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# Study on the functional quality of durum wheat variety Neptun 2

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**SUMMARY –** The end-use quality of thirty samples of durum wheat variety Neptun 2, grown in Bulgaria at 6 locations for 5 years was studied. Neptun 2 was bred in the Institute of Wheat and Sunflower "Dobrudza". The gluten strength, mixing properties and pasta cooking quality were analysed and compared with these of other Bulgarian durum wheat varieties. The following indices were determined: SDS-sedimentation volume of ground grain; viscoelastic properties of wet gluten; Osborne solvent protein composition of semolina; ALPAG gliadin electrophoretic profile; farinograph mixing parameters at low water absorption; and rheological characteristic of cooked pasta product. The gliadin proteins of Neptun 2 contain γ-gliadin fraction 45 and possess strong gluten/protein characteristics and good pasta quality. The other Bulgarian durum wheats belong to the gliadin type 42 and consequently have inferior pasta making potential. Durum wheat Neptun 2 is a good achievment of Bulgarian breeding and according to the technological suitability for the pasta industry after the official testing it was approved as an original variety in 1999 from the State Variety Testing Commission of Bulgaria.

**Key words:** Durum wheat, protein, gluten, quality, pasta, cooking quality.

***RESUME –*** *"Etude de la qualité fonctionnelle de la variété de blé dur Neptun 2". La valeur d'utilisation de trente échantillons de blé dur Neptun 2 cultivés en Bulgarie dans 6 localités pendant 5 années a été examinée. Le blé dur Neptun 2 a été sélectionné à l'Institut du Blé et Tournesol "Dobroudza". La force du gluten, l'aptitude à la pastification et la qualité culinaire furent analysées et comparées à celles des autres variétés de blé dur bulgares. Les indices suivants furent déterminés : DSS-sédimentation du blé ; propriétés viscoélastiques du gluten humide ; Osborne composition protéique de la semoule ; AAL-PAG profil électrophorétique des gliadines ; paramètres farinographiques à basse teneur en eau ; et texture des pâtes alimentaires cuites. L'analyse électrophorétique a montré que les gliadines de la variété Neptun 2 possèdent la γ-gliadine 45 contribuant à la viscoélasticité élevée du gluten, ainsi que de bonnes caractéristiques des produits finis. Les autres blés durs examinés appartiennent au type électrophorétique γ-gliadine 42 et en conséquence se caractérisent par une qualité inférieure du gluten et des pâtes cuites. Le blé dur Neptun 2 est une bonne réalisation de la sélection variétale en Bulgarie. Grâce à sa valeur technologique convenable pour l'industrie, d'après un jugement global il a été enregistré en 1999 comme une variété originale par la Commission Variétale d'Etat.*

***Mots-clés :*** *Blé dur, protéine, gluten, qualité, pâtes alimentaires, qualité culinaire.*

## Introduction

The gluten strength is an important factor for functional quality of durum wheat and creating varieties with high pasta making potential is a major purpose of breeding (Matsuo *et al.,* 1982; Feillet ,1984; Autran *et al.,* 1986; D'Egidio *et al.,* 1990). There are approved durum wheat varieties in Bulgaria, two of which, Zagorka and Progress, are used for mass sowing. The Zagorka variety also serves as a quality standard and Progress serves as a crop yield standard in approving new varieties by the State Variety Testing Commission. The variety Neptun 2 was bred and subjected to official testing by the Institute of Wheat and Sunflower "Dobrudza".

This study presents the results from technological evaluation of Neptun 2 and standard durum wheat varieties based on protein/gluten characteristics, semolina mixing properties and pasta cooked quality.

## Materials and methods

The samples used are from the main Bulgarian winter durum varieties Zagorka and Progress and the new one Neptun 2, grown at 6 locations for 5 crop years (1993-1998). Ninety samples, grown in experimental trials were analysed.

The 300-g grain portions, cleaned and tempered overnight to 16.5% mc, were milled with an adapted QC-109 laboratory mill and purified by the method of Bolling and Zucingelberg (1988). The mean semolina yield was 55% at 200-400 μm particle size.

Total protein content of grain and semolina was determined by conventional Kjeldahl method (N x 5,7, % db)(BSS standard 13,490-76). Gluten content (% wet gluten at 14% mb) was determined on 25-g samples using gluten washer and distilled water (BSS 13,375-90). The rheological quality of gluten was evaluated on a 4-g samples with IDK apparatus and graded by compressibility with scores ranging from 0 to 120 as follows: 45-75 = strong gluten; 20-40 and 105-120 = weak; 80-100 = medium. The gluten strength was measured as well by sodium dodecyl sulfate (SDS) sedimentation test for ground grain on 6-g samples according to ICC standard 151 with solution of 3% SDS (Kovacs, 1985).

Semolina was fractionated by the modified Osborne method of Chen and Bushuk (1970). Albumins, globulins, gliadins and insoluble residue were separated by sequential extraction in 0.5 M sodium chloride, 70% aqueos ethanol and 0.05 M acetic acid. Albumins and globulins were determined as a single fraction.

Gliadins were extracted in 70% ethanol and fractionated in 6% polyacrylamide gel (aluminum lactate buffer, pH = 3.1) (AL-PAG) by the modified Bushuk and Zillman electrophoretic technique of Velkov (1986). The gliadin bands were numbered according to gliadin nomenclature of Bushuk and Zillman (1978), chosing band 52 of common wheat Marquis as a reference.

Pasta mixing properties were evaluated with farinograph technique, using 50-g bowl by the Irvine *et al.* (1961) method. All samples were mixed at constant absorption of 36.5% and the following parameters were measured: maximum consistency (MC); mixing time (MT) (the time to reach MC); tolerance index (decrease in consistency 4 min after the peak); and bandwidth (measured 4 in after the peak).

Processing of the pasta product (microdisk with diameter 7 mm) and cooked disk quality were carried out by the method of Alause (1977). The laboratory technique was designed in the Grain laboratory of the Institute. The principle of the cooking test is to compress the cooked disk under constant force (2000 g for 60 s) and measure the diameter of the disk after compression. Cooking score (range from 0 to 8) was obtained on the basis of the disk diameter values at increased cooking time. The other cooking quality criterion used is the tolerance to overcooking, defined as the time required for the cooked disk diameter to reach value over 16 mm (Schreurs *et al.,* 1986).

All data are mean of duplicate analysis.

## Results and discussion

In Fig. 1 are shown the electrophoregrams of gliadins, extracted from the durum varieties studied and from the standard Marquis. As seen, the durum wheat Neptun 2 contains γ-gliadin component 45, whereas Zagorka and Progress belong to durum of γ-gliadin type 42. As is well known, the γ-gliadin composition is a marker for intrinsic quality of durum wheat grain. γ-gliadin 45 is linked to strong gluten characteristics and good pasta quality, whereas γ-gliadin 42 is associated with poorer gluten and pasta quality (Damidaux *et al.,* 1978; Feillet, 1984; Taha and Sàgi, 1987).

The protein contents of grain and semolina, presented in Table 1, show comparable ranges and mean values for the three tested varieties. The results as regard to the wet gluten content are analogous. So the varieties are similar in possibility for protein accumulation in suitable conditions (agricultural practices, climate).

The results for gluten/protein quality by SDS-sedimentation volume, rheological properties of wet gluten and Osborne solubility (Table 1) affirm the different gluten type of Neptun 2, established by the

gliadin electrophoresis. In general Neptun 2 has stronger gluten with better viscoelasticity compared to Zagorka and Progress. The average of SDS value, which is an excellent predictor of gluten strength of durum wheat (Dexter *et al.,* 1980; Kovacs *et al.,* 1985; Liu *et al.,* 1996), for Neptun 2 is nearly twice as high as Zagorka and Progress and the wet gluten quality as compressibility of Neptun 2 is much better than the two standards.

