Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2001
Volume 4
Issue 1
Series
FOOD SCIENCE AND TECHNOLOGY

OBUCHOWSKI W., STRYBE K. 2001. THE EFFECT OF GRAIN CLEANING AND MILLING IN SOME POLISH MILLS ON THE LEVEL OF GRAIN AND FLOUR MICROBIAL CONTAMINATION **Electronic Journal of Polish Agricultural Universities**, Food Science and Technology, Volume 4, Issue 1.
Available Online http://www.ejpau.media.pl

THE EFFECT OF GRAIN CLEANING AND MILLING IN SOME POLISH MILLS ON THE LEVEL OF GRAIN AND FLOUR MICROBIAL CONTAMINATION

Wiktor Obuchowski, Karolina Strybe
Cereal Science and Technology Department, August Cieszkowski Agricultural University of Poznań, Poland

ABSTRACT

The effect of wheat grain preparing to milling, and milling process on grain and flour bacteria, mould and yeast number was evaluated. It was found, that however grain preparing to milling mostly reduce total microbiological contamination, tempering of grain increase number of yeast and mould spores on surface of kernels. It influences the number of such microorganisms in the patent flour.

Key words: grain and flour microbial contamination, moulds, yeast, effect of grain processing, milling, tempering, cleaning

INTRODUCTION

Poland, and many other countries of north and central Europe have not useful climatic conditions for growing durum wheat, which is especially good raw material for pasta production. We assume, that in our Country about 50 % of pasta is made only from flour obtained from domestic vulgare wheat cultivars (*Triticum Aestivum, ssp. vulgare*), or as a mixture in various proportions of vulgare wheat flour with durum semolina [5, 6].

Our climatic conditions of wheat growing are favourable to microbial contamination, located mostly on the surface of grain [14]. There are information's from other European countries, that in some conditions of grain growing, harvesting, storing and milling the bacteria count on semolina can exceed 1 million/g, although mostly is on the level up to 20000- 60000/g [1,8]. Dangerous to pasta quality are also moulds and yeast spores. Admissible is the level less than 1000/g.

According to Pasta Professional [13], if when setting the mixing machine in motion there were a total microbial content of 200.000 CMU per gram of semolina, eggs and water, at the out feed of the forming machine there will be 800000/g, and, after another 15-20 minutes of processing can reach 2-2.5 mln spores per gram of dough. It's obvious, that this level is a function of initial raw material contamination [3,4,5].

It should noted, that pasta from domestic vulgare wheat is mostly produced in small factories, equipped in standard machinery, according to the technology requiring long time of pasta drying in medium temperatures and high moisture of air [6,7]. There is no possibility to pasteurizing the pasta dough. This circumstances gives the excellent possibility to intensive proliferation the microbial population and enzymatic reactions, which deteriorate the quality and nutritional value of pasta. The step of such reactions depends mostly of microbial population and enzymatic activity of flour used to pasta production.

There are two main ways decreasing the flour contamination [4]:

- Decreasing the level of grain contamination used to milling, and
- Improving the technology of flour milling

Actually, the only way to reduce microbial contamination, used to in practice, is dry cleaning the surface of grain and production of flour extracted from middle of endosperm with ash content as low as possible, usually not exceeding 0.45% [2, 4]. Probably it is not enough to be sure, the product is without faults, because still a great amount of grain contaminants goes to flour.

The purpose of this study was to describe the microbial contamination of wheat grain coming to mills located in different regions of Poland, and evaluate the possibility to decrease such contamination on the basis of grain cleaning and tempering prior to first break. The aim of this work was also to evaluate the effect of initial level of grain microbial contamination and milling process on bacteria count in two classes of flour, mostly purposed for pasta production.

MATERIAL

Samples of commercial shipments of common wheat grain arriving to 9 randomized mills located in different regions of Poland. The samples of the same grain but after cleaning process, and sometimes tempering process used to in particular mill was next evaluated. To find the effect of milling process and grain microbial contamination on the number of microorganisms in the flour, the samples of first grade coarse and fine flours with ash content not exceeding 0.5%, obtained from above mentioned wheat grain were then evaluated. The grain was from the harvest 1999, and used to experiments in July and August 2000.

METHODS

Basic technological characteristics of wheat grain (grain vitreosity, 1000 kernel weight, hectoliter weight, moisture content) were evaluated according to Polish Official PN methods described by [11,12].

Total number of bacteria, mould and yeast spores and aerobic bacteria *Bacillus mesentericus* as well were evaluated, according to Polish Approved PN–ISO-4833 and PN-ISO-7954 methods [9,10]. The tests were done with the microbial kits made of 3M Company, consisting:

- Petriphilm ACP to evaluation of total number of microorganisms, and
- Petriphilm Yeast and Mould Count Plates.

The time and temperature for bacteria incubation were 48-72 hours and 30^{o}C, for yeast and mould 3-5 days at 20-25^{o}C. Microbial tests were triplicated. Results of microbial examination were statistically evaluated.

RESULTS AND DISCUSSION

General characteristic of evaluated samples (Table 1) proves, that wheat grain coming to polish mills is good technological quality: with 1000 kernels weight between 35.9 and 45.6g; hectoliter weight between 76.0 and 82.1 kg, moisture content not exceeding 14.4%, but mostly low percentage of vitreous kernels. Grain cleaning and tempering in all mills increased 1000 kernel weight scores (effect of small impurities and kernels separating), and influenced on decreasing hectoliter weight and percent of vitreous kernels characteristics, mostly due to grain moistening and tempering.

Table 1. Basic characteristics of wheat grain processed in the mills chosen to experiments

Sample origin and characteristic	Moisture content [%]	1000 kernel weight [g]	Hectoliter weight [%]	Vitreosity [%]
Mill I from Central part of Poland:				
Grain from storage Grain after cleaning	13.4 15.6	35.9 39.2	79.3 76.6	21 11
Mill II from Central part of Poland:				
Grain from storage Grain after cleaning	14.0 16.1	37.2 38.5	79.5 76.0	15 9

Mill from West of Poland:				
Grain from storage Grain after cleaning	13.9 16.0	44.3 45.6	82.1 79.7	14 13
Mill I from North of Poland :				
Grain from storage Grain after cleaning	13.3 15.4	37.8 41.4	78.7 77.0	44 18
Mill II from North of Poland:				
Grain from storage Grain after cleaning	13.2 16.1	41.6 43.3	80.9 77.8	26 14
Mill from South of Poland:				
Grain from storage Grain after cleaning	14.4 15.6	40.8 40.4	76.0 74.0	7 5
Mill from South-west of Poland:				
Grain from storage Grain after cleaning	14.0 15.9	39.5 41.8	76.8 74.5	21 4
Mill from South-east of Poland:				
Grain from storage Grain after cleaning	14.2 15.1	45.6 45.6	78.0 77.0	- -

The experiments confirmed, that surface of grain coming to domestic mills is reach in microbial contamination, consisting bacteria, mould and yeast spores. The level of bacteria count was different in various mills (Table 2). The highest – up to 4mln/g was in some mills located in central and south regions of Poland, average was about 1.900.000/g (Table 4). The number of mould and yeast spores in all shipments was similar – on the level 4000/g. The highest yeast number – up to 7300/g was on the grain from north parts of Poland.

Table 2. The effect of wheat grain preparing to milling on its microbial contamination

Sample characteristic	Total bacteria count [CMU/g]	Mould spores count [CMU/g]	Yeast spores count [CMU/g]
Mill I from Central part of Poland:			
Grain from storage	9.2×105	1.1×103	9.2×102
Grain after cleaning	7.8×105	9.4×102	1.8×102
Mill II from Central part of Poland:			
Grain from storage	4.6×105	1.4×102	3.8×102
Grain after cleaning	5.6×105	1.0×103	3.4×103
Mill I from North of Poland:			
Grain from storage	2.3×106	5.3×102	1.9×103
Grain after cleaning	5.8×105	4.6×102	2.5×103

