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CHANGES OF THE SAFETY AND THE TECHNOLOGICAL QUALITY CAUSED BY MOLD CONTAMINATION

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In determined climate conditions the infection of wheat by the field fungi is more expressive and unavoidable.This infection influences the yields, the total quality and the hygienic conditions. At the mill, the cleaning process is not sufficienty effective, so the well developed, but infected kernels are present in the mass in front of the first grinder. For that reason, the aim of this study was investigation of the presence of the field fungi in the wheat kernels as well as the changes in the quality complex to be determined because of this infection. The samples contaminated by the field fungi were compared with the relatively healthy wheat grains. The identification of the isolated micropopulations was included in the investigations, first of all of the toxic species, as well as the determination of their influence on the biological and the technological quality. The results obtained from the investigations have shown that fungi of the genus *Fusarium* were the most present contaminants, and the most present among them was *F. oxysporum*. Besides the *Fusarium,* the fungi of the genus *Alternaria* were also present. Their influence on the wheat quality was determined taking into consideration the hygienic conditions.

Key words: wheat; molds; mycotoxins; technological quality; ochratoxin; zearelenon

ПРОМЕНИ НА БЕЗБЕДНОСТА И НА ТЕХНОЛОШКИОТ КВАЛИТЕТ ПРЕДИЗВИКАНИ ОД КОНТАМИНАЦИЈА СО ГАБИ

Во одредени климатски услови инфекцијата на пченицата со полските габи е поизразена и непредвидлива. Оваа инфекција влијае на приносите, вкупниот квалитет и хигиенската состојба. Во млинот процесот на чистење не е доволно ефикасен, така што добро развиените, но инфицирани зрна се присутни во масата пред првото мелење. Поради тоа целта на овој труд беше да се испита присуството на полските габи во пченичните зрна и да се утврдат промените во квалитетот. Мострите заразени со полските габи беа споредени со релативно здрави зрна. Во истражувањата беше вклучена идентификација на изолираните микропопулации, пред сè на токсичните видови, како и утврдување на нивното влијание врз биолошкиот и технолошкиот квалитет. Резултатите добиени од истражувањата покажаа дека габите од родот *Fusarium* беа најзастапени контаминанти, а меѓу нив беше најзастапена *F. oxysporum*. Покрај *Fusarium,* присутни беа и габите од родот *Alternaria*. Од пченичните зрна беа изолирани нивните токсични метаболити, микотоксините охратоксин А и зеареленон. Утврдено беше нивното влијание врз квалитетот на пченицата, земајќи ја предвид хигиенската состојба.

Клучни зборови: пченица; габи; микотоксини; технолошки квалитет; охратоксин; зеареленон

MATERIAL AND METHODS

The kernel fraction was performed on the basis of the sensorial evaluation, as well as of mycological and toxicological check. The contaminated kernels are devided into three fractions: 1) Darkgerm kernels at which the colour change of the outer layers was registered, mostly in the germ

area and the crease of the potbellied part [1]; 2) Little fusarious kernels are weakly wrinkled kernels with less expressed white and pink coating; 3) Strong fusarious kernels are expressively wrinkeled white and pale red and light kernels [2, 3].

All the kernel categories are analyzed by the official mycological, mycotoxicological, biological, physical-chemical, biochemical and rheological methods [4, 5].

RESULTS AND DISCUSSION

Mycopopulation of wheat kernels: The results of investigation of the number of molds per wheat kernel, performed in the frame of this study, are presented in Table 1.

Table 1

Average content of mold number per kernel of wheat fraction pattern

Fraction name	1	2	3
Sound	0,92	0,73	0,83
Dark-germ	2,00	2,97	2,94
Slightly fusarious	2,87	3,12	3.21
Strong fusarious	3,21	3,25	3,25

The most infected were the strong fusarious fractions.

Mycotoxicological contamination of wheat: Table 2 presents the results of investigation of AB1, AG1, OA and ZEA in the wheat kernels. CA was present in slightly and strong fusarious fractions, and ZEA which was found even in the 87% of the patterns with concentrations too high.

