



# VALUE ADDED WHEAT CRC FINAL REPORT

**Project 2.1.7 - Microbiological safety and stability of noodles –  
breadcrumbs and steamed breads made from Australian flour**

## **Studies on the microbiological safety of breadcrumb products – Part 3**

**Yang Huang<sup>1</sup>, Ailsa Hocking<sup>1</sup>, Nancy Jensen<sup>1</sup>, Di Miskelly<sup>2</sup>**

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and steamed breads made from Australian flour**

## **Part 3**

### **Studies on the microbiological safety of breadcrumb products**

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## EXECUTIVE SUMMARY

Breadcrumbs are usually made from bread returns, so there is a potential risk that mouldy bread could be included with the bread used for the crumbing process. There is, therefore a potential risk of mycotoxin contamination of the process. There are no data concerning the presence of moulds or mycotoxins in bread returns in Australia, so this project was initiated to provide such data.

A survey was conducted of four breadcrumb manufacturers in New South Wales, Victoria, Queensland and Western Australia. Samples were obtained over four consecutive weeks and then at monthly intervals, and were tested for standard plate count, rope spores, yeasts, moulds, pH, and water activity ( $a_w$ ). In addition, the relationship between the moisture content and water activity of breadcrumbs was determined at 22°C.

The results showed that most of the **dried** breadcrumb products had standard plate counts and yeast and mould counts below their detection limits of 10 and 100 colony forming units (cfu)/g, respectively. Both categories for the **wet** samples ranged from  $10^3$ – $10^5$  cfu/g. One potentially toxigenic fungal species, *Penicillium crustosum*, was detected in one batch of wet crumb. This was the only sample containing bread returns beyond their use by date.

The counts for rope-producing spores for all samples were < 10 cfu/g. The samples ranged between pH 5.2 and 5.7.

The **wet** samples were around  $a_w$  0.96, while the **dry** samples ranged from  $a_w$  0.26-0.64. Most of these samples were  $a_w \leq 0.4$ , however five samples were  $a_w > 0.60$ , and three were  $a_w$  0.55-0.60. The (slow) growth of xerophilic moulds can occur at  $a_w \geq 0.61$ , so it is important that products are dried to well below  $a_w$  0.60 to avoid this risk, and have a large enough safety margin to prevent growth if the moisture content increases during the shelf life of the product.

The moisture sorption isotherm determined during the project showed  $a_w$  0.6 is associated with moisture contents of around 12%. Therefore drying breadcrumbs to  $\leq 10\%$  should provide an adequate safety margin to prevent the growth of moulds.

The report makes the following recommendations:

- **Only bread returns within their use-by date should be used for breadcrumb manufacture, and**
- **The maximum moisture content for dried breadcrumbs should not exceed 10%.**

## **1. INTRODUCTION**

Different types of moulds have been isolated from bread in Australia, including *Aspergillus*, *Penicillium*, and *Fusarium* spp. If conditions are suitable, these organisms can produce mycotoxins that may be toxic to humans (Appendix 1). Breadcrumbs are usually made from bread returns, so there is the potential for mouldy bread to enter the process, as sorting procedures may not always be rigorous. Thus the possibility of mycotoxin contamination exists. The heating process for breadcrumb manufacture is 69-72°C for 7-8 mins, which is unlikely to inactivate mycotoxins since most mycotoxins are heat stable (Appendix 2). There are no data on the presence of moulds or mycotoxins in bread returns in Australia, or on the effects of the breadcrumb processes (crumbing and baking) on pre-formed mycotoxins.

This project commenced in March 2002 with a survey of the microbiological status of bread returns and dried breadcrumbs in four Australian plants. Based on the results of the survey, a literature review was conducted to consolidate published information on the heat stability of the mycotoxins likely to present in these products.

## **2. PROJECT AIMS**

1. To evaluate the microbiological status of breadcrumb manufacture in Australia
2. To evaluate the potential for mycotoxin contamination of breadcrumb
3. To report on the heat-stability of pre-formed mycotoxins.

## **3. MATERIALS AND METHODS**

### **3.1 Samples**

Samples were obtained from four factories in the Goodman Fielder Milling and Baking Group, notably Moorebank (New South Wales), Malaga (Western Australia), Clayton (Victoria), and Burleigh Heads (Queensland). Samples of their wet and dried breadcrumb products were provided every week for the first month, and then every month for three months. There were two types of breadcrumb products sampled: one was 100% white crumb and the other was a blend of around 60% white and 40% wholemeal crumb.

Samples were transported to Food Science Australia at North Ryde, within 24 h of sampling. Samples were tested immediately after receipt, or sealed and stored at 1°C and tested within 24 h.

## **3.2 Media**

All microbiological media were purchased from Oxoid Australia Pty Ltd.

## **3.3 Methods**

### **3.3.1 Sample preparation**

An initial dilution was prepared from each sample using 25 g sample and approximately 225 mL 0.1% peptone solution. The initial dilution was homogenised by stomaching for 60 s. Serial tenfold dilutions were then prepared using the peptone solution.

### **3.3.2 Standard plate count**

In accordance with Australian Standard 1766.2.1 (Standards Australia 1991), homogenates and dilutions of samples were plated onto plate count agar using the pour plate technique. Plates were incubated under aerobic conditions at 30°C for 72 h and all bacterial and fungal colonies counted. The number of colony forming units per gram of sample was calculated.

