

Functional Properties of Wheat: Phytochemical Profiles of Old and New Varieties

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Numerous lines of research have categorized the cereals, within the context of a balanced diet, as having a protective function in human health. The relationship between the consumption of whole grain cereals and the reduction of chronic illness, such as cardiovascular disease and cancer, strongly indicates the importance of functional properties contained in these foods. Such beneficial effects are partly attributed to the unique phytochemical content of whole grains (Thompson, 1994). More recent studies on the health benefits of functional products from wheat have become increasingly more focussed on the importance of introducing phytochemicals through the use of different varieties (Abdel-Aal and Wood, 2004). As a consequence, there is a renewed interest in the ancient varieties, particularly with regard to potential nutraceutical qualities.

The aim of this research was to analyze the variability of the phytochemical profiles in a collection of soft and durum wheat, comprised of old and modern varieties and to find out possible relationships among genotype, growing location (Bologna and Firenze, Italy) and quali-quantitative content of bioactive compounds in whole grains.

Methodology

The trials were run in two different growing locations (Bologna and Firenze, Italy) in 2006-2007 on 35 Italian wheat varieties. The investigated germplasm consisted of 19 old and 6 modern soft wheat

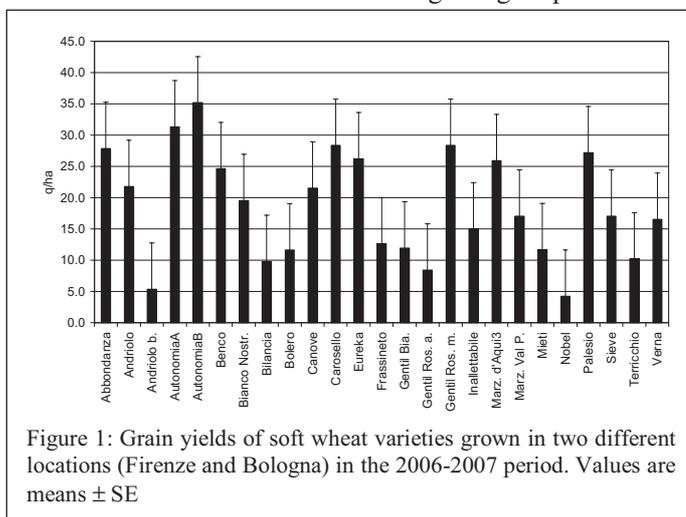


Figure 1: Grain yields of soft wheat varieties grown in two different locations (Firenze and Bologna) in the 2006-2007 period. Values are means \pm SE

(*Triticum aestivum* L.) varieties and of 7 old and 3 modern durum wheat (*Triticum durum* L.) varieties. The wheat genotypes were cultivated under low-input growing systems in a randomized block design. For each genotype and growing site, the following investigations were carried out: grain yield (q/ha), hectolitic weight (kg/hl), 1000-kernel weight (g), proteins (%), gluten (%), lipids (%), resistant starch (%), carotenoids ($\mu\text{g}/100\text{g}$), polyphenols (mg/100g), flavonoids ($\mu\text{mol}/\text{g}$), lignans ($\mu\text{g}/\text{g}$).

Results

In field trials carried out in both locations (Bologna and Firenze) old soft wheat varieties highlighted higher grain yields than the modern ones, 19.9 ± 2.5 and 15.1 ± 4.5 q/ha, respectively (Figure 1). Among the new varieties, Eureka and Palesio had the highest grain yield values (more than 25 q/ha). The old varieties showed a great variability and five of them (ie Abbondanza, Autonomia A, Autonomia B, Carosello, Gentil rosso mutico) had yield values ranging between 28.5 and 35.4 q/ha. An opposite trend was observed for grain yields of durum wheat cultivars: the mean value for modern varieties was 39.0 ± 7.6 q/ha whereas for old genotypes the mean yield was 31.8 ± 7.3 q/ha. As regards the hectolitic weight and

the 1000-kernel weight of soft and durum wheat varieties, values were higher in the old genotypes as compared to the modern ones. This could be attributed to the fact that old populations are probably less affected by the applied low-input growing conditions.

