



CEREAL RESEARCH COMMUNICATIONS

REPRINT

Vol. 18 No. 1-2 1990

BREEDING VALUE OF DURUM WHEAT CULTIVAR "TRINAKRIA"
AS A SPAGHETTI COOKING QUALITY DONOR PARENT

by V.Vallega, S.Nardi and M.G. D'Egidio

Istituto Sperimentale per la Cerealicoltura, Via Cassia, 176
00191 Rome, Italy.

ABSTRACT

Durum wheat cvs. "Trinakria" (tall, high-protein) and "Valgerardo" (semi-dwarf, low-protein), as well as twenty semi-dwarf lines derived from "Trinakria x Valgerardo" were evaluated for grain protein percentage, SDS-sedimentation volume and various spaghetti cooking quality characteristics. Grain protein percentage means of lines and of parental cultivars coincided almost exactly. For all other characters, the average values recorded on semi-dwarf lines were better than those of the lower quality parent, "Valgerardo", but worse than the expected parental means. Further analysis indicated that the quality improvement exhibited by semi-dwarf lines was due solely to their higher mean grain protein content, inherited from cv. "Trinakria". "Trinakria" carries other genes which affect spaghetti cooking quality, but these were either not transmitted or not expressed in the semi-dwarf lines examined.

INDEX WORDS: durum wheat, spaghetti cooking quality, grain protein, SDS-sedimentation volume, "Norin-10"

INTRODUCTION

The development of cultivars suited for the manufacture of high-quality pasta products, i.e. characterized by low stickiness and high firmness, constitutes a major goal in durum wheat breeding. Unfortunately, the large sample sizes required for spaghetti cooking quality assays and the costs involved render early generation selection for these traits impractical. To date, therefore, breeding results in this field depend, almost exclusively, on the choice of appropriate parents.

"Trinakria", a tall durum wheat cultivar bred in Sicily (Ballatore 1970), is renowned in Italy and elsewhere for its relatively high grain protein content as well as for its excellent pasta cooking quality (Vallega 1977; D'Egidio et al. 1979; Zitelli et al. 1978). Because of these characteristics "Trinakria" has been crossed quite extensively, especially with high-yielding "Norin 10" derivatives. Indeed, recent studies have shown that "Trinakria" carries a major protein gene which can be readily transferred to short-statured genotypes (Vallega 1985). So far, however, the effects of this gene on the quality of semi-dwarf materials and, in general, the breeding value of "Trinakria" as a spaghetti cooking quality donor parent, have not been investigated.

MATERIALS AND METHODS

During the 1986/87 season, durum wheat cultivars "Trinakria" (tall) and "Valgerardo" (semi-dwarf), as well as twenty F10 semi-dwarf lines derived from different F2 plants of "Trinakria x Valgerardo" were grown in a rainfed field experiment near Rome, Italy. The trial, planted 20 November 1986 according to a randomized block design with three replications (10 sq. m. each), was conducted following the local agronomical practices (146 Kg N/ha and 109 kg P/ha) and harvested 15 July 1987 (mean grain yield of the trial = 6388 kg/ha). Grain protein percentage, adjusted to 13% moisture, was measured by the Technicon Infra-analyzer system on wholemeal flour samples. Sodium dodecyl sulphate (SDS) sedimentation volumes (Axford et al. 1978) were determined using a 3% SDS solution in order to obtain a wider range of values (Dexter et al. 1980). Two kilograms of seed from each replication were bulked to fabricate pasta samples. Spaghetti were manufactured and evaluated organoleptically (for firmness, bulkiness and stickiness) according to the procedures described by D'Egidio et al. (1982). A conventional, low-temperature cycle (40°C for 20 hrs) was used for drying spaghetti. Organoleptical judgements were expressed using a 10 (bad) to 100 (excellent) scale. Stickiness and bulkiness were estimated also by determining the total amount of organic matter (T.O.M.) in the washing water after cooking (D'Egidio et al. 1982).