### **3.3.3 Yeast and mould count**

Homogenates and sample dilutions were plated onto dichloran rosebengal chloramphenicol (DRBC) agar and dichloran 18% glycerol (DG18) agar using the spread plate technique, as described in Australian Standard 1766.2.2 (Standards Australia 1997). Plates were incubated under aerobic conditions at 25°C for 5 days (DRBC) and 7 days (DG18). Colonies were counted and moulds identified to genus level, using methods described by Pitt and Hocking (1997). Presumptive yeast colonies were confirmed by microscopic examination. The number of colony forming units of yeasts and moulds per gram of sample was calculated.

### **3.3.4 Rope spore count**

As described by Stevenson and Segner (2001), 10 mL of the initial homogenate of each sample was transferred into a 250 mL flask containing 100 mL of molten (45°C) dextrose tryptone agar. The agar suspension was steamed at 95°C for 15 min, cooled to 45°C in a water bath and poured into 5 sterile plates. Plates were incubated under aerobic conditions at 37°C for 48 h. Subsurface colonies were pulled to the agar surface and incubated for a further 24 h. Colonies positive for 'stringiness' were examined for microscopic morphology. Those displaying macroscopic and microscopic morphology typical of rope-producing spore formers were counted. The number of colony forming units of rope spores per gram of sample was calculated.

### **3.3.5 Measurement of pH**

As described in an approved method of the American Association of Cereal Chemists (2000), 15 g of sample was weighed, and 100 mL of filtered water added. The solution was stirred for 30 min using a magnetic plate stirrer, followed by standing for 10 min. The pH of the supernatant was measured using a Sentron 1001 pH meter (Sentron Europe BV, Roden, The Netherlands).

### **3.3.6 Measurement of water activity**

Water activity measurements were made using an AquaLab CX-3 dew point instrument (Decagon Devices, Washington, USA) according to the manufacturer's instructions.

### **3.3.7 Measurement of desorption isotherm of breadcrumb**

Wonderwhite (Buttercup, Australia) sliced bread was purchased from a local supermarket. The slices (with crusts) were transferred into a blender for crumbing and were then dried at 30°C for 1–2 days. Crumb samples were collected in triplicate at intervals during the drying process and transferred into preweighed AquaLab cells. The cells and lids were immediately wrapped in aluminum foil to prevent moisture loss and left to equilibrate at 22°C for at least 2 h. After equilibration, the water activity of each sample was measured, and the lid replaced on the container. The entire container was weighed immediately on an AE260 DeltaRange® digital balance (Mettler, Switzerland) and then placed in a vacuum oven (LaBec, Laboratory Equipment, Australia), preheated to 60°C, and dried at 60°C under vacuum for 16 h. The cells were then transferred to a desiccator, and weighed soon after they reached room temperature. The samples were subsequently discarded, and the empty cells re-weighed. The moisture was calculated as the percentage weight loss of the initial weight of crumb.

## 4. RESULTS

### 4.1 Weekly samples

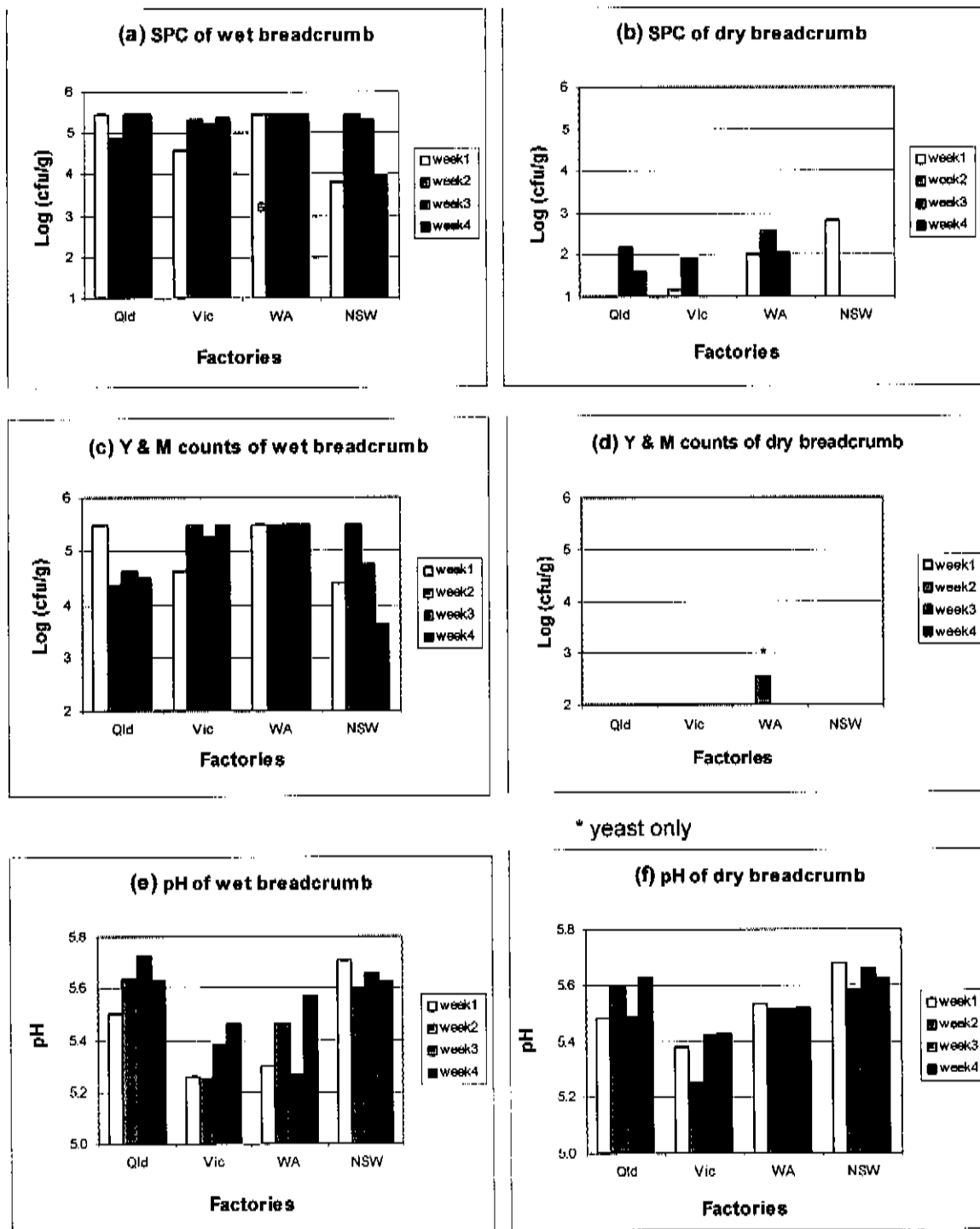
The results for the weekly samples are shown in Figures 1 and 2. Detection limits were 10 colony forming units (cfu)/g for standard plate and rope spore counts and 100 cfu/g for fungal counts.

