

# Assuring the Microbial Safety and Quality of Australian Malt and Barley



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## Introduction

- The barley grain carries with it a community of micro-organisms referred to as its microbiota.
- The microbiota of barley consists principally of bacteria, including members of the Eubacteria, and the filamentous actinomycetes, filamentous fungi and yeasts (Flannigan, 2003).

- The degree to which the grain is colonised or contaminated depends on the field conditions under which the barley is grown and the storage of the grain post harvest.
- To date, relatively few investigations have been attempted with Australian barley that is typically grown under less humid conditions and dry harvest conditions.

## Microbial Contamination of Barley and Malt

### Field.

- Barley kernels can be contaminated by airborne bacteria, yeast, fungi and moulds.
- In Australia, our typically dry environment presumably reduces the potential grain microbial loads resulting in an enviable reputation for producing 'bright', 'clean' barley.
- The most important species are: *Alternaria*, *Epicoccum* and *Fusarium*.



### Storage.

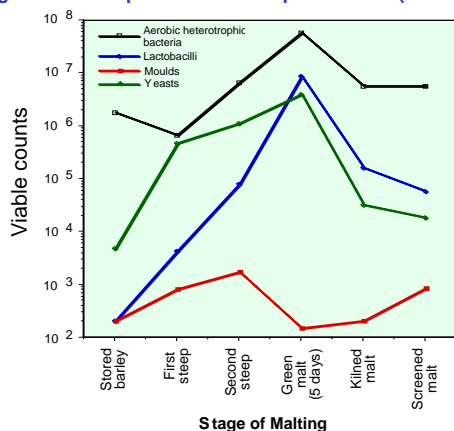
- During storage the principle issue is of water.
- High temperature (>25°C) and moisture content above 14% promotes microbial contamination.
- In Australia, our generally very hot harvest conditions result in grain moistures typically between 9-11%, with moisture greater than 13% not accepted for silo receipt.
- The most important storage microbes are: *Aspergillus*, *Eurotium* and *Penicillium* species.



### Malting.

- Malting activates dormant micro-organisms, resulting in a dramatic increase in microbial growth (Figure 1).
- Imbibing of grain with water during steeping is the first period favouring microbial growth.
- Microbial growth is also favoured during germination where the germinated barley grows in a water-saturated atmosphere.
- Drying of malt with hot air up to 85°C during kilning reduces microbial load markedly.
- The most important microbe species are *Fusarium*, *Aspergillus*, *Penicillium*, *Pseudomonas*, *Lactobacillus*, and various yeast species.

Figure 1: Viable counts of micro-organisms associated with kernels during commercial production of sulphured malt (Petters *et al.*, 1988).



## Effects of Microbial Contamination

- Adverse effects on malt quality have been reported as poorer germination, higher protein modification leading to higher wort nitrogen, lower diastatic power, and lower  $\alpha$ -amylase levels.
- Suggested to stimulate the secretion of xylanase to release arabinoxylan fragments and anti-microbial proteins that are responsible for premature yeast flocculation (PYF).
- Can indicate presence of mycotoxins (Table 1), which have the potential to survive the malting and brewing process. *Fusarium* can also contribute gushing inducing proteins
- Certain moulds may taint beer flavour
- Conversely, microbes may be responsible for improved barley germination during malting due to plant hormones secretion including gibberellin and auxin or the secretion of enzymes such as  $\beta$ -glucanases, xylanases and proteases.

Table 1: Important mycotoxins detected in barley, malt and producing micro-organisms (adapted from Noots *et al.*, 1998). \* LD<sub>50</sub>

Fungal species	Mycotoxin	LD <sub>50</sub> (mg/kg body wt)*
<b>Storage fungi</b>		
<i>Aspergillus flavus</i>	Aflatoxin B1	9.0
<i>Penicillium species</i>	Citrinin	35.0
<i>A. ochraceus</i> , <i>P. viridicatum</i> , <i>P. verrucosum</i>	Ochratoxin A	22.0
<b>Field fungi</b>		
<i>Fusarium graminearum</i> , <i>F. culmorum</i>	Dexonivalenol (DON)	43.0
<i>F. graminearum</i> , <i>F. culmorum</i> ,	Diacetoxyscirpenol (Das)	7.8
<i>F. sporotrichoides</i> , <i>F. poae</i>	T2 toxin	6.5
<i>F. sporotrichoides</i> , <i>F. poae</i> <i>F. graminearum</i> , <i>F. culmorum</i>	Zearalenone (ZER)	5.0

## Conclusions

- Demonstrate and ensure that Australian malt and barley is 'clean' and safe.
- Australian has an enviable reputation for 'bright' and clean malting barley that infers a relatively low load of micro-organisms
- Direct result of the typically very dry harvest conditions in Australian cropping zones.
- We expect that Australian barley does not have a problem in most years with microbial contamination,
- The microbiota of barley has a significant effect on potential malt quality, efficiency of the brewing process and final beer quality.
- Investigation will benchmark Australian malt and barley for PYF and mycotoxin content.
- This investigation will lead to a set of diagnostic tools, based on molecular biology techniques be developed.

**Microbial safety and quality assurance for Australia's domestic & international barley and malt customers is expected to enhance Australia's reputation as a quality grain supplier.**

### References

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