Ancient grains

Publication of 'wheat is bad' books have led consumers to believe that wheat has somehow been tampered with, and encouraged them to seek alternatives. This accompanies a natural desire to see our food less processed and trends are now emerging in favour of raw foods as well as paleo and ancient grains. But what is "ancient" with respect to "ancient grains"? And should we consider just the grains or the whole spectrum of cereals and pseudo-cereals? And what challenges do we face when using them in our current formulations?

Table 1: Of the Triticeae tribe[5], the following are best known:

Species	Chromosomes	Common name
Triticum aestivum	6	Wheat/ Bread Wheat
Hordeum vulgare	2	Barley
Secale cereale	2	Rye
Triticum spelta	6	Spelt
Triticum durum	4	Durum
Triticum emmer	4	Emmer
Triticum turanicum	4	Khorasan
Triticum monococcum	2	Einkorn
X Triticosecale wittmack	6	Triticale (man-made cereal)

HISTORY & BIOLOGY

Archaeology shows that consumption of the seeds of specific grasses, ground between stones, began around 19,000 years ago, near Lake Galilea[1], Israel. About 10,000 years ago, in a region that stretched from Syria through Iraq to Ethiopia, the first forms of agriculture were born, creating such wealth in that region that the need for hunting and gathering of food became less important[2]. In about 6000 BC, it is believed that the first wheat was spontaneously generated in Iran[3]. During the rise of the Egyptian, Greek and Roman empires, these species were select ed and spread throughout Europe[4].

Wheat is one of the near 11,500 species accepted[4] as part of the family Poaceae (Gramineae), belonging to the Angiosperms (flowering plants). Among the subfamily Festucoideae are to be found what we consider cereals or grains. Spelt, Emmer, Khorasan and Einkorn are, as part of the Triticeae, considered nowadays as "ancient". Contrary to what is sometimes 'preached', all species of the Triticeae tribe have gluten proteins. Therefore these products are not suitable for people suffering from coeliac disease. Cereals such as wild rice, oats, finger millet and teff are also considered "ancient" (Table 1), and do not contain gluten.

ANCIENT VS ANCESTRAL

Triticeae members such as wheat are self-pollinating[5]; making it quite a challenge to create new wheat species. Coincidently, Spelt arose from a crossing of Emmer and Aegilops squarrosa, a grass. Emmer in its turn was a crossing of Einkorn and another grass; Durum, Khorasan and Wheat were bred in similar ways[6,7]. Over the years we have seen that the genes naturally mutate, as demonstrated the first DNA-research on wheat (2012)[8].

Spelt, Einkorn and Emmer are covered wheats, meaning that the kernels are enclosed on the plant, which makes dehulling more difficult and lowers yields slightly[9]. They are considered to have a higher gliadin to glutenin ratio[10], making it more difficult to make acceptable bread:

- Einkorn tends to give more sticky doughs, with low water retention capacity.
- Emmer can produce good loaf volumes for bread, but has a slightly more acidic flavour, however milder than rye.
- Spelt can give similar bread loaf volumes and a slightly more nutty, creamy flavour.

Khorasan and Durum have both much higher protein content than Wheat, and different handling properties. Khorasan grains are generally high in protein and its whole grain flours have a mild, nutty flavour. Durum is also high in protein and low in gluten content. This makes it not very resistant for proofing; the skins have a tendency to rupture. Durum also gives a more bland nutty flavour.

