Tunisian Durum Wheat Varieties: Influence of Geographical Origin

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Abstract Durum wheat is an important crop, whose grain is used for the production of pasta, bread, couscous, bulgur, and other products. The end-use of wheat is heavily determined by the grain's characteristics, which depend on the wheat variety, the environmental effects, and genotype–environment interactions. In Tunisia, ancient durum wheat varieties disappeared and they were replaced by other new breeding programs. Modern Tunisian durum wheat varieties were collected from different zones throughout the country. The wheat varieties were evaluated for various chemical and technological quality parameters. Results of quality characteristics of the examined wheat grains showed a strong influence of the growing zone on almost all analytical parameters. These differences between wheat varieties may be ascribed to the differences between the genotype–environment interaction such as soil, climate, and the use of fertilizers, etc.

Keywords Wheat · Quality parameters · Variation · Geographical origin

1 Introduction

Wheat endosperm contains mostly starch and protein, whereas bran and germ are rich in dietary fiber, minerals, and phytochemicals which play an important role in nutrition and health benefits for humans. Therefore, the customers are strongly recommended to consume whole wheat flour and its related products. Epidemiological studies showed that regular consumption of whole grains and whole-grain products are associated with reduced risks of various types of chronic diseases such

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as cardiovascular disease [2], type 2 diabetes [6], and some cancers [7, 11]. The quality of end-products is related to the quality of the durum grain, which, in turn, is mainly determined by the genotype but also by the environment (weather and nutrition) and crop management. Different environmental variables such as climate, soil, and agronomic practices exert a strong influence on different technological quality parameters of wheat. This effect is particularly marked in Mediterranean environments, where the climate, characterized by increasing water deficit and thermal stress during grain filling, may cause large fluctuations, not only of grain yield but also of grain quality traits, mainly protein content [9]. This investigation examined the variation observed in the qualitative characteristics of three wheat varieties grown under different environmental conditions in Northern and Central Tunisia.

2 Materials and Methods

2.1 Sampling

Grain samples of three Tunisian wheat varieties (Karim, Razzek, and Om Rabia) were collected, at the mature stage, from four locations (Zaghouan, Jendouba, Kef, and Kairouan) in Northern and Central Tunisia. Flour was obtained by milling mature dry grains from the same cultivar to a fine powder and immediately cooled to −20 °C and kept at this temperature until analysis. The moisture content of all samples was determined by taking the weight of the samples before and after drying and used to express phytochemical contents at a dry weight (DW) basis.

2.2 Analytical Methods

Quality analyses were performed on mature kernels from the three replications combined. Several commercial and technological quality parameters were determined. Thousand kernel weights were calculated as the mean weight of three sets of 100 grains per plot. Test weight was measured on a 1-L sample and expressed as kg/hl. Ash content was determined after incinerating the grains in a muffle furnace. Grain protein content was determined by means of the standard Kjeldahl method. Percentage of protein was calculated after multiplying Kjeldahl nitrogen by 5.7 and was expressed on a dry weight basis. The fatty acid composition of the oils was determined by gas chromatography according to the method described by Ouzouline et al. [8].

3 Results and Discussions

3.1 Physical Characteristics

Kernel weight is a function of both kernel size and kernel density. Though kernel size is an inherited characteristic, it is affected by the growing conditions [5]. The test weight for all studied samples varied significantly according to the cultivars and the growing area ($P < 0.01$) (Table 1). So, for Om Rabia variety, the samples taken from Kairouan showed the lowest test weight (82.02 kg/hl), while the grains grown in Zaghouan recorded the highest mean (85.28 kg/hl). For Om Rabia grains, the test weight of the samples grown in the North of the country is higher than those cultivated from the Centre (Table 1). Our results showed that the growing zone had also an effect on the thousand kernel weights of studied varieties (Table 1). High values of thousand kernel weights and test weights were found in the North, while the South favored lower mean values of these physical parameters. Test weights also exhibit a strong linear relationship to kernel weights and therefore a good predictor of semolina milling [3]. Based on the above results, it can be predicted that all the examined durum varieties with their relatively high test weight have the potential for good semolina yield on milling.