Thirteen of the wet samples showed standard plate counts of around  $10^5$  cfu/g sample; the remaining three were around  $10^4$  cfu/g (Figure 1a). Nine samples had yeast and mould counts  $> 10^5$  cfu/g (Figure 1c). The yeast and mould counts were similar to the standard plate counts for most wet samples, indicating that the majority of their microflora were yeasts and moulds. Most of the moulds belonged to non-mycotoxigenic genera, including *Endomyces* and *Cladosporium*. However, the week 2 sample from Western Australia was found to contain a potentially toxigenic fungal species, *Penicillium crustosum* at  $3.4 \times 10^4$  cfu/g. This batch of breadcrumb contained bread returns beyond their use by date (Appendix 2).

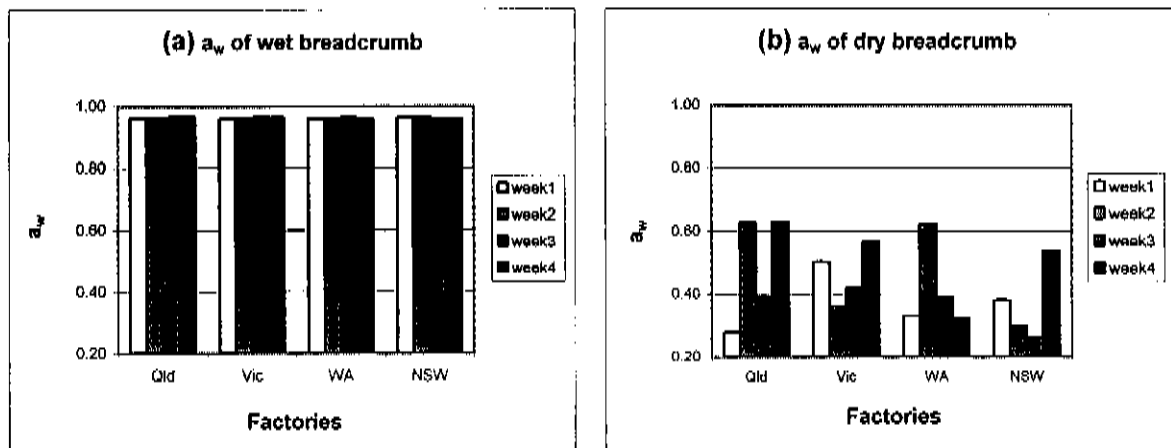
The dried breadcrumb samples all had low ( $< 10^3$  cfu/g) standard plate counts (Figure 1b), with only eight samples having detectable counts. All had yeast and mould counts below the detection limit, except the week 2 sample from Western Australia, which registered  $3.5 \times 10^2$  yeast (only) cfu/g, (Figure 1d). The wet crumb from this sample contained *P. crustosum*.

The rope spore counts of all wet and dried samples were  $< 10$  cfu/g (results not shown). The pH ranged from 5.2 - 5.7 for both wet and dried samples respectively (Figures 1e and 1f).

The water activity results for the wet samples were uniformly high with all around 0.96 (Figure 2a). Those for the dried samples were more varied, ranging from  $a_w$  0.26-0.63 (Figure 2b). Three samples were  $a_w > 0.60$ , with three others  $\geq 0.50$ . The dried sample from Western Australia taken at the same time as the one that contained *P. crustosum*, was  $a_w$  0.62.