Table 2

		Wheat	Barley	Rye	Spelt	Durum	Emmer	Khorasan	Einkorn
Energy	Kcal	340	345	349	338	339		337	347
Water	g	10.74	12.11	10.97	11.02	10.94		11.07	11
Protein	g	13.21	10.5	10.88	14.57	13.68	17	14.54	18.2
Lipids	g	2.5	1.6	1.52	2.43	2.47	2.2	2.13	2.48
- Saturated	g	0.43	0.34	0.18	0.41	0.45		0.2	
- Mono unsaturated	g	0.28	0.21	0.19	0.45	0.34		0.21	
- Poly unsaturated	g	1.17	0.77	0.7	1.26	0.98		0.62	
Carbohydrate	g	71.97	74.52	75.43	70.19	71.13		70.58	68.2
- sugars	g	0.41	0.8	1.1	6.82			7.84	2.67
Fibers	g	10.7	10.1	11.8	10.7		7.9	11.1	8.7
Calcium	mg	34	32	24	27	34		22	
Iron	mg	3.6	2.68	2.54	4.44	3.52		3.77	4.59
Magnesium	mg	137	96	63	136	144	170	130	
Phosphorus	mg	357	296	225	401	508	520	364	415
Potassium	mg	363	309	374	388	431	440	403	390
Sodium	mg	2	4	2	8	2		5	
Zinc	mg	2.6	2	2.17	3.28	4.16		3.68	2.24
Vitamin A	µg	0	0	0	0	0		1	
Thiamin	mg	0.5	0.37	0.29	0.36	0.42	0.49	0.57	0.5
Riboflavin	mg	0.17	0.11	0.11	0.11	0.12	0.38	0.18	0.45
Niacin	mg	4.96	6.27	1.73	6.84	6.74	4.9	6.38	3.1
Vitamin B-6	mg	0.41	0.4	0.27	0.23	0.42		0.26	
Folate	µg	44	8	34	45	43		0	
Vitamin B-12	µg	0	0	0	0	0		0	
Vitamin C	mg	0	0	0	0	0		0	
Vitamin D	µg	0	0	0	0	0		0	
Vitamin E	mg	0.71	0.57	1.43	0.79	0		0.61	
Vitamin K	µg	1.9	2.2	5.9	3.6	0		1.8	
Source		1	1	1	1	1	5	1	4.5

1 http://www.usda.gov/United States Department of Agriculture, Agricultural Research Service, National Nutrient Database for Standard Reference Release 27 : http://ndb.nal.usda.gov/ndb/search
2 Product specifications available on www.organic.nl
3 SelfNutriondata: http://nutritiondata.self.com/
4 source: http://www.einkorn.com/
5 Baking evaluation, sensory analysis, and nutritional characteristics of modern, heritage, and ancient wheat varieties: http://www.extension.org/pages/72647/baking-evaluation-sensory-analysis-and-nutritional-characteristics-of-modern-heritage-and-ancient-wh#.VY5gZ_ntlBc

All the alternative cereals are considered to produce lower volume, more dense structures than common wheat bread. Nowadays many bakeries are working with more advanced bakery equipment systems and find it very difficult to make commercially acceptable breads from popular grains such as spelt. Some bakeries are unable to adapt their formulations or processes and are desperately searching for essential spelt gluten and other improvers for their 100% spelt-based bread.

Spelt is often considered by people who have a wheat allergy. However, only products made with Franckenkorn spelt have been reported to be beneficial for those with a wheat allergy, which is not to be confused with celiac disease[11,12]. The most economically important spelt varieties are (partly) reverse-engineered[13]:

- Franckenkorn, a backcross from old species, at that time the 'purest' Spelt.
- Oberkulmer Rotkorn, a read-out of an old Swiss landrace
- Schwabenkorn, a backcross at the Roter Tiroler Wheat content at the Hohenheim University

The lack of gluten in other cereals like rice, millet, oat and teff makes baking acceptable breads difficult[14]. Rice is bland-tasting and needs support systems to reach acceptable bread loaf volumes, as can be seen when looking into gluten free developments. Oat is also challenging, but it has a high protein and fibre content, creating more options to make acceptable bread loaf volumes, as demonstrated by the recent introductions of oat-based breads into the market. Millet, as sorghum, is used in typical breads with low volumes. They have a starchy, slightly nutty flavour and can give a gritty mouth feel, due to a high ash content. The African cereal teff is typically used in flat breads, and gives a grainy, slightly bitter flavour, probably due to high levels of micronutrients and fibre. Teff also has very interesting viscosity properties, allowing functionalities with regards to fat reduction. Sourdough technology and enzymatic improvement systems can aid in creating more volume with regards to bread[15] .

