

Food Safety in Grain Milling

Urs Dübendorfer



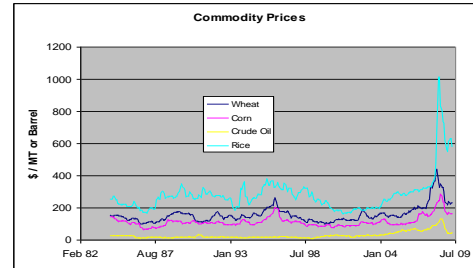
Agenda

- 1 In general
- 2 The consumers view
- 3 Main risks for grain based food
- 4 Micotoxines, allergens and bacteria
- 5 Possible controls and processes for risk minimisation

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Challenges for the Miller.



Price pressure



Increasing contaminants



Food safety non-negotiable



Lower wheat quality

Increasing consumer sensitivity



The risks within the value chain.

Possible places of contamination



Raw Material

Recontamination



Solids

Organisms

Solids

Organisms



What are the greatest dangers in the value chain of cereals?

■ Biological hazards

- insects, larvae and eggs
- mycotoxins
- - microorganisms (bacteria, yeasts and mold)
- - genetically modified organisms (GMOs)



■ Chemical hazards

- residues of pesticides and fungicides
- pollutants from machines (eg. lubricants)
- result of processing contaminants (eg. acrylamide)
- contaminants that migrate from packaging into food
- allergens
- - additives and supplements
- adulteration of food



■ Physical hazards

- foreign matter (sand, metal, glass, plastics, ...)



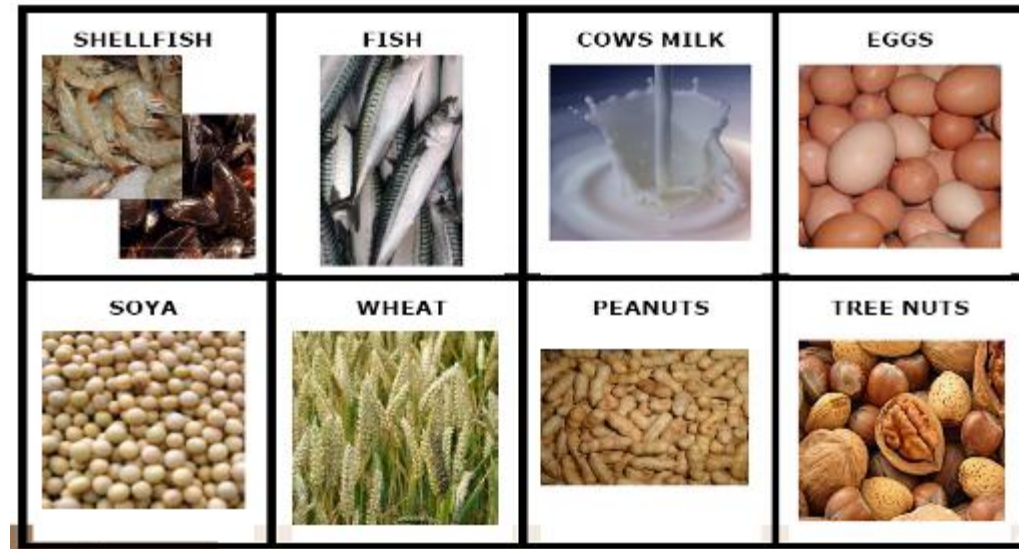
Codex Alimentarius

Hazard Definition: A biological, chemical or physical agent in food, or property thereof, which may cause adverse health effects.

Definition of pollutant: Any biological or chemical agent, foreign matter or other substances not intentionally added to food which may compromise the safety or suitability of food.

Allergens and gluten

- It is estimated that 6-8% children and 2-3% adults are allergic to food.
- Celiac disease is the most common genetic disease in Europe (1:300). This is a gluten intolerance that affects intestinal health.
- Most common allergens are:
 - cow's milk
 - eggs
 - soy
 - wheat
 - fish and crustaceans
 - almonds and walnuts
- Containing gluten:
 - wheat
 - rye
 - barley
 - oats



Quality Management Tools

Management level

Risk analysis
Recommendations

International organisations
(FAO, EHEDG...)

