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Relationship between the test weight and some physical and chemical properties of the wheat kernel

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Abstract

For a long period of time, the test weight has been used as an indicator for cereal quality evaluation in a large number of countries, and it is still in use as a fast method for determination of a price range for raw material. Correlation between the test weight, flour yield, and other quality parameters varies depending on the variety and growing conditions. In order to evaluate technological quality of wheat, the aim of this study is to determine correlation between the test weight (TW) and some physical and chemical parameters of the wheat kernel [the 1000 kernel weight, vitreousness, moisture content, ash content on dry matter, fat content, protein content, starch content, protein sedimentation volume (the Zeleny test), gluten index, content of wet gluten]. Six samples of wheat were analysed in this study. Physical and chemical parameters of wheat kernels were tested, and then correlation between the mentioned parameters was analysed. Among the identified correlations, the correlations between the test weight (TW) and 1000 kernel weight (TKW) ($p<0.01$), vitreousness ($p<0.01$), moisture content ($p<0.01$), fat content ($p<0.01$), protein content ($p<0.05$), protein sedimentation volume (the Zeleny test) ($p<0.01$), and wet gluten content ($p<0.05$) stand out as very important. It can be concluded that the test weight can be used in the evaluation of technological suitability and baking quality of wheat because it is related to most of the analysed physical and chemical properties.

Key words: wheat, test weight, physical properties, chemical properties, relationship

Introduction

Wheat is one of the world's most important grains. It is considered that approximately 70% of wheat is used for food production (Dendy and Dobraszczyk, 2001). Milling of wheat is a very demanding and important process, which is an almost an art, with flour production as the end goal. Wheat flour and end products of milling industry are further used to produce a very broad range of final products. Flour yield and flour characteristics are strongly connected with kernel properties, among other factors. Properties that are usually taken into consideration for the evaluation of wheat quality in milling industry are as follows: the kernel size and shape, kernel colour, density, vitreousness, test weight, 1000 kernel weight. Predicting usable value of wheat is possible if one takes into consideration the previously stated parameters.

The test weight is one of important physical indicators for wheat quality, and it represents mass of the kernel per volume unit. The most common method as an indicator of wheat quality is the method for determination of the test weight because of its fast and simple performance. More precise information about the value of wheat for the milling industry can be obtained from the kernel density, but that method is more complex than the determination of the test weight. The test weight has been used for a long period of time as an approximate indicator in flour yield (Finney et al., 1957). This particular method is very important for wheat producers and breeders if you take into consideration that it has influence on the market categorization and the wheat price (Schuler et al., 1995). Some studies showed that the test weight can be an unreliable factor of prediction of the wheat quality for milling because it cannot distinguish origin for the low-density kernel (Ghaderi et al., 1971; Hook, 1984). However, the general rule is that higher test weight results in better wheat quality. Wheat in a certain category must meet the minimum requirements concerning the test weight. The test weight can vary from 40 kg hL^{-1} to 80 kg hL^{-1}, although the milling industry uses wheat samples with the test weight over 76 kg hL^{-1} (Owens, 2001). Many factors have influence on the test weight: the kernel size and shape, grain filling, water content, the amount and type of foreign materials, condition in surface area, weather conditions, etc. (Gaines et al., 1997). Williams (2003) has classified wheat in six categories according to the test weight: from the extra light (under 64 kg hL^{-1}) to very heavy (above 80 kg hL^{-1}). The test weight is a part of the calculation for wheat quality on the market. Therefore, according to the legislation in our country, the reference value for the test weight is 78 kg hL^{-1} (Official Gazette BA, No 76/10). In case that the test weight is higher than the reference value, the price of wheat increases (for every unit), but in case that the test weight is lower, the price decreases (0.32% for the same percentage). Some studies have pointed out the fact that there is no strong correlation between the test weight and certain quality properties, and that is the reason for less frequent use of the test weight as a method (Žeželj, 1995). The aim of this work is to investigate correlation between the test weight with other quality parameters, where the end goal would be the evaluation of technological quality of wheat.