**Figure 1. Weekly test results for standard plate counts (SPC), yeast and mould counts (Y & M) and pH of wet and dry breadcrumbs.**



**Figure 2. Weekly test results, for water activity ( $a_w$ ) on wet and dry breadcrumbs.**

## 4.2 Monthly samples

The results for the monthly samples are shown in Figures 3 and 4.

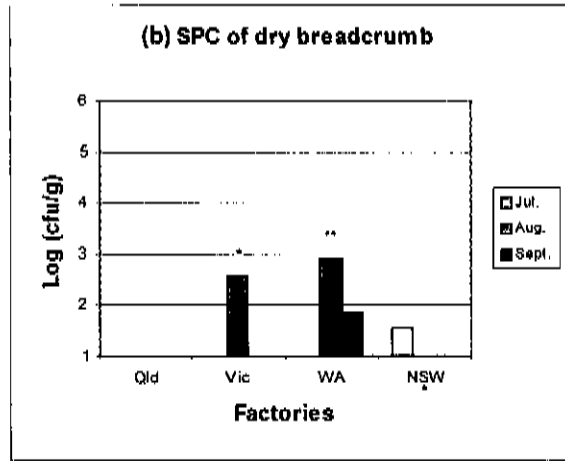
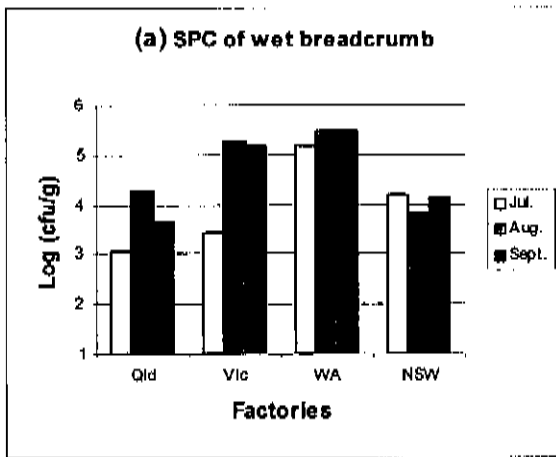
Most standard plate count, yeast and mould results were lower for the monthly wet crumb samples compared with the weekly samples (Figures 3a, c). Five samples (only) had standard plate, yeast and mould counts  $> 10^5$  cfu/g. The lower counts may reflect cooler environmental temperatures during the monthly sampling (July to September). For most samples, the counts again indicated that the dominant microflora were yeasts and moulds. No toxigenic fungi were detected amongst the genera.

Few dried samples had detectable total counts (Figure 3b) and none had detectable counts of yeasts and moulds (results not shown). However, one sample from Western Australia contained nearly  $10^3$  yeast cfu/g but these were not recovered on the yeast and mould count (Figure 3b), possibly indicating that they were sublethally damaged. A second sample (from Victoria) contained  $5 \times 10^2$  *Bacillus* spp. cfu/g, which was not observed in any other sample.

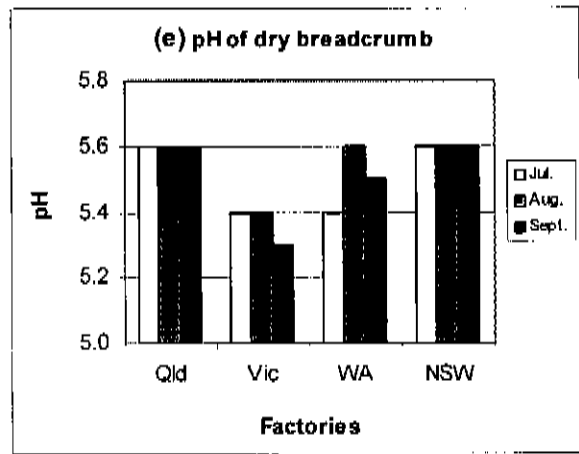
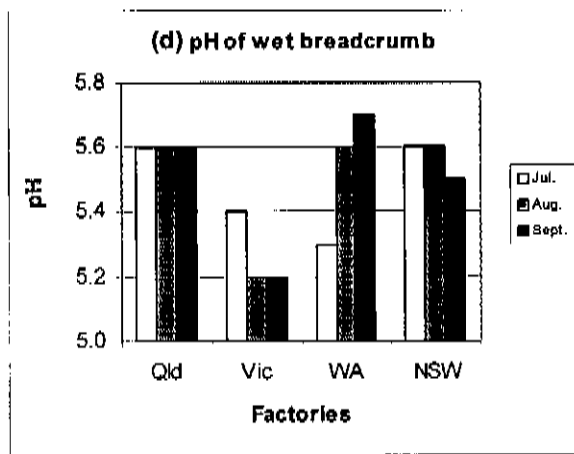
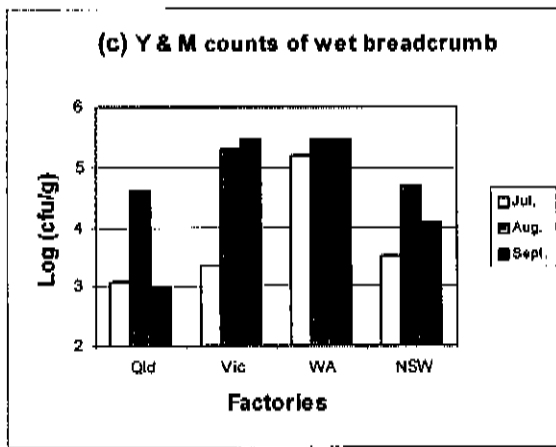
The pH ranged from 5.2-5.7 and 5.3-5.6 for wet and dried samples, respectively (Figures 3d, e).