Table 3

		Rice	Oat	Millet	Teff	Buckwheat	Quinoa	Amaranth
Energy	Kcal	366	380	382	367	350	350	371
Water	g	11.89	12	8.67	12	15	15.5	
Protein	g	5.95	11	10.75	13.3	12.9	14.2	13.6
Lipids	g	1.42	6.3	4.25	2.4	3.2	5.7	7
- Saturated	g	0.39	1.2	0.54	0.5	0.66	0.71	1.5
- Mono unsaturated	g	0.44	2.18	0.92		1.23	1.61	1.7
- Poly unsaturated	g	0.38	2.54	2.62		1.17	3.29	2.8
Carbohydrate	g	80.13	66	75.12	65.1	65.9	59.8	59
- sugars	g	0.12		1.66	1.8	1.16	1.4	1.7
Fibers	g	2.4	5	3.5	8	3	5.1	6.7
Calcium	mg	10	54	14	180	18	66.6	159
Iron	mg	0.35	4.7	3.94		2.2	10.9	7.6
Magnesium	mg	35	177	119		231	204.2	248
Phosphorus	mg	98	523	285		347	408.3	557
Potassium	mg	76	429	224	427	254	1040	508
Sodium	mg	0	10	4	12	11	5	4
Zinc	mg	0.8	3.2	2.63		3	7.5	2.9
Vitamin A	µg	0	0	0		0	0	0
Thiamin	mg	0.14	0.76	0.41		0.1	0.36	0.1
Riboflavin	mg	0.02	0.14	0.07		0.43	0.42	0.2
Niacin	mg	2.59	0.96	6.02		7.02	1.4	0.9
Vitamin B-6	mg	0.44	0.12	0.37		0.21		0.6
Folate	µg	4	32	42		54		82
Vitamin B-12	µg	0	0	0		0		0
Vitamin C	mg	0	0	0		0	3	4.2
Vitamin D	µg	0	0	0		0		0
Vitamin E	mg	0.11	0.7	0.11		0.32		1.2
Vitamin K	µg	0	3.2	0.8		7		0
Source		1	2	1	2	2	2	3

1 http://www.usda.gov/United States Department of Agriculture, Agricultural Research Service, National Nutrient Database for Standard Reference Release 27 : http://ndb.nal.usda.gov/ndb/search
2 Product specifications available on www.organic.nl
3 SelfNutriondata: http://nutritiondata.self.com/
4 source: http://www.einkorn.com/
5 Baking evaluation, sensory analysis, and nutritional characteristics of modern, heritage, and ancient wheat varieties: http://www.extension.org/pages/72647/baking-evaluation-sensory-analysis-and-nutritional-characteristics-of-modern-heritage-and-ancient-wh#.VY5gZ_ntlBc

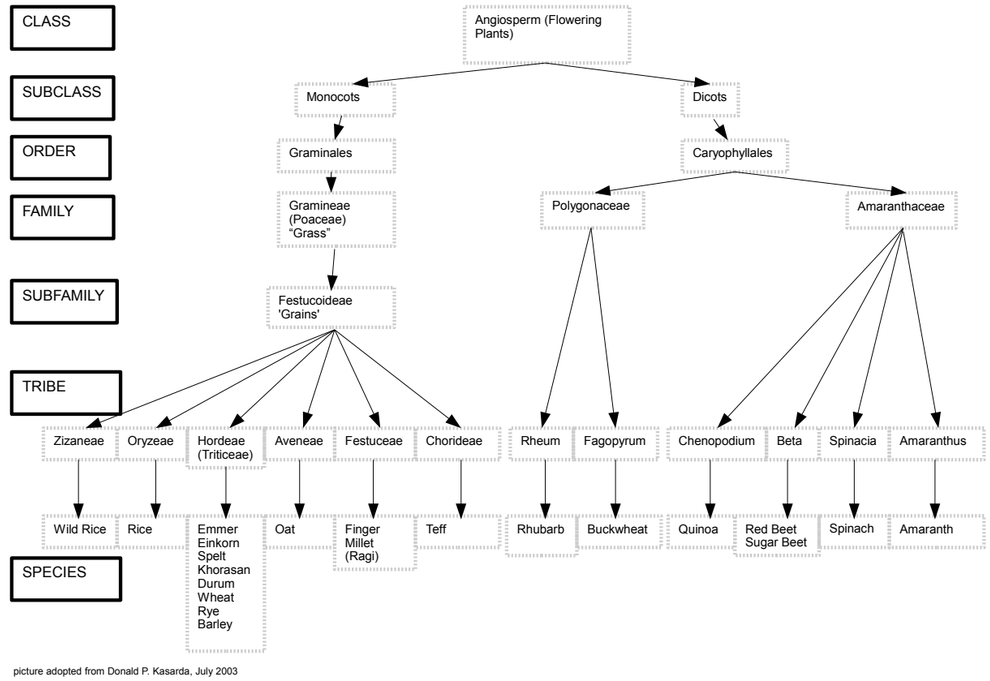
Table 4: Selected characteristics of pseudo-cereals