RESULTS AND DISCUSSION

The main results of the quality assays performed are summarized in table 1. Grain protein percentage means of lines (11.43%) and of parental cultivars (11.40%) were almost identical. For all other characters, the average values recorded on semi-dwarf derivatives of "Trinakria x Valgerardo" were better than those of "Valgerardo", but worse than the anticipated means between parents. Moreover, although a few lines presented SDS and firmness values comparable to those of "Trinakria", none equalled its excellent stickiness, bulkiness and T.O.M. characteristics.

Correlation coefficients (computed on 22 genotypes) between grain protein percentage and each of the other parameters considered were, in all cases, statistically significant (table 2). Thus, in order to establish whether the quality improvement exhibited by semi-dwarf lines with respect to "Valgerardo" should be attributed to their higher mean protein content, i.e. to the major protein gene inherited from "Trinakria" (Vallega, 1985), or to genes of other nature, the original data were adjusted to a fixed protein level (11.43%) using the pertinent regressions. The new values obtained (table 3) strongly suggest that the stickiness, bulkiness and T.O.M. differences between semi-dwarf lines and "Valgerardo" can be explained in terms of protein content alone. Indeed, the adjusted means computed for these characters on semi-dwarf lines coincided almost exactly with those of "Valgerardo", the lower quality parent, and none of the lines, taken individually, equalled the excellent values presented by "Trinakria". "Trinakria" no doubt carries other genes which affect the stickiness-bulkiness-T.O.M. complex, but these were either not transmitted

or not expressed in the semi-dwarf lines analysed. The results obtained with regards to firmness and S D S sedimentation volume are more difficult to interpret, owing to the relatively small quality differences displayed by the two parental cultivars. In any case, it appears noteworthy that the adjusted means computed on lines were lower than those obtained for "Valgerardo", the lower quality parent.

Heritability of grain protein percentage has been generally found to be moderately high in crosses between high and low-protein wheat cultivars (Kaul et al., 1965, inter alia) and analogous results, in the range of 38-67% broad-sense heritability, have been computed on semi-dwarf derivatives of "Trinakria x Valgerardo" (Vallega, 1985). Early generation selection for high protein should be therefore very effective and, if the results of the present study can be extrapolated, determine an appreciable improvement of some of the main spaghetti cooking quality characteristics of semi-dwarf lines derived from cv. "Trinakria". In this respect, "Trinakria" appears as a highly recommendable parent in quality-oriented programs, especially if one considers the relatively low costs of protein determinations and the positive effects of protein on other aspects of quality, such as spaghetti processing suitability (Dexter and Matsuo 1980) and nutritional value. Moreover, it should be noted that the increasing use of high temperatures during the spaghetti drying process has partly overcome spaghetti stickiness (Dexter et al. 1983) and that, under such conditions, the positive effects of protein quantity on stickiness become preponderant over those of protein quality (D'Egidio et al. 1989, and unpublished). As underlined above, however, the spaghetti cooking quality characteristics of neither low nor high-protein semi-dwarf derivatives of "Trinakria" are expected to be as good as those of their tall parent, at least in those cases where low temperatures are employed during the spaghetti drying process.

Commenting the remaining correlation coefficients computed between quality parameters (table 2) appears superfluous, since most of these are obvious or corroborate well established associations. However, it seems worthwhile to note that the results of the SDS-sedimentation test of Axford et al. (1978), currently used to select for improved spaghetti-processing quality and bread-baking quality (Moonen et al. 1982; Dexter et al. 1980) were, in our study, significantly correlated with protein content ($r = .505^*$) but not with spaghetti stickiness or firmness.

Table 1 - Quality characteristics of "Trinakria", "Valgerardo" and 20 semi-dwarf lines derived from "Trinakria x Valgerardo"

	Grain protein (%)	S.D.S (ml)	Firmness (10-100)	Stickiness (10-100)	Bulkiness (10-100)	T.O.M. (g)
"Valgerardo"	10.5	49	60	40	40	2.32
"Trinakria"	12.3	57	80	90	80	1.16
Parental mid-values	11.4	53	70	65	60	1.74
Semi-dwarf lines: mean	11.4	49	66	54	52	2.14
range	10,2-12,8	41-56	55-80	35-83	40-70	1,72-2,74

Table 2 - Correlation coefficients between various quality parameters

	Bulkiness	T.O.M.	Firmness	S.D.S.	Protein
Stickiness	(1) .779** (2) ---	-.763** ---	.136 ---	.358 ---	.542* .608**
Bulkiness		-.584** -----	.128 ---	.398 ---	.553* .621**
T.O.M.			-.033 ---	-.288 ---	-.433 -.508*
Firmness				-.156 ---	.379 .476*
S.D.S.					.473* .505*

(1) n=20, lines only

(2) n=22, lines and parental cvs.

