DEBRANNING HUNGARIAN WINTER WHEAT VARIETIES

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Abstract.

Wheat hardness has an effect on the milling process, it determines the properties, qualities and end use of flours. In recent years the debranning of kernels before milling has moved to the forefront. We did a debranning research using two different wheat kernels; called GK Fény (with soft kernel hardness), and GK Békés (with hard kernel hardness) in different water-conditions. The aim of our work was to demonstrate and compare the changes in different parameters of wheat kernels such as grinding energy, percentage of broken kernels, peeled bran content, Hardness Index as the function of debranning times. The results: longer debranning times caused a decrease in kernel hardness and grinding energy in both wheat varieties.

Keywords: PeriTec technology, SATAKE, debranning, wheat kernel hardness

Intruduction

In the last 20 years, the importance of endosperm classification (soft and hard wheat kernel) has grown bigger. Wheat-hardness is an important parameter of wheat quality, which has become the basis of trade-classification in the last decades. Wheat hardness has an effect on the milling process, it determines the properties, qualities and end use of flours. In recent years the debranning of kernels before milling has moved to the forefront. The kernel hardness has great effect on the baking properties of the resulting flour. Flour, which is made from hard wheat generally have a medium to high protein content and stronger gluten than flour, which is made from soft wheat. The friabilin protein complex determines the kernel hardness. Generally, when the amount of the friabilin is high, the kernel hardness is soft and when the amount of the friabilin is low the kernel hardness is hard (Gyimes 2002).

Ranieri (2011) based on a process of peeling, which is traditionally milled grain products (rice, barley, oats) are used during production. Funds that intense influences (peeling, grinding) on the grain surface of the shell is detachable parts, the outer layers of the kernel can be removed.

The bran of wheat kernel branch makes up 14-16%, which is the outer skin layers, including the aleurone layer. The latter is usually removed together with the other layers during milling technology, although botanically the aleurone layer is the outer layer of the endosperm (Mousie et. Al. 2004). Bottega et al (2009) highlight the fact that the wheat peeling allows the removal of the outer skin layers and keeping the aleurone layer in a controlled manner.

Nowadays, more and more attention is paid to micotoxin contamination in the food safety considerations of wheat, as an essential nutrient raw material, in particular to the toxins produced by fusarium fungi (Zomborszkyné, 2004; Scott, 1990; Egmond, 1984) . During our experiments we dealt with the laboratory modelling of a new milling surface treatment called PeriTec technology to find out to what extent this method can reduce toxin contamination (Véha 2014).

The fungi causing the infection and most of the harmful toxins they produce are concentrated in the bran of the grain, thus the intensive surface cleaning, the so-called debranning operation could allow the reduction of contamination in the milling technology. The essence of the PeriTec technology - originally developed by SATAKE, a Japanese company, to clean rice - is that it gradually removes the bran layers of the grain by mechanical means before further processing (Gold, 2005).

Fig. 1. raw wheat **Fig. 2.** debranned wheat
(www.satake-europe.com)

Cereals are essential mass sustaining products, covering significiant fraction of Earth's nutrition necessities. Besides human nourishment, cereal crops are used for forage and industrials needs as well (Tanács 2003). Cereals can be easily produced, can be grown anywhere, exertion facilities are large, and grain kernel can be siloed easily. It is typican for them that, their protein content is average or high, and provide high energy.

The wheat gives almost half of the produced amount of grain. It is grown in each of our nineteen counties. Best quality crop is produced in Békés-, Szolnok-,Hajdú-,Bács-,Pest counties and in Mezőföld and Kisalföld.

In the world's grain- , crops, grown and used for commercial purposes, are sorted in numerous classes. In case of durum and aestivum kernel, it contains the vernal and autumnal, the red and white just as soft and hard corns and all their combinations. In the last 20 years, the importance of endosperm classification (soft and hard wheat kernel) has grown bigger.