Material and methods

Six samples of wheat available on the market were used in this study. The wheat samples were provided by the "Žitoprodukt 2012" d.o.o. company Banja Luka, where the wheat material was a mixture of different cultivars and it was grouped and composited based on their protein content, quality group, and TW. Sample 1 was based on a composite of three commercial cargo loading samples of the wheat from the Adony locality (Hungary), which has been used as an improver. Sample 2 was based on a composite of ten commercial cargo loading samples of the wheat from the Vojvodina locality (Republic of Serbia). Sample 3 was mixture of the samples 1 and 2 in the ratio 20:80. Sample 4 was a mixture of samples 1 and 2 in the ratio 30:70. Sample 5 was a mixture of samples 1 and 2 in the ratio 40:60. Sample 6 was based on a composite of four commercial cargo loading samples of wheat from the Lijevče polje locality (Republic of Srpska). Wheat material was prepared from the harvest wheat material provided by producers from the 2016 growing year. The reason for making samples 3, 4, and 5 is economic, to investigate the possibility of producing the wheat mixture of good technological quality, with as smaller amount of expensive wheat (improver) as possible.

The test weight (TW) was determined according to ISO 7971-3:2009, the 1000 kernel weight (TKW) was determined according to ISO 520:2010, and the protein sedimentation volume (the Zeleny test) was determined according to ISO 5529:2007. Vitreousness was determined according to the Kaluđerski and Filipović method (1998). The moisture content was determined according to ISO 712:2009, ash content according to ISO 2171:2007, protein content according to ISO 20483:2013, fat content according to ISO 7302:1982. The starch content was determined according to the Kaluđerski and Filipović method (1998). The gluten content and gluten index were determined according to ISO 21415-2 and 21415-4:2006, using the Glutomatic system Perten Instruments, Model CF2015.

Statistical analysis was performed using the IBM SPSS Statistics 26.0 software. Analysis of the variance (One way ANOVA) and following post hoc LSD and Tukey tests were used to determine significant differences between the mean values (with a level of $p<0.05$). The correlation analysis was performed to determine correlation between the chosen quality parameters (with a level of 0.01 and 0.05).

Results and discussions

Values for the test weight in the analysed samples of wheat ranged from 85.3 kg hL^{-1} to 86.3 kg hL^{-1} (Table 1). The previously mentioned values are over 76 kg hL^{-1}, which is the referent value for the quality of wheat intended for human nutrition (Owens, 2001). The analysed samples of wheat meet the criteria as raw material for milling, according to the test weight which is in compliance with the legislative and literature reviews (Official Gazette BA, No 76/10; Žeželj, 1995; Kaluđerski and Filipović, 1998; Tulse, 2014). According to the results of analysis of variance (Table 1), there is a statistically significant difference in the test weight between the analysed samples of wheat [$F(5.12)=19.044$, $p<0.05$]. Results of the post hoc LSD and Tukey tests indicate that samples 1, 2, 3, 4, and 5 do not show statistically significant differences in the test weight. However, sample 6 has a lower value of the test weight, which is statistically significantly different, compared with the rest of the samples.

Tab. 1. Results for physical quality parameters for wheat samples

Physical quality parameters	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Test weight (kg hL^{-1})	$86.3^{b}\pm0.09$	$86.2^{b} \pm 0.19$	$86.1^{b} \pm 0.15$	$86.2^{b} \pm 0.08$	$86.2^{b} \pm 0.10$	$85.3^{a} \pm 0.09$
1000 kernel weight (g)	$42.28^{e}\pm0.03$	$36.30^{b}\pm0.05$	$37.12^{c}\pm0.02$	$37.43^{c}\pm0.03$	$38.29^{d} \pm 0.18$	$34.89^{a}\pm0.22$
Vitreousness (%)	$67.3^{d} \pm 2.05$	$51.7^{b} \pm 0.47$	$53.3^{b} \pm 0.94$	$55.3^{bc}\pm 1.25$	$59.3^{c} \pm 1.25$	$33.3^{a} \pm 1.25$

All tests were repeated in triplicate and mean values were stated with standard deviations. Test weight has been calculated on 13% moisture content.