	Wateruptake	Gelatinisation temperature
Rice	120	74
Oat	95	56
Quinoa	95	58
Teff	95	71
Sorghum	95	74
Maize/Corn	90	67
Buckweat	85	66
Wholemeal Wheat	67	61
Wheat	63	61

PSEUDO-CEREALS

Sometimes Pseudo-cereals are also considered as ancient grains. Like the cereals that are not part of the Triticeae, they do not contain gluten and are often used in baking for flavour and nutritional profile improvement:

- Buckwheat gives a bitter taste, predominantly in unhusked buckwheat flour.
- Quinoa was vital to the Incas and considered sacred. The protein isolate from quinoa resembles cows milk protein in quality[15] creating new lactose free options. Quinoa also has quite high levels of enzymatic activity; making that the key characteristics of breads, cakes and cookies decreased. The satiety properties of Quinoa are being investigated[16].
- Amaranth was a staple food for the Aztecs, and having



picture adopted from Donald P. Kasarda, July 2003

an amino acid composition close to the ideal protein[17]. For application in bread the amount is limited, although the high protein and ash content improves colour and flavour.

APPLYING ANCESTRAL FLOURS

Ancestral grains give options in nutritional profile and flavour improvement, potentially allowing specific consumer groups to be targeted. Working with alternative (pseudo-) cereals poses other challenges, since they differ in water uptake, viscosity, gelatinisation and pasting temperature curves. So one needs to be aware to properly implement these into their formulations and processes. Particularly in breads, where consumers are used to light textures, use of wholegrain/-seed, flours produces dense, heavy textures, which may require improvers, sourdough and sponge-dough methods[18]. Other products, like cakes and biscuits, do not face this challenge; but different viscosities or rheology properties may introduce the need either for changes in the leavening or stability (e.g. emulsifiers and hydrocolloids). The commonest mistakes arise due to different gelatinisation and pasting, resulting in baking times that are either too long or too short. ■

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1. Kislev et al, 1992 Epipaleolithic (19,000 Bp) cereal and fruit diet at Ohalo-Ii, Sea of Galilea, Israel. Review of Paleobotany and Palynology, 73 (1-4), 161-166
2. Houtzager, G. 2005 Brood in de oudheid, Veltman Uitgevers
3. Belderok, B. 2000 Developments in bread-making processes. Plant Foods for human nutrition, 55 (1), 1-14
4. www. Plantlist.org
5. Bajaj, Y. P. S. 1990 Wheat. Springer. pp. 161-63. ISBN 3-540-51809-6.
6. Lindhauer, M.G. 2004 Grundlagen Weizenmahlerzeugnisse, Getreideerzeugnisse
7. Franck, P. 2005 Dinkel asl Rohstoff in der Getreideverarbeitung, Getreideerzeugnisse
8. Hall. "Analysis of the bread wheat genome using whole-genome shotgun sequencing: Nature : Nature Publishing Group". Nature. Retrieved 5 February 2014
9. Vallega, V. 1992 Agronomic performance and breeding value of selected strains of diploid wheat, Triticum monococcum. Euphytica 61: 13-23
10. Stallknecht et al., 1996: "Alternative Wheat cereals as Food Grain: Einkorn, Emmer, Spelt, Kamut and Triticale; New Crop, proceedings 1996/ V3
11. Hildegard von Bingen 1098-1175:Physica: "Causae et curae"
12. Stallknecht et al., 1996: "Alternative Wheat cereals as Food Grain: Einkorn, Emmer, Spelt, Kamut and Triticale; New Crop, proceedings 1996/ V3
13. Franck, P. 2005 Dinkel als Rohstoff in der Getreideverarbeitung. Getreideerzeugnisse
14. Arendt et al. 2013 Cereal grains for the food and beverage industry., Woodhead publishing Ltd.
15. Koziol M, 1992. Chemical composition and nutrional evaluation of quinoa. Journal of Food Composition an Analysis, 5, 35-68
16. Berti et al, 2005, Effect on appetite control of minor cereal and pseudo-cereal products. Britsh Journal of Nutrition, 94, 850-858.
17. Yanez et al, 1994. Chemical and nutrtional characterization of amaranthus. Archivos Latinoamericanos de Nutrición, 44, 57-62.
18. Hoseney, R.C. 1992 Principles of cereals science and technology. Am. Assoc. Cereals Chemists, St. Paul. MN.