Improving the content and composition of dietary fibre in wheat

Peter Shewry
(Rothamsted Research and University of Reading)

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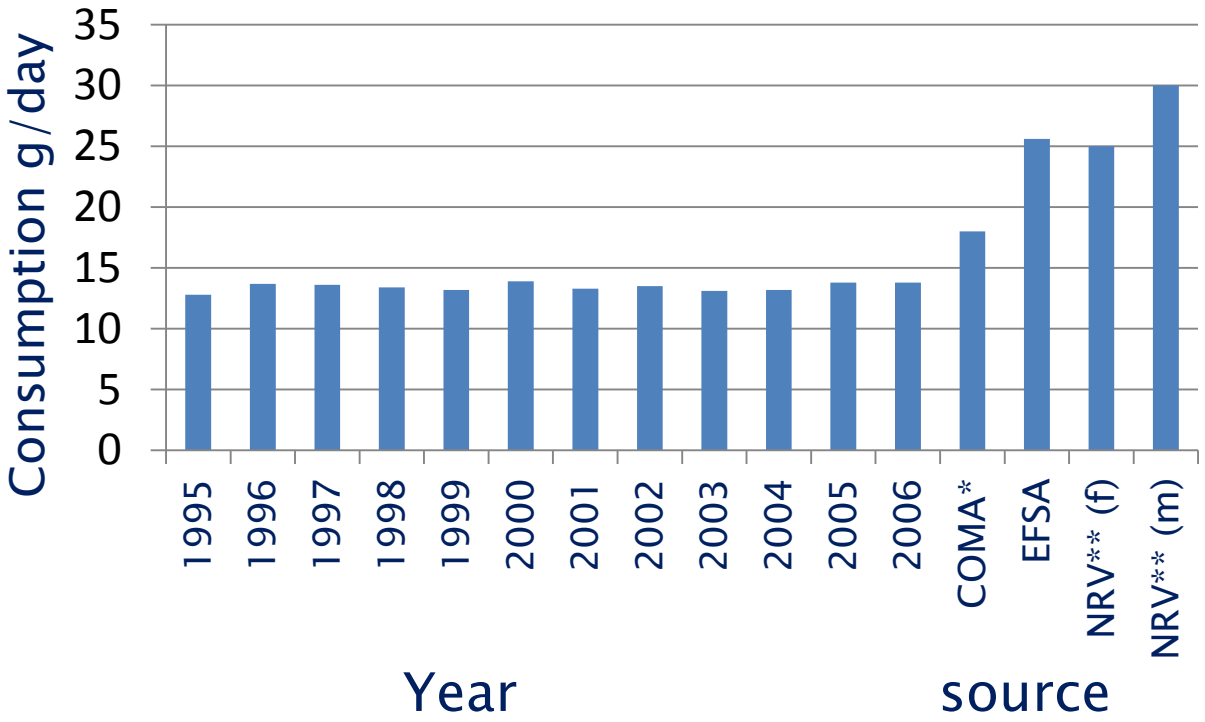
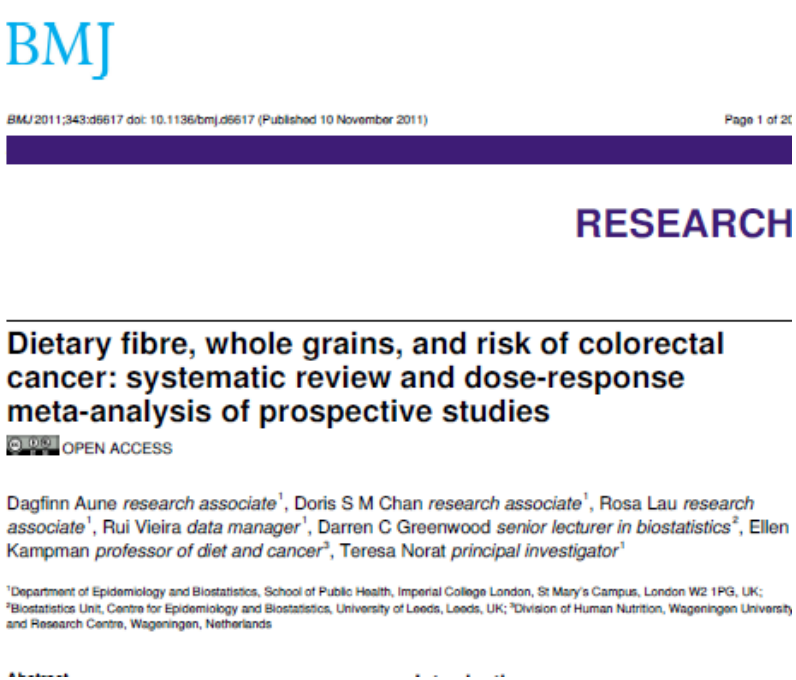
Consumption of DF
In the UK is below dietary guidelines



The National Diet and Nutrition Survey (2002 and 2003); Scientific Advisory Committee on Nutrition (2003); DoH (2004). *UK, ** Australia/NZ

There is increasing evidence for health benefits of dietary fibre in wholegrain cereals



BMJ

BMJ 2011;343:d6617 doi: 10.1136/bmj.d6617 (Published 10 November 2011) Page 1 of 20

RESEARCH

Dietary fibre, whole grains, and risk of colorectal cancer: systematic review and dose-response meta-analysis of prospective studies

OPEN ACCESS

Dagfinn Aune *research associate*[1], Doris S M Chan *research associate*[1], Rosa Lau *research associate*[1], Rui Vieira *data manager*[1], Darren C Greenwood *senior lecturer in biostatistics*[2], Ellen Kampman *professor of diet and cancer*[3], Teresa Norat *principal investigator*[1]

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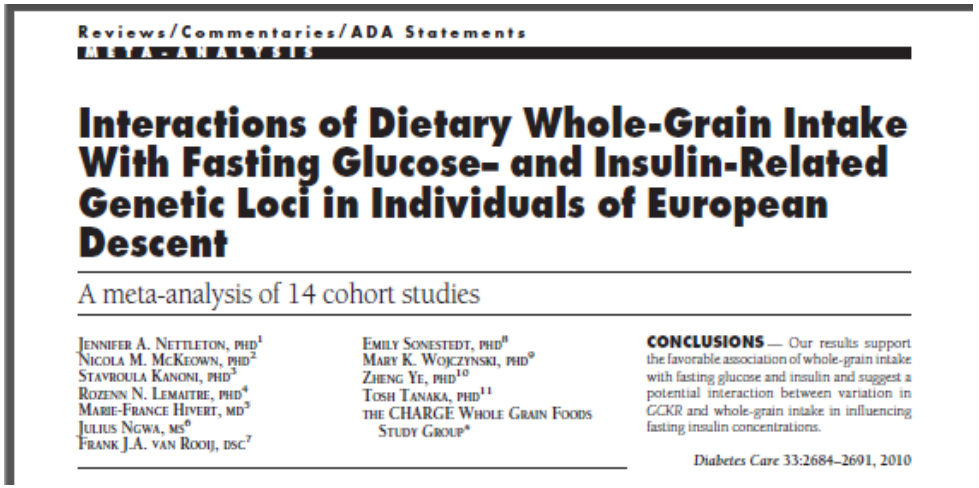

Reviews/Commentaries/ADA Statements

META-ANALYSIS

Interactions of Dietary Whole-Grain Intake With Fasting Glucose– and Insulin-Related Genetic Loci in Individuals of European Descent

A meta-analysis of 14 cohort studies

JENNIFER A. NETTLETON, PHD[1]
NICOLA M. MCKEOWN, PHD[2]
STAVROULA KANONI, PHD[3]
ROZENN N. LEMAITRE, PHD[4]
MARIE-FRANCE HIVERT, MD[5]
JULIUS NGWA, MS[6]
FRANK J.A. VAN ROOIJ, DSC[7]
EMILY SONESTEDT, PHD[8]
MARY K. WOJCZYNSKI, PHD[9]
ZHENG YE, PHD[10]
TOSH TANAKA, PHD[11]
THE CHARGE WHOLE GRAIN FOODS STUDY GROUP*

CONCLUSIONS — Our results support the favorable association of whole-grain intake with fasting glucose and insulin and suggest a potential interaction between variation in *GCKR* and whole-grain intake in influencing fasting insulin concentrations.

Diabetes Care 33:2684–2691, 2010

OPEN ACCESS Freely available online PLOS MEDICINE

Whole Grain, Bran, and Germ Intake and Risk of Type 2 Diabetes: A Prospective Cohort Study and Systematic Review

Jeroen S. L. de Munter[1,2], Frank B. Hu[1,3,4], Donna Spiegelman[3,5], Mary Franz[1], Rob M. van Dam[1,2,4*]

1 Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts, United States of America, 2 Institute of Health Sciences, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands, 3 Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts, United States of America, 4 Channing Laboratory, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, 5 Department of Biostatistics, Harvard School of Public Health, Boston, Massachusetts, United States of America

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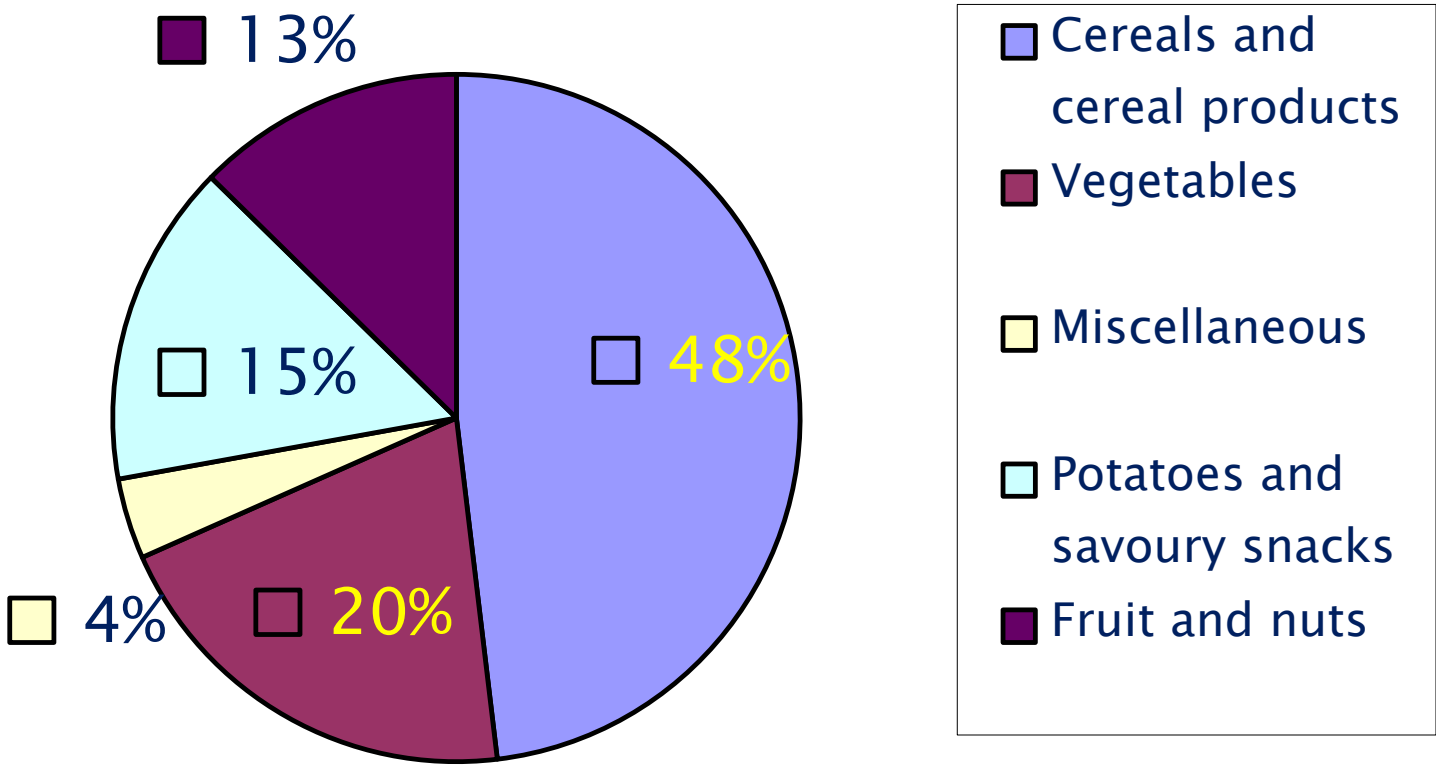
Take home messages from meta-analyses

- 10% reduction in risk of colon cancer with10g extra cereal and wholegrain fibre
- 5% reduction in risk of breast cancer with 10g extra soluble fibre
- 7% reduction in risk of stroke with 7g extra total fibre

Thanks to Janet Cade, University of Leeds

Cereals contribute 40% of the DF intake in the UK
(NDNS 2001)



http://www.food.gov.uk/multimedia/pdfs/ndnsv2.pdf

Slide provided by Janet Cade, Leeds

Bread contributes significantly to the Intake of fibre of adults in the UK

	Energy	Protein	Carbohydrate	Fibre
All bread	13	12	21	20
White bread	8	8	14	11
Wholemeal bread	2	2	3	5

Mean percentage contribution

Taken from Steer et al., Proc. Nutr. Soc. 2008, 67, E363

Potential mechanisms for benefits of DF

Increased stool bulk	• Decreased transit time • Dilute carcinogens
Binds with bile acids etc	• Excrete potential carcinogens
Reduce cholesterol	• Reduced absorption • Fermentation by fecal flora to SCFA
Slow glucose absorption, improve insulin sensitivity	• Form diffusion barrier due to increased viscosity • Inhibit amylase and absorption of sugars
Increase in luminal AOs	• BUT may not all be bioavailable from fibre substrate
Affect estrogen metabolism	• Inhibit reabsorption • Inhibit synthesis

Lower blood pressure | Promote weight loss | Anti-inflammatory

Slide provided by Janet Cade, Leeds

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The HEALTHGRAIN diversity screen of 150 bread wheat lines

Landraces and old varieties (10): Ble des Domes, Bankuti 1201, Fleischmann 481, Seu Seun 27, Grandrieu population, Queyras 72 population, Haute Loire
population, Portugaise 3 population, Portugaise 6 population, Lovaszpatonai 1
Old and transitional varieties (64): Etoile de Choisy, Maris Huntsman, Estica, Disponent, Herzog, Kanzler, Monopol, Agron, Amadeus, Capo, Probstdorfer Perlo,
Arina, Tamaro, Hana, Alba, Autonomia, Produttore, San Pastore, Libellula, Roussalka, Sadovo 1, Sava, Ferto¨di 293, GK Tiszataj, Fundulea 29, Carmen,
Flamura 85, Alabasskaja, Bezostaya 1, Aurora, Skorospelka 3B, Saratov 29, Iljicovka, Yubileinayais 50, Obriy, Atlas 66, Scout 66, Plainsman V, Key,
Stephens, Glenlea, Red Fife, Thatcher, Manitoba, Augusta, Fredrick, Su 321, Janz, Kukri, Chara, Red River, Atay-85, Gerek-79, Kirac 66, Dankowskie Zlote,
Erhard Frederichsen, Borzymowicki, Dicktoo, Creso, Parus, Altin, Oberkulmer Rotkorn, Arthur 71, Kirkpinar 79
Modern varieties (103): Camp Remy, Courtot, Isengrain, MagdalenaFR, Recital, Renan, Soisson, Tremie, Apache, Qualital, Ornicar, Thesee, Taldor, Valoris, Caphorn,
Avalon, Claire, Galahad, Hereward, Lynx, Malacca, Moulin, Rialto, Spark, Riband, Cubus, Tommi, Dekan, Akteur, Campari, Ellvis, Lona, Begra, Korweta, Ravenna,
Sagittario, Blasco, Nomade, Bilancia, Geronimo, Granbel, Guarni, Mieti, Palesio, Momtchil, NS Rana1, Balkan, Agrounia, Lasta, Pobeda, Baranjka, Martonvasar 17,
Mv Suba, Mv Palotas, Spartanka, Krasnodarskaya 99, Albatros Odeskaja, Ukrainka, TAM 200, Karl 92, Gene, Cardinal, Millenium, Alliance,
Vona, Azteca 67, Cadenza, Milan, Pastor, Sultan 95, Klein Estrella, Buck Catriel, Yumai 34, Sunstar, Warko, Amilo, Rekrut, Avanti, Fernando, Rasant, Nikita,
Igri, Tiffany, Lomerit, Morex, Plaisant, Semperdur, Durabon, Orjaune, Lajtadur, Mv Makaroni, Franckenkorn, Spy, Ressac, Rouquin, Cacko, Zvezda, Manital,
Mexique 50, Kotuku, Rastik, Altar 84
Germplasm (23): B16, Nap Hal, Chinese Spring, Sumai 3, Catbird, CF99075, CF99102, CF99105, CF99007, CFL 93-149, CFL 98-398, CFL 98-404, CFL 98-450,
1529-91, MvGB04, 08-2004, MvGB57, 122-2004, MvGB304, MvGB317, MvGB349, 192-2004, 265-2004

Winter types (169) (all except those listed below)
Spring or alternative types (31): Chinese Spring, Sumai 3, Saratov 29, Glenlea, Red Fife, Thatcher, Manitoba, Janz, Kukri, Chara, Red River, Catbird, Erhard
Frederichen, Borzymowicki, Creso, Lona, Cadenza, Milan, Pastor, Sultan 95, Sunstar, Morex, Cacko, CFL 93-149, CFL 98-398, CFL 98-404, CFL 98-450, Bajka,
Mv Pehely, Fengli, Expander

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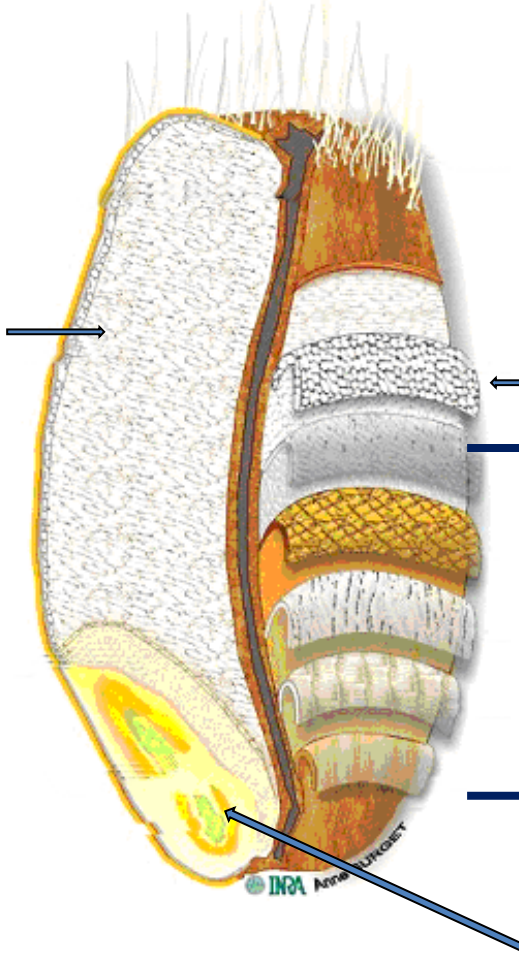
The content and composition of DF varies between tissues with the major components being arabinoxylan (AX) and β-glucan (BG)

White flour
2-3% TDF

Cell Walls
70% AX
20% BG
10% other



Aleurone
60 AX
29% BG
11% other

Pericarp
60% GAX
30% cellulose
10% lignin

Embryo
AX
BG

Bran
45-50
%TDF

ALSO
Fructans
Raffinose
Resistant Starch

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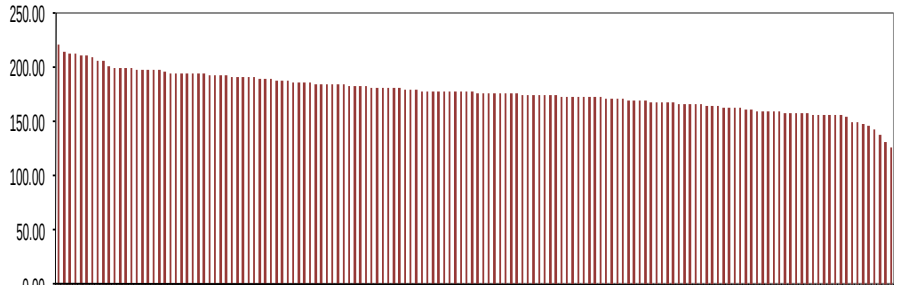
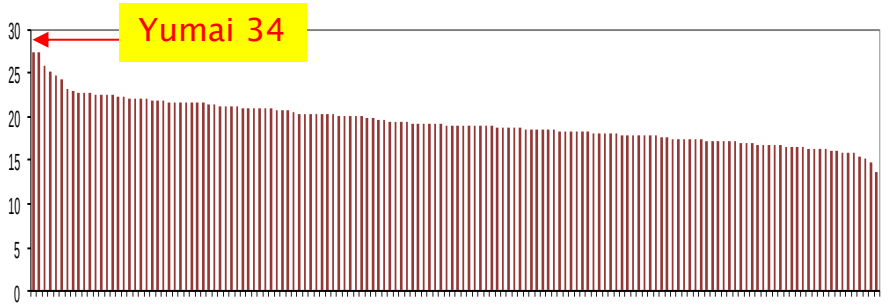
The contents of soluble and total AX fibre vary widely in bran and white flour of 150 wheat lines

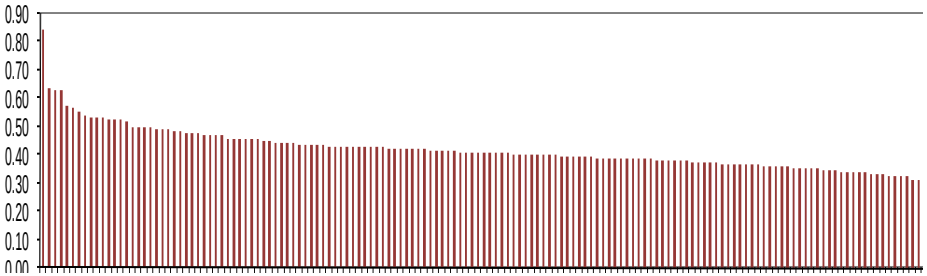
BRAN TOTAL: 12.7–22.1%



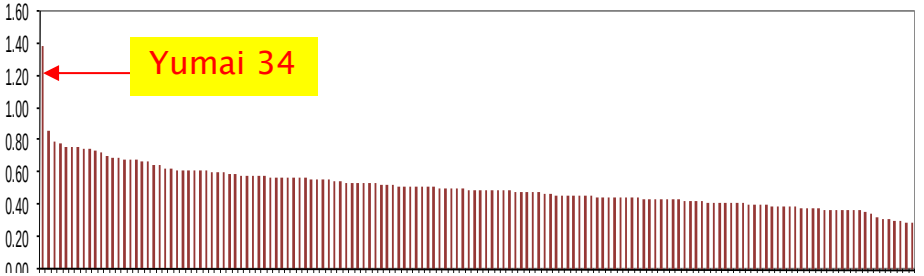
FLOUR TOTAL: 1.35–2.75%



BRAN
SOLUBLE: 0.3–0.85%



FLOUR
SOLUBLE: 0.3–1.4%



Data of Kurt Gebruers, Christophe Courtin and Jan Delcour (KU Leuven)

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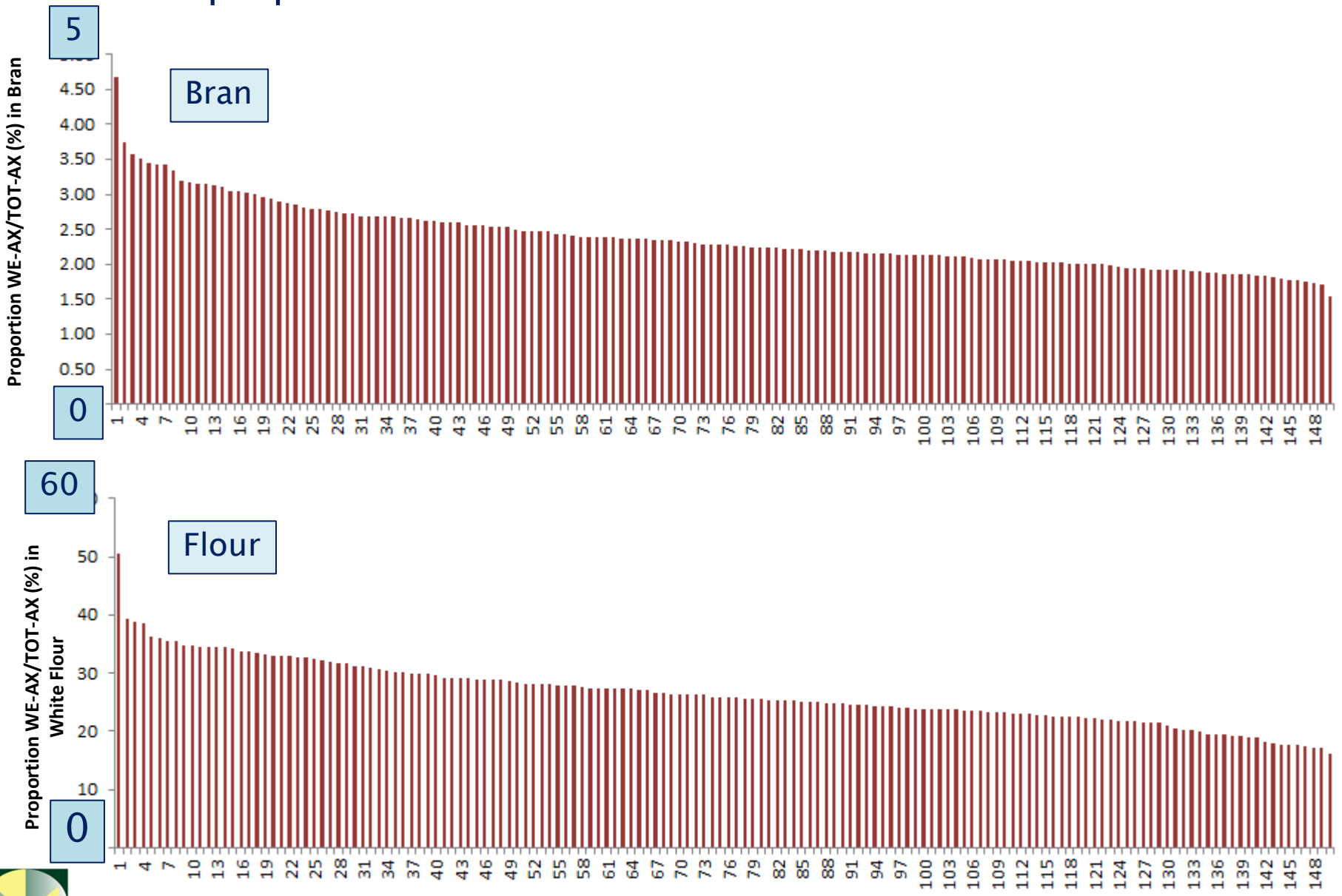
The proportion of WE-AX in flour and bran also varies



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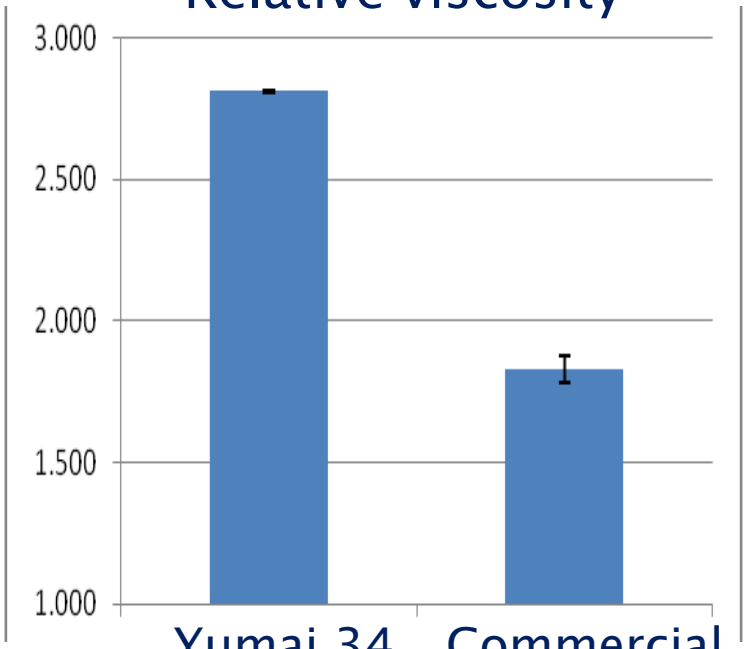
Yumai 34 is a source of high viscosity with good breadmaking performance

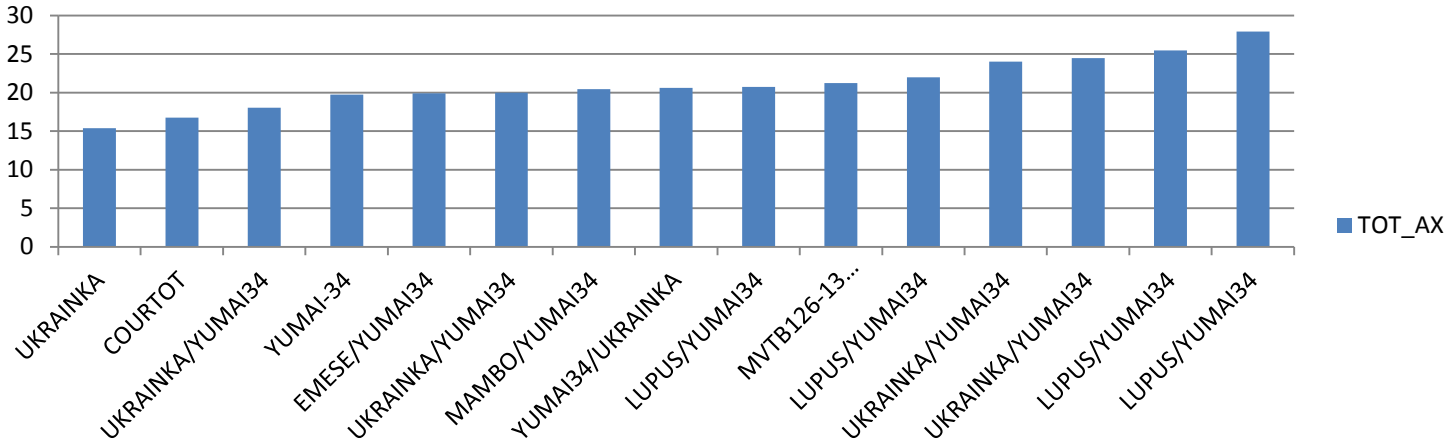
Yumai 34 Commercial control



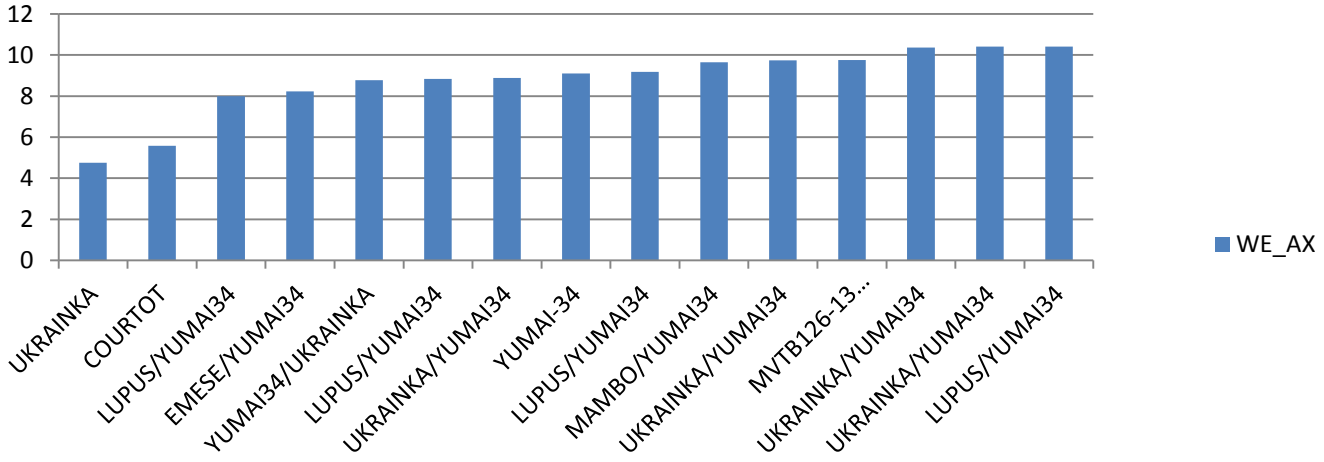
Loaves made by Campden BRI with grain grown at Martonvasar (Hungary)

TOT-AX and WE-AX in flour of Yumai 34 crosses

TOT-AX

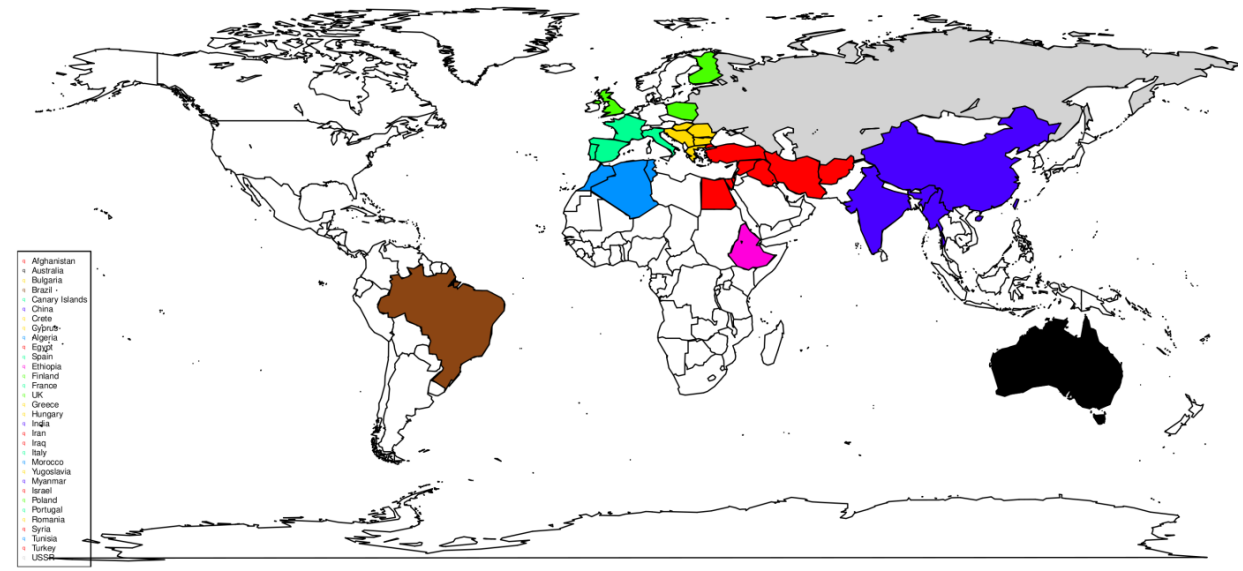


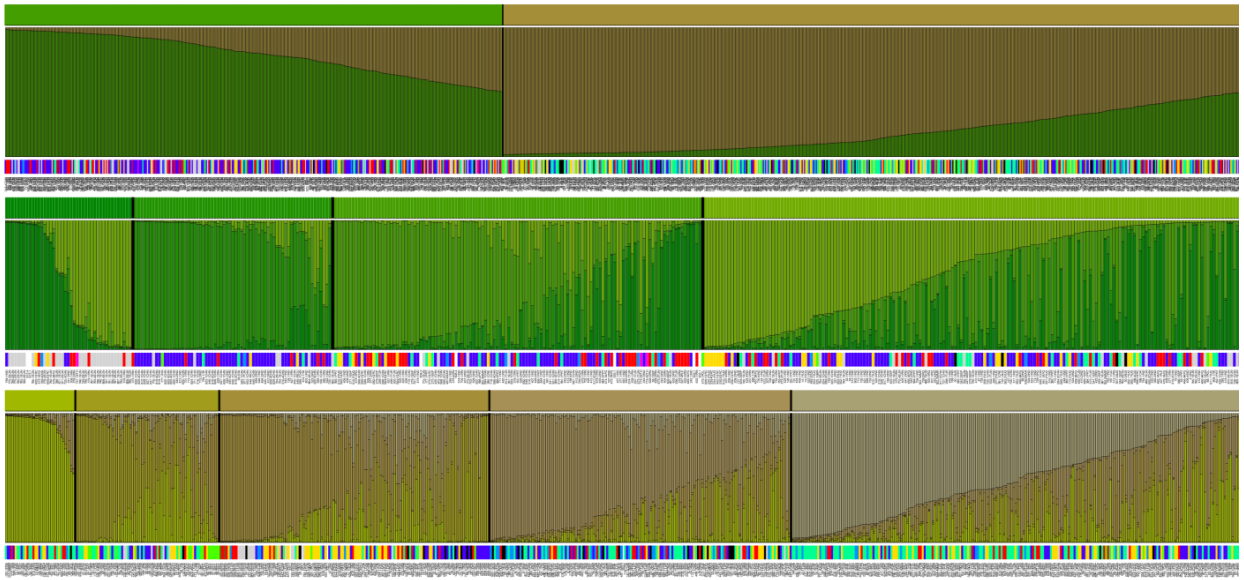
WE-AX



Data of Mariann Rakszegi and Zoltan Bedo, Martonvasar, Hungary

Watkins Collection





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A E Watkins (University of Cambridge)
1920s and 30s

Farmers, markets and researchers

Several thousand but now 1300

34 countries

Held at JIC, duplicated in Australia

Core genetic collection, c 120 lines

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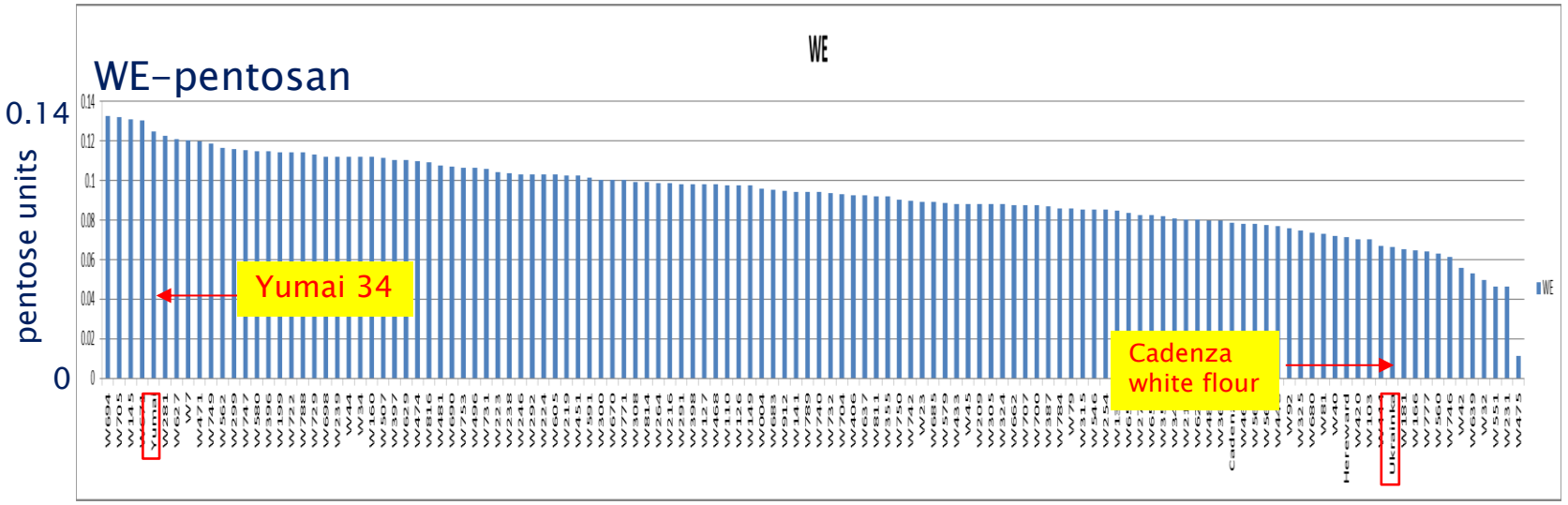
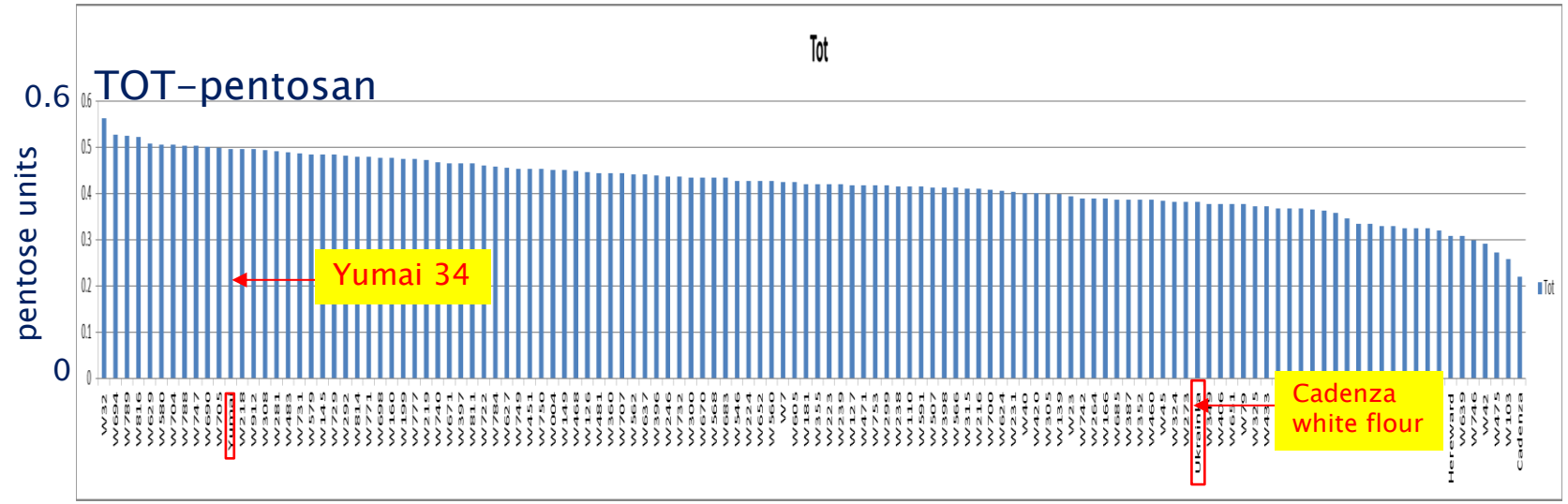
John Innes Centre