$^{a-e}$ *Mean values marked with the different letter in the same row are significantly different with 95% probabilities ($p<0.05$)*

The 1000 kernel weight (TKW) of the analysed wheat samples (Table 1) has ranged within the limits that have been shown in the study by Kovačević and Rastija (2014). According to Kaluđerski and Filipović (1998), the TKW should be 35 g minimum, and the analysed samples meet this value, with the exception of sample 6 which has the minimal value of the TKW. Žeželj (1995) describes very wide limit values from 20 to 50 g for the TKW, and the TKW for the analysed samples is in that interval. In the study by Amir et al. (2020), the results for the TKW ranged from 36.0-49.3 g in five wheat varieties, and the values for the TKW in our research were in that range with the exception of sample 6 whose TKW value was below the mentioned range. According to the results of analysis of variance, statistically significant difference for the TKW [$F (5.12) = 18.907$, $p < 0.05$] was found between the analysed samples of wheat (Table 1). Values for vitreousness of the analysed samples varied from 33.3 to 67.3% (Table 1). Values for vitreousness of the wheat from our areas, according to Prpa (2004), varied within a very wide interval from 14.7 to 91.5%, depending on many factors. Analysis of variance has shown that statistically significant difference in vitreousness [$F (5.12) = 153.302$, $p<0.05$] exists between the analysed samples of wheat.

Tab. 2. Results for chemical quality parameters for wheat samples

Chemical quality parameters	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Moisture content (%)	10.38^{a} ± 0.13	10.29^{a}±0.04	10.33^{a}±0.05	10.46^{a}±0.03	10.45^{a} ± 0.04	10.90^{b}±0.06
Ash content on dry matter (%)	1.68^{a} ± 0.03	1.88^{b} ± 0.06	1.71^{a} ± 0.01	1.69^{a} ± 0.03	1.64^{a} ± 0.01	1.63^{a} ± 0.01
Fat content (%)	2.05^{b} ± 0.02	1.84^{a} ± 0.04	1.83^{a} ± 0.09	1.74^{a} ± 0.05	1.83^{a} ± 0.05	2.17^{b} ± 0.03
Protein content (%)	14.65^{c} ± 0.41	11.96^{a}±0.17	12.68^{b}±0.02	12.70^{b}±0.04	13.00^{b} ± 0.08	11.66^{a}±0.03
Starch content (%)	57.91^{a} ± 0.05	62.94^{c}±0.64	62.7^{bc}±0.47	62.76^{bc}±0.1	62.66^{bc}±0.27	61.07^{b}±0.90
Protein sedimen. volume (ml)	65.0^{d} ± 0.41	44.7^{b} ±0.22	45.8^{b} ± 0.54	50.9^{c} ± 0.09	51.2^{c} ± 0.12	37.1^{a} ± 0.61
Gluten index (%)	96.3^{e} ± 0.17	78.5^{a} ± 0.39	91.2^{d} ± 0.45	88.6^{c} ± 0.60	88.6^{c} ± 0.17	83.3^{b} ± 0.05
Wet gluten (%)	30.2^{e} ± 0.05	24.5^{b} ± 0.14	24.0^{a} ± 0.05	25.7^{c} ± 0.05	26.4^{d} ± 0.09	23.7^{a} ± 0.12

All tests were repeated in triplicate and mean values were stated with standard deviations.

$^{a-e}$ *Mean values marked with the different letter in the same row are significantly different with 95% probabilities ($p<0.05$)*

The basic samples of wheat 1 and 2, which have been used for preparing samples 3, 4, and 5, were sampled from the cells of the silos (storage bins), as well as sample 6. Samples 3, 4, and 5 were sampled after the mixing stage (where volume dispensers and a collecting transporter system have been used), in industrial conditions.

The kernel (grain) mass as a heterogeneous system consists of kernels, different categories of impurities, and fluid interkernel space. A kernel can be observed as an anisotropic system with complex structure and different properties (Žeželj, 1995). One should have in mind the fact that moisture and chemical composition in individual kernels can vary, so kernels with different characteristics can be found in kernel mass. Because of the specificity of structure and heterogeneity of kernel mass and fractions of kernel, it is possible that minor deviations from the expected chemical composition of mixture samples of wheat 3, 4, and 5 can occur.