* significant at the .05 probability level

** significant at the .01 probability level

Table 3 - Quality characteristics of "Trinakria", "Valgerardo" and 20 semi-dwarf lines derived from "Trinakria x Valgerardo". Values adjusted to 11.43 % protein

	Grain protein (%)	S.D.S (ml)	Firmness (10-100)	Stickiness (10-100)	Bulkiness (10.100)	T.O.M. (g)
"Valgerardo"	(11.4)	52	64	53	49	2.10
"Trinakria"	(11.4)	54	76	78	71	1.36
Parental mid-values	(11.4)	53	70	66	60	1.73
Semi-dwarf lines: mean	(11.4)	49	66	54	52	2.14
range	(----)	42-55	58-79	31-69	33-66	1.73-2.77

REFERENCES

- Axford, D.W.E., E.E. Mc.Dermott and D.G. Redman. 1978. Small-scale tests of bread-making quality. *Mill. Feed Fertil.* 16:18.
- Ballatore, G.P. 1970. Two new durum wheat cultivars. *L'Inf. Agr.* 26:2947-2949 (in Italian).
- D'Egidio, M.G., S. Fortini, G. Galterio, B.M. Mariani, D. Sgrulletta and M. Volpi. 1979. Protein content and composition of Italian durum wheat semolina; correlations with spaghetti cooking quality. *Qual. Plant. Pl. Fds. Hum. Nutr.* 14:333-348 (in French).
- D'Egidio, M.G., E. De Stefanis, S. Fortini, G. Galterio, S. Nardi, D. Sgrulletta, and A. Bozzini. 1982. Standardization of cooking quality analysis in macaroni and pasta products. *Cereal Food World* 27: 367-368.
- D'Egidio, M.G., B.M. Mariani, S. Nardi and P. Novaro. 1989. Protein content and gluten quality: the simplest indicators of the pasta-making value of durum wheat. *L'Inf. Agr.* 45:51-52 (in Italian).
- Dexter, J.E. and R.R. Matsuo. 1980. Relationship between durum wheat protein properties and pasta dough rheology and spaghetti cooking quality. *J. Agric. Food Chem.* 28:899-902.

Dexter, J.E., R.R. Matsuo, F.G. Kosmolak, D. Leisle and B.A. Marchylo 1980. The suitability of the SDS-sedimentation test for assessing gluten strength in durum wheat. Can J. Plant Sci. 60: 25-29.

Dexter, J.E., R.R. Matsuo and B.C. Morgan. 1983. Spaghetti stickiness and relationship to other cooking quality characteristics. J. Food Sci. 48:1545-1551.

Kaul, A.K. and F.W. Sosulski. 1965. Inheritance of flour protein content in a Selkirk x Gabo cross. Can. J. Genet. Cytol. 7:12-17.

Moonen, J.H.E., A. Scheepstra and A. Graveland 1982. Use of the SDS-sedimentation test and SDS-polyacrylamidegel electrophoresis for screening breeder's samples of wheat for bread-making quality. Euphytica 31: 677-690.

Vallega, J. 1977. Italian durum wheats. L'Inf. Agr. 21: 26649-26697 (in Italian).

Vallega, V. 1985. Identification of major protein gene compatible with high grain yields in semi-dwarf Triticum durum genotypes. Cereal Res. Comm. 13: 201-207.

Zitelli, G., B.M. Mariani, E. Biancolatte and J. Vallega 1978. A durum wheat of high grain protein content useful for breeding purposes. Proc. Fifth Intern. Wheat Genet Symp., New Delhi (India), p. 177-187.

Received 12th January 1990



