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Original Article

Ethnic food perspective of North Dakota Common Emmer Wheat and relevance for health benefits targeting type 2 diabetes

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ABSTRACT

Background: Ancient grains with ethnic food origins are gaining renewed interest in contemporary food design due to its balanced nutritional profiles and health benefits. The "North Dakota Common Emmer Wheat" (*Triticum dicoccum*), a tetraploid species, had ethnic origins with German immigrants from Russia migrating to North Dakota in late 19th century. Targeting such grains with ethnic origins that are rich in fibers, amino acids, minerals, and other bioactive compounds has significant merit for advancing health benefits against emerging diet-linked chronic diseases. Based on this rationale, phenolic-linked antioxidant and antihyperglycemic properties of North Dakota Common Emmer Wheat was compared with those of other commercial wheat cultivars in order to integrate it into a health-targeted food design based on past ethnic food insights.

Methods: Aqueous extracts of the North Dakota Common Emmer Wheat (with and without hull) and two other commercial wheat varieties, Barlow and Coteau, were analyzed before and after milling. The total soluble phenolic content, phenolic acid profile, protein content, antioxidant activity, type 2 diabetes relevant α-amylase, and α-glucosidase enzyme inhibitory activities were determined using *in vitro* assay models.

Results: North Dakota Common Emmer Wheat with hull had highest total soluble phenolic content and associated antioxidant and antihyperglycemic properties (before and after milling) when compared to the other commercial wheat cultivars.

Conclusion: Results indicated that North Dakota Common Emmer Wheat with hull can be integrated into a health-targeted contemporary food design as a part of dietary support against chronic hyperglycemia and oxidative stress associated with early stages type 2 diabetes.

1. Introduction

The origin of cultivated emmer wheat (*Triticum dicoccum*) lies in parts of the Fertile Crescent including Syria, Egypt, and Turkey. Ancient emmer wheat was domesticated around 8000 BC and was closely associated with Neolithic agriculture [1,2]. The wild progenitor of emmer wheat, *Triticum dicoccoides* (Schrank) is said to have originated from Israel and the near East [1,3]. From this center of origin, cultivation of emmer spread to the other parts of the world such as Mediterranean regions of Europe and Northern Africa, Eastern Europe and Russia, and Indian subcontinent during 60000 BC to 3000 BC [2]. Cultivation of emmer wheat was an integral part of early agriculture in Europe [2]. Introduction and domestication of the free-threshing wheat slowly replaced the emmer wheat from its original geographical distribution. However, emmer wheat was extremely popular in Egypt until Greco-Roman period because of its higher stress tolerance and the dietary preference associated with superior bread quality [2]. In Italy, emmer wheat was cultivated until recently and was commonly referred as "Pharaoh's wheat". Currently, emmer wheat is cultivated in over 17 countries and is grown as a major crop only in Ethiopia and as a minor crop in India and Italy [2,4].

In the United States, landraces of emmer was introduced by the East-European German origin immigrant farmers during the late 19th century (Fig. 1A). The introduction of emmer in the Northern Great Plains during the late 19th century was mainly due to its high resilience against extreme climate and its value as both human food

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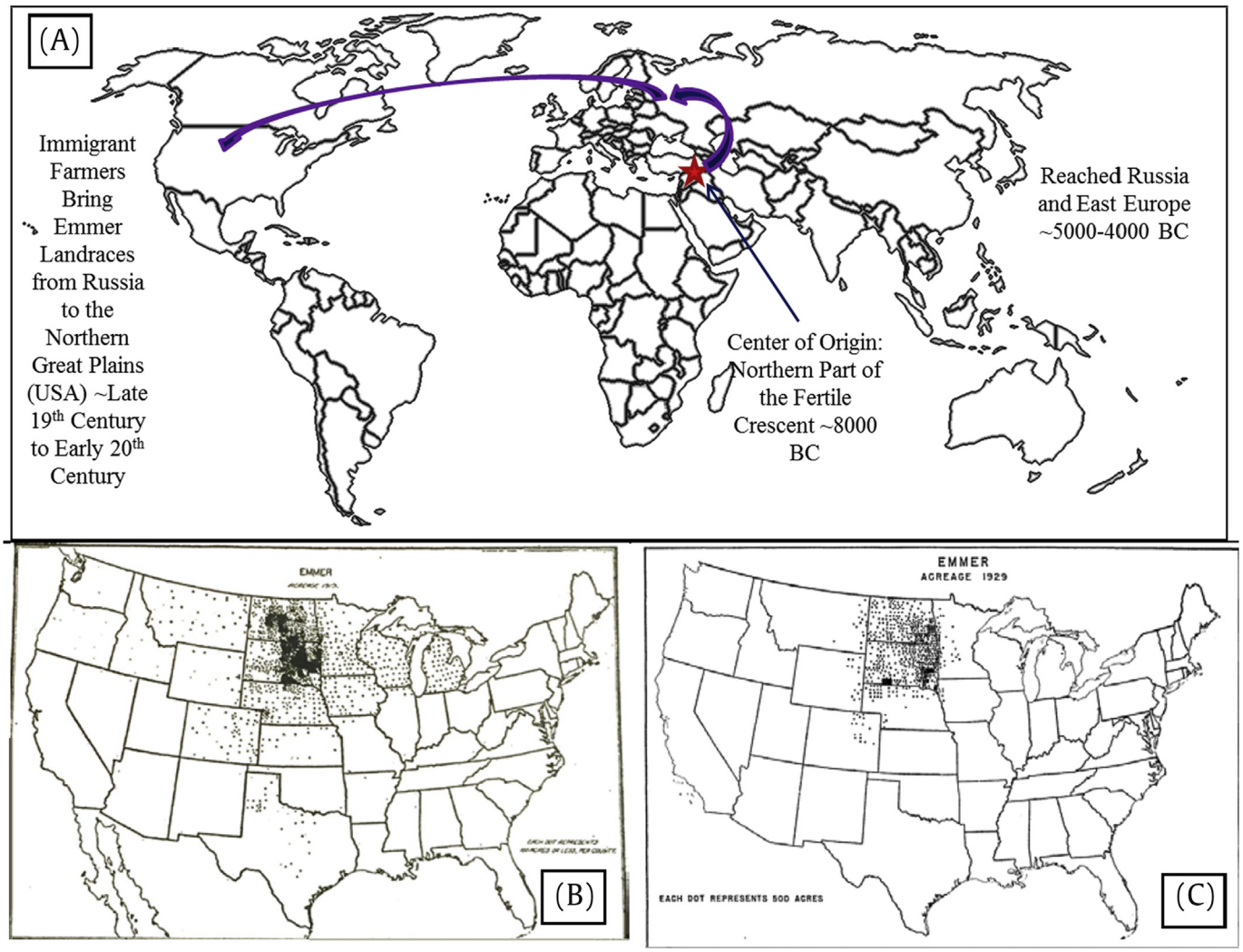

Fig. 1. The origin of emmer wheat and its first domestication in parts of the fertile crescent around 8000 BC. From its center of origin, cultivation of emmer spread in different parts of Europe, North Africa, and Asia between 6000 and 3000 BC. (A) In the United States especially in the Northern Great Plain region, emmer wheat was introduced by Russian–German immigrant farmers in the late 19th century (adapted and modified from Zaharieva et al [2]). In the early 20th century emmer was extensively cultivated in the Northern Great Plain region as ethnic food source and as animal feed. (B) Distribution of emmer wheat cultivation in the early 20th century (1919) in the United States. (C) Distribution of emmer wheat cultivation in the early 20th century (1929) in the United States. Each dot represents 500 acres. Currently emmer wheat including North Dakota Common Emmer is only cultivated by few farmers in North Dakota and in Montana.

and animal feed. In the early 1900s, thousands of acres of land in the Midwestern and Western regions of the United States were utilized for emmer wheat cultivation (Figs. 1B and 1C), but now this wheat variety is grown only under small acreage in the states of Montana and North Dakota, with Cenex emmer and common emmer wheat being the two commercially available emmer varieties [2,4]. One reason for the decline in emmer wheat production in the Northern Great Plains could be due to the replacement by high yielding free threshing wheat varieties and difficulty associated with commercial dehulling of emmer [2]. The beneficial traits of emmer wheat from an agronomic and nutritional standpoint include its tolerance against biotic and abiotic stresses, the high concentration of micronutrients, superior grain quality, rich amino acid profile, and high storage protein content of the seed grains [5–9].

Crop domestication has inadvertently led to the reduction of genetic diversity, leading to the loss of desirable traits which are important for the plant response to biotic and abiotic stresses [3,6,10,11]. The key metabolites responsible for the plant response to biotic and abiotic stress are secondary metabolites [12]. In general, cultivars of food crops resilient against stress have a higher concentration of these secondary metabolites providing protection against abiotic and biotic stress-induced oxidative stresses [13]. These secondary bioactive compounds when consumed as a part of diet can potentially play a beneficial role in protection against oxidative stress-linked chronic diseases [13]. Owing to diverse health benefits and bioactive functionalities, these phenolic bioactives from plant-based food sources are gaining increasing attention [14–17]. In wheat, phenolic acids, carotenoids, flavonoids, tocopherols, and tocotrienols are largely responsible for protection against oxidative stress [18–23]. Emmer wheat with its late 19th century roots in North Dakota as ethnic food of German immigrants from Russia has potential health benefits. This ethnic origin wheat significantly has higher total phenolic acid content, as well as associated antioxidant activity when compared to Einkorn and other wheat cultivars traditionally used for making breads [21]. Therefore, North Dakota Common Emmer Wheat with superior abiotic stress resilient traits and with higher health relevant nutritional profile is ideal target to design foods for better health outcomes of the population experiencing higher prevalence of diet-