Proteins. No significant differences were observed among old and modern genotypes of soft wheat as well as of durum wheat.

Gluten. The highest gluten values were observed in wheat cultivars grown in Firenze: $71.1 \pm 0.1\%$ for *T. aestivum* varieties versus $58.8 \pm 0.2\%$ for the same cultivars grown in Bologna and $61.8 \pm 0.1\%$ for *T. durum* genotypes versus $57.7 \pm 0.2\%$ the same cultivars grown in Bologna. Moreover, the mean gluten content of old varieties (soft and durum wheats) was significantly higher than the gluten content of modern cultivars in both growing locations.

Lipids. In soft wheat varieties, the mean values were not affected by the growing location and the old varieties showed lipid contents higher than the modern ones ($3.0 \pm 0.21\%$ and $2.3 \pm 0.4\%$, respectively). As concerns the durum wheat cultivars no differences in lipids were observed as a function of the growing site, whereas the old genotypes had lipid percentages lower than those detected in the modern cultivars ($2.0 \pm 0.1\%$ and $2.3 \pm 0.1\%$, respectively).

Resistant starch. In both soft and durum wheat cultivars the values of resistant starch were significantly higher in old populations ($1.5 \pm 0.7\%$ for *T. aestivum* and $4.1 \pm 0.8\%$ for *T. durum*) than in modern ones ($0.5 \pm 0.3\%$ for *T. aestivum* and $2.8 \pm 0.4\%$ for *T. durum*).

Carotenoids. The total carotenoid content was higher in old soft wheat populations as compared to modern ones (202.9 ± 0.3 and $149.99 \pm 0.4 \mu\text{g}/100 \text{ g}$ seed, respectively). Conversely, the modern cultivars of durum wheat had carotenoids amounts higher than the old varieties. In both soft and durum wheat the most abundant carotenoid was lutein, followed by neoxanthin, violaxanthin and zeaxanthin.

Polyphenols. As concerns *T. aestivum* cultivars the polyphenol content was affected by both growing location (Bologna and Firenze) and genotype (old and modern varieties). Old and modern genotypes cultivated in Bologna had a total polyphenol two times higher than the same cultivars grown in Firenze. On the whole the old genotypes ($100 \text{ mg}/100 \text{ g}$ in Firenze and $250 \text{ mg}/100 \text{ g}$ in Bologna) showed values higher than the modern ones ($90 \pm 9.5 \text{ mg}/100 \text{ g}$ in Firenze and $200 \pm 11.5 \text{ mg}/100 \text{ g}$ in Bologna). As concerns *T. durum* cultivars, in both locations, the total polyphenol content was higher in the modern varieties ($150.4 \pm 8.8 \text{ mg}/100 \text{ g}$) as compared to the old ones ($90.5 \pm 9.8 \text{ mg}/100 \text{ g}$).

Flavonoids. The total flavonoid content was affected by both growing location and genotype. In particular the old cultivars and the Bologna growing conditions yielded high total flavonoid values in soft wheat genotypes (mean value $1.65 \pm 0.2 \mu\text{mol}$ catechin eq./g). Conversely, in durum wheat cultivars, the highest amounts of flavonoid were detected in the old genotypes cultivated in Firenze (mean value $1.50 \pm 0.5 \mu\text{mol}$ catechin eq./g).

Lignans. Qualitative analyses (performed only in soft wheat genotypes) highlighted remarkable differences between modern and old cultivars for the type of aglycon lignans and for the number of glucosidic forms. In particular, three lignan aglycon forms, namely arctigenin, isolariciresinol and syringaresinol, were exclusively identified in old wheat varieties. Moreover, the total lignan content in old varieties was approximately two times higher than the lignan content of modern ones (5.0 ± 1.3 and $2.6 \pm 0.2 \mu\text{g}/\text{g}$) (Dinelli et al., 2007).

Conclusions

On the whole, results highlighted that investigated old wheat varieties may represent a rich source of genetic diversity, especially with regard to functional properties. The unique composition in biologically active compounds of the old cultivars may suggest to expand their uses into a wide range of regular and specialty products, distinguished by their added value, based on health properties.

References

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