Risk analysis
Recommendations
and
Inspections

Government (FDA, EFSA, ...)
Legislation

Operational level

ISO 22000

Industrial Level

HACCP

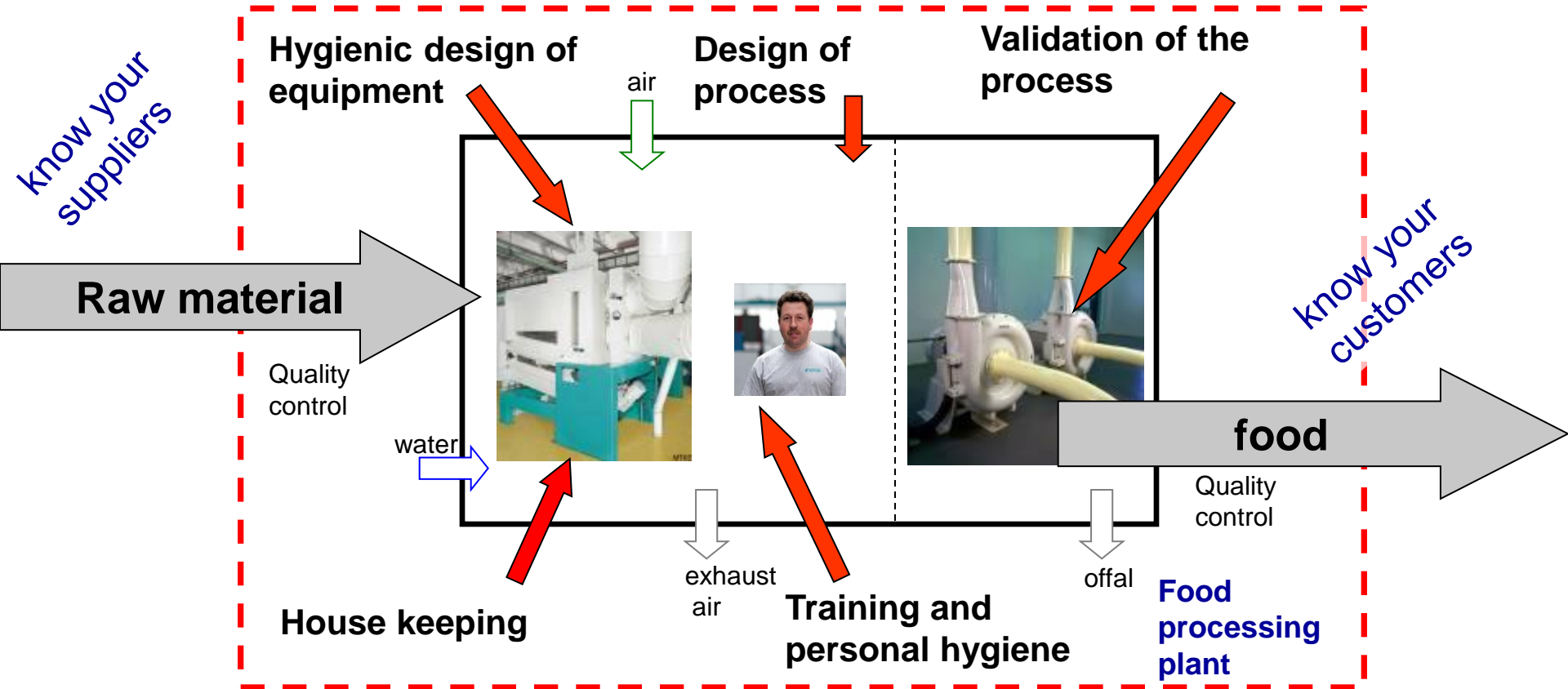
Conditions and needed measures to grant a production, storage and distribution of food which is guaranteed harmless, in good condition and fit for human consumption

Traceability

BP
(Best practice)

Food Safety is a systemic solution

Food Producer: learn and take all precautions as necessary to ensure food safety and quality



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What are the consumers concerns?

Dioxine in animal feed

sueddeutsche.de

Suche

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Dioxin im Tierfutter

Panscherei ungeahnten Ausmaßes



GMO in Food (rice)

USA: Nicht-Gentech-Reis verunreinigt: Anbau-Verbot in Arkansas



Melamine in milk powder

THE TIMES
THE SUNDAY TIMES

Archive Article | Please enjoