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# Statistical confirmation of the wheat evaluation system

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***Abstract:*** *In this paper the results of the investigations on technological quality of new domestic breeding lines are statistically worked out, with an aim indirect and direct indexes of milling and backing to be found out as determination factors of wheat variety belonging to a certain technological group. The aim of the paper is on the basis of the interdependence of the selected indirect and direct indices, data to be found out if the indicated choice which define the variety belonging to a certain technological group is adequate, i.e. if in the classifying scheme another indices should be included.*

***Key words:*** *technological quality parameters, variation coefficient, correlations*

## INTRODUCTION

It is known that wheat classification as a regulator of the relation between the sale and processing, is changeable, and it is necessary to perform a permanent checking of the parameters on which it is based. Because of cyelical character of varieties within the assortment, the structure of their relation is changed almost each five years. The reason for the classification system improvement comes out from the efforts such assortment to be maintained, which will enable an intended production of the necessary quantity of wheat. The evaluation of the technological quality of the half-final and final products from the wheat varieties, on the basis of the direct and indirect indicators of milling and backing, is very important for the approval, as well as for the spreading out and including in the assortment structure. It is also important for the organization and the reception of the wheat, as well as for making of mixture combinations for the intended milling, i.e. wheat distribution as mercantile goods.

By determination of the interdependence between the particular indirect components and direct baking indicators, as well as interdependence among the own indirect indicators, a suggestion was brought in the 70-is, which was based on the principle of the varieties guarantee and the minimal values of protein content and sedimentation value.

That suggestion was adopted in 1978 by the Regulation (Official paper) 40/78. in 80-is it was made again a statistical confirmation of the five-year results obtained from the investigations on varieties from the macro experiments of SFRJ. It was concluded that the evaluation on the variety belonging into respective technological group, can be determined on the basis of 6 indicators of technological quality, two legal indirect (protein content and sedimentation value) and four direct indicators (flour yield, I1, bread yield, bread volume yield and valuable number of bread crumb [1,3].

The decreasing of the variation among varieties which were represented in the production, can be also achieved on the suggested way, by the concentration of the varieties with approximately the same values, what, in the same time, make more simple the way of making mixtures of kernels or of flour for the further finalization [2].

The **aim** of this study is on the basis of the interdependence between the chosen indirect and direct indicator data, to check if the choice of the indicators which define the variety belonging to a technological group is adequate, i.e. if in the classification

| | |
|---|---|
| TW-Test weight of wheat (kg/hl) | FWA- Farinograph water absorption |
| M1000- 1000 kernel weight (g/db) | ( %/ 13 % flour base) |
| Wit..-Virtuousness ( % ) | DDT-Dough Development Time (min) |
| % 2,8-Kernel size on sieve of 2.8 mm (%) | DDS-Dough Degree of Softening (FJU) |
| CPC-Crude Protein Content (%/db) | FQN-Farinograph Quality Number |
| SV-Sedimentation value | E-Ekstenzogram Energy ($cm^2$ ) |
| WGC-Wet gluten content ( % ) | El-Elasticity (mm) |
| DGC-Dry gluten content ( % ) | R/N –Ratio number |
| I1-Flour yield ( % ) | BY-Bread Yield (g/100 g flour) |
| Iu-Total Flour yield ( % ) | BV-Bread Volume (ml/100 g flour) |
| HN-Hagberg falling number (s) | VNBC-Valuable number of bread crumb |

scheme some other indicators should be included.

## MATERIAL AND METHODS

31 samples of new domestic wheat lines were analyzed, which originated from micro experiments from two locality. The defining of technological quality of the new lines was performed on the basis of the methods which are indirect and direct indicators of milling and baking [4].

Legend of the indicators of technologycal quality*

* The obtained results are presented in the tables numbered from 1 to 4.

On the basis of the value of the cited technologycal quality parameters, which are necessary for matematical processing, the staistical parameters were choosen [5,6,7].

## RESULTS AND DISCUSsion

With data analysis by descriptive statistics (tab. 1), it was noticed at:

The indirect and direct indicators of milling,

Test weight values were very high at the all three registries levels, and the deviations are relative small caused by the locality, which was confirmed by the coefficient of variation.