Values for contents of the analysed chemical compounds (Table 2) were in accordance with the referent values that can be found in the literature (Pena, 2004; FlourPedia, 2017; Vissers et al., 2019). Protein content values ranged from 11.66-14.65% for the analysed wheat samples. Similar results were reported by Asim et al. (2018) who found protein content in the range of 8-15% for the Pakistani wheat cultivars. Kovačević and Rastija (2014) in their study found different values of grain protein content for the analysed wheat varieties which, according to the value of protein content, belong to different quality groups, classified as follows: very good quality – over 13%, medium quality with grain protein content in the ratio 12-13% and low quality with protein content below 12%. In this study, wheat samples 2 and 6 have the low protein content (11.96% and 11.66%), samples 3, 4, and 5 have average protein content (12.68%, 12.70% and 13.0%), while sample 1 has very good protein content (14.65%). According to the protein sedimentation volume (the Zeleny test) in JUS Standard (JUS E.B1.200 and 200/1), the analysed wheat samples 1, 2, 3, 4, and 5 can be categorized in the I class (grade) wheat quality, while sample 6 belongs in the II class of wheat quality. Gluten quality for wheat samples 1, 3, 4, 5, and 6 is strong, while it is normal for sample 2, if we take into consideration the results in the

Oikonomou study (2015). All of the collected results for the protein sedimentation volume (the Zeleny test), the gluten index and content of the wet gluten are in accordance with the research results of the Živančev's study (2014). There is a statistically significant difference in the values of the examined chemical compounds ($p<0.05$) based on the results of analysis of variance between the observed samples (Table 2).

Table 3. Correlation between physical and chemical properties of wheat

	TW	TKW	VTR	MC	ACDM	FC	PC	SC	ZT	GI	WG
TW	1	0.600**	0.861**	-0.87**	0.386	-0.61**	0.560*	0.035	0.665**	0.362	0.502*
TKW		1	0.877**	-0.440	-0.173	0.032	0.973**	-0.69**	0.983**	0.805**	0.964**
VTR			1	0.725**	0.071	-0.396	0.852**	-0.293	0.914**	0.657**	0.797**
MC				1	-0.514*	0.581*	-0.423	-0.132	-0.488*	-0.214	-0.283
ACDM					1	-0.340	-0.251	-0.347	-0.121	-0.527*	-0.216
FC						1	0.057	-0.64**	-0.090	0.039	0.141
PC							1	-0.68**	0.955**	0.854**	0.929**
SC								1	-0.605**	-0.557*	-0.734**
ZT									1	0.767**	0.959**
GI										1	0.714**
WG											1

*** Correlation is significant at the level 0.01; * Correlation is significant at the level 0.05*
Results were shown as Pearson's correlation coefficient (r). TW –test weight, TKW – 1000 kernel weight, VTR–vitreousness, MC-moisture content, ACDM- ash content on dry matter, FC-fat content, PC- protein content, SC- starch content, ZT – protein sedimentation volume (the Zeleny test), GI- gluten index, WG – wet gluten content.

The correlation analysis has shown that statistically significant correlation exists between the TW and the following parameters: TKW, vitreousness, moisture content, fat content, protein content, protein sedimentation volume (the Zeleny test), and wet gluten content (Table 3). The correlation between the TW and the following parameters: TKW, vitreousness, protein content, protein sedimentation volume (the Zeleny test), and content of wet gluten, is positive, which means that with the increase of values of the previously listed parameters the value for TW is also increasing, and vice versa. Correlations between the TW and moisture and fat content are negative, which means that with the increase of value of moisture and fat content, the value for TW decreases. According to the Chaddock's scale for the evaluation of correlation strength (Žižić et al., 1999), the observed relationship between the TW and two parameters (vitreousness and moisture content) is strong, while it is medium strong for the rest of the parameters.

In the studies by Arjoo et al. (2018) and Markowska et al. (2016) it has been found that, among other selected parameters, the TKW was positively correlated with the moisture content, whereas the bulk density was negatively correlated. According to Dziki and Laskowski (2005), the test weight (TW) is also called bulk density. In our research, negative correlation between the TW (bulk density) and moisture content was established ($r=-0.87$, $p<0.01$), but correlation between the TKW and moisture content was not confirmed.

In their research, Schuler et al. (1995) have proved positive correlation between the TW and protein content (r=0.54), and accordingly, positive correlation has also been found in our research between the TW and protein content for the analysed wheat samples (Pearson's coefficient is 0.560). Weak but statistically significant correlation has been confirmed in the study by Kleijer et al. (2007), between the TW and the following parameters: TKW, protein sedimentation volume (the Zeleny test), grain score, grain hardness, protein content, and falling number. Similarly, in the study by Dziki and Laskowski (2005) for durum wheat, correlations between the TW and TKW, and correlation between the vitreousness and protein content were established. The correlations determined between the parameters of the analysed wheat samples in our research are in accordance with the previously mentioned findings in Kleijer et al. study (2007) and Dziki and Laskowski study (2005).