The water activity of the wet samples was around  $a_w$  0.96, while that of the dried samples ranged from  $a_w$  0.32-0.64 (Figures 4a, b). Two samples were  $a_w > 0.60$  and one was  $a_w$  0.57.

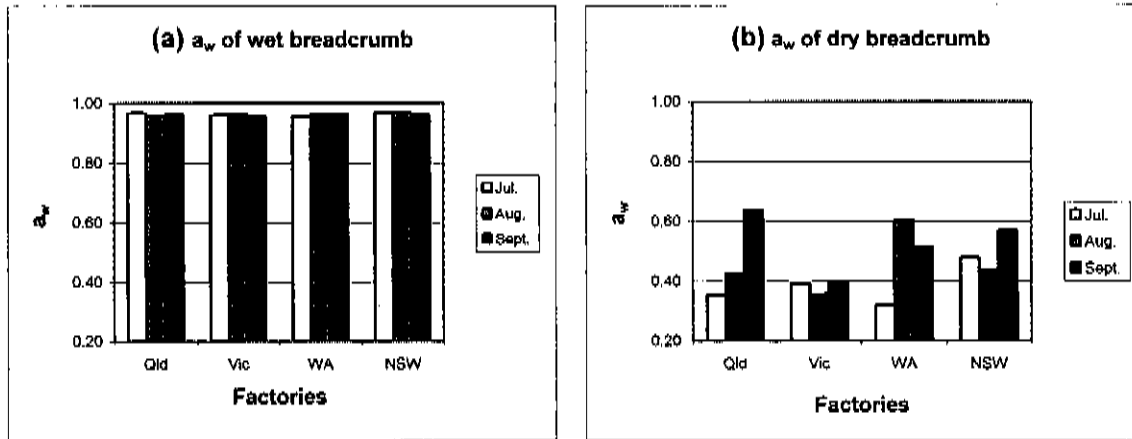
The rope spore counts for all samples were  $< 10$  cfu/g.



\**Bacillus*, \*\*Yeast



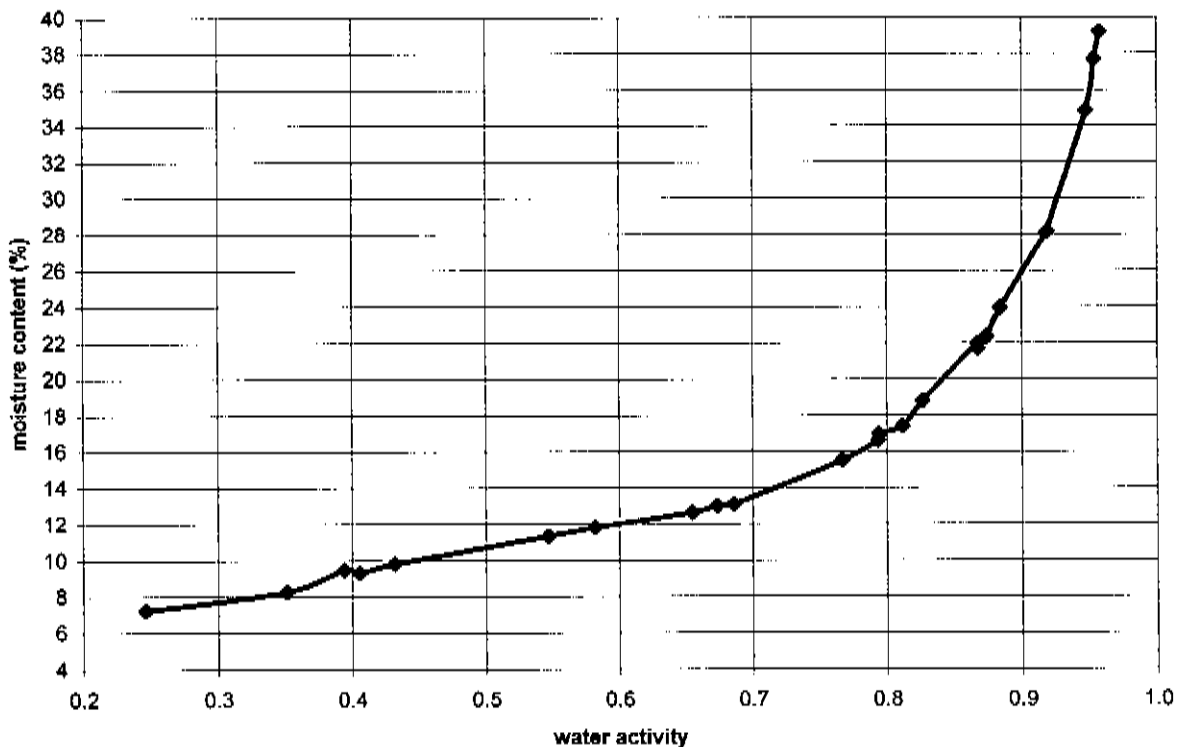
**Figure 3. Monthly test results for standard plate counts (SPC), yeast and mould counts (Y & M) and pH of wet and dry breadcrumbs.**