In the past 20 – 25 years , the interest in connection with commercial assortment, has grown considerably. Among from the previously mentioned emerges the significance of endosperm classification, rating according to the inner structure of the kernel. At wheat rating, postulating the inner structure of the kernel, it is extremely important that kernel hardness is the dependant of many properties in connection with the grain's technological quality. The system of endosperm classification of wheat means essential advantage for all participants of the wheat varieties, from the grower, through the dealer to the user (Békés 2001).

The good mill and baker quality wheat belong to the hard grain type. As well as the mill industry and the baker industry (making of bread) prefer this type. The hard endosperm composition is in close relationship with the large flour yield (from amongst the better is the greater ratio of the more valuable fraction), with the flour's greater water consumption, the volume of the bread, the bread's quality parameters (inner, height etc.) and the protein content.

For the determination and measuring of the endosperm structure, kernel hardness indicators were made, which measures the power needed to snap a seed. With this method, they determine a ration: Hardness Index (HI), which is one of the bases of mill crop's acceptance qualification. The kernel hardness has great effect on the baking properties of the resulting flour. Flour, which is made from hard wheat generally have a medium to high protein content and stronger gluten than flour, which is made from soft wheat. The friabilin protein complex determines the kernel hardness. Generally, when the amount of the friabilin is high, the kernel hardness is soft and when the amount of the friabilin is low the kernel hardness is hard. Hardness in wheat is largely controlled by genetic factors but it can be affected by the environment (Gyimes, 2004). The transgenic expression of wild type Pina sequence in the Pina null genotype gave soft grain with the characteristics of soft wheat including increased starch bound friabilin. Hardness is suggested to influence the adhesion forces between starch granules and protein matrix whereas vitreousness would rather be related to the endosperm microstructure (Greffeuille, et. al., 2006).

Kernel hardness reliant assortment, and the quality acceptance is essential for the companies, and this is why the identification of hardness that can be automate able if is so necessary. Kernel hardness is an important measurable attribute of wheat that has been correlated to it's chemical and genetic make-up. The evaluation of wheat kernel hardness has been used in predictions of flour yield and gives early indication of baking performance (Pomeranz and Williams, 1990). Factors influencing kernel hardness include variety and environment, however the total variation in hardness has yet to be explained.

Our experiments were carried out between 2004 and 2007, at the Faculty of Food Engineering at the University of Szeged and later at it's successor the Faculty of Engineering. In our experiments we measured the physical properties of wheat (Triticum aestivum) reology, with various methods.

PeriTec technology

The essence of the PeriTec technology - originally developed by SATAKE, a Japanese company, to clean rice - is that it gradually removes the bran layers of the grain by mechanical means before further processing. During our experiments we dealt with the laboratory modelling of a new milling surface treatment called PeriTec technology to find out to what extent this method can use to debranning wheat (Véha 2012).

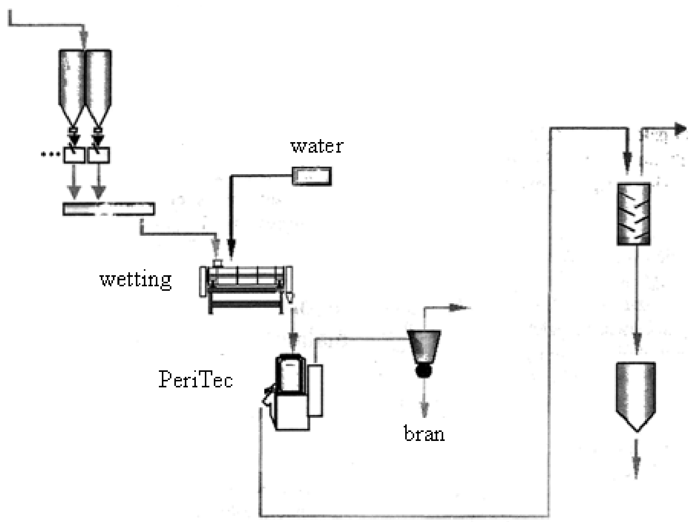

Fig. 3. Flowsheet of the PeriTec technology
(www.satake-europe.com)

The aim of our work was to demonstrate and compare the changes in different parameters of wheat kernels such as grinding energy, ash content, percentage of broken kernels, peeled bran content, Hardness Index as the function of debranning times. At first we examine the technology (Table 1.).

Table 1. Development of the measured characteristics of wheat as a result of debranning

	Width (mm)	Length (mm)	Thickness (mm)	Broken grains (%)
unpolished wheat grains	3,25	6,64	2,86	2,32
10s polished wheat grains	3,22	6,53	2,72	4,01
20s polished wheat grains	3,24	6,53	2,69	5,12
40s polished wheat grains	3,13	6,38	2,55	9,28

The mass ratio of the debranned hull (parts) as a function of polishing time can be seen on Figure 4.

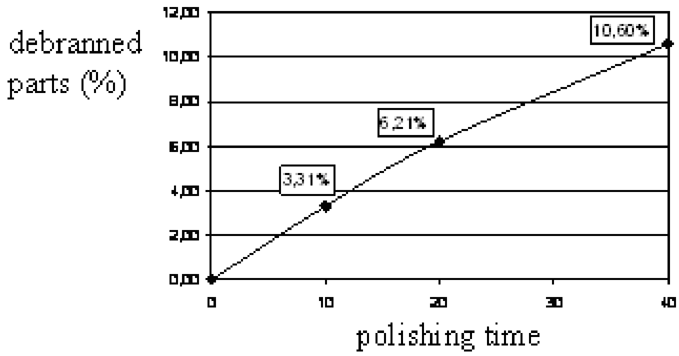

Fig. 4. Proportion of the debranned parts as a function of polishing time

Materials and methods

We carried out our experiments using a wheat from Gabonakutató Ltd, Szeged; called GK Fény (with soft kernel hardness), and GK Békés (with hard kernel hardness) in different water-conditions. GK Békés and GK Fény samples were air-dried (at 10-11% humidity) and 15% moisture content, they were carried out in the conditioned state experiments. The conditioning was calculated based on the initial moisture content and weight of the amount of wheat, with tap water at 20 ^{o}C. After conditioning the samples to a moisture content of 15%, they were subjected to different levels of rubbing applying 10, 20 and 40 s operation times.

To the debranning we used PeriTec technology. The essence of the PeriTec technology - originally developed by SATAKE, a Japanese company, to clean rice - is that it gradually removes the bran layers of the grain by mechanical means before further processing. We modelled the PeriTec technology with a laboratory size, batch-operating, horizontal debranning machine by SATAKE (Figure 5.).

Fig. 5. SATAKE machines

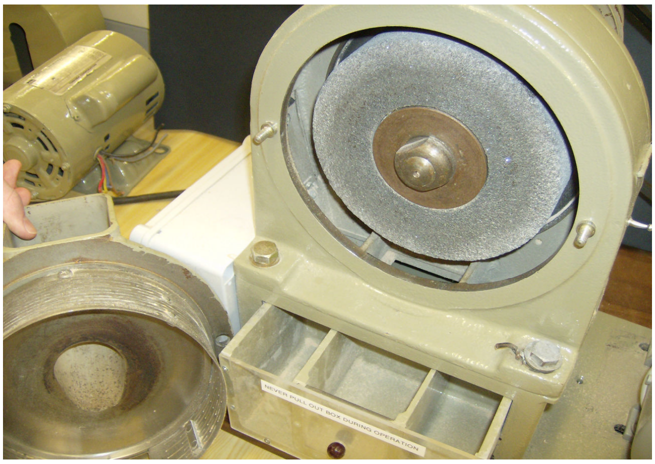

Fig. 6. Disc sander of SATAKE laboratory machines

Fig. 7. The perforated plate of SATAKE laboratory machines after the debranning

We studied the development of the physical parameters of the wheat grains, as well as the rate of grain breakage. We determined the ash content of the samples according based on MSZ 6367/15-84.

