

Diminution Effect on Mycotoxin Content by Different Processing Methods in Barley and Wheat Infected with *Fusarium graminearum*

Oh-Kyung Kwon*, Su-Myeong Hong¹, Dal-soon Choi¹, Jeom-Sig Lee, You-Chun Song, Un-Goo Ha and S.J. Yang

Yeongnam Agricultural Research Institute, NICS, RDA, Milyang 627-803, Korea <http://www.rda.go.kr>

* Corresponding author (Fax : +82-55-352-3059, <mailto:okkwon@rda.go.kr>)¹ NIAST, RDA, Suwon 441-707, Korea

Abstract

The objective of this study is to analyze mycotoxins contents in cereals infected with *Fusarium graminearum* and consider the reduction of mycotoxin contents by different processing methods in cereals. The result of quantitative analysis showed major contaminants were Deoxynivalenol(DON), Nivalenol(NIV), and Zearalenone(ZEA) and the level of NIV concentration was high in comparison with that of the other mycotoxins. The mycotoxin contents in hulled barley were more than those in naked barley. Total concentration range of mycotoxins detected in marketing barley was 0.284–0.593 ppm and this level was below US/EPA guidelines. Effect of different processing methods on the reduction in mycotoxin contents in barleys indicated water-washed treatment, barley tea process, and alcohol fermentation reduced concentration by 67%, 72.5% and 100%, respectively. The ferment waste produced from alcohol fermentation indicated a low concentration of mycotoxins because of fermentation activity and a decomposition ratio of major mycotoxins in waste showed the order of DON>NIV>ZEA. The residue levels of mycotoxins in boiled barley after washing treatment were unwashed barley 0.347ppm, 1st washing 0.152ppm, 2nd washing 0.066ppm, and boiled barley 0.060ppm. In case of wheat, changes of mycotoxin content showed the reducing effect of tempering(0% water) was the greatest of the three processing methods tested.

Media summary

The analysis of mycotoxins contents by different processing method in cereals infected with *Fusarium graminearum* will show the diminution effect and provide the safety evaluation.

Key Words

Fusarium mycotoxins, Quantitative analysis, Cereals, Diminution effect, Different processing method

Introduction

Mycotoxins deoxynivalenol, nivalenol, and zearalenone are groups of secondary metabolites produced by *Fusarium* species which induce mycotoxicosis of humans and animals (Desjardins et al 1989; Ichinoe et al 1983; Kim et al 1993). Since the mycotoxins are accumulated in cereals infected with *Fusarium graminearum*, they have high possibility to affect the crop quality and human safety (Jelinek et al 1989; Luo 1988). The objective of this study is to compare the concentration levels of major mycotoxins and evaluate the reducing effect on mycotoxin contents in cereals of different processing methods. We also considered the relation of mycotoxin content and milled grade of grain.

Methods

Sampling and pretreatment

A comparative study on the concentration levels of mycotoxins was done with 100 barley, 10 wheat samples collected from 4 provinces in Korea. The ground samples were shaken for 1hr with CH₃CN/H₂O and the filtrates were partitioned with organic solvents after filtering. The evaporated EtOAc layer, which was solved with MeOH was applied to florisil column chromatograph for purification.

Instrument condition for analysis of *Fusarium* mycotoxins

Detection of DON and NIV was carried out by HRGC/MS method after derivatization with TMS. Concentrations of DON and NIV were determined by HRGC with a DB-5 column (J&W Scientific, US), connected to a HRMS (TSQ7000, Finnigan MAT, US) operation on a resolution of 10,000 using a positive electron ionization source and operating in the selected ion monitoring (SIM) mode. The ionization energy was 70eV and the temperature of ion source and injector was 185 and 280°C. In case of ZEA analysis, the concentration was determined by HPLC (1046A, Hewlett Packard, US) with a RP18 column of 5 μ m, 4.6mm(ID) x 150mm(L). The condition of fluorescence detector indicated the wave length of excitation and emission was 236 and 418nm respectively. Mobile phase was CH₃CN/H₂O(50/50,v/v) and flow rate was 0.8ml/min.