Good kernel filling, disregarding of the variety and locality, was of small variation.

Kernel vvirtuousness varied much from the expressively vitreous to completely floury kernels.

Aanalogy of the 1000 kernel weight, the kernel size at the both level has also less varied.

At the both direct indicators of milling, the value levels were in average high. On the flour yield I1 locality had an greater influence, than on the total flour extraction (It), as the statistical parameters, such as the standard deviation and the coefficient of variation, have completely confirmed.

Chemical-biochemical properties,

Protein content on the average was at the level of the II technologycal group, i.e. it varied from the level of the III group, and has exceeded demand of the I technologycal group.

Sedimentation value was also on the average of the II technologycal group. However, the variation was high from the value level out of a group, to the expressively high value, which significantly has exceeded demand of the I technologycal group.

Wet and dry gluten content was at the optimal level for bread making, but, they differed at the level of variation, and the dry gluten variation was greater than that of the wet gluten.

Falling number on the average was at the optimal level, but, even the minimum value can satisfy demands of the baking industry.

Dough rheologycal quality and baking,

The average value of the water absorption was at the optimal level and varied relatively less, com

**Table 1.** *Descriptive Statistics (one year)*

| Guality Indic. | N | $\overline{X}$ | Min | Max | $\sigma$ | V |
|---|---|---|---|---|---|---|
| PHYSICAL AND MILLING PROPERTIES OF WHEAT | | | | | | |
| TW | 31 | 86,666 | 83,500 | 88,700 | 1,323 | 1,527 |
| 1000kernel wt. | 31 | 41,277 | 38,400 | 45,700 | 1,773 | 4,294 |
| Virtuousness | 31 | 75,414 | 2,380 | 98,250 | 30,158 | 39,989 |
| 2,8 mm | 31 | 62,132 | 39,700 | 83,300 | 9,826 | 15,815 |
| I1 | 31 | 68,871 | 60,000 | 74,500 | 2,961 | 4,299 |
| It | 31 | 79,261 | 77,300 | 81,300 | 0,986 | 1,244 |
| CHEMICAL – BIOCHEMICAL PROPERTIES | | | | | | |
| CPC | 31 | 12,684 | 11,300 | 13,900 | 0,653 | 5,146 |
| SV | 31 | 35,258 | 12,000 | 55,000 | 10,070 | 28,559 |
| WG | 31 | 28,855 | 22,000 | 34,500 | 2,942 | 10,195 |
| DG | 31 | 10,161 | 7,000 | 12,000 | 1,128 | 11,104 |
| HN | 31 | 356,839 | 216,000 | 471,000 | 59,964 | 16,804 |
| FARINOGRAM | | | | | | |
| FWA | 31 | 59,548 | 50,700 | 67,700 | 4,386 | 7,365 |
| DDS | 31 | 44,790 | 10,000 | 102,000 | 25,537 | 57,015 |
| FQN | 31 | 74,135 | 48,900 | 100,000 | 13,368 | 18,032 |
| EKSTENZOGRAM | | | | | | |
| E | 31 | 80,071 | 20,000 | 122,000 | 27,395 | 34,213 |
| EI | 31 | 139,290 | 118,000 | 175,000 | 12,714 | 9,128 |
| R/N | 31 | 2,384 | 0,800 | 3,600 | 0,732 | 30,713 |
| EXPERIMENTAL BAKING | | | | | | |
| BY | 31 | 138,090 | 133,000 | 141,500 | 2,469 | 1,788 |
| BVY | 31 | 524,984 | 380,000 | 632,000 | 69,973 | 13,329 |
| VNBC | 31 | 4,710 | 0,000 | 6,900 | 2,048 | 43,481 |

