Innovating
special nutrition

Introduction to alternative grains: history and consumption in Europe

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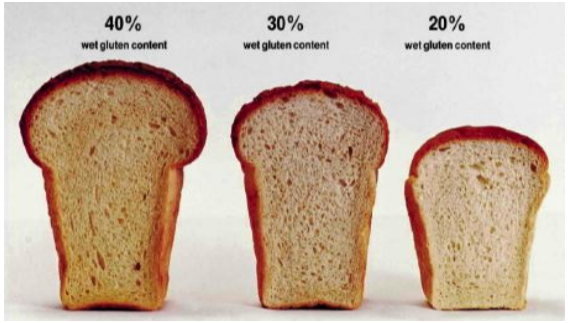
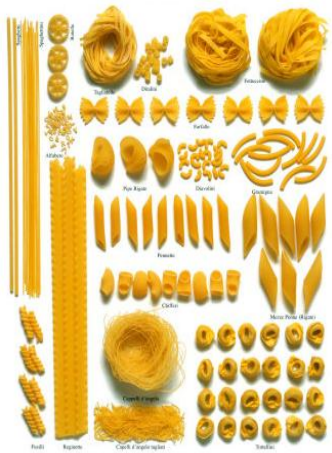
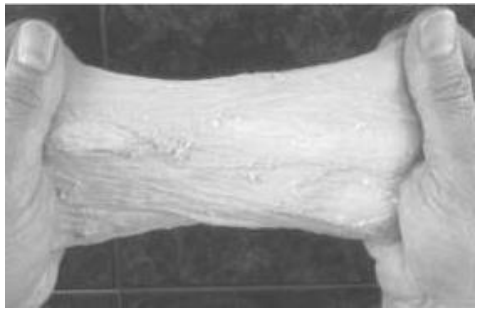
Wheat since 1950s

- Increased monopoly of bread wheat (*Triticum aestivum*)
- Large-scale development of food technological applications adapted to bread wheat
- Consequences
  - Decrease of genetic diversity of bread wheat
  - Limited attention to other wheat species, other cereals and grains and the products thereof
  - Loss of small-scale processing technologies
  - Increase of wheat and gluten-related diseases

Wheat gluten and starch: current applications







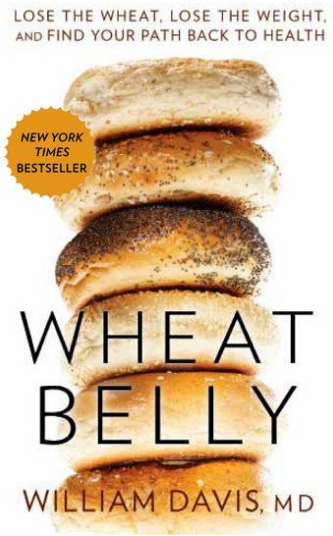
Canned vegetables
Dairy products
Seafood

Wheat is a major food crop

Increase of gluten application as major food industrial protein

Wheat components are applied in 30% of super market food items

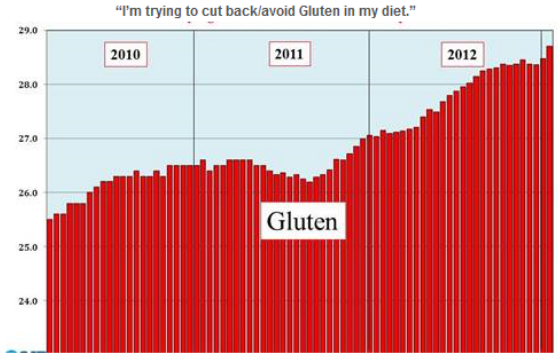
Global change towards negative appreciation of common wheat



- Increased awareness on healthy diets
- Increased gluten-free consumption
- Increased attention towards traditional wheat species and alternative (gluten-free) grains

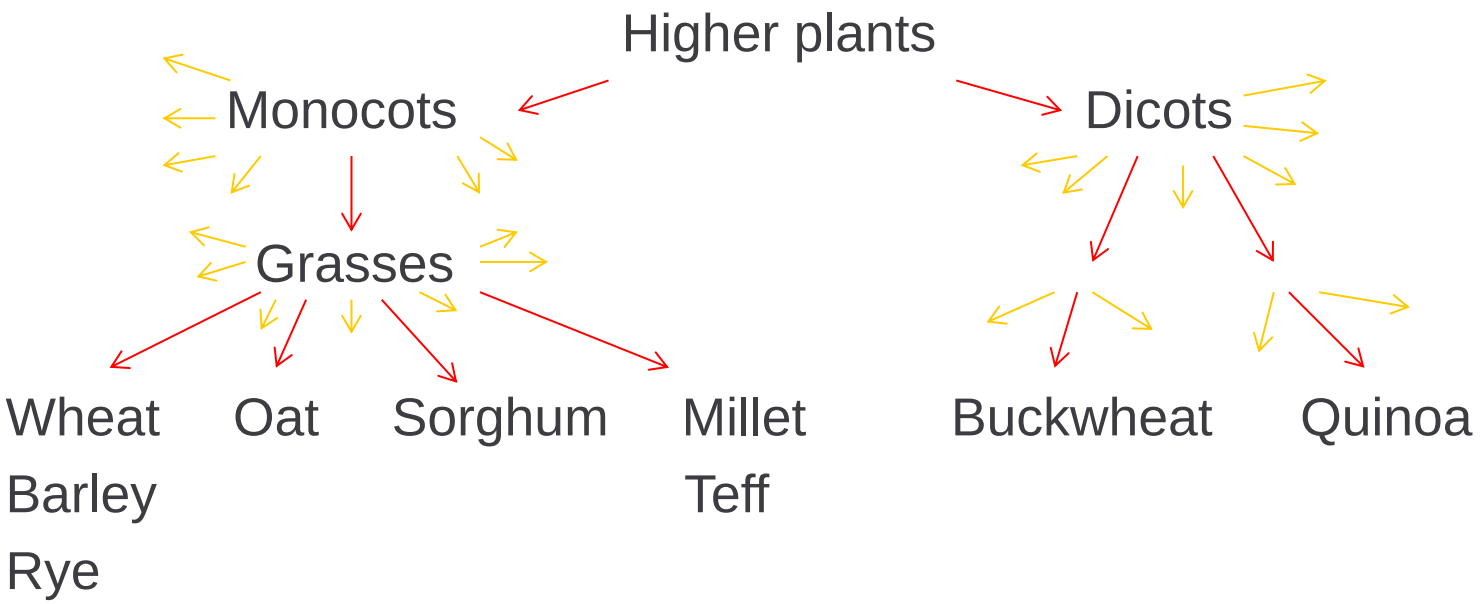
—200 million restaurant visits include a gluten-free order

Chicago, March 6, 2013 —As of this January about a third of U.S. adults say they want to cut down or be free of gluten in their diets, the highest percentage making this claim since The NPD Group, a leading global information company, began asking the question in 2009. NPD's ***Dieting Monitor,*** which continually tracks on a bi-weekly basis top-of-mind dieting and nutrition-related issues facing consumers, reports that 30 percent of adults, one in every three adults, claimed to cut down on or avoid gluten completely in January 2013.



Source: The NPD Group/Dieting Monitor, 52 week data year ending January 30, 2013

Relationship of cereals and pseudo-cereals



- Wheat
  - Einkorn (*T. monococcum* [2n] AA-genome)
  - Durum (*T. durum*); Emmer (*T. dicoccoides*); Kamut® (*T. turgidum*) ([4n] AABB genome)
  - Common or bread wheat (*T. aestivum*); Spelt (*T. spelta*) ([6n] AABBDD genome)
  - Triticale (*Triticum x Secale*) ([4n, 8n, mainly 6n] AABBRR genome)

Quinoa (Chenopodium quinoa – Chenopodiaceae)

- History
  - Domesticated for human consumption 3-4000 BP, known as feed 7000 BP, in Andean region (S-America)
  - Sacred crop for Incas; forbidden crop after Spanish conquest
  - From peasant food to luxury food (Peru)
  - Recently introduced in Europe
  - Increased (triple) production since 1960 (total world: 80 kT) (Quinoa as ‘superfood’)
  - Breeding of ‘sweet’ quinoa (Wageningen)
- Applications
  - Breakfast (cooked)
  - Bakery products (flour mixed with tapioca flour and oatmeal to improve structure)
  - Medicinal: anti-inflammatory (phenolics); gluten-free
  - Allergy: rare; high in oxalate

Buckwheat (Fagopyrum esculentum – Polygonaceae)

- History
  - Domesticated 8000 BP in southeast Asia (Yunnan region China)
  - Spread to central Asia and Tibet, then to Middle East and Europe (Balkans) (6000 BP)
  - First crop introduced from Europe to N-America (18th and 19th century)
  - In 2006: Canadian buckwheat variety widely planted in China
  - Sharp decline in USA in 20th century; major production in Russia and China (total world production: 200 kT)
- Applications
  - Noodles: Tibet, N-China: traditionally; Japan, Korea more recently
  - Groats (porridge, roasted and cooked): Russia, Ukraine, Poland
  - Pancakes: Russia, France, UK
  - Polenta (mixed with wheat, maize): N-Italy
  - Honey, beer
  - Medicinal: rutin strengthens capillary walls; protein may reduce plasma cholesterol; gluten-free
  - Allergy: IgE-mediated anaphylaxis; known as ‘hidden allergen’

Millet (variable group of small-seeded grasses – Poaceae)

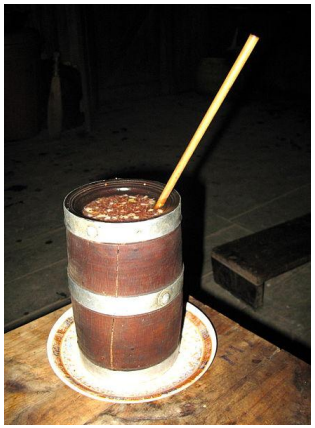
- General
  - Millets do not form a taxonomic but a functional-agronomic group
  - General characteristic: small to very small grains
  - Many crop genera and species:
    - Pennisetum (pearl millet) (India; Africa [S-Sahara])
    - Panicum (proso millet) (China)
    - Setaria (foxtail millet) (China)
    - Eleusine (finger millet) (India)

    - Digitaria (blood millet)
    - Paspalum (kodo millet)
    - Echinochloa (Japanese millet)
    - Urochloa (browntop millet)

    - Sorghum (US, Africa)
    - Coix lacrima-jobi (Job's tears)
    - Eragrostis tef (teff) (E-Africa)

Millet (Panicum; Pennisetum – Poaceae)

- History
  - Domestication of several millet species 10.000 BP in NE-China and Africa (S-Sahara)
  - Move from China to Red Sea area 8.000 BP; high drought-resistance
  - Staple in E-Europe (Middle Ages; before introduction of potato)
  - Major production in India, Nigeria (total world production: 27 MT)
  - Decline since 1970s (replaced by cereals)
- Applications
  - Flour based products: noodles in N-China (stone age; traditional), flat bread in India (traditional), candy (Japan)
  - Porridge (Russia, Germany, China, all traditional)
  - Low nutritional value; only edible in cooked (heated) forms
  - Beer (Taiwan); other fermented alcoholic drinks (E-Africa)
  - Medicinal: high fibre (heart-protective; lowering T2D risk; prevention of gall-stones); gluten-free
  - Allergy: not known; thyroid peroxidase inhibitor



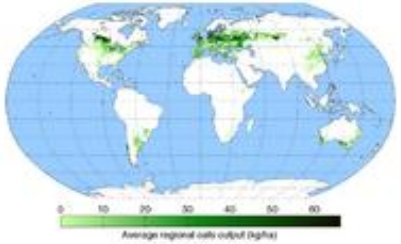
Teff (Eragrostis tef – Poaceae)

- History
  - One of the first domesticated plants: Ethiopia 10.000 BP
  - Accounts for 25% of Ethiopian cereal production (total world production = from Ethiopia: 0.9 MT)
  - Also cultivated in India and Australia; recently, teff breeding in US (Kansas)
- Applications
  - As meal/flour in flat-bread, pastry, pancakes, as binder in soups and sauces
  - In diet foods and sports foods
  - Medicinal: mitigation in diabetes (high fibre); high iron content; gluten-free
  - Allergy: not known

Sorghum (Sorghum bicolor – Poaceae)

- History
  - Domesticated in Africa (S-Sahara) > 4.000 BP
  - Migration to India and Pakistan 4.000 BP
  - During Muslim Agricultural Revolution (7th century) extensively planted in Middle East, N-Africa and S-Europe; in France since 12th century)
  - Major production in US, Nigeria, India, Mexico (total world: 65 MT)
- Applications
  - Unleavened bread: India
  - Porridge: S-Africa
  - South US: syrop
  - Arab cuisine: couscous, porridge, soups, cakes, bread, popped
  - Central America: tortillas
  - Alcoholic drinks: sorghum beer is popular in S-Africa
  - Medicinal: gluten-free products
  - Allergy: not known; anti-nutritional tannins

Oat (Avena sativa – Poaceae)



- History
  - Domestication 5.000 BP as hulled oat in NW-Europe and as naked oat in W-China but originating as weed from Near East
  - Transfer to N-America in 17th century
  - Sharp decline after 1950 (from horse to tractor)
  - Increased attention as ‘super food’ since 2000
  - Major production in Russia and Ukraine, Canada, US, Poland, Finland; total world: 25 MT
- Applications
  - Fits in organic farming and several crop rotations
  - Traditionally known as horse, cattle, chicken and dog feed
  - Europe, N-America: porridge
  - Scotland (oat as mainstay in national diet) and Brittain: bread; as thickener in soups; oat beer (also in Medieval Netherlands)
  - Latin America: ‘avena’ (cold sweet drink with milk)
  - Medicinal: cholesterol-lowering (EFSA and FDA health claims); in diabetes and obesity; oat extracts in skin cosmetics; intestinal applications in Ayurveda and TCM
  - Allergy: very rare, not severe, limited to infancy

Einkorn (Triticum monococcum – Poaceae)

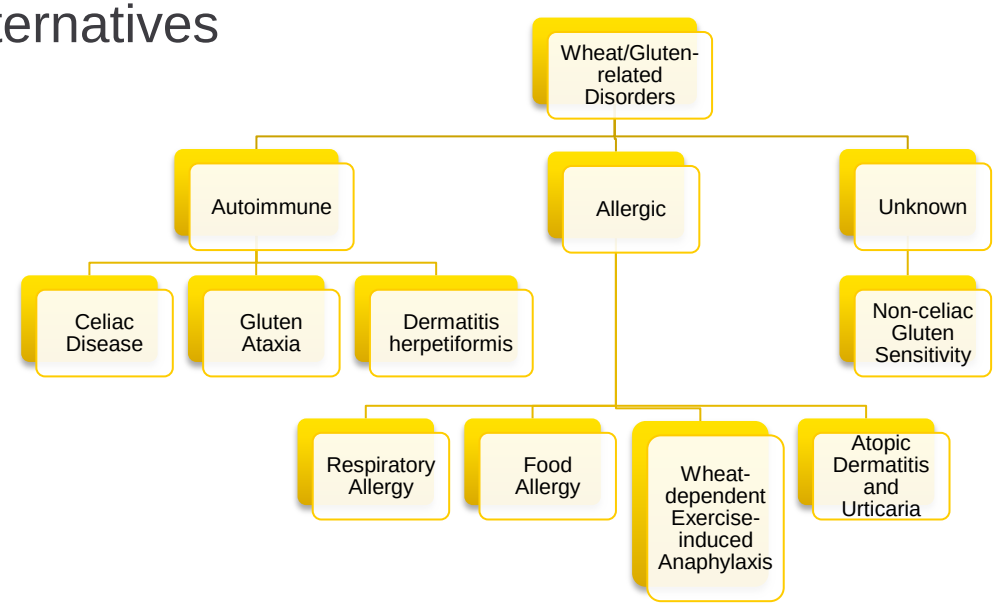
- History
  - Earliest cultivated (diploid, hulled) wheat 10.000 BP in SE-Turkey
  - For several thousand years staple food of European farmers
  - Traditional local cultivation in France, Morocco, former Yugoslavia in organic farming for feed (total world production: ?)
- Applications
  - New small niche market as health food
  - High-quality flour for cookies and pasta
  - Fits in low-impact and sustainable agriculture
  - Medicinal: high in anti-oxidants; high in mono-unsaturated fatty acids
  - Allergy: gluten (80% of total protein) may have reduced toxicity in celiac disease

Crop / com pound (%, 100g)	Quinoa	Buckwheat	Millet	Teff	Sorghum	Oat	Einkorn	Wheat
Starch	60%	60%	75%	70%	75%	55%	60%	65%
Protein	13% High in essential AA	14% High in essential AA	11%	13%	11%	17% 85% Globulin; High in essential AA	18% Prolamins	11% Prolamins
Oil/fat	5%	3%	4%	2%	3%	7-14%	3%	2%
Fibre	6%	10%	8%	8%	6%	10% High beta glucan	1%	4% Low beta glucan
Water	16%	9%	9%	9%	9%	10%	10%	13%
Vitamins	Medium in B High in folate Tocopherol (Vit E)	High in B	High in B	High in B	Low in B	Low in B High in folate	Low in B	Low in B
Minerals	Calcium 40 Iron 4 mg Magnesium 170 Phosphorus 390 Potassium 480 Zinc 3	Calcium 15 Iron 2mg Magnesium 200 Phosphorus 320 Potassium 360 Zinc 2	Calcium 30 Iron 3 mg Magnesium 110 Phosphorus 290 Potassium 200 Manganese 2	Calcium 175 Iron 7mg Magnesium 180 Phosphorus 415 Potassium 410 Manganese 9	Calcium 25 Iron 4 mg Magnesium ? Phosphorus 275 Potassium 330	Calcium 48 Iron 5 mg Magnesium 270 Phosphorus 440 Potassium 360 Zinc 3 Manganese 4 Selenium 35 ug	Calcium 42 Iron 4 mg Magnesium 160 Phosphorus 520 Potassium 420 Zinc 7 Manganese 5	Calcium 29 Iron 3 mg Magnesium 130 Phosphorus 290 Potassium 360 Zinc 3 Manganese 4
Anti-inflammatory	Moderate-High	High	High	High	?	Moderate (?)	?	Low

Wheat allergy, intolerance, sensitivity

- Wheat allergy: very rare (IgE sensitization: high [2%])
- Wheat intolerance (CD): 0.5-2%; only 1 in 5 properly diagnosed
- Wheat sensitivity: real trend or passing hype (0-10%)?

→ Increasing interest in alternatives



Strategies to reduce the prevalence of wheat-related diseases

- Focus on non-diagnosed population
  - Limitation of application of wheat/gluten in regular food products
  - Large-scale application of less-CD-toxic wheat: Einkorn may help
  - Promotion of sourdough applications to ‘pre-digest’ gluten
  - Replacement of common (bread) wheat by alternatives

- Focus on diagnosed population
  - Improvement of gluten-free quality (pure unprocessed foods helps in refractory CD)
  - Produce alternative grains in strict gluten-free production chains (according to agreed protocol and contract)

  - Oats are allowed to be sold as gluten-free according to Regulation EC 41/2009

Recent developments

Growing interest in alternative grains (pseudocereals and cereals)

- Health
- Diversification of food products (also in new combinations)
- Diversification and sustainability in agriculture
- Stimulation of traditional agriculture and food technologies

- EU KBBE.2013.1.2-03: Minor small-grain cereals
- EU KBBE.2013.2.3-02: Traditional food networks (TraFooN)
- ERA-net: Sustainable Food

KBBE.2013.2.3-02 Traditional food networks [TraFooN)

Knowledge transfer to SMEs, aiming at:

Increasing attention to traditional grains

- Buckwheat in Slovenia
- Durum wheat in France
- Spelt wheat in Germany and The Netherlands
- Oat in The Netherlands

Increasing attention to traditional small-scale technologies

- Sourdough in Germany

Increasing attention to ‘gluten-free’

- Gluten-free grains in Ireland an The Netherlands

Conclusion

Alternative grains

- Have a great potential to improve the quality of healthy and gluten-free diets
- Deserve a wide revival as traditional foods produced by traditional technologies
- Form a rich and varied source to challenge the food industry towards innovative (health and gluten-free) products

Thanks for your attention