**Figure 4. Monthly test results, for water activity ( $a_w$ ) on wet and dry breadcrumbs.**

### 4.3 Desorption isotherm of breadcrumbs

The desorption isotherm of breadcrumb at 22°C is presented in Figure 5. The isotherm shows that at a moisture content of 10%, the expected  $a_w$  would be 0.45, a safe level for preventing mould growth. However, if the moisture content is 12%, the resultant  $a_w$  is 0.6, which is marginal for microbiological stability, due to the potential for growth of xerophilic moulds.



**Figure 5. Desorption isotherm for white breadcrumb at 22°C.**

## 5. DISCUSSION AND RECOMMENDATIONS

A variety of moulds have been isolated from bread (Appendix 1), including the potentially mycotoxigenic species *Aspergillus*, *Penicillium* and *Fusarium*. Most mycotoxins are heat stable and are unlikely to be inactivated by the heat process during breadcrumb manufacture (69-72°C for 7-8 min). There are, therefore, potential risks that mycotoxins could be present in dried breadcrumb products.

In this study, most moulds detected belonged to the genera *Endomyces* and *Cladosporium*. Only one potentially mycotoxigenic species, *Penicillium crustosum*, was detected in one batch of wet breadcrumbs from Western Australia at  $3.4 \times 10^4$  cfu/g. The other results for this sample were  $> 10^5$  cfu/g for standard plate, yeast and mould counts, and  $a_w$  0.96. Although moulds were not detected in the dried crumb sampled at this time, yeasts were detected at  $3.5 \times 10^2$  cfu/g. This was the only sample of dried crumb to show a positive fungal count. These results indicate that the high microbial load in the original wet crumb may have reduced the effectiveness of the drying process, and that it may not have been dried sufficiently ( $a_w$  0.62).

*P. crustosum* has been isolated from a variety of cereal products (Pitt and Hocking, 1997) and can produce a powerful neurotoxin, penitrem A. The toxicity of penitrem A to humans is unknown, however it is known to be toxic to large domestic animals, such as dogs. It is therefore likely that it is also toxic to humans. There are no published data of the heat stability of penitrem A. The batch in which *P. crustosum* was detected was the one batch that included bread returns past their use-by-date. This result therefore shows the potential contamination of breadcrumbs with mycotoxins such as penitrem A.

- **We therefore recommend that only bread returns within their use-by date be used for breadcrumb manufacture.**

The water activity of a substrate is most conveniently defined as the ratio of the partial pressure of water in the atmosphere in equilibrium with the substrate,  $P$ , compared with the partial pressure of the atmosphere in equilibrium with pure water at the same temperature ( $P_0$ ). Effectively, it is a measure of the amount of water available for microbial growth.

Fungi are able to grow on dry foods with  $a_w$  as low as 0.61, although mycotoxin production at such low water activities is unlikely (Adams and Moss, 2000). To avoid fungal growth after processing, we recommend that the water activity of breadcrumbs should be controlled under 0.6, preferably 0.55 or lower, to ensure an adequate safety margin. Breadcrumbs are generally dried to moisture contents lower than 10%, which will be  $a_w \sim 0.45$ . During this survey, some breadcrumb samples were  $a_w > 0.6$ , which could present a risk for fungal growth during storage. A higher moisture content also increases the probability of moisture migration, should the product be subjected to extreme temperature variation. Good control of the moisture content of dried breadcrumb products is critical to prevent the risk of mould growth during transport and storage.

- **We therefore recommend that the maximum moisture content for dried breadcrumbs not exceed 10%.**

## 6. OUTCOMES

In investigating the microbiological status of breadcrumb samples from Australian processors, the following outcomes have been achieved:

- Wet and dried breadcrumb samples were tested and were generally observed to be of good microbiological quality, although some variation in water activity and hence moisture content were observed in the dried crumb
- There is a small but finite risk of the presence of mycotoxins in breadcrumbs
- Using bread returns that are within the use-by date of the bread and controlling the moisture content of dried breadcrumbs to less than 10% can minimize the risk of mould growth and associated mycotoxin contamination.

## 7. ACKNOWLEDGEMENTS

This work was made possible by the financial contribution of Value Added Wheat CRC and the in kind contribution of Food Science Australia. The authors thank Goodman Fielder Milling and Baking for providing the breadcrumb samples.

