UK FLOUR MILLERS BRIEFING DOCUMENT

Microbiological condition of white flours

Revised November 2019

Summary

The microbiological condition of flour is a reflection of the wheat from which it was milled. As wheat is naturally exposed to a wide variety of potential contaminants, a diverse microbial population is to be expected. Weather conditions at time of harvest, as well as transport and storage conditions, also have a part to play.

Under the Food Safety Act (1990) there is a general duty of care for producers to ensure that food and food ingredients are safe. Purchasers of food ingredients seek quality assurances from suppliers and the results from the annual microbiological flour survey carried out by Campden BRI are useful to millers and their customers when discussing microbiological specifications for flours.

This briefing document gives a background on factors influencing the microbiological condition of flour, a brief description of the effects of individual microbes and an outline of the impacts for the milling industry. The survey results since 2005 are presented along with a brief commentary on the 2019 results.

Background

The microflora of flour is normally considered to reflect that of the wheat from which it was milled. Wheat growing in the field is naturally exposed to a wide variety of potential contamination sources (soil, water, animals and birds) and it also carries its own population of microbes which grow naturally in association with plants; therefore a diverse microbial population is to be expected. Further opportunities for microbiological contamination of wheat occur during handling on farm where machinery may contaminate by machinery tyres transferring soil material from floors to grain heaps. Similarly, conditions in grain stores and during transport may also make a contribution.

Flour itself tends to be of better microbiological quality than the wheat from which it was derived. This is because the microorganisms associated with wheat grains reside on the outer bran layers.

The microbiological condition of flour is generally worse in years where the weather was wet before, and during, harvest than in dry years.

Significance to the milling industry

There are no legislative levels for microorganisms in flour. However, under the Food Safety Act (1990) there is a general duty of care for producers to ensure that food and food ingredients are safe.

Purchasers of food ingredients seek assurances from suppliers to protect commercial positions and to enable a ‘due diligence’ defence in the event of a prosecution arising under the Food Safety Act (1990). Therefore, the results from the annual microbiological flour survey carried out by Campden

BRI are useful to millers and their customers when discussing microbiological specifications for flours.

Microbiological Condition of White Flours survey

An annual survey of the microbiological condition of white flours has been carried out for **UK Flour Millers** by Campden BRI, and its predecessors, since 1971. Results are sent to **UK Flour Millers** members each year. Approximately 60 white flour samples sent by **UK Flour Millers** members' mills, chosen to provide representation from all parts of the UK, are tested each year.

Results of the annual microbiological survey since 2006 are given below. The full reports are available from **UK Flour Millers** (contact JoeBrennan@UK Flour Millers.org.uk), or visit the Member Resource Library on the **UK Flour Millers** website (http://www.UK Flour Millers.org.uk/resource-library/list/flour-tech).

Selection of individual microbes

The microorganisms selected for analysis in the survey are those considered of greatest importance to millers, bakers and food processors working with flour. A description of the significance of each group of microorganism to the quality or food safety of the flour is listed below:

Total aerobic bacteria: The count of aerobic bacteria present gives an indication of the overall condition of the flour. High counts suggest poor hygiene or storage at some point in the production chain between the crop in the field and testing of the finished flour and there is considerable annual variation.

Moulds and yeasts: The mould and yeast count adds more information about the overall microbiological condition of the samples. High counts can suggest inappropriate conditioning for storage of the grain.

Lactic acid bacteria: Lactic acid bacteria are well known as the starter organisms for cheese, yoghurt and a number of other fermented food products. In flour they are more important for their potential as spoilage organisms, particularly in moist, unheated products (e.g. chilled pastry) where they can cause souring.

Presumptive coliforms and Escherichia coli: *E coli* is the most important member of the coliform group as an indicator of poor hygienic condition of flour. These microorganisms can originate from faecal contamination of grain from birds, rodents, etc.

Suphite-reducing clostridia: These spore-forming, anaerobic bacteria which are naturally present in soil are able to spoil heat-processed foods (e.g. canned products, soups, stews, gravy). They are important to the miller if flour-based materials are used to thicken foods.

Presumptive *Bacillus cereus:* This bacterium is commonly found in soil and natural environments. It has the potential to cause food poisoning and produces heat-resistant spores.

Listeria species: Of the 8 species in the genus *Listeria,* only *L. monocytogenes* is recognised as a human pathogen. It causes a range of symptoms and has a high mortality rate associated with it. *Listeria* species are widely distributed in nature and baking processes are more than adequate to destroy them.

Salmonella species: Another important member of the coliform group. This pathogen originates from the guts of birds and animals. Its presence in flour suggests faecal contamination of grain.

Aerobic mesophilic spores: This is a general name for the heat-resistant resting bodies produced by *Bacillus* species. High counts (>100 cfu/g) suggest to bakers that the flour has a high "rope" potential.

