Journal of Traditional and Complementary Medicine 5 (2015) 138–143

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Contents lists available at ScienceDirect

Journal of Traditional and Complementary Medicine

journal homepage: http://www.elsevier.com/locate/jtcme

Review article

Re-discovering ancient wheat varieties as functional foods

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ARTICLE INFO

Article history:
Received 30 January 2015
Received in revised form
10 February 2015
Accepted 23 February 2015
Available online 29 March 2015

Keywords:
Ancient grains
Lignans
Triticum
Einkorn
Chia
Quinoa

ABSTRACT

With the gluten-free food market worth almost $1.6 bn in 2011, there is every reason for renewed interest in ancient grains. This resurgent interest is expressed in re-discovering ancient varieties as functional foods. In particular, people affected by celiac disease have to avoid all gluten in their diet and several ancient grains may offer an important alternative.

1. Introduction

Ancient grains include chia, a forgotten food of the ancient Aztecs; quinoa which originated in the Andean region of Ecuador, Bolivia, Colombia and Peru; triticum (wheat), in the form of einkorn, known today as farro in Italy, as a type of awned wheat and one of the first crops domesticated in the Near East. Other grains, acknowledged as gluten-free ancient grains are amaranth, eaten in Mexico since the time of the Aztecs; quinoa, sorghum, millet; and teff, the main ingredient in the stable fermented flatbread, *injera*, in Ethiopia. A description of modern wheat is presented together with each one of the above mentioned grains.

1.1. Modern day wheat

The three main cash crop cereals in the world today are wheat, rice and maize. Wheat, (*Triticum* spp.), (Fig. 1) originating from the Levant region of the Near East and Ethiopian Highlands is now cultivated worldwide. The global leading ten wheat producing countries in 2013/2014 produced over 606 million metric tons of wheat. The European Union was the top ranked wheat producing country in that year. The grain has always provided an important source of vegetable protein in human food. The grain was easily cultivated, particularly on a large scale and could be stored after harvest. This source of food enabled settlements to be established at the start of civilization as populations grew in the Babylonian and Assyrian empires known as the “Fertile Crescent”.

Wheat has the ability to self-pollinate and this attribute greatly facilitated the selection of many distinct domestic varieties. It was used to make flour for baked breads, and eventually its use spread to cakes, and in modern times to breakfast cereal, pasta, and noodles. Wheat is used in the fermentation process to make beer and other alcoholic beverages; and biofuel. Also, it provides food for domestic livestock. In England, thatching, using bundles of wheat was used for roofing in the Bronze Age and was in common use until the late 19th century.

1.2. Possible origins of ancient wheat

Archeological findings show that wheat first occurred in parts of Turkey, Lebanon, Syria, the Levant, Israel, Egypt and Ethiopia.[1] Domesticated Einkorn wheat in Turkey dates back to 9,000 B.C.[2] Evidence of the existence of wild barley (*Hordeum sp*) goes as far back as 23,000 B.C.[3] Cultivation of wheat began to spread beyond the Fertile Crescent after about 8000 BC. Jared Diamond in his excellent book, “Guns Germs and Steel”,[4] traces the spread of cultivated emmer wheat starting in the “Fertile Crescent” about 8500 BC, reaching Greece, Cyprus and India by 6500 BC, Egypt shortly thereafter, followed by introductions in Germany and Spain

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Peer review under responsibility of The Center for Food and Biomolecules, National Taiwan University.

http://dx.doi.org/10.1016/j.jtcme.2015.02.004

Fig. 1. Modern wheat.

by 5000 BC. The early Egyptians were developers of bread and with the use of oven technology, developed baking into one of the first large-scale food production industries. By 3000 BC, wheat had reached England, and Scandinavia. A millennium later it reached China. Recent findings of wheat grains in the Kunming area of Yunnan Province, China date the wheat at around 4000 BC. Wheat has spread successfully globally and is widely cultivated as a cash crop because it produces a good yield per unit area, grows well in a temperate climate in a moderately short growing season of about120 days.