Total and WE-pentosans (AX) in wholemeal flours of the Watkins lines





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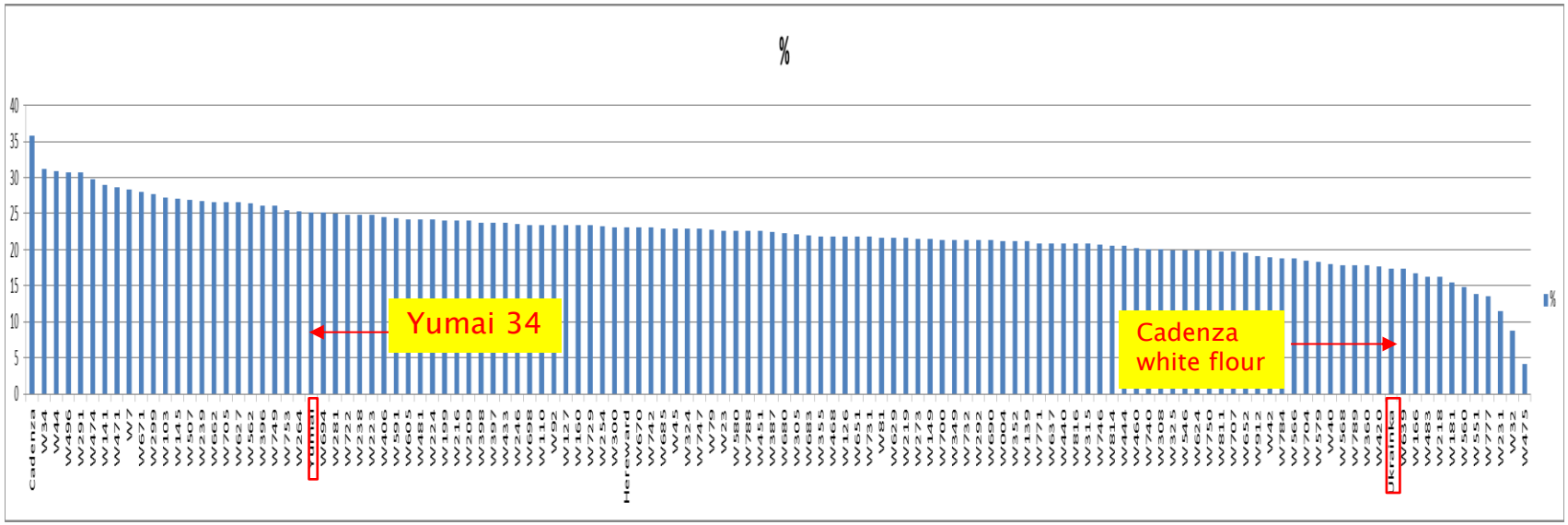
The proportion of WE-pentosans (AX) in wholemeal flours of the Watkins lines

WE-pentosan as % of TOT-pentosan



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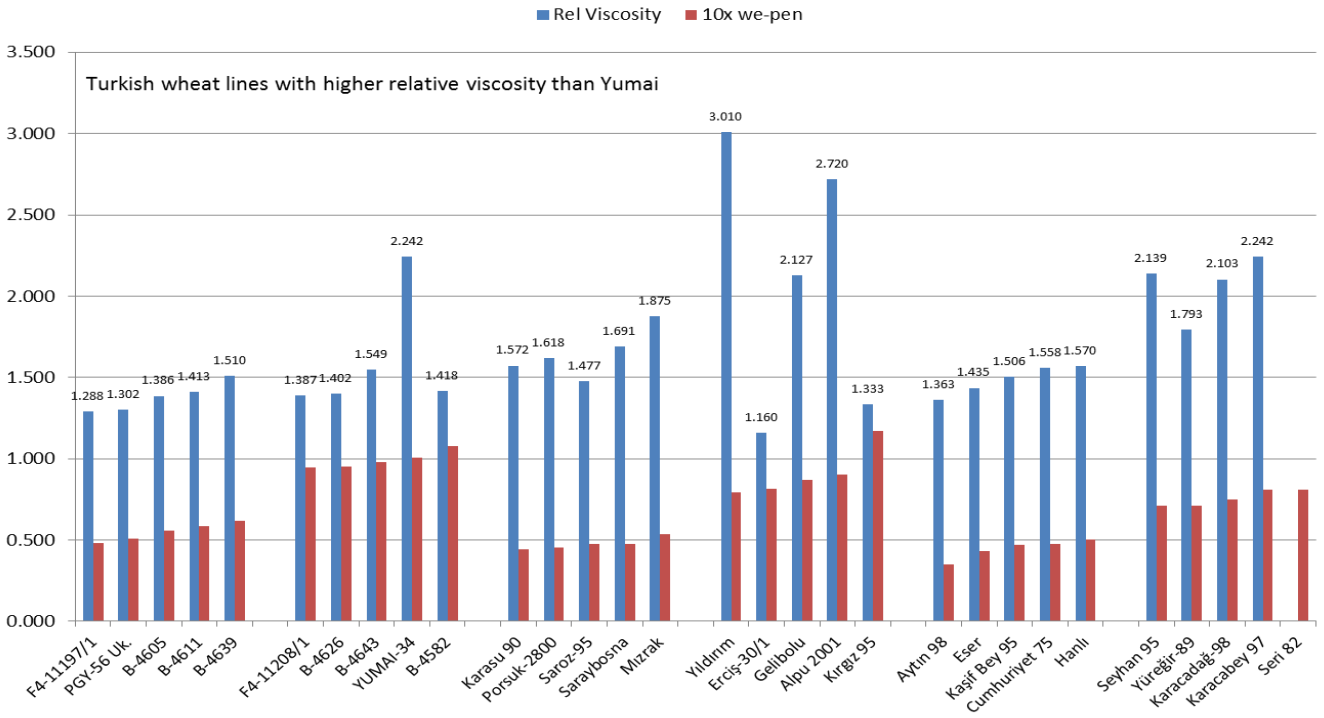
Turkish wheat lines