Table 1 Chemical parameters of studied wheat samples

Varieties	Region	Test weight (kg/hl)	Thousand kernel weight (g)	Moisture content (%DW)	Ash content (%DW)	Protein content (%DW)
Razzek	Zaghouan	83.55b	53.33a	9.77a	1.84c	12.13a
	Jendouba	84.45c	50.26a	10.84b	1.77b	12.58b
	Kef	82.42a	51.03a	11.84d	1.54a	14.84c
	Kairouan	82.56a	50.72a	10.93c	1.90d	12.42ab
Karim	Zaghouan	85.35b	50.35b	9.58a	1.75a	11.52a
	Jendouba	82.93a	53.46c	10.56b	1.96b	14.15d
	Kef	82.73a	48.67a	11.83d	1.75a	12.79b
	Kairouan	83.15a	48.36a	11.39c	1.84c	13.66c
Om Rabia	Zaghouan	85.28d	53.97d	9.85a	1.85d	13.11b
	Jendouba	84.84c	52.68c	10.86b	1.79c	12.46b
	Kef	83.47b	48.85b	11.86c	1.67a	10.12a
	Kairouan	82.02a	41.82a	11.00d	1.77b	15.60c

Table 2 Fatty acid composition of studied wheat samples (% of total fatty acids)

Varieties	Region	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1
Razzek	Zaghouan	17.06a	0.43a	1.58ab	21.89ab	54.28a	3.82bc	0.25ab	0.67bc
	Jendouba	16.91a	0.75a	2.31bc	21.66ab	53.94a	3.70ab	0.14a	0.59a
	Kef	16.82a	0.52a	1.94bc	22.98b	53.01a	3.64ab	0.31ab	0.76abc
	Kairouan	17.71ab	0.76a	1.16a	21.67ab	53.79a	3.72ab	0.23ab	0.95c
Karim	Zaghouan	17.25a	0.57a	1.90bc	20.90ab	54.35a	3.90bc	0.25ab	0.88bc
	Jendouba	16.90a	0.64a	1.79abc	22.62b	53.05a	3.77abc	0.30ab	0.94c
	Kef	17.14a	0.51a	1.84abc	21.40ab	54.32a	3.84bc	0.24ab	0.71abc
	Kairouan	17.53ab	0.68a	2.22bc	18.46a	55.48a	4.38c	0.63b	0.63a
Om Rabia	Zaghouan	17.72ab	0.42a	1.94bc	21.46ab	53.51a	4.07bc	0.25ab	0.64bc
	Jendouba	18.24b	0.41a	2.34c	20.12ab	53.89a	4.14bc	0.20ab	0.67bc
	Kef	17.36ab	0.47a	1.73abc	21.93ab	54.41a	3.18a	0.20ab	0.72abc
	Kairouan	17.52ab	0.80a	2.04bc	21.58ab	53.06a	3.85bc	0.36ab	0.80abc

3.2 Chemical Characteristics

Dry wheat grains can be kept for years when it is stored properly but wet wheat grains with high moisture content (>13.5%) may deteriorate faster [4]. Thus, all tested samples showed low mean values for this parameter (9.58–11.86% (Table 1)). Semolina quality is related directly to protein content and quality, samples with protein levels of 11.5–13.0% can be processed with little difficulty and expected to give satisfactory results [1]. In our study, all the examined samples showed appreciable amounts of protein (11.52–15.60% (Table 1)). The purity of flour is assessed by the amount of ash in flour. The ash content of the studied samples differs significantly ($P < 0.01$) according to the growing area and the variety. It fluctuated, respectively, between 1.54 and 1.90, 1.75 and 1.96, and 1.67 and1.85 for Razzek, Karim, and Om Rabia varieties (Table 1). Ash was responsible for the increase in the amount of protein in wheat flour [10]. Concerning the fatty acid composition of the analyzed wheat grain extracts (Table 2), the major fatty acids are linoleic (C18:2), palmitic (C16:0), and oleic acids (C18:1), whereas linolenic (C18:3), stearic (C18:0), arachidic (C20:0), and eicosenoic (C20:1) acids are minor components (Table 2). The analysis of fatty acid composition of the studied samples did not reveal any strong differences according to the geographic origin.

4 Conclusion

The quality of wheat is affected by many intrinsic and extrinsic factors. The wheat quality is a result of the cumulative effects of soil, climate and seed stock in the wheat plant and its kernel component. The obtained results showed a large effect of

the growing area and genotype on the chemical composition of wheat flour samples. These two factors have a considerable effect on all the technological parameters. Finally, this study showed that durum wheat grains grown in the North tend to be heavier and vitreous; they accumulate more protein and low ash levels; they have most of the quality requirements of the market. Thus, Northern Tunisia appears to be a favorable environment for producing a good quality of Karim and Razzek durum wheat, while the Centre seems to be an adequate environment for Om Rabia wheat.

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