Determining the kernel hardness by Perten SKCS 4100 equipment

We used a Perten SKCS 4100-type instrument to measure kernel hardness (Hardness Index). Cleaned grain samples were used to identify the hardness index (HI) by SKCS-4100 instrument (Perten Inc.). The SKCS-4100 can complete a test in about 3 minutes, and simultaneously reports mean and standard deviation data for kernel weight, diameter, and moisture content, as well as the HI.During the measurement, the instrument (Figure 7.) measures the weight, size, moisture content and the hardness of the kernels. After determining 300 kernels unique properties it counts the average of the data gathered and counts standard deviation value and also, there is an opportunity to illustrate the measured results in column charts. The program provides an opportunity to see the last results after the following measurement. The measured results and their histograms can be printed if wished. The Hardness Index, produced by the machine as final results, is a physically non determined ratio, so in extremes cases the outcome can be zero or negative value (Szabó P., 2016).

Fig. 8. Perten Single Kernel Characterization System (SKCS) 4100 device

We used Perten 3303 mill to determine the Particle Size Index (PSI). This involves grinding a sample, and sieving a weighed amount through a standard screen for a standard time. The percentage of throughs is recorded as the PSI. We determine the specific grind energy pretence (e_f). All measurements were repeated 3 times.

Results and discussion

Examine the function of the various grinding times (0, 10, 20 and 40 seconds), the detached shell, the broken grains rate and ash content, we can be a following conclusion: more grinding time with the SATAKE laboratory peeling equipment, more hulls have been removed.
As the mass ratio and the detached shell material grew, it reduced the ash content of wheat. The grinding time is increased by the shell content of endosperm has also been discarded parts. The increasing grinding time, the sample had a greater amount of mechanical stress, which resulted in a growing proportion of broken grains (Figure 9., Figure 10.).

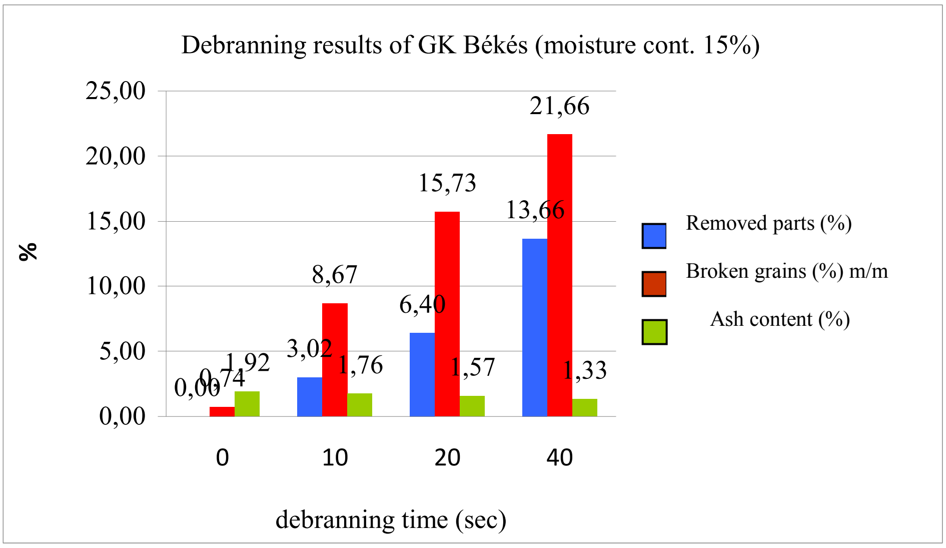

Fig. 9. Debranning results of GK Békés (moisture content 15 %)