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**Appendix 1. Literature review of the presence of fungi and heat stable mycotoxins in bread**

Species	Type of bread	Source	Toxin potential
<i>Aspergillus fumigatus</i> , <i>A. niger</i> , <i>A. flavus</i> , <i>A. glaucus</i> , <i>A. carneus</i> , <i>A. terreus</i> , <i>A. ochraceus</i> , <i>Rhizopus stolonifer</i> , <i>Trichoderma harzianum</i> , <i>Trichothecium roseum</i>		(Rai et al. 1990)	fumitremorgens; aflatoxins; ochratoxin A; territrems
<i>Aspergillus terreus</i>	balady	(El Sayed Amabdalla et al. 1998)	territrem A, territrems B
<i>Penicillium</i> , <i>Aspergillus</i>	White and Raisin	(Bullerman and Hartung, 1973)	luteoskyrin, ochratoxin A, penicillic acid
<i>Penicillium</i> , <i>Aspergillus</i>		(Viljoen and von Holy, 1997)	unspecified <i>Penicillium</i> and <i>Aspergillus</i> toxins
<i>Moniliella suaveolens</i>	White	(Naito et al. 2000)	
<i>Penicillium</i> , <i>Rhizopus</i> , <i>Aspergillus niger</i> , <i>Alternaria</i> , <i>Fusarium</i> , <i>Mucor</i>	Khamir	(Gassem, 1999)	unspecified <i>Penicillium</i> and <i>Aspergillus</i> toxins
<i>Aspergillus</i> , <i>Penicillium</i> , <i>Rhizopus</i> , <i>Paecilomyces</i>	Turkey	(Gocmen and Sahin, 1997)	unspecified <i>Penicillium</i> and <i>Aspergillus</i> toxins
<i>Penicillium roqueforti</i> , <i>P. corylophilum</i> , <i>Eurotium</i> , <i>P. decumbens</i> , <i>Paecilomyces variotii</i> , <i>Aspergillus flavus</i> , <i>P. commune</i> , <i>P. solitum</i> , <i>A. niger</i> , <i>Mucor</i>	Rye	(Lund et al. 1996)	roquefortine, PR toxin, aflatoxins, cyclopiazonic acid
<i>Cladosporium herbarum</i> , <i>Eurotium repens</i> , <i>Penicillium expansum</i> , <i>Rhizopus stolonifer</i>	Wheat	(Kunz et al. 1995)	patulin, citrinin
<i>Aspergillus</i> , <i>Penicillium</i>	NS <sup>a</sup>	(Spicher, 1986)	unspecified <i>Penicillium</i> and <i>Aspergillus</i> toxins
<i>Mucor</i> , <i>A. amstelodami</i> , <i>A. niger</i>	NS	(Paramasivan and Kalyanasundaram, 1986)	
<i>A. flavus</i>	NS	(Augustine et al. 1984)	aflatoxins
<i>Penicillium verrucosum</i> var. <i>cyclospium</i> , <i>Penicillium expansum</i> , <i>Aspergillus niger</i> , <i>A. flavus</i> , <i>Neurospora</i> , <i>Paecilomyces</i> , <i>Penicillium brevicompactum</i>	White, Brown	(Andersson et al. 1978)	patulin, citrinin, aflatoxins

Species	Type of bread	Source	Toxin potential
NS	NS	(Osborne, 1980)	ochratoxin A, patulin, citrinin
<i>Aspergillus niger</i> , <i>Penicillium cyclospium</i>	Rye	(Tyllinen et al. 1977)	
<i>A. niger</i> , <i>Penicillium cyclospium</i> , <i>Penicillium steckii</i> , <i>Paecilomyces</i>	White	(Tyllinen et al. 1977)	citrinin
<i>A. niger</i> , <i>Penicillium cyclospium</i> , <i>Penicillium steckii</i> , <i>Paecilomyces</i> , <i>A. glaucus</i> , <i>A. terreus</i> , <i>A. flavus</i> , <i>Penicillium</i> spp. <i>citrinum</i> , <i>viridicatum</i> , <i>rugulosum</i>	Sweet white	(Tyllinen et al. 1977)	citrinin
<i>Aspergillus niger</i> , <i>Penicillium corylophilum</i>		(Davis et al. 1975)	
<i>A. fumigatus</i> , <i>A. niger</i>	Baladi	(Megalla et al. 1985)	fumitremorgens

<sup>a</sup> Not stated.

**Appendix 2. Effect of temperature on stability and inactivation of some mycotoxins**

Mycotoxin	Substrate	Heating method	Temperature (°)	Time (min)	Reduction (%)	Reference
Aflatoxin	Cottonseed meal	Jacketed kettle	100	120	70	(ICMSF, 19
	Corn grits	Boiling	100	30	30	
	Corn grits	Baking	220 <sup>a</sup>	25	16	
	Corn grits	Frying	175	20	35-50	
	Peanuts	Roasting	235	NS <sup>b</sup>	20-50	
	Peanuts	Boiling with 5% salt	116	30	80-100	
	Peanuts	Boiling without salt	116	30	32-37	
	Peanuts	Microwave (1.6 kW)	137	15	69	
	Peanuts	Microwave (3.23 kW)	150	5	95	
	Coconut oil	Sunlight	Ambient	NS	75	
Fusaproliferin	Wet flour	Heating	240	20	78	(Ritieni et
Fumonisin B2	Citrate-phosphate-borate buffer	Heating	125	60	No significant loss	(Jackson et

<sup>a</sup> Temperature of oven, not product.

<sup>b</sup> Not stated.