Mill from West of Poland:			
Grain from storage	2.2×106	7.7×102	3.6×103
Grain after cleaning	2.5×106	2.7×103	4.0×103
Mill III from Central part of Poland:			
Grain from storage	4.0×106	5.6×102	1.3×103
Grain after cleaning	9.1×105	6.0×102	2.0×103
Mill II from North of Poland:			
Grain from storage	9.0×105	1.8×103	7.3×103
Grain after cleaning	1.0×106	1.4×103	7.3×103
Mill from South of Poland:			
Grain from storage	3.9×106	8.7×102	2.1×102
Grain after cleaning	1.7×106	9.1×103	1.6×103
Mill from South-west of Poland:			
Grain from storage	7.0×105	8.7×102	1.3×103
Grain after cleaning	4.6×105	1.9×103	1.9×103
Mill from South-east of Poland:			
Grain from storage	1.0×106	1.5×103	8.6×102
Grain after cleaning	1.0×106	5.0×102	2.4×103
Results of Analysis of Variance			
Source of Variation	DF	F	F	F
Mill location	8	14.471**	12.983**	8.709**
Grain treatment	1	20.286**	10.038**	8.924**
Interactions	8	4.209**	5.831**	2.709*
Total	53			

****significant at p=0.01**
***significant at p=0.05**

Removing from the grain shipments the foreign material, then scouring the surface of the grain and tempering with different time given for the water to penetrate the grain, reduce the total number of microorganisms in statistically significant level (p=0.01), but level of mould and yeast spores during such processing in most cases (five mills by nine) significantly increased (Table 2 and 4). In few mills, where tempering was not prolonged, and grain moisture not too high, total number microorganisms as well as mould and yeast colonies was on the same level or little decreased. Nevertheless generally, after cleaning and tempering process the number of mould and yeast spores on the surface of wheat grain increased

(Table 4 and 5). Probably in that mills the time of grain tempering was much longer, and other circumstances more favourable to microbial proliferation, especially for moulds and yeast spores (temperature, moisture and time) [4].

Table 3. The comparison of microbial contamination on various steps of flour milling

Sample characteristic	Total bacteria count [CMU/g]	Mould count [CMU/g]	Yeast count [CMU/g]
Mill I from Central part of Poland :			
Grain coming to first break	7.8×105	9.4×102	1.8×102
Fine patent flour	1.5×104	6.9×102	1.1×103
Coarse patent flour	9.7×103	2.0×102	1.5×103
Mill II from Central part of Poland:			
Grain coming to first break	5.6×105	1.0×103	3.4×103
Fine patent flour	1.6×104	1.4×103	7.1×102
Coarse patent flour	1.5×103	1.3×102	4.0×102
Mill from West of Poland:			
Grain coming to first break	2.5x106	2.7x103	4.0x103
Patent flour	3.7x104	5.1x102	5.0x102
Mill I from North of Poland:			
Grain coming to first break	5.8×105	4.6×102	2.5×103
Patent flour	7.3×103	1.5×102	1.0×102
Mill II from North of Poland:			
Grain coming to first break	1.0×106	1.4×103	7.3×103
Patent flour	4.3×105	2.9×102	3.2×102
Mill from South of Poland:			
Grain coming to first break	1.7×106	9.1×103	1.6×103
Patent flour	7.7×105	2.3×102	9.5×102
Mill from South-west of Poland:			
Grain coming to first break	4.6x105	1.9x103	1.9x103

Patent flour		3.6x104	7.6x102	3.2x102
Mill from South-east of Poland:				
Grain coming to first break		1.0×106	5.0×102	2.4×103
Patent flour		8.7×104	4.3×102	2.6×102
Results of Analysis of Variance				
Source of Variation:	DF	F	F	F
Mill location	8	32.769**	8.667**	4.306*
Flour milling technology	1	715.211**	79.011**	114.774**
Interactions	8	18.165**	10.026**	8.669**
Total	53			

****significant at p=0.01**
***significant at p=0.05**

Table 4. Microbial average contamination of grain and patent flour for characterized mills

Material	Total microbial contamination [CMU/g]	Mould spores number [CMU/g]	Yeast number [CMU/g]
Grain from storage	1.9×10^6	2.1×10^3	1.7×10^3
Grain after cleaning	1.2×10^6	2.7×10^3	2.5×10^3
First grade (patent) flour	1.6×10^5	4.7×10^2	5.3×10^2

Table 5. The effect of technological operations on the level of reduction or increasing of microbial contamination in the grain and flour (average for 9 mills).

Material/Process	Percent of total microbial contamination:	Percent of mould spores number:	Percent of yeast number:
Cleaning and tempering the grain	↓30% (reduction)	↑36% (increasing)	↑69% (increasing)
First grade (patent) flour	↓90% (reduction)	↓47% (reduction)	↓84% (reduction)

In comparison to grain, the flour microbial contamination was definitely lower and, with one exemption, count between 20-50 thousand spores per gram. The number of mould spores, with one exemption, not exceed 800 per gram, but yeast 1500 per gram. Total bacteria number decreased in compare to grain 10 to 100 times, mould and yeast by 47% and 84% respectively. It proves, that microbial contamination mainly appear on the surface of kernels and endosperm of healthy grain is free of microorganisms. Generally microbial contamination of average patent flour from polish mills is relatively low, but in some cases number of yeast and mould spores can be higher than admissible [1,8].

The comparison of flour obtained from the same grain and with the same ash content 0.45%, but different particle size showed, that coarse flour has microbiologically less contamination in compare to flour consisting fine particles (Table 3). Probably the differences results from the more easy possibilities secondary contamination of fine ground flour during milling process, because of its much higher relative surface area in compare to the weight [8].

CONCLUSIONS

The results showed, that wheat grain ground in polish mills is generally good quality and low microbial contamination. Technology of grain preparing used to in most mills (cleaning and purifying) reduce its microbial contamination, but in some circumstances tempering of grain can increase total bacteria count, and especially mould and yeast on its surface above admissible level for pasta production.

The patent flour with low ash content, is many times more clean in compare to milled grain but depends on initial grain contamination. Coarse flour is relatively less infested in compare to flour with small particle size. Nevertheless of relatively low flour contamination in compare to literature information [1,4] it couldn't be ignored, especially in the case, if the flour is used to pasta production in small factories, without possibilities of dough pasteurizing.

REFERENCES

1. Duchi G., 1995. New trends in durum wheat grinding. Golfetto, 1-23, Padova.
2. Hoseney R.C., 1986. Principles of Cereal Science and Technology. AACC St. Paul, Minn., 327.
3. Lazzari F. A., Pereira P.R.V.S, 18-22.05.1997. Fungi in Wheat Stored in Southern Brazil. Proceedings Intern. Wheat Quality Conf. Manhattan, Kansas, 478.
4. Miszustin E.N., Triswiataskij L.A., 1960. Microbiology of grain and flour. Moskwa. [in Russian]
5. Obuchowski W., 1997. Technology of pasta manufacturing. Agr. Univ. Poznań, Poland, 84. [in Polish]
6. Obuchowski W., 1997. Microbial contamination of flour for pasta production: influence on pasta quality and ways of its improving. Przegl. Zboż.-Młyn., 10, 42-43.[in Polish]
7. Obuchowski W., Strybe K., May 2000. The technology of vulgare wheat preparation to be more useful as an ingredient for pasta products. Food Ingredients Central and Eastern Europe. Conference abstracts, 22-23, Warsaw, Poland, 9-11.
8. Poisson J., Guibot, 1957. Microflora des farines francaises. Annales de technologie, 1.
9. Polska Norma PN-ISO-4833., 1998. Microbiology. General guidance for the enumeration of micro-organisms-colony count technique at 30^{o}C.
10. Polska Norma PN-ISO-7954., 1999. Microbiology. General guidance for enumeration of yeasts and moulds-colony count technique at 25^{o}C.
11. Polska Norma PN-ISO 7971-2, 1988. Determination of bulk density, called "mass per hectolitre".
12. PN –70/R-74008 and PN-68/R-74017
13. Production Process and Microbiological Risk. Technological Outline and Control Over Critical Points. Professional Pasta. 24-31, 11, 2000.
14. Stawicki S., 1968. Exterior and interior contamination of wheat grain as a factor of its quality and shelf-life. Roczniki WSR, Poznań. [in Polish]

Submited:

Wiktor Obuchowski, Karolina Strybe
Cereal Science and Technology Department
A. Cieszkowski Agricultural University of Poznań
31 Wojska Polskiego, 60-624 Poznań, Poland