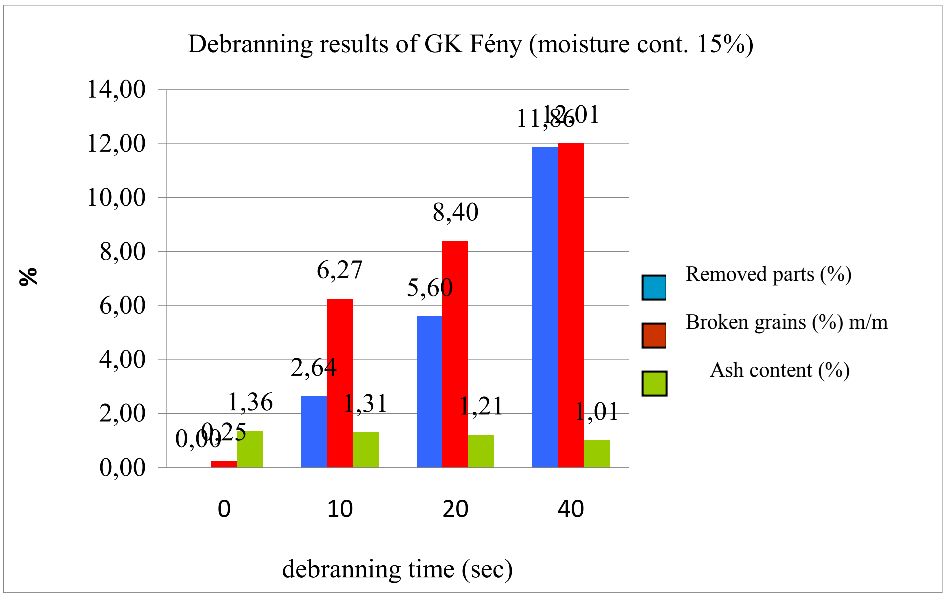

Fig. 10. Debranning results Of GK Fény (moisture content 15 %)

The hard kernel structure (GK Békés) has greater broken kernel ration (in conditioned and unconditioned state) than the soft kernel structure (GK Fény), for any period of grinding.

The conditioning increases the detached shells, the soft wheat kernel (GK Fény) and the hard wheat kernel (GK Békés), although the rate of increase was smaller in the soft wheat grain. The longer the grinding time was used; the rate of increase was greater.

Results of the SKCS

In the condition and unconditional wheat, the kernel hardness changed: The different debranning time chose the weak of the structure on the hard wheat variety (GK Békés). The debranning time was increase and the hardness index was decrease. The soft wheat (GK

Fény), as prolonged grinding was performed several shell portion removed from the grain surfaces, the kernel hardness decreased.

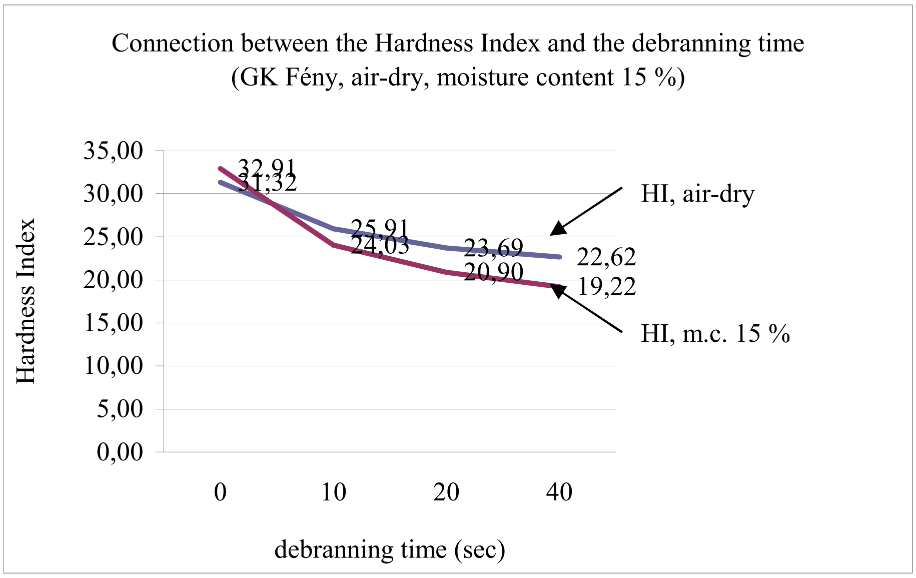

Fig. 11. Connection between the Hardness Index and the debranning time (GK Fény, air-dry, moisture content 15 %)

Perten mill

Figure 12 shows the conditional effect. The grinding energy (e_g) decrease in both cases (soft and hard kernel).