Table 2

Contamination of wheat kernels by mycotoxins

Fraction name	Variety	Mycotoxin ($\mu g \cdot kg^{-1}$) Alfatoxins B_1 +	G_1	Oxratoxin A	Zearalenon
Sound	1	0	0	0	500
Dark-germ	1	0	0	0	0
Slightly fusarious	1	0	0	0	260
Strong fusarious	1	0	0	0	1400
Sound	2	0	0	0	250
Dark-germ	2	0	0	0	180
Slightly fusarious	2	0	0	0	270
Strong fusarious	2	0	0	48	350

The regulation [6] issues the maximal allowed concentration for the CA till 10 g/kg and for the ZEA till 1 g/kg. Mycotoxins are included in the expressively thermostable compounds, because they do not lose their toxicity during the thermal processing.

Biological quality of wheat: The energy of sprouting and sprouting of the sound and darkgerm fractions had normal values, as it can be seen on Table 3. These values significantly decrease at the fusarious fractions the high fungus contamination influences badly the biological reproduction. The consequence of that is the increased share of the abnormal number of sprouts and sick kernels.

Table 3

Survey of biological properties of wheat varieties

Kernel fractions	Sprouting energy (%)	Sprouting (%)	Types of sprouts: Normal	Abnormal	Sick kernels	Fresh kernels
Average sample	44	44	40	4	56	0
Sound fraction	96	100	80	20	0	0
Dark-germ	88	96	90	6	4	0
Slightly fusarious	64	64	60	4	32	4
Strong fusarious	0	0	0	0	100	0

The greatest yield was obtained at the sound fractions, while the smallest one at the strong fusarious (Table 4), which is opposite proportional with the ash content (Table 5). At the strong fusarious fractions the smallest flour yield and the highest ash content were registered, which is an undesirable property from the aspect of milling processing.

Table 4

Level of flour yield of the investigated wheat fractions

Variety	Flour yield of fractions (%) Sound	Dark-germ	Slightly fusarious	Strong fusarious
1	65	60		5 0
2	55	53	52	50
3	50	49	48	45

Table 5

Content of mineral substances in wheat fractions

Variety	Ash content (% / d.b.)			
	Sound	Dark-germ	Slightly fusarious	Strong fusarious
1	0.88	0.89	0.90	0.97
2	0.90	0.93	0.96	0.96
3	0.94	0.95	0.98	0.98

Chemical methods clearly point out to the disturbances which happen in the wheat conglomerate of gluten and starch provoked by the contamination of molds (protein content, wet gluten content and other).

Table 6

Protein content in wheat fractions

Variety	Protein content (% / d.b.)			
	Sound	Dark-germ	Slightly fusarious	Strong fusarious
1	13.3	13.7	13.8	13.9
2	13.6	14.0	14.5	14.9
3	14.0	14.6	14.8	15.0

All investigated wheat varieties had relatively high protein content at the level of the I technological group at all fractions, and the highest concentrations were registered at the strong fusarious fractions (Table 6).

The wet gluten content of all analyzed varieties has shown considerable variations in the analyzed fractions. The darkgerm fractions at all varieties had the highest values of this rheological indicator, and the strong fusarious fractions had the smallest (Table 7). It is probably a consequence of a high mold contamination which has caused changes in the gluten stucture destroying one of the important gluten components – the glutenin fraction which gives dough elasticity.

Table 7

Wet gluten content in the wheat fractions

Variety	Wet gluten content (%)			
	Sound	Dark-germ	Slightly fusarious	Strong fusarious
1	32	33	3 0	26
2	33	35	31	27
3	34	36	32	30

Besides the differences in the wet gluten quantity, in the analyzed fractions the difference in regard to its quality can also be emphasized. Gluten of sound fractions shows good flexibility, small stickiness and plasticity, as well as light yellow colour. Gluten quality of darkgerm and slight fusarious fractions has decreased, while at the strong fusarious kernels has shown the weakest rheological characteristics (sticky, brittle and incoherent gluten with dark gray colour).

CONCLUSIONS

On the basis of the results obtained during these investigations, the following can be concluded:

– Molds are frequent contaminants of the wheat kernel and bread, which sometimes have the ability to produce mycotoxins.

– The attack of the field molds, especially Fusariums and representatives of the genus *Alternaria*, decrease the total quality of the wheat kernel, which more or less depends on the share of the contaminated kernels and the degree of their infection.

– The field molds with their philaments decompose the wheat kernel and with this they decrease or lead to unusage of the biological and processing quality and the hygienic conditions.

– The molds and their methabolits-mycotoxins in the kernel, flour as well as in the bread and baked goods, can not be seen and felt, but they settle with years in the human organism and in a corresponding moment (immunity decrease) they can influence the appearance of difficult diseases.

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