NUTRACEUTICAL PLATFORMS

Ancient Grains for Modern Times

Having been with us for thousands of years, ancient grains have enjoyed a remarkable rise in popularity among Western consumers. Nutritional qualities back up this consumer interest beyond any hypes.

by Rob Barnhoorn

As a popular term, "ancient grains" are defined in different ways by different consumer groups, but generally they refer to staple crops cultivated of old which were replaced in modern times by big commercial grain crops such as wheat, rice and corn. Ancient grains can be categorized in two main groups: cereals, such as spelt, oats, sorghum, millet and teff, all pertaining to the large family of grasses (*Poaceae* or *Gramineae*); and pseudocereals, like buckwheat, amaranth, quinoa and chia, all of which bear grain-like seeds without being related to grasses at all and actually pertaining to very different genera and families.

Nutritional Qualities

Generally speaking, small kernel grains like Indian rice grass, teff and quinoa tend to have a relatively higher protein content than maize/corn and rice, while quinoa can contain up to 50% more protein than maize and rice, and more or less matches wheat's protein content. Botanically, modern commercial wheat varieties are closely related to ancient grains of the *Triticum genus* like spelt, emmer and einkorn. In Roman times, spelt was the number one staple food that kept the Roman empire going, feeding cities and armies alike. This importance is still reflected in the modern French word "farine" (flour) which traces back to the Latin term "far" (spelt). Consumers with a gluten intolerance or celiac disease have to recur to cereals other than wheat, spelt, rye and barley, to prevent gluten-related digestive problems. Gluten free cereals include millet, sorghum, teff and maize. Pseudocereals (buckwheat, amaranth, quinoa and chia) are all gluten free.

SOURCE: INNOVA MARKET INSIGHTS

› *Sanitarium Weet-Bix Gluten Free Breakfast Biscuits inlcude a variant with sorghum and another with sunflower seeds and puffed rice.*

Barley, Spelt and Oats

Among the cereal crops, barley stands out as one of the earliest cultivated cereal species. In Medieval Europe, barley was consumed as a staple food e.g. bread, while in the Middle East and modern Tibet barley is still very popular as a cereal ingredient for various dishes. In the Western world, barley is nowadays mostly used for beer production and animal feed, but barley bread has seen renewed consumer interest in recent years, particularly in outlets for health food and organic foodstuffs. The same goes for spelt (*Triticum spelta*), the elder kin of modern wheat. Health food stores and organic food stores are nowadays the main suppliers for consumers. Another ancient Triticum cereal is khorasan wheat, of which one specific variety is traded as KAMUT khorasan wheat. Oats are also a gluten containing ancient grain, although levels can be considerably lower than in wheat, rye and barley. A well-known health-promoting substance in oats are beta glucans, a type of dietary fiber that exerts strong positive effects on the immune system and cholesterol. The relatively high dietary fiber content also leads to higher satiety and lower GI levels.

Gluten Free Cereals

Interestingly, several cereals, including Indian rice grass, the sorghum family and the various millet types, including teff, are all gluten free. In recent years, they have gained substantial consumer interest. Teff flour is used as a main ingredient in sourdough-risen Ethiopian flatbread, injera. Sorghum (*Sorghum bicolor*), currently the fifth most important cereal grown worldwide (behind rice, wheat, maize/corn and barley), actually originates from Northern Africa and has spread to various warm climate zones, including South East Asia, Northern Australia, the US and South America. Besides for livestock feed and bioethanol production, it is also used for bread (India), fermented and distilled alcoholic beverages (China), molasses or sweat sorghum syrup, and increasingly as gluten free wheat substitutes. A product example of the latter is gluten free Australian Weet-bix, produced with sorghum. For the gluten free market, sorghum now provides an optimal substitute for wheat.

Buckwheat is an ancient pseudocereal botanically related to sorrel and rhubarb,

which was domesticated early in agricultural history, probably 8,000 years ago, in South East Asia. Russia was and is still known for its buckwheat production. China and Japan still use buckwheat in various dishes, including noodles. Protein levels are relatively high, hovering at around 18% and the amino acid profile is very advantageous, including essential amino acids like lysine, threonine, tryptophan and the sulphur-containing amino acids, cysteine and methionine. Currently buckwheat is highly valued as a quality raw material for gluten free beer production.