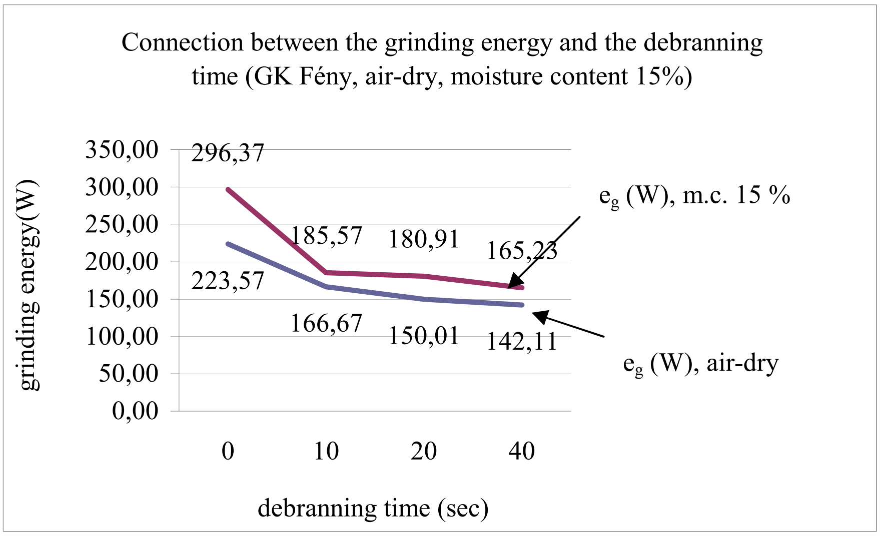

Fig. 12. Connection between the grinding energy and the debranning time (GK Fény, air-dry, moisture content 15 %)

Conclusion

Our main findings: longer debranning times caused a decrease in kernel hardness (did not change significantly, however, the rate of broken grains in the lot increased significantly as a result of the strong mechanical impact applied during the operation) and grinding energy in both wheat varieties. The value of the ash content – used to characterize the hull content of flour – decreased when the debranning time increases. The broken grains and the removed parts of the hull percent increase.

Longer debranning times caused a decrease in kernel hardness (did not change significantly, however, the rate of broken grains in the lot increased significantly as a result of the strong mechanical impact applied during the operation).

The different debranning time weakened the structure of the hard kernel hardness wheat sample (GK Békés). The increasing debranning time resulted the hardness decreasing. We measured hardness decreasing after 10 and 20 seconds debranning time. Some growth was seen, when there was 40 seconds is the debranning time by air dry and the 15 % conditioned state. When examining the reasons for this trend, we presumption the following. The wheat coat is softer and more flexible; the endosperm is harder and more brittle. After the shorter debranning time, coat remains on the surface of the kernel. After 40 seconds debranning time, the endosperm part remains only, and it is harder and brittle than the coat.

References

Antal Véha, P. Balázs Szabó, Tibor Bartók, Ernő Gyimes (2014): Opportunity of DON toxin on wheat using debranning technic, NAFI 2014 - INTERNATIONAL FOOD CONGRESS Novel Approaches in Food Industry - 26 - 29 MAY 2014., Kusadasi, Turkey, ISBN: 978-605338-069-6, p. 189.

Balázs P. Szabó, Antal Véha (2016): Examine the endosperm structure of winter wheat varieties, XIIth International Conference of Food Physicists, ISBN 978-963-473-939-5, p. 35

Békés, F. (2001): A búza endospermium szerkezetének szerepe néhány minőségi búzát termelő országban, CSIRO Division of Plant Industry, Canberra, Ausztrália, http://www.elitmag.hu/informaciok/szakcikk/endosper.htm

Bottega, G - Cecchini, C. - D'Egidio, M. G. - Marti, A.- Pagani: M. A. (2009), Debranning process to improve Quality and safety of wheat and wheat products – Tecnica Molitoria International – Yearly issue 67-68.

Egmond, H.P. (1989): Mycotoxins in dairy products; Elsevier Science Publishers Ltd; Essex

Gold M. (2005): Gabonaelőkészítés PeriTec eljárással, Molnárok lapja 110. évf. 2005. 1-2 sz., (in Hungarian)

Greffeuille V, Abecassis J., Rousset M, Oury, FFaye A, Bar L 'Helgouac'h, CLullien-

Pellerin V. (2006): Grain characterization and milling behaviour of near-isogenic lines differing by hardness. Theor. Appl. Genet. 114:1-12.

Gyimes E. (2004): Összefüggés-vizsgálatok búzafajták szemtermésének agrofizikai tulajdonságai között, Doktori (PhD) értekezés Mosonmagyaróvár (PhD thesis, in Hungarian)

Gyimes, E. – Neményi M. - Véha, A. (2002): Reológia és szemkeménység összefüggése őszi búzáknál. In: A növénytermesztés szerepe a jövő multifunkcionális mezőgazdaságában (Ötven éves az Acta Agronomica Hungarica Martonvásár (ISBN 963 8351 35 7). p. 117-124

http://www.openfields.it/doc/110919-openfields.pdf http://www.satake-europe.com/peritec/index.html (2012. 11. 25.)

Kovács F. , Banczerowski J. (1997): Környezetszennyező kemikáliák és természetes toxinok. Magyar Tudomány, 8.sz., 897-909. p., (in Hungarian)

Laczay, P. (2004): Állati eredetű élelmiszereink kémiai-toxikológiai biztonsága 3. Biológiai eredetű szennyező anyagok. Magy. Állatorv. Lapja 126, p. 371-380., (in Hungarian)

Monda S., DR. Mosonyi Á., Tóth J. (1990): Gabonaipari technológiák, Kertészeti és Élelmiszeripari Egyetem Élelmiszeripari Kar, Budapest, (in Hungarian)

Mousia, Z. – Edherley, S. – Pandiella, S. S. – Webb, C., (2004), Effect of wheat pearling on flour quality, Food Research International, 37, 449-459.

Pomeranz Y - Williams PC (1990): Wheat hardness: its genetic, structural and biochemical background, measurements and significance. In: Advances in Cereal Science and Technology, AACC, St. Paul, vol. X: 471-544

Rafai, P. (1999): A takarmány alapanyagok szennyezettsége. Magyar Tudomány 1999. áprilisi p. 1-8. (in Hungarian)

Ranieri, R. (2011), Wheat debranning: industrial applications on durum wheat, Open Fields srl, Parma, Italy, 6th Annual IAOM Eurasia District Florence, Italy September 13th 2011.

Scott, P. M. (1990): Trichotecenes in grains. Cer. Foods World 35, p. 661-666.

Szeitzné Szabó M., (2009): Gabonaalapú élelmiszerek fuzáriumtoxin szennyezettségének csökkentési lehetőségei, Magyar Élelmiszer-biztonsági Hivatal tájékoztatója (in Hungarian)

Tanács L. (2003): Élelmiszerek növényi eredetű nyersanyagai, SZTE-SZÉF jegyzet, 6-22. p.

Téren J., Draskovics I.., Novák E. (1990): Mikotoxinok, toxinogén gombák, mikotoxikózisok. Magyar Élelmezéstudományi Egyesület (in Hungarian)

Véha, A.; Szabó, P. B.; Gyimes, E. (2012): Peritec technology to reduce fusarium toxin in the milling technology. Review of Faculty of Engineering Analecta Technica Szegedinensia, 6. 131-136.

Zomborszkyné Kovács M. (2004): A penészgombák toxinjainak állategészségügyi vonatkozásai. MezőHír, Mezőgazdasági Szaklap, VIII. évfolyam 2004 február (in Hungarian)