan ASSR);
 - T. dicoccon..(Palestine) and
 - T. dicoccon..(Brno)
- Zeleny sedimentation very low 6 ml to 19 ml
- Emmer wheat landraces - more suitable for other purposes than for the preparation of bread (e.g. for different grain mixtures, purée, etc.)

Bread making parameters

<i>Genotype / variety</i>	<i>Wet gluten content</i> (%)	<i>Gluten index</i>	<i>SDS sedim.</i> (ml)	<i>Zeleny sedim.</i> (ml)	<i>Falling number</i> (s)
Rudico	24,2	4	32	19	402
May-Emmer	28,1	6	37	10	337
Weisser Sommer	27,6	6	34	8	331
T. dicoccon..(Dagestan)	*	*	11	6	386
T. dicoccon..(Palestine)	*	*	17	9	379
T. dicoccon..(Tapioszele)	30,2	9	18	11	421
T. dicoccon..(Brno)	*	*	17	9	317
T. dicoccon..(Tabor)	33,8	4	25	18	328
Vlasta (<i>T. aestivum</i> check)	26.7	65	-	36	-

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Grain compounds valuable from dietary viewpoint

Total dietary fibre content and its components

- ***Used methods:***

- Enzyme – gravimetric method according to AOAC 991.42 enzyme set Bioquant (Merck) filter machinery FIBERTEC (Scan Tec)

- ***Results summary:***

- Total dietary fibre (TDF) content - from 8.68 (T.dicoccon..Dagestan) to **13.89 (Rudico)**
- Proportion between soluble and insoluble fractions of TDF in average nearly 1 : 1
- Differences among emmer accessions in the ratio between IDF and SDF reflect opportunity to select suitable genotypes

Grain compounds valuable from dietary viewpoint

Total dietary fibre content and its components			
<i>Genotype / variety</i>	<i>TDF*</i>	<i>IDF**</i>	<i>SDF***</i>
Rudico	13,89	7,01	5,88
May-Emmer	9,18	4,34	4,84
Weisser Sommer	8,77	5,02	3,75
T.dicoccon..(Dagestan)	8,68	3,33	5,35
T.dicoccon..(Palestine)	8,9	4,89	4,01
T.dicoccon..(Tapioszele)	10,59	6,71	3,88
T.dicoccon..(Brno)	9,56	4,85	4,71
T.dicoccon..(Tabor)	12,51	6,56	5,95
Vlasta (T. aestivum check)	11,13	7,06	4,07
*) Total Dietary Fibre; **) Insoluble Dietary Fibre; ***) Soluble Dietary Fibre			

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Grain compounds valuable from dietary viewpoint

Total polyphenols, catechin and feluric acid contents

▪ *Method used:*

➤ ***Lachman et al 1997 (total polyphenols), RP – HPLC method*** (catechin, feluric acid)

▪ *Results summary:*

- Content of total polyphenols - differences relatively deep
- Catechin - prevailing among polyphenolyc substances (Rudico - 149.5 mg/100 g d.m. of catechin)
- Feluric acid - from 1.1 mg/100 g d.m to 2.5 mg/100 g d.m
- Contents of chlorgenic acid and epicatechin - immeasurable

Grain compounds valuable from dietary viewpoint

Total polyphenols, catechin and feluric acid contents			
Genotype / variety	total polyphenols (g GAE.kg⁻¹ d.m)	catechin (mg.100g⁻¹ d.m)	feluric acid (mg.100g⁻¹ d.m)
Rudico	3.55	149.5	2.2
May-Emmer	2.72	66.0	2.3
Weisser Sommer	2.54	57.5	2.5
T.dicoccon..(Dagestan)	2.85	109.6	1.5
T.dicoccon..(Palestine)	3.22	112.5	1.2
T.dicoccon..(Tapioszele)	3.31	43.6	2.3
T.dicoccon..(Brno)	3.40	66.8	1.2
T.dicoccon..(Tabor)	3.50	78.6	1.1
Vlasta (T. aestivum check)	2.81	97.1	1.3

Grain compounds valuable from dietary viewpoint

Total polyphenols, catechin and feluric acid contents

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Grain compounds valuable from dietary viewpoint

Vitamins of B group

▪ *Method used:*

➤ *RP – HPLC method (B1), fluorescence method (B2), ATCC 8014 (niacin), ATCC 8014 (pantothenic acid), ATCC 9080 (B6)*

▪ *Results summary:*

➤ Higher content of vitamins B1 and B2 in Rudico - (0.44 mg/100 g d.m., 0.135 mg/100 g d.m. respectively)

➤ Also the highest contents of other B vitamins (niacin, pantothenic acid and B6) were found in Rudico variety

Grain compounds valuable from dietary viewpoint

Vitamins of B group (mg.100g⁻¹ d.m)					
Genotype / variety	B1	B2	niacin	pantothenic acid	B6
Rudico	0,44	0,135	10,6	1,06	0,45
May-Emmer	0,33	0,108	8,4	0,95	0,27
Weisser Sommer	0,36	0,108	8,9	0,91	0,28
T.dicoccon..(Dagestan)	0,29	0,111	9,7	0,78	0,27
T.dicoccon..(Palestine)	0,36	0,113	9,7	1,04	0,38
T.dicoccon..(Tapioszele)	0,36	0,115	10,2	0,92	0,39
T.dicoccon..(Brno)	0,35	0,120	8,5	0,84	0,38
T.dicoccon..(Tabor)	0,34	0,115	8,4	0,94	0,43
Vlasta (T. aestivum check)	0,36	0,071	6,8	0,95	0,37

Grain compounds valuable from dietary viewpoint

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Grain compounds valuable from dietary viewpoint

Content of E vitamin and carotenoids

- ***Methods used:***

- Sample saponification and extraction of unsaponifiable part, HPLC method (vitamin E)
- Spectrophotometric method (carotenoids)

- ***Results summary:***

- The highest content of E vitamin – 1.30 mg/100 g d.m. (T. dicoccon.. Tapioszele)
- Total content of carotenoids - from 18.31 mg/100g d.m. (T. dicocum Tabor) to 26.58 mg/100g d.m. (T. dicocum Palestine)

Grain compounds valuable from dietary viewpoint

Content of E vitamin and carotenoids		
<i>Genotype / variety</i>	<i>Vitamin E (mg.100g⁻¹ d.m)</i>	<i>Total carotenoids (mg.100g⁻¹ d.m)</i>
Rudico	1.24	20.23
May-Emmer	1.21	20.65
Weisser Sommer	1.09	23.88
T.dicoccon ..(Dagestan)	1.09	24.86
T.dicoccon ..(Palestine)	0.83	26.58
T.dicoccon..(Tapioszele)	1.30	21.56
T.dicoccon ..(Brno)	1.03	20.43
T.dicoccum ..(Tabor)	1.09	18.31
Vlasta (T. aestivum check)	1.22	20.44

Grain compounds valuable from dietary viewpoint

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Conclusions

- Tests of bread making quality confirmed very well known fact that **emmer wheat grain is much more suitable for other purposes as whole grain mixtures, cereal purée etc.** than for bread preparation.
- The preliminary results described above indicate **possibilities to select emmer wheat genotypes differing in grain composition, containing compounds with positive effect on human health.**
- Among tested emmer wheat accessions the **Rudico variety had complex of positive characters as content of total dietary fibre, total polyphenol content with prevailing catechin and the highest amount of B group vitamins as B1, B2, niacin, pantothenic acid and B6.**



Thank you for your attention

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