**Table 2.** *Correlation coefficients of the indirect and direct indicators of milling and baking (one year)*

| CHEMICAL-BIOCHEMICAL PROPERTIES | | | | | |
|---|---|---|---|---|---|
| Qualiry indicators | CPC | SV | WGC | DGC | HN |
| CHEMICAL-BIOCHEMICAL PROPERTIES | | | | | |
| CPC | - | 0,52* | 0,72* | 0,58* | - |
| SV | 0,52* | - | 0,43* | 0,68* | 0,55* |
| WGC | 0,72* | 0,43* | - | 0,77* | - |
| DGC | 0,58* | 0,68* | 0,77* | - | - |
| HN | - | 0,55* | - | - | - |
| FARINOGRAM | | | | | |
| FWA | 0,40* | 0,62* | 0,62* | 0,50* | 0,62* |
| DDT | 0,64* | 0,63* | 0,61* | 0,55* | 0,40* |
| DDS | -0,36* | -0,75* | - | - | -0,44* |
| FQN | 0,48* | 0,77* | - | 0,39* | 0,38* |
| EXTENZOGRAM | | | | | |
| E | - | 0,54* | - | 0,44* | - |
| EI | - | 0,53* | 0,45* | 0,59* | - |
| R/N | - | - | - | - | - |
| EXPERIMENTAL BAKING | | | | | |
| BY | - | 0,70* | 0,42* | 0,47* | 0,71* |
| BVY | 0,50* | 0,75* | 0,49* | 0,61* | - |
| VNBC | 0,43* | 0,76* | 0,43* | 0,56* | - |

Correlations (I year)The marked correlations are significant at p < ,05000 N=31

**Table 3.** *Correlation coefficients of the indirect and direct indicators of milling and baking (one year)*

| DOUGH RHEOLOGYCAL PROPERTIES ACCORDING TO FARINOGRAPH | | | | |
|---|---|---|---|---|
| Qualiry indicators | FWA | DDT | DDS | FQN |
| Farinogram | | | | |
| FWA | 1,00 | 0,61* | - | 0,42* |
| DDT | 0,61* | 1,00 | -0,47* | 0,57* |
| DDS | - | -0,47* | 1,00 | -0,91* |
| FQN | 0,42* | 0,57* | -0,91* | 1,00 |
| Extenzogram | | | | |
| E | - | - | -0,61* | 0,46* |
| EI | - | 0,45* | - | - |
| R/N | - | - | -0,42* | - |
| Experimental baking | | | | |
| BY | 0,86* | 0,50* | -0,47* | 0,52* |
| BVY | 0,54* | 0,60* | -0,59* | 0,66* |
| VNBC | 0,54* | 0,51* | -0,58* | 0,62* |

**Correlations (one year) Marked correlations are significant at p < ,05000 N=31**

pared with the degree of softening.

The majority of the samples, on the average, according to the farinograph quality number, belong to the A2 quality subgrpoup, and the variation was widely from C1 to A2 quality subgrpoup.

The extenzograph energy was optimal, which was rarely obtained during the last years. With dough measuring by this apparatus, results were obtained, which have pointed out to a variation of dough rheologycal quality from an useless for the processing industry, to an exellent quality.

The dough elasticity was on the average short, only the maksimal values were on an optimal level, as the ratio number was (R/N).

Among the baking parameters, bread yield and bread crumb valuable number, were on the level of the II technologycal group, while bread volume yield has exceeded the demand of the I one. All the three indicators with maksimum values have expressively exceeded demands of the I technologycal group, while the minimal values were on the level of useless for baking industry.

**Protein content** (tab.2) is in a positive correlation with the all chemical-biochemical and rheologycal indicators, except with the degree of softening. The correlations with the extenzograph indicators also were not registered with the bread yield, while with the **bread volume yield and the bread crumb valuable number** was in a positive correlation.

**Sedimentation value** is in a positive correlation with the all chemical-biochemical and rheologycal indicators, except with the ratio number, while it was in a negative correlation with the degree of softening.

**Wet gluten content** is in a positive correlation with the major chemical-biochemical, rheologycal and baking indicators, except with the falling number according to Hagberg, the degree of softening, farinograph quality number, the energy and the ratio number.

Similar was for the **dry gluten content**, only except no correlation was found with the falling number according to Hagberg, the degree of softening, and the ratio number.

**The falling number according to Hagberg,** is in a positive correlation only with the sedimentation value, which is among the chemical-biochemical properties.

The ability of water absorption (tab. 3) is in a positive correlation with the all chemical-biochemical and baking indicators, as well as with the dough development time, and farinograph quality number.

**The dough development time** is in a positive correlation with the all chemical-biochemical and baking indicators, as well as with farinograph indicators, except with the softening degree, with which is in a negative correlation.

The **farinograph quality number** is in a positive correlation with the all indicators of the experimental baking, extenzograph energy, as well as with the ability of water absorption and with dough development time, while is in a negative correlation with the softening degree.

In a positive correlations with experimental baking indicators (tab. 4), were the all chemical-biochemical indicators, with the exception of that, no relation was found between the protein content and the bread yield. A significant correlation was noticed among the all farinograph indicators, and the all indicators of experimental baking; except the all three parameters of the experimental baking were in a negative correlation with the softening degree. Correlations between the extenzograph indicators and the bread yield were missing, while the bread

**Table 4.** *Correlation coefficients of the indirect and direct indicators of technological quality for the one year*

| Quality indicators | Experimental baking | | | Quality indicators | Experimental baking | | |
|---|---|---|---|---|---|---|---|
| Chem.-bioch. properties | BY | BV | VNBC | Farinogram | BY | BV | VNBC |
| CPC | - | 0,50* | 0,43* | FWA | 0,86* | 0,54* | 0,54* |
| SV | 0,70* | 0,75* | 0,76* | DDT | 0,50* | 0,60* | 0,51* |
| WGC | 0,42* | 0,49* | 0,43* | DDS | -0,47* | 0,59* | 0,58* |
| DGC | 0,47* | 0,61* | 0,56* | FQN | 0,52* | 0,66* | 0,62* |
| Extenzogram | | | | Experimental baking | | | |
| E | - | 0,39* | 0,44* | BY | 1,00 | 0,52* | 0,54* |
| EI | - | 0,44* | 0,48* | BV | 0,52* | 1,00 | 0,93* |
| | | | | VNBC | 0,54* | 0,93* | 1,00 |

volume yield with the energy and elasticity was in a positive correlation. The correlation among the particular parameters of the experimental baking was also positive significant.

## CONCLUSION

The system of criterion formatting for the evaluation of wheat technological quality is:

A regular variety evaluation by using the indirect and direct methods for estimation of milling and baking.

A complex problem for estimation of wheat quality characteristics is restricted by the increasing of the number of specific observations, and by the enriching the analytical procedures by introducing some new and specific methods for certain area of observation.

The very significant relations among the observed parameters (protein content and sedimentation value) and the indirect and direct baking parameters, point out to the harmonization and the stability of technological quality parameters.

For the evaluation of the total technological quality, according to the results obtained in this study, the scheme of technological groups, should be supplemented with the indirect milling indicators - the kernel hardness (virtuousness), as well as with the indirect baking indicators, such as the ability of , farinograph quality number and the elasticity according to the extenzograph.

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# Uticaj soja kvasca rh (Saccharomyces cerevisiae) na sadržaj vicinalnih diketona u pivu

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***Kratak sadržaj:*** *Uticaji soja Rh analizirani su u četiri fermentacije sa različitim generacijama kvasaca (I, IV, IX i X) . Čista kultura kvasca soja Rh je iz zbirke kvasaca Zavoda za ispitivanje i Instituta za pivarstvo (VLB) iz Berlina. Soj Rh spada u vrstu Saccharomyces cerevisiae (Saccharomyces uvarum). Praćeni su prvi, drugi, šesti, osmi i deveti dan fermentacije, kao i poslednji dan pre hlađenja na -1,8°C, ukoliko je fermentacija trajala duže od devet dana. Sadržaj vicinalnih diketona je određivan spektrofotometrijskom metodom u laboratoriji Banjalučke pivare sa uređajem Spectrometer Lambda 35 UV/VIS (Perkin Elmer). Granična vrednost za svetla piva treba da je ispod 0,15 mg/kg [9].*

*Sadržaj vicinalnih diketona u pivu pre filtracije bio je najmanji sa kvascem generacije I kod fermentacije i odležavanja piva koje je najduže trajalo. Sadržaj vicinalnih diketona na početku fermentacije sa kvascem generacije IV i IX bio je približno isti, iako je broj ćelija kvasca generacije IX bio veći, ali je i količina sladovine u fermentoru na početku bila veća zbog kraćeg vremena. Broj ćelija kvasca generacije X za zasejavanje bio je najveći i punjenje fermentora je najkraće trajalo, ali je početni sadržaj vicinalnih diketona bio manji u odnosu na generaciju IV i IX. Rezultati analiza u pivu pre filtracije sa kvascem generacije IV, IX i X pokazuju da se razgradnja vicinalnih diketona odvijala i u periodu odležavanja piva, ali je u toku glavne i naknadne fermentacije bila zadovoljavajuća.*

*Fermentacije sa kvascem generacije IV, IX i X u odnosu na fermentaciju sa generacijom I trajale su znatno kraće i nije bilo povećanja sadržaja vicinalnih diketona. Rezultati analiza pokazuju da je soj Rh pogodan za odvijanje brze fermentacije bez velikih sadržaja vicinalnih diketona na početku fermentacije, kao i za brzu razgradnju toku same fermentacije. Sadržaj vicinalnih diketona u pivu pre filtracije bio je manji od granične vrednosti*

***Klučne reči***: *Rh sojevi kvasca, fermentacija, vicinalni diketoni.*

Proizvodnja piva predstavlja jedno od najstarijih umeća poznatih čoveku, i stoga iznenađuje činjenica da proces fermentacije nije bio objašnjen do kraja devetnaestog veka. Kultura kvasca je dugo vremena posmatrana kao nepoželjna pena, koju treba ukloniti. U sedamnaestom veku pojedini pivari ponovo počinju upotrebu kvasca, neshvatajući značaj svojih praktičnih zahvata. C. Caignard Latour 1836. godine pretpostavlja da je fermentacija šećera posledica životnih aktivnosti kvasca, koji predstavljaju posebne gljivice, i nazvao ih "*Zuckerpilz*", što u prevodu znači *Saccharomyces* [1].

Kvasci, koji se upotrebljavaju u pivarstvu, predstavljaju sojeve koji se međusobno razlikuju po karakteru rasta na hranljivim podlogama (kolonijama), veličini i obliku ćelija, stepenu previranja šećera itd. Pivski kvasci su tzv. kulturni sojevi, koji postoje samo u industriji i koje je izolovao čovek.

Kulturni kvasci pripadaju familiji Saharomiceta i nazivaju se *Saccharomyces cerevisiae.* Postoje kvasci gornjeg i kvasci donjeg vrenja. Svakom od ovih grupa obuhvaćeno je nekoliko posebnih sojeva.

U pivarstvu se upotrebljavaju uglavnom kvasci donjeg vrenja, koji su adaptirani na relativno niske temperature. Svi kvasci donjeg vrenja usvajaju glukozu, fruktozu, saharozu, maltozu i rafinozu, ali ne usvajaju dekstrine, inulin i laktozu [2].

Da bi od sladovine nastalo pivo, enzimi kvasca moraju u njoj prisutne šećere da prevedu u etanol i ugljen -dioksid. Zbivanja tokom fermentacije dele se na ona koja se dešavaju tokom glavnog vrenja i ona koja se dešavaju za vreme dozrevanja piva, jer se pojedine reakcije međusobno prepliću. Stoga se promene koje se dešavaju prilikom glavnog i prilikom naknadnog vrenja moraju posmatrati kao međusobno zavisni procesi. Pri tom treba istaći da tokom vrenja nastaju sporedni proizvodi metabolizma kvasca, od kojih se mnogi dalje razgrađuju. Pored sastojaka poreklom iz hmelja, ovi sporedni proizvodi vrenja su odlučujući za ukus i miris piva. Stoga je poznavanje njihovog nastajanja i razgradnje posebno značajno.

Sporedni proizvodi fermentacije veoma mnogo utiču na kvalitet piva. Doprinose punoći ukusa piva, ali mogu i veoma negativno da utiču na ukus i miris piva, kao i na stabilnost pene piva.

Imajući ovo u vidu, uvođenjem novih postupaka za skraćenje fermentacije i dozrevanje piva, sporedni proizvodi fermentacije i faktori koji utiču na njihovo