Amaranth species are pseudocereals that were once used as staple foods in Central America and have spread to other continents too. Particularly *Amarantus caudatus* is now also being cultivated in Eastern Africa, where it is sometimes mixed with teff for preparing injera flatbread. Besides their seeds, which are used in breakfast food, bakery products, extruded foods, gluten free foods, injera bread and also for local beverages, amaranth leaves are highly esteemed vitamin-rich vegetables.

Market Trends

Besides nutritional factors as oil and protein content, the mainstreaming of gluten free products has clearly been of key importance. According to Innova Market Insights, North America saw a 15% rise in launches of products that contain ancient grains in the past year. Quinoa was the number one most used ancient grain, while the highest growth was accounted for by sorghum (+49%) and chia (+22%). Health positionings of these products included allergy and gluten free, wholegrain, high/source of fiber and organic. The combination of quinoa with oats as ingredients in cereal bars and biscuits and cookies is another interesting trend.

Tailor-Made Quinoa Flours

Quinoa (*Chenopodium quinoa Willd*) is a pseudocereal seed crop originating from the Andes region, botanically related to goosefoot. In the past few years it has seen a steep rise in popularity, to the extent that prices tripled and the main producing and exporting countries, Peru and Bolivia, were temporarily unable to meet global demand.

Marcel Minor, senior researcher and protein expert at Food & Biobased Research, Wageningen UR, discussed the potential of quinoa seeds referring to new non-bitter varieties, smart fractionation processing and resulting ingredient opportunities. Until recently, quinoa seeds were treated with wet processing, a necessary step to wash out the intensely bitter saponins. But with the new non-bitter quinoa varieties developed at Plant Breeding, a research department at Wageningen UR, the wash-out step is no longer necessary. Instead, dry processing can be applied, polishing the hull, comparable to polishing the outer coat of rice kernels. A further processing refinement is achieved by separating the embryonic root and cotyledons, (appearing as a miniature tube around the grain) from the nutritive kernel.

While the kernel holds most of the seed's carbohydrates, the tubelike plant embryo contains relatively high levels of protein and oil. Smart fractionation enabled Dr. Minor and his team to develop tailor-made quinoa flour products. Dr. Minor comments: "Both processing techniques have their advantages and disadvantages. While wet fractionation provides a higher purity, dry fractionation is a less complicated process. Both fractionation products are applicable as high value product ingredients, e.g. in multigrain baby food, or as oil, protein or fiber supplemental ingredients in various food formulations. And with a protein level of 15% in raw seeds, the protein fraction in dry matter after smart dry fractionation could easily reach 30 to 35%, which is quite high." International players Nestlé and Heinz show interest in quinoa as an ingredient in food formulas.

European Varieties

Robert van Loo, senior scientist at Plant Breeding, Wageningen UR, discusses the potential of quinoa crops in saline soils, new non-bitter varieties and novel food applications. Since the early nineties Plant Research International (PRI), now part of Wageningen UR as Plant Breeding, has been actively involved in developing new non-bitter quinoa varieties that are also suitable for cultivation in more temperate zones, such as Northern Europe and Central/Southern Chile. This has resulted in three varieties that are now cultivated in France by the company Abbott Agra, led by European quinoa pioneer Jason Abbott. A South American pilot has been simultaneously set up in Santiago by Wageningen UR Chile, with the purpose of investigating Chile's potential for cultivating commercially interesting temperate zone quinoa cultivars. Traditionally, Northern Chile has known quinoa cultivation, particularly in Andean saline soils where other grains would not thrive

Table 1: Ancient Grains and Gluten Status

Crop	Genus	Gluten Status
Cereals		
Barley	Hordeum	High
Spelt, emmer, einkorn, farro, khorasan wheat	Triticum	High
Oats	Avena	Low
Indian rice grass	Oryzopsis	Gluten free
Sorghum	Sorghum	Gluten free
Millet species including teff	Various	Gluten free
Pseudocereals		
Buckwheat	Fagopyrum	Gluten free
Amaranth	Amaranth	Gluten free
Quinoa	Chenopodium	Gluten free
Chia	Salvia	Gluten free