Table 1. Percentage of samples that tested positive

Test for:	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aerobic total viable (=bacteria)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mould	98	98	86	98	92	100	100	100	98	100	84	100	98	100
Yeast	92	83	36	90	98	89	47	82	90	75	42	65	15	3
Mould & yeasts	100	100	86	100	100	100	100	100	100	100	100	100	100	100
Lactic acid bacteria	95	37	69	82	60	67	81	100	65	68	15	63	42	20
Presumptive coliforms (MPN)	67	88	82	83	90	52	93	85	90	87	78	85	53	*
Presumptive coliforms (Plate)	*	100	*	100	85	97	100	98	82	100	100	100	98	98
Presumptive *Escherichia coli* (MPN)	20	18	28	20	5	6	39	18	28	17	16	25	12	*
Presumptive *Escherichia coli* (Plate)	*	0	*	0	0	0	5	0	2	3	6	5	0	3
Sulphite reducing clostridia	50	60	47	17	23	19	44	23	47	28	27	30	38	28
Presumptive *Bacillus cereus*	0	0	0	0	0	15	2	5	10	7	18	15	18	43
***Listeria* spp (count)**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
***Listeria* spp (presence in 25g)**	8	13	0	8	5	2	22	18	17	7	11	5	8	0
***Salmonella* spp (presence in 25g)**	0	3.3	0	0	0	0	0	0	0	0	0	0	0	0
Mesophilic aerobic spores	50	75	72	67	68	85	61	74	78	47	86	62	28	16

* = not tested

Table 2. Mean observed count

	Mean Observed Count (/g)													
Test for:	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Aerobic total viable count (=bacteria)	39,578	122,021	53,500	46,190	52,947	229,666	112,617	26,287	50,268	60,906	21,313	61,568	7,749	24,813
Mould count	947	921	1,920	2,045	377,244	870	3,469	2,416	1,724	1,069	917	1,975	1,933	3,620
Yeast count	1,573	19,040	330	149	22,800	1,516	20,136	178	234	294	87.7	81.7	79	8.3
Moulds & yeasts	2,516	19,961	2250	2,194	399,978	2,414	24,002	2,610	1,958	1,360	1,004	2,117	2,012	3,628
Lactic acid bacteria	1341	26	234	488	1,218	3,537	546	898	260	48	2.85	50.7	58.7	28.5
Presumptive coliforms	3.8	561	394	11	922	30,178	386	184	375	6,421	5,670	8,437	1,860	12,500
Presumptive *Escherichia coli*	1.3	0.3	3.0	0.8	<0.1	<0.3	188	<0.3	0.6	0.4	0.7	2.4	0.11	0.43
Sulphite reducing clostridia	11	9	6.8	2.9	4.1	5.6	7.7	1.7	7.8	2.5	2.29	2.9	5.78	3.2
Presumptive *Bacillus cereus*	<50	<50	<50	<50	<50	43	1.3	2.9	11.1	2.3	3.8	3.1	9	24.5
***Listeria* spp (count)**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
***Listeria* spp (presence in 25g)**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
***Salmonella* spp (presence in 25g)**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mesophilic aerobic spores	18	82	25	16	36	59	28	14	308	260	387	10	19	8.2

2019 Results

The 2018 microbial levels were some of the lowest seen throughout the survey, owing to the exceptionally dry conditions of summer 2018 and during harvest. Despite 2019 being a wetter year, there are few significant differences in the levels of microbes between the 2019 and 2018 harvests.

The levels of total aerobic bacteria were higher in 2019 than in 2018 and presumptive *E.coli* was found in 3% of samples compared to 0% in 2018, indicating a lower level of hygienic quality. A similar number of samples tested positive for mesophilic aerobic spores and the average spore count was similar, which indicates that the rope potential of 2019 flour is similar to that of 2018. No samples tested positive for *Listeria* or *Salmonella* species.

The 2019 survey did not include MPN tests for presumptive coliforms or *E.coli*, only plate tests were used.

Future actions

In 2012, Campden BRI produced a report (commissioned by **UK Flour Millers**) that made a 'horizon scan' to identify microbiological issues which may become significant in the future. This study examined surveys, incidents and outbreaks relating to bacterial contamination of flour and related products. It concluded that the best forms of overall control are good agricultural and food manufacturing practices to prevent the contamination of flour. There do not appear to be significant emerging issues but the report highlighted the best forms of bacterial control come from the cooking processes or the heat treatment of basic flours. **UK Flour Millers** will continue to monitor and report on the levels of bacteria in flour annually, as well as monitor any contamination events linked to bacteria, both domestic and international.

Appendix 1. Trends in flour microbiology 1973-2019