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Durum Wheat (*Triticum turgidum* ssp. durum) and its Comparison to Bread Wheat in Some Aspects

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Abstract

Durum wheat is an important cereal produced mainly in Middle East, North Africa, South Europe and North America. Under Mediterranean conditions, water deficiency and high temperature during reproduction period limit durum crop production severely. Water deficit is the major limiting factor in Mediterranean basin and durum yield is greatly reduced by drought in this zone. Origin, grain quality, diseases tolerance, adaptation to environmental conditions and changes and consumption areas of this species are different than common wheat. Old durum landraces are now replaced with modern cultivars due to demand of higher technological quality requirements from food industry. Wild emmer wheat gene pool is a major source for durum wheat genetic and breeding improvements. Breeders increased productivity and resilience of durum wheat by strong selection of genes managing important agronomical traits. Cropping system, tillage management and weather conditions can greatly affect durum wheat and common wheat grain yield and quality. Here in this review, knowledge extracted and selected from latest articles published in high quality articles in the last decade on durum wheat are mentioned and some of them are compared to bread wheat. Different than a systematic presentation of well known informations related to wheat and durum, as it will require hundred of pages, here in this mini review, it was targeted to present some interesting aspects of relation of durum wheat to common wheat.

Keywords: Durum wheat, *Triticum turgidum* ssp. durum, common wheat, *T. aestivum*

INTRODUCTION

Durum wheat (*Triticum turgidum* ssp. *durum*) (or *Triticum durum*) is a tetraploid species (2n = 28) with estimated acreage of 18 million ha (8–10% of all global wheat acreage) and yearly production of 35–40 million tones. Mediterranean Basin and North America (especially Canada) produce 60% of global durum production (De Vita and Taranto, 2019). Mediterranean zone pedoclimatic conditions (microclimate in soil in combination with temperature, water amount and aeration) fit more to durum cultivation than common wheat cultivation (Pasqualone et al., 2019). Durum covers more than 50% of total wheat acreage in Mediterranean region (Guzman et al., 2016). Durum is an important cereal in semiarid parts of Middle East, North Africa and South Europe in Mediterranean basin (Hammami and Sissons, 2020).

Major consumption areas of durum are pasta, bulgur, couscous and bread production (De Vita and Taranto, 2019). Traditionally, durum wheat is used for bread production in Mediterranean countries. Old landraces are now replaced with modern cultivars due to the poor technological quality of old landraces there for bread making (Farbo et al., 2020). Durum bread is more compact in texture than common wheat bread (Pasqualone et al., 2019). Durum wheat price is approximately 20% higher than bread wheat and have very high quality to produce pasta (Knödler et al., 2010).

Modern durum wheat is a domesticated wild emmer wheat (*T. turgidum* ssp. *dicoccoides,* genome BBAA) developed by selections (Maccaferri et al., 2019). Wild emmer wheat gene pool is a major source for wheat improvements (Avni et al., 2014).

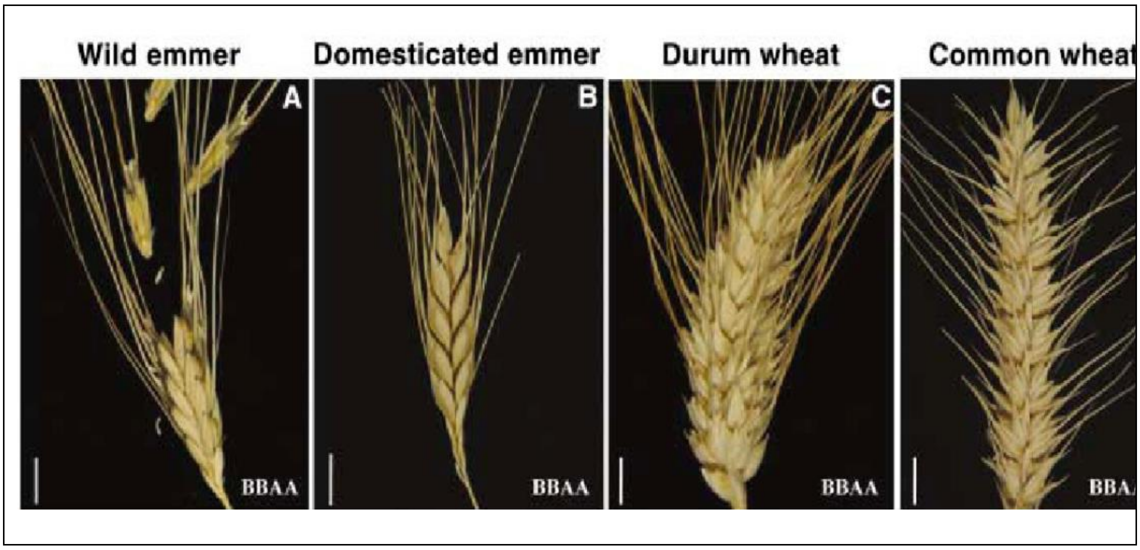

Fig 1. Wheat spikes of A) Wild emmer wheat (*T. dicoccoides*), B) domesticated emmer (*T. dicoccum*), C) durum (*T. durum*), D) common wheat (*T. aestivum*) (adopted from Dubcovsky and Dvorak, 2007 and Peng et al., 2011).

In a field study of Marti & Slafer (2014), durum and bread wheat performance were compared under contrasting water and nitrogen treatments at three seasons. Opposite to their hypothesis, bread wheat outyielded durum under low yielding conditions. But potential yield of durum were tended to be higher. When varieties were categorised, it was seen that 1960s bread wheat genotypes outyielded durum in most of the comparisons but 2000s durum genotypes outyielded bread wheat in many comparisons. Grain weight was higher for durum wheat compared to bread wheat. Grain number/m^2 was the responsible component for yield sensitivity to environment shifts for both wheat types. For water and nitrogen use, bread wheat was more efficient than durum wheat under low-yielding conditions. But under high-yielding conditions durum wheat was more efficient and these found significant reflection in grain yields (Marti and Slafer, 2014).

Druing 1900s, breeders increased productivity and resilience of durum wheat by strong selection of genes managing important agronomical traits. A part of primitive genetic diversity of durum wheat was lost along this process (Zaim et al., 2017). Quality (gluten strength and protein content) are among major objectives of durum wheat breeding programmes (Conti et al., 2011). Gluten is very important for quality of bread wheat and durum wheat. Glutens are also a type of immunogenic peptides triggering T cell reaction in patients of celiac disease which leads to inflammation in small intestine (Salentijn et al., 2013).

Dietary fibre contents of old and new durum wheat genotypes was compared in a study of De Santis et al., (2018). Total arabinoxylan content were similar in semolina or wholemeal. Instead soluble arabinoxylan and beta-glucan contents were higher in wholemeal of new genotypes. As a result, it was concluded that breeding didn’t result with dietary fibre decreases in durum wheat.

Fig. 2. The spike and its threshing in parents and progeny. a) Spike of *Triticum turgidum* ssp. *durum* cv. Langdon (AABB). b) Spike of *Ae. tauschii* ssp. *strangulata* (DD) with its barrel-type diaspores. c) Spike of the synthetic wheat S-6214 (AABBDD). d) Spike of *T. aestivum* cv. Chinese Spring (Katkout et al., 2014).

Main objective of durum breeding programs is to develop good quality and high yielding cultivars. As a highly complex trait, yield depends on different components which are genetically controlled and affected from environment (Romero et al., 2013). In a study of Royo et al. (2010), a durum wheat collection including 191 accessions from Mediterranean Basin was field grown in 9 locations in 4 countries and yields were ranged between 0.99-6.78 t/ha (Royo et al., 2010). Yield differences among wheat varieties are usually related to number of grain/m^2 (Ferrante et al., 2012). Further increasing yield potential remains one of the main objectives of wheat breeding, even in stressful environments. Genetic gains obtained in past in bread and durum wheats in general were obtained by harvest index increases; but future gains will probably be related to biomass increases (Pedro et al., 2011). Shape and color of durum wheat grain strongly influence yield and quality of the crop (Alemu et al., 2020). Major compounds determining yellow colour of durum wheat semolina and flours are carotenoids. The carotenoids concentration in durum and common wheat depends on genotype and growth conditions (Van Hung et al., 2011). Aroma and smell are important to increase consumer acceptance and due to this, deep analysis of bread aroma and smell are research goals in some breeding studies in durum wheat (Ficco et al., 2017). Italian regulation force pasta producers to put maximum 3% common wheat in durum wheat for pasta production.

Cropping system, tillage management and weather conditions can greatly affect durum wheat and common wheat grain yield and quality (Campiglia et al., 2015). For durum, yield stability improvements are very important component for global progress (De Vita et al., 2010). Protein content of grains in durum wheat is negatively correlated with grain yield (Blanco et al., 2012). Management of nitrogen and irrigation are critical for high protein durum production in arid regions (Mon et al., 2016). Durum wheat is the most salt-sensitive cereal. Instead physiological reactions to salt stress vary between different cultivars (Ami et al., 2020).

Some durum wheat varieties have the genetic tendency to accumulate cadmium in grains. Genetic factors related to low and high cadmium (Cd) uptake are unknown but further knowledge may help to understand metal accumulation in cereals (Wiebe et al., 2010). Lowering accumulation of Cd in durum is a good strategy to prevent potential hazards to consumers (Zhou et al., 2021). Fertilizer management may influence Cd levels in durum grains. Soil type, season and nitrogen fertilization (timing, source and soil placement) has great affect on Cd concentration in durum grains (Gao et al., 2010). Different Cd uptake of roots of low Cd accumulating isolines may be function via chelation with organic acids (Adeniji et al., 2010).

Fusarium graminearum (Fusarium Head Blight) makes severe grain yield and quality losses in cereals via production of mycotoxins harmful to human and farm animals. Resistance in common wheat were identified but not in durum wheat which is the most susceptible cereal to *F. graminearum* (Lionetti et al., 2015).

CONCLUSIONS

When considered the

- Approximately 20% higher price of durum wheat than bread wheat;
- Durum wheat oriented pedoclimatic conditions (microclimate in soil with combined effects of temperature, water

amount and aeration) of Mediterranean zone,

- Higher durum wheat grain yields in high yielding cereal zones,

it is more beneficial to promote durum production instead of bread wheat production, in high cereal yielding irrigated and semi-irrigated zones in Mediterranean countries like Turkey. This approach may increase farmer and nation incomes more in these regions.

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