Table 2: Feed Conversion for Meat and Equivalent Quinoa Amount

Livestock	Wheat (used for feeding livestock)	Feed conversion (feed > meat)	Resulting meat production	Quinoa needed for same protein amount
Chickens	8.0 tons	3 > 1	2.7 tons	3.6 tons
Pigs	8.0 tons	5 > 1	1.6 tons	2.1 tons
Cattle	8.0 tons	8 > 1	1.0 tons	1.3 tons

anymore. Wageningen UR based its cultivar breeding project on quinoa's particular quality of high salt tolerance and has won a prize in 2014, awarded for its project "Salt Tolerant Quinoa for food in China, Vietnam and Chile" for non-genetically modified, salt-tolerant quinoa that grows well and even thrives in saline soils. Van Loo comments: "Quinoa is naturally tolerant to high salt levels in soils, and it would therefore be very suitable for saline regions. In Northern Chile, some areas are saline to a point that weeds do not grow any more in these salt plains, while quinoa still produces substantial yields. Just for the sake of comparison, a common cereal like barley can tolerate salt levels of up to 25% of sea water mixed in with the water supply, while quinoa's salt toleration goes up to the astounding level of 80% sea water. And according to Italian research, quinoa still produces 2.8 tons per hectare at a mixture of 50% sea water/50% fresh water."

Powerful Protein Profile

Van Loo and Minor agree that quinoa's advantageous amino acid profile and high protein fraction would make it a very suitable ingredient for those consumer segments that, more than the average consumer, depend on a high-quality dietary protein profile: infants and toddlers, sportspeople/ athletes and the elderly. Another advantage of quinoa is its textural properties. According to Minor and Van Loo, quinoa would also be a very suitable raw material or basic ingredient for fermented products, noodles and as a meat substitute. Van Loo illustrates this by calculating the protein equivalent of quinoa compared to various types of meat, in terms of feed conversion and sustainability. "When we take well-known rough figures to estimate the amount of wheat needed to produce 1kg of meat, chicken, pork or beef, respectively, it appears that chickens need 3kg of wheat per kilo of meat, cattle as much as 8kg/kg meat, while pigs show an intermediate position. With the protein percentage of meat hovering around 20%, and quinoa containing 15% of protein, it becomes clear that 3 tons of chicken meat (9 tons of wheat needed for feed, thus having a conversion factor of 3) are equivalent to 4 tons of quinoa in terms of equivalent amounts of protein." "However, as a bonus, quinoa also throws in considerable amounts of oil, starch and fiber. Compared to the amount of wheat needed for meat production, particularly pork and beef, quinoa is clearly a much more efficient protein supplier. Taking into consideration that quinoa crop yields lie between 2.0 and 3.5 tons/ha. versus wheat yields in Western Europe producing between 6.0 and 8.0 tons/ha., quinoa protein production is still more sustainable than wheat cultivation used for feeding pigs and cattle. Global wheat production hovers around 3 tons/hectare, which makes quinoa's sustainable qualities even more pronounced on a worldwide scale."

SOURCE: INNOVA MARKET INSIGHTS

› *Plum Organics Quinoa & Leeks With Chicken + Tarragon (US)*

Chia: A Rising Oil Seed

Chia, botanically known as *Salvia hispanica*, is an ancient pseudocereal originating from Mexico. In Central America, chia is used as an ingredient in traditional food dishes and drinks. It is characterized by a relatively high oil content (containing between 25 and 30% extractable oil) of which more than 50% is alpha-linolenic acid (ALA), an important omega 3 oil. Actually, cultivation of chia crops dates back to pre-columbian times and the name chia was derived from an indigenous word chian, meaning "oily" in Nahuatl, the language of the Aztecs. The omega 3 fatty acid present in chia, alpha-linolenic acid, can be converted to DHA and EPA in the human body, which makes chia an important vegetable source of omega 3 fatty acids. The actual conversion rate seems to depend on the amount of linoleic acid (LA) in the diet, due to ALA's an LA's competitive use of the same enzymes during conversion (substrate competition).

Since the intake ratio of ALA:LA in Western consumers is known to be heavily unbalanced, a very favorable quality of Benexia chia oil in terms of its fatty acid profile is that 63% of its composition is Alpha Linolenic Acid (ALA), outnumbering omega 6 with a ratio Omega 3:Omega-6 = 3:1. Ingredia Nutritional exclusively distributes Benexia Chia Oil (produced by Functional Product Trading S.A. in Chile) in Europe and Asia. The application "for the placing on the market of chia oil as a novel food ingredient pursuant to Article 4 of Regulation 258/97," has just been approved by the EU Member States and the European Commission after the Advisory Committee on Novel Foods and Processes delivered a positive opinion. The uses in Europe are the following applications: food supplements (2g/day), plant fats and oils (maximum 10%). Besides alpha linolenic acid, other health-promoting bioactive substances in chia seeds include antioxidants (tocopherols/vitamin E) and phytosterols. Potential uses as an ingredient include supplementing products like gourmet cooking oils, breads, cereals, pasta and margarines.▼