Prof.Mehmet Ulker

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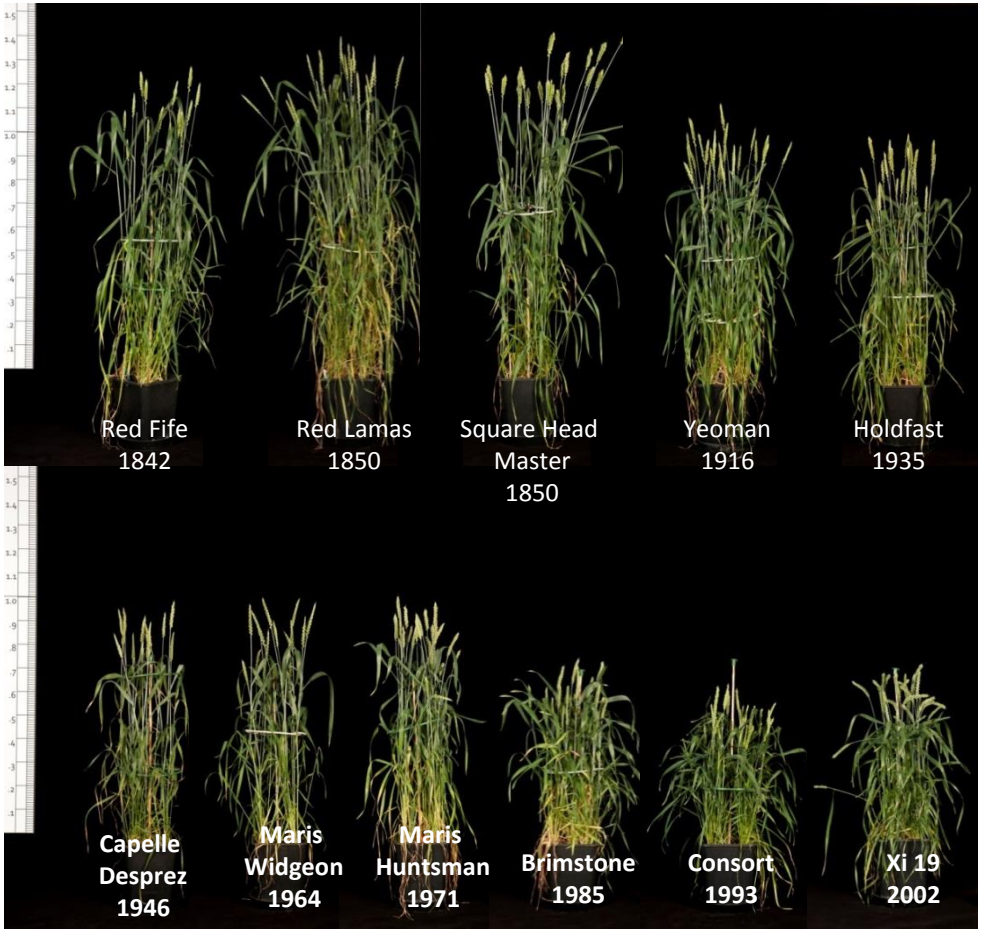
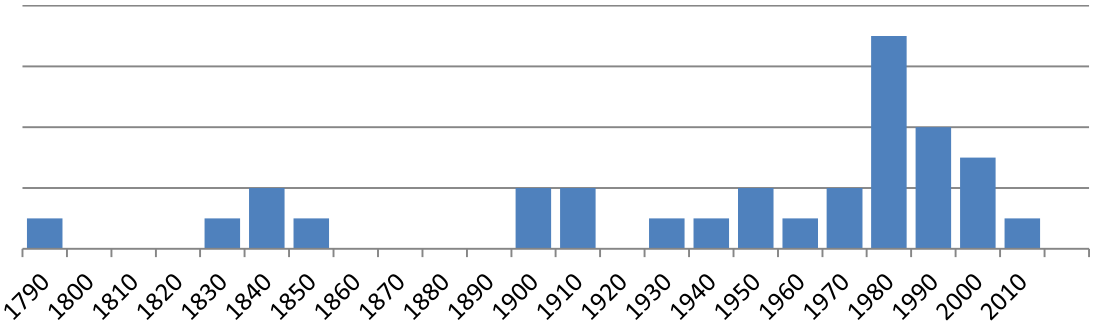
“Historic “ UK wheats are being grown for detailed comparisons

1790	Chidham White Chaff
1838	April Bearded (Spring)
1842	Red Fife (Canadian spring)
1844	Browick
1850	Red Lammas (Lammas?
1905	Red Standard
1908	Little Joss
1911	Squareheads Master
1916	Yeoman
1935	Holdfast
1940	Warden
1942	Gartons 60
1947	Victor
1946 (1953 UK)	Cappelle Desprez
1952	Steadfast
1954	Masterpiece
1956	Viking
1957	Rampton Rivet (turgidum)
1957	Dominator
1958	Milfast
1964	Maris Widgeon
1971	Maris Huntsman
1972	Maris Ploughman
1974	Mega
1980	Avalon
1983	Galahad
1984	Apollo
1985	Mercia
1985	Brimstone
1986	Flanders
1989	Hereward
1991	Spark
1992	Cadenza
1993	Consort
1995	Flame
1997	Malacca
2002?	Solstice
???	Xi 19
2003?	Robigus
2009	Gallant
2012	Crusoe





Thanks

ROTHAMSTED
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Zoltan Bedo (Martonvasar)
Mariann Rakszegi (Martonvasar)

Kurt Gebruers (Leuven)
Jan Delcour (Leuven)

Simon Griffiths (JIC)
Simon Orford (JIC)
Luzie Wingen (JIC)

Sam Millar (Campden BRI)