Results of the correlation analysis showed also that correlation exists between the TKW of the analysed wheat samples and the following parameters: TW, vitreousness, protein content, starch content, protein sedimentation volume (the Zeleny test), gluten index, and wet gluten content. According to the Wang and Fu study (2020), strong positive inter-relationship was observed between the TKW and TW in the samples of durum wheat ($r=0.92$, $p<0.001$), which is in compliance with our research where medium strong positive correlation has been found between the TKW and TW ($r=0.60$, $p<0.01$). According to the results of correlation analysis, the vitreousness of the analysed wheat samples is in statistically significant correlation with the following parameters: TW, TKW, moisture content, protein content, protein sedimentation volume (Zeleny test), gluten index, and wet gluten content (Table 3). Vitreous kernels are usually harder and have a higher protein content than the non-vitreous (starchy) kernels (Warechowska et al., 2013). Statistically significant correlation has been confirmed between the vitreousness and protein content for two wheat varieties in the study by Warechowska et al. (2013) ($r=0.58$ and $r=0.67$, $p<0.05$). Similar results have been found in our research where strong and positive correlation between the vitreousness and protein content has been detected ($r=0.852$, $p<0.01$).

Conclusions

Determining physical properties for the wheat kernel can provide the information about technological quality and optimal conditions necessary during the production process. Knowing the interaction between characteristics of the raw material that is wheat and conditions in the production process is required for the optimization of the process. In this study, selected physical and chemical properties of six wheat samples and correlation between them, especially correlation between the TW and the rest of the properties, were investigated.

Results of the conducted research have shown statistically significant correlation between the test weight (TW) and 1000 kernel weight (TKW) ($r=0.600$, $p<0.01$), vitreousness (VTR) ($r=0.861$, $p<0.01$), moisture content (MC) ($r=-0.870$, $p<0.01$), fat content (FC) ($r=-0.610$, $p<0.01$), protein content (PC) ($r=0.560$, $p<0.05$), protein sedimentation volume (the Zeleny test) (ZT) ($r=0.665$, $p<0.01$), and wet gluten content (WG) ($r=0.502$, $p<0.05$). The test weight is in correlation with the majority of the analysed quality parameters, physical and chemical, so it is a reliable indicator for wheat quality evaluation in terms of technological suitability and baking quality. Correlation between the TW and protein content stands out as very significant, because the protein content is a very important factor for baking industry. With that in mind, and if we know that the test weight method is quick, simple, and low-cost, the use of this method is justified in combination with other methods for wheat quality evaluation and making smart decisions. Knowledge of the correlations between physical, chemical, and rheological properties of wheat, may be applied in designing and monitoring technological processes in the cereal – milling industry.

References

Amir, R.M., Hussain, M.N., Ameer, K., Ahmed, A., Ahmad, A., Nadeem, M., Riaz, A., Chughtai, M.F.J., Khaliq, A., Ahsan, S. & Kausar, R. (2020). Comprehensive assessment and evaluation of selected wheat varieties for their relationship to chapatti quality attributes, *Food science and technology 40* (Suppl. 2): 436-443. https://doi.org/10.1590//fst.31619

Arjoo, Satya, S., Pant, K.K. & Naik, S.N. (2018). Effect of moisture content on engineering properties of some wheat varieties for post-harvest processing or designing grain storage bins. *International Journal of Chemical Studies 6(5):* 485-491

Asim, S.M., Ahmed, A., Amir, R.M. & Nadeem, M. (2018). Comprehensive identification and evaluation of selected wheat cultivars for their relationship to pan bread quality. *Journal of Food Processing and Preservation 42(7),* e13670, https://dx.doi.org/10.1111/jfpp.13670

Dendy, D.A. & Dobraszczyk, B.J. (2001). *Cereals and cereal products. Chemistry and technology*. Aspen Publishers, Inc., Gaithersburg, Maryland, pp. 13.

Dziki, D. & Laskowski, J. (2005). Wheat kernel physical properties and milling process. *Acta Agrophysica, 6(1):* 59-71.