Results

Table 1. Changes of mycotoxin contents in hulled barley by different milling rates

Disease severity (%)	Milling rate (%)	Mycotoxin content (ppm)			
		Total	DON	NIV	ZEA
Normal	100	0.324	0.041	0.293	ND
	59	ND	ND	ND	ND
	50	ND	ND	ND	ND
10	100	2.581	0.187	2.347	0.047
	59	0.628	0.030	0.586	0.012
	50	0.178	ND	0.165	0.013
30	100	8.600	0.452	8.125	0.023
	67	1.039	0.036	0.992	0.011
	59	0.923	0.022	0.890	0.011
	50	0.563	ND	0.563	ND
50	100	16.320	0.897	15.333	0.090
	59	3.372	0.099	3.259	0.014
	50	2.548	0.083	2.435	0.030

Table 2. Changes of mycotoxin contents in naked barley by different milling rate

Disease Severity (%)	Milling rate (%)	Mycotoxin content (ppm)			
		Total	DON	NIV	ZEA
Normal	100	0.286	0.060	0.226	ND
	68	ND	ND	ND	ND

	60	ND	ND	ND	ND
10	100	2.025	0.094	1.931	ND
	68	0.428	ND	0.428	ND
	60	ND	ND	ND	ND
30	100	2.331	0.125	2.193	0.013
	75	0.763	0.031	0.732	ND
	68	0.406	ND	0.406	ND
	60	0.327	ND	0.327	ND
50	100	4.932	0.188	4.723	0.021
	68	0.690	0.026	0.664	ND
	60	0.281	ND	0.281	ND

Table 3. Effect of water-washed treatment on the diminution of mycotoxin contents in hulled barley

Grade	NIV (ppm)		Total (ppm)	
	Barley	Water-washed barley (%)	Barley	Water-Washed barley (%)
First	0.547	0.105(19)	0.583	0.105(18)
	1.130	0.431(38)	1.163	0.446(38)
	0.276	0.084(30)	0.288	0.084(29)
Second	0.521	0.208(40)	0.569	0.239(42)
	0.321	0.089(28)	0.321	0.089(28)
Offgrade	0.865	0.282(33)	0.961	0.294(32)
Average	0.610	0.200(33)	0.640	0.210(33)
Range	0.276~1.130	0.084~0.431	0.288~1.163	0.084~0.446

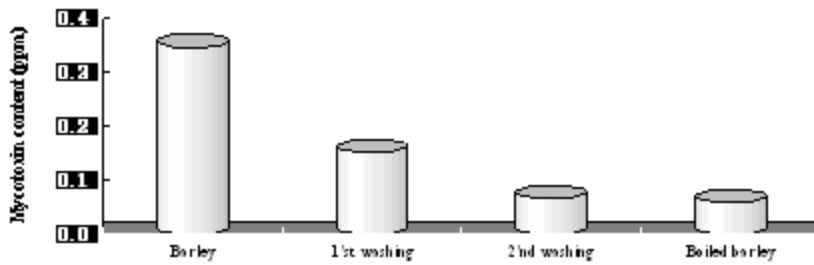


Fig. 1. Mycotoxin residues in boiled barley after water washing treatment

Table 4. Changes of mycotoxin contents in wheat by different processing method

Processing method	Part	Mycotoxin content(ppm)			
		Total	DON	NIV	ZEA
Raw-material	Wheat	0.751	0.181	0.570	ND
Tempering (water 14%)	Flour	0.202	0.064	0.138	ND
	Inner Bran	0.505	0.129	0.376	ND
	Outer Bran	0.509	0.130	0.379	ND
Tempering (water 0%)	Flour	0.117	0.033	0.084	ND
	Inner Bran	0.464	0.110	0.354	ND
	Outer Bran	0.557	0.169	0.388	ND
Korea type	Flour	0.185	0.041	0.144	ND
	Bran	0.477	0.116	0.361	ND

Conclusion

1. The tendency of mycotoxin content in cereals

- The kind of mycotoxin : NIV>DON> ZEA
- Barley variety : hulled Barley > naked barley
- Different polishing rate of diseased barley (50%)
 - hulled barley (50% polishing) : 16.320→2.548ppm
 - naked barley (60% polishing) : 4.932 → 0.281ppm
- wheat part : Outer bran > Inner bran > Flour
- Processing method of wheat flour : Tempering > Korean wheat > Free water

2. Effect of different processing method on the diminution of mycotoxin contents in cereals

- Mycotoxin residues in boiled barley after water washing:
0.347→0.066→0.060ppm
- Water-washed treatment of barley : 0.640 → 0.210ppm

- Alcohol fermentation of barley : 16.32ppm → ND

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