1.2.1. Crop domestication and germination

Cultivation and repeated harvesting and sowing of the grains of wild grasses led to the creation of domestic strains. Domesticated wheat has larger grains and the seeds (spikelets) remain attached to the ear by a toughened rachis during harvesting. In the case of wild strains, a more fragile rachis allows the ear to easily shatter and disperse the spikelets. As the traits that improve wheat as a food source also involve the loss of the plant's natural seed dispersal mechanisms, highly domesticated strains of wheat cannot survive in the wild. A detailed re-evaluation of varieties of the wheat complex, particularly *Triticum* and *Aegilops* species was undertaken.[5] In 1994, Cooper et al,[6] screened species of wild wheats and barleys (Fig. 2) for the presence of their major flavonoid constituents. (Fig. 3) and germination inhibitors (Fig. 4). Two lignans were found as naturally occurring germination inhibitors of Aegilops species. The, lignan named MEL I shown in Fig. 4 was synthesized[7] using a biogenetic approach from well known precursors to lignans, the phenylpropanoids (ferulic acid and its reduced alcohol) as shown in Fig. 5.

Thirty eight species were examined and a common phenolic pattern emerged. Comparison of the wild species to the cultivated forms (*H. vulgare*, *T. monococcum*, *T. dicoccum*) showed a reduction in the total quantity of phenolics in the latter species. In 14 species of wild wheat of *Aegilops*, four species of *Triticum* and two species of *Hordeum*, a complex of rare phenolic compounds was found that showed there are quantitative differences (about 5% of the amount of these phenolic constituents) between the wild and domestic species. Importantly, it was shown that in these species of wild wheats the phenolic compounds, particularly the rare lignans, act as important germination regulators. Since these phenolics are water-dissolving germination inhibitors they may act as natural 'rain gauges'. This aspect is especially important for the germination of wheat and similar crops at the appropriate time in those species inhabiting arid regions or deserts – an attribute developed during the domestication of the wild species to the cultivated forms.[8]

1.3. Farming techniques

Although seed selection is important, improvement in wheat production is mainly due to technological advances. One of the first innovations occurred with the use of the horse and ox pulling the plows (~3000 BC). Use of seed drills was introduced by the 18th

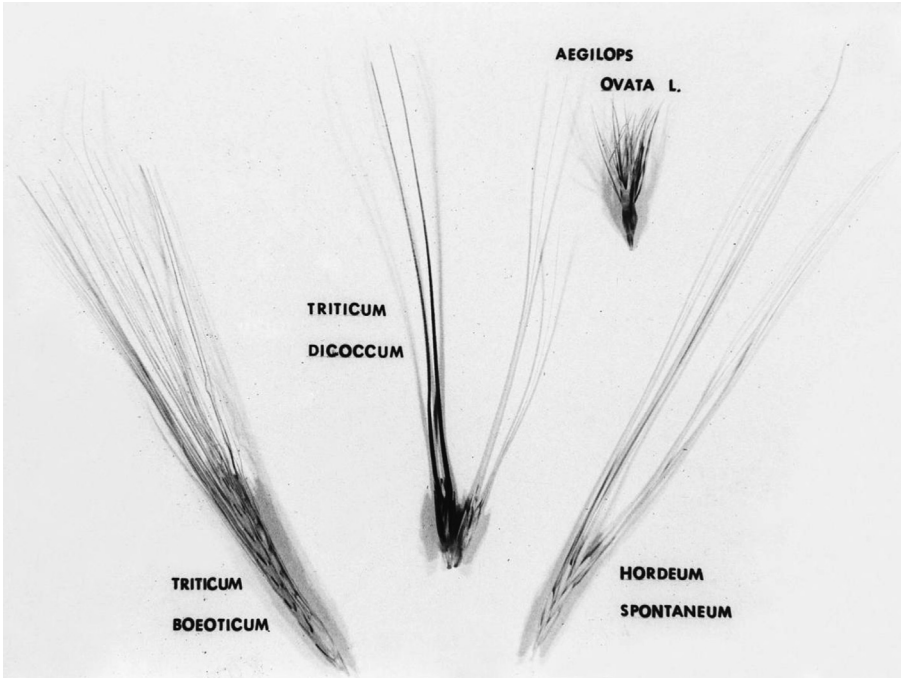

Fig. 2. Ancient varieties of wheat and barley.