Finney, K. F., Meyer, J. W., Smith, F. W. & Fryer, H. C. (1957). Effect of foliar spraying of pawnee wheat with urea solutions on yield, protein content, and protein quality. *Agronomy Journal, 49:* 341–347.

Gaines, C.S., Finney, P.L. & Andrews, C. (1997). Influence of kernel size and shriveling on soft wheat milling and baking quality. *Cereal Chem., 74(6):* 700-704.

Ghaderi, A., Everson, E. H. & Yamazaki, W. T. (1971). Test weight in relation to the physical and quality characteristics of soft winter wheat (*Triticum aestivum* L. em Thell). *Crop Sci., 11:* 515-518.

Hook, S. C. W. (1984). Specific weight and wheat quality. *Journal of Sci. Food and Agric., 35:* 1136-1141.

ISO Standard 712:2009, Cereals and cereal products – Determination of moisture content – Reference method.

ISO Standard 2171:2007, Cereals, pulses and by-products – Determination of ash yield by incineration.

ISO Standard 7302:1982, Cereals and cereal products – Determination of total fat content.

ISO Standard 20483:2013, Cereals and pulses – Determination of the nitrogen content and calculation of the crude protein content – Kjeldahl method.

ISO Standard 5529:2007, Wheat – Determination of sedimentation index – Zeleny test.

ISO Standard 7971-3:2009, Cereals – Determination of bulk density, called „mass per hectolitre“ – Part 3: Routine method.

ISO Standard 520:2010, Cereals and pulses – Determination of the mass of 1000 grains.

ISO Standard 21415-2:2006, Wheat and wheat flour – Gluten content – Part 2: Determination of wet gluten by mechanical means.

ISO Standard 21415-4:2006, Wheat and wheat flour – Gluten content – Part 4: Determination of dry gluten from wet gluten by a rapid drying method.

JUS Standard E.B1.200 and 200/1, Pšenica kao sirovina za mlinsku industriju. Opšti uslovi kvaliteta 1978. i Izmjene i dopune 1992. [Wheat as raw material for milling industry. General terms of quality 1978. and Amendments 1992.]

Kaluđerski, G. & Filipović, N. (1998). *Metode ispitivanja kvaliteta žita, brašna i gotovih proizvoda*. Tehnološki fakultet, Univerzitet u Novom Sadu [*Methods for examination quality of wheat, flour and end product*, Faculty of Technology, University of Novi Sad]

Kleijer, G., Levy, L., Schwaerzel, R., Fossati, D. & Brabant, C. (2007). Hektolitergewicht und Qualitatsparameter beim Weizen [Relationship between test weight and several quality parameters in wheat]. *Agrar Forschung, 14(11-12):* 548-553.

Kovačević, V. & Rastija M. (2014). *Žitarice*. Poljoprivredni fakultet, Sveučilište u Osijeku [*Cereals*. Faculty of Agriculture, University of Osijek]

Markowska, A., Warechowska, M. & Warechowski, J. (2016). Influence of moisture content on external friction coefficient and basic physical properties of Astoria variety wheat grain. *Technical Sciences*, 19(1): 17-26.

Oikonomou, N. A., Bakalis, S., Rahman, M. S. & Krokida, M. K. (2015). Gluten Index for Wheat Products: Main Variables in Affecting the Value and Nonlinear Regression Model, *International Journal of Food Properties*, 18(1): 1-11. https://doi:10.1080/10942912.2013.772198

Owens, G. (2001). *Cereals processing technology*, Woodhead Publishing Limited, CRC Press

Pena, R.J. (2004). Food uses of triticale, *Triticale improvement and production*, FAO, 37-48.

Pravilnik o proizvodima od žitarica, Službeni glasnik BiH, broj 76/10 [Regulations about cereal products, Official Gazette BA, No 76/10]

Prpa, Đ. (2004). Neki pokazatelji hemijskog sastava i kvaliteta pšenice i mogućnosti ekstrakcije brašna. Materijal namijenjen komercijalno-tehnološkim i tehnološko-tehničkim službama, Gomađo d.o.o., Beograd [Certain indicators of chemical composition and wheat quality and possibilities of flour extraction. Material intended to commercial- technological and technological-technical services, Gomadjo d.o.o. Belgrade].