**Appendix 3. Details of weekly breadcrumb samples**

Week	Factory	Date collected	Date received	Type	Bread used	Bread use-by date
Week 1	Burleigh Heads, Qld	21.03.2002	22.03.2002	Super fine white	Wonder white, Wonder white toast	23/03/02; 24/03/02; 25/03/02
Week 1	Clayton, Vic	25.03.2002	26.03.2002	Fine white	Wonder white, SSM Mighty soft white, Country Split white	26/03/02; 27/03/02; 28/03/02
Week 1	Malaga, WA	25.03.2002	26.03.2002	Fine blend	B/cup soft white; Wonder White; Helgas WH W/meal; C/Split WH W/meal; Coles WH W/meal	25/03/02; 26/03/02; 27/03/02
Week 1	Moorebank, NSW	14.03.2002	15.03.2002	White	N/A	N/a
Week 2	Burleigh Heads, Qld	27.03.2002	28.03.2002	Super fine white	Mighty soft Toast; Supersandwich Marker; Wonder White; Wonder White Toast	31/03/2002
Week 2	Clayton, Vic	02.04.2002	03.04.2002	Fine white	Mighty White; Wonder White; Country split; Farmland White; Super Toasty	03/04/02; 04/04/02
Week 2	Malaga, WA	04.04.2002	08.04.2002	Fine blend	SSM White; Wonder White; C/split white w/meal; Helgas white w/meal; W/meal SSM	7/04/2002
Week 2	Moorebank, NSW	03.04.2002	04.04.2002	Fine white	White sliced	7/04/2002

Week	Factory	Date collected	Date received	Type	Bread used	Bread use-by date
Week 3	Burleigh Heads, Qld	03.04.2002	04.04.2002	Coarse super blend	Mighty soft meal; Farmland meal; Wonder white; Mighty soft grain	06/04/02; 07/04/02
Week 3	Clayton, Vic	08.04.2002	12.04.2002	Fine white	Wonder White; Super sandwich; Mighty soft; Helgas traditional white; Super Toasty	9/04/02; 10/04/02
Week 3	Malaga, WA	10.07.2002	12.04.2002	Fine & coarse blend	SSM white; Wonder White; SSM w/meal; Vita Good U/T; C/split white w/meal	9/04/2002
Week 3	Moorebank, NSW	08.05.2002	09.05.2002	White conventional	Mighty soft white; Wonder White	10/05/02; 11/05/02; 12/05/02
Week 4	Burleigh Heads, Qld	11.04.2002	12.04.2002	Super fine	Coles superfibre; Wonder white; Farmland sungold	13/04/2002
Week 4	Clayton, Vic	16.04.2002	17.04.2002	Coarse white		
Week 4	Malaga, WA	01.05.2002	02.05.2002	Fine blend	W/white; White SSM; Vita Good; Vita White; C/split White w/meal	01/05/02; 02/05/02
Week 4	Moorebank, NSW	15.05.2002	15.05.2002	White conventional	Mighty soft white; Wonder White	17/05/02; 18/05/02

**Appendix 4. Details of monthly breadcrumb samples**

Sample ID	Factory	Date collected	Date received	Type	Bread used	Bread use-by date
July	Burleigh Heads, Qld	03.07.2002	04.07.2002	Fine white	W/white; UT Vita white; Fielders; Mighty soft; Country Bake café's	04/07/02; 06/07/02
July	Clayton, Vic	01.07.2002	02.07.2002	Fine white	Wonder White; Mighty soft jumbo; Might soft; Super Toasty; Coles super fibre white	2/07/02; 3/07/02; 4/07/02
July	Malaga, WA	02.07.2002	03.07.2002	Fine blend	SSM White; SSM w/meal; UT white; UT w/meal; Wwonder	02/07/02; 03/07/02
July	Moorebank, NSW	03.07.2002	04.07.2002	White coarse	Wonder White; Mighty soft	6/07/2002
July	Moorebank, NSW	11.07.2002	12.07.2002	White coarse	Wonder White; Mighty soft	12/07/200
August	Burleigh Heads, Qld	30.07.2002	31.07.2002	Superfine white	W/white	1/08/2002
August	Clayton, Vic	01.08.2002	02.08.2002	Fine white	Super sandwich; Wonder white; Helgas Traditional white; Mighty soft; Uncle Toby's vitawhite	2/08/02; 3/08/02

Sample ID	Factory	Date collected	Date received	Type	Bread used	Bread use-by date
August	Malaga, WA	30.07.2002	01.08.2002	Fine white	SSM White; W/white, Mias white; tasty; vita white	1/08/2002
August	Moorebank, NSW	02.08.2002	02.08.2002	White coarse	Wonder White; Mighty soft	5/08/2002
September	Burleigh Heads, Qld	04.09.2002	05.09.2002	Coarse white	Mighty soft (Buttercup); Country Bake Mighty soft	6/09/2002; 7/09/2002
September	Clayton, Vic	02.09.2002	03.09.2002	Fine white	Helgas Traditional white; Wonder white sandwich; Farmland Sungolden white; Mighty soft; Uncle Toby's vitawhite	4/09/02; 6/09/02
September	Malaga, WA	11.09.2002	12.09.2002	Coarse blend & fine blend	SSM White; W/white; Vita white; Helgas white w/meal; SSM w/meal	11/09/2002
September	Moorebank, NSW	02.09.2002	03.09.2002	White coarse	Mighty soft	5/09/2002