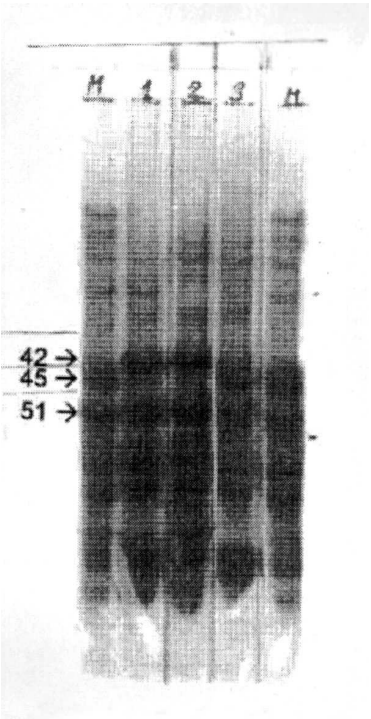


Fig. 1. AI-PAG gliadins electrotoregrams of Bulgarian durum wheat cultivars:
M: Marquis standard; 1: Zagorka; 2: Progress; 3: Neptun 2.

Table 1. Protein/gluten characteristics of Bulgarian durum wheat varieties

| Variety parameters | Neptun 2 (n = 30) | | Zagorka (n = 30) | | Progress (n = 30) | |
|---|---|---|---|---|---|---|
| | Range | Mean±sd | Range | Mean±sd | Range | Mean±sd |
| *Wheat grain* | | | | | | |
| Protein content (% db) | 12.49-18.41 | 14.72±1.42 | 12.38-18.78 | 4.84±1.41 | 11.86-18.45 | 14.77±1.59 |
| SDS-sedimentation value ($cm^3$) | 39-60 | 51.1±6.5 | 16-31 | 23.3±4.1 | 20-35 | 26.8±4.2 |
| Wet gluten (% at 14% mb) | 23.5-37.5 | 27.9±3.6 | 21.2-38.5 | 28.7±3.8 | 20.8-37.4 | 27.8±4.4 |
| Gluten compressibility (mm/10) | 55-105 | 67.8±10.7 | 90-120 | 103.4±11.0 | 85-120 | 102.8±10.2 |
| *Semolina* | | | | | | |
| Protein content (% db) | 11.34-17.38 | 13.64±1.46 | 11.35-17.65 | 13.77±1.43 | 10.83-17.48 | 13.68±1.62 |
| Wet gluten (% at 14% mb) | 25.2-39.8 | 29.7±3.4 | 23.6-40.2 | 30.3±3.6 | 22.9-39.2 | 29.2±4.2 |
| Gluten compressibility (mm/10) | 60-110 | 74.5±10.4 | 100-120 | 113.7±9.2 | 100-120 | 112.8±8.7 |
| Protein fractions (% of total semolina protein) | | | | | | |
| albumins + globulins | 14.62-16.82 | 15.24±0.78 | 14.49-19.39 | 16.29±1.25 | 14.10-19.06 | 15.39±1.33 |
| gliadins | 36.74-45.43 | 40.42±2.15 | 41.94-51.04 | 46.69±2.63 | 42.67-51.03 | 47.71±2.92 |
| glutenins | 13.64-14.73 | 14.68±0.42 | 14.16-18.75 | 15.29±1.29 | 14.21-17.44 | 15.03±0.98 |
| residue | 21.94-32.48 | 29.66±2.19 | 18.57-25.83 | 21.73±2.71 | 18.39-25.78 | 21.87±2.41 |

Better protein/gluten quality of Neptun 2 is supported also by the results for protein solubility according to Osborne. Dexter and Matsuo (1978, 1980) concluded that high percentage of insoluble proteins is an indicator for strong gluten and good pasta quality. The comparative analysis of the current protein fractionation results (Table1) lead to the conclusion that differences in distribution of endosperm proteins between Neptun 2 and the two standards are significant. Neptun 2 semolina contains lower quantity alcohol-soluble proteins and higher quantity insoluble proteins than the protein composition of Zagorka and Progress which are significantly unfavorable – high gliadin and low residue content.

In Fig. 2A,B typical farinograms of the wheats investigated for high (A) and low (B) protein level of the semolina are shown. The farinograph test also confirms the results obtained. The differences in dough mixing properties are also attributes concerned with gluten type (Matsuo *et al.,* 1982). The doughs from Neptun 2 semolinas are stable and unsticky, with long mixing times, low tolerance indices and wide farinogram bands in contrast with dough parameters of Zagorka and Progress (Table 2).

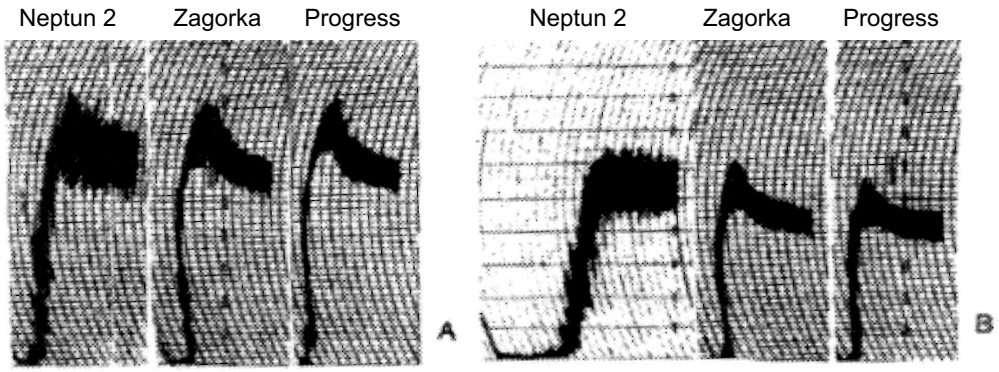


Fig. 2. Farinograms of Bulgarian durum wheat varieties at 36.5% water absorption.
A: High protein semolina; B: Low protein semolina.

Table 2. Physical dough properties and pasta cooking quality of the tested varieties

| Variety parameters | Neptun 2 (n = 30) | | Zagorka (n = 30) | | Progress (n = 30) | |
|---|---|---|---|---|---|---|
| | Range | Mean±sd | Range | Mean±sd | Range | Mean±sd |
| *Farinograph parameters* | | | | | | |
| Mixing time (min) | 4.25-9.25 | 5.85±1.14 | 2.55-4.50 | 3.44±0.60 | 2.15-4.25 | 3.18±0.56 |
| Maximum consistency (BU) | 475-710 | 562.2±55.3 | 490-790 | 625.8±67 | 8 460-735 | 610.2±74.9 |
| Tolerance index (BU) | 10-105 | 40.5±24.2 | 50-190 | 130.4±39.9 | 70-210 | 138.7±37.6 |
| Bandwidth (BU) | 90-140 | 118.2± 9.8 | 60-90 | 73.5±9.2 | 60-90 | 74.9±7.4 |
| *Pasta disk quality* | | | | | | |
| Score ranging (from 0 to 8) | 3-8 | 5.8±1.8 | 2-7 | 3.5±1.7 | 1-7 | 3.2±1.6 |
| Tolerance to overcooking (min) | 12-40 | 23.8±8.5 | 8-30 | 13.6±6.8 | 6-28 | 13.3±7.1 |

The stronger gluten type of Neptun 2 determines its better cooking parameters (Table 2). The cooking scores of cooked pasta disks and the tolerance to overcooking of Neptun's experimental pasta products exceed these of Zagorka and Progress.

One very important factor with negative effect on protein/gluten quality of Bulgarian durum wheat crop is the damage by wheat bug (Eurigaster sp.). At equal levels of damaged kernel content (over 2%) the quality changes of the protein/gluten parameters of Zagorka and Progress are much higher compared to these of Neptun 2 (Petrova and Belcheva, 1998). The stronger gluten of Neptun 2 has considerably

more reserves to react against the enzymes effect of wheat bug damage. This is one more advantage of the variety Neptun 2.

## Conclusions

Durum wheat variety Neptun 2 belongs to the γ-gliadin electroforetic type 45 and consequently has a good protein/gluten characteristics and pasta quality.

The variety Neptun 2 is a good achivement of Bulgarian breeding and according its suitable end-use quality for the pasta industry in 1999 was approved as an original new variety from the State Variety Testing Commission of Bulgaria.

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