Schuler, S.F., Bacon, R.K., Finney, P.L. & Gbur, E.E. (1995). Relationship of test weight and kernel properties to milling and baking quality in soft winter wheat, *Crop Sci., 35(4)*: 949-953. https://doi.org/10.2135/cropsci1995.0011183X003500040001

Tulse, S.B., Reshma, V., Inamdar, A. & Sakhare, S.D. (2014). Studies on multigrain milling and its effects on physical, chemical and rheology characteristics of milled streams, *Journal of Cereal Science*, 60(2): 361-367. https://doi:10.1016/j.jcs.2014.05.010

Vissers, A., Adams, M. & Tucker, G. (2019). Wheat preprocessing methods to improve nutritional and technological functionality, *Cereal Foods World, 64(*4). https://doi.org/10.1094/CFW-64-4-0040

Wang, K. & Fu, B.X. (2020). Inter-relationships between test weight, thousand kernel weight, kernel size distribution and their effects on durum wheat milling, semolina composition and pasta processing quality, *Foods, 9:* 1308. https://doi:10.3390/foods9091308

Warechowska, M., Warechowski, J. & Markowska, A. (2013). Interrelations between selected physical and technological properties of wheat grain, *Technical sciences, 16(4):* 281-290

Williams, P. (2003). *Variety development and quality control of wheat in Canada*. Paper presented at the International Japanese Conference on Near-Infrared Reflectance. 1997, http://www.grainscanada.gc.ca/Cndgrain/VarietyDev/variety1-e.htm

Žeželj, M. (1995). *Tehnologija žita i brašna – poznavanje čuvanje i prerada žita*. Tehnološki fakultet, Univerzitet u Novom Sadu [*Technology of wheat and flour – knowledge, storage and wheat processing*, Faculty of Technology, University of Novi Sad]

Živančev, D. (2014). Analiza uticaja genetskih, mikroklimatskih i ekoloških faktora na sastav glutena i tehnološki kvalitet sorti pšenice. *Doktorska disertacija*, Univerzitet u Novom Sadu [Analysis of influence of genetics, microclimatic and ecological factors on composition of gluten and technological quality for wheat types, *Doctoral dissertation*, University of Novi Sad] http://nardus.mpn.gov.rs/handle/123456789/5434

Žižić, M., Lovrić, M. & Pavličić, D. (1999). *Metodi statističke analize*. Ekonomski fakultet, Univerzitet u Beogradu [*Methods of statistical analysis*. Faculty of Economy, University of Belgrade]

http//:flourpedia.com/2017/12/structure-of-wheat-kernel-and-its//html

Повезаност између хектолитарске масе и неких физичких и хемијских особина пшеничног зрна

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Сажетак

Хектолитарска маса се дуги низ година користила као показатељ за процјену квалитета житарица у великом броју земаља, и још увијек се користи као брза метода за одређивање цјеновног разреда сировине. Корелација између хектолитарске масе, приноса брашна и осталих квалитетних параметара варира зависно од сорте и услова гајења. Циљ овог рада је да се утврди постојање корелација између хектолитарске масе и неких физичких и хемијских параметара зрна пшенице [маса 1000 зрна, стаклавост, садржај влаге, садржај пепела на суву материју, садржај масти, садржај протеина, садржај скроба, волумен седиментације протеина (Zeleny тест), глутен индекс, садржај влажног глутена], да би се оцијенио технолошки квалитет пшенице. За потребе рада испитивано је шест узорака пшенице. Проведена су испитивања физичких и хемијских параметара пшеничног зрна, а потом се испитивало постојање корелација између анализираних параметара. У оквиру утврђених корелација, као врло битне се истичу корелације хектолитарске масе са масом 1000 зрна ($p<0.01$), стаклавости ($p<0.01$), садржајем влаге ($p<0.01$), садржајем масти ($p<0.01$), садржајем протеина ($p<0.05$), волуменом седиментације протеина (Zeleny тест) ($p<0.01$) и садржајем влажног глутена ($p<0.05$). Могуће је закључити да се хектолитарска маса може употребљавати у процјени технолошке подобности пшенице и њеног квалитета за потребе пекарске индустрије, због своје повезаности са већином анализираних физичких и хемијских особина.

Кључне ријечи: пшеница, хектолитарска маса, физичке особине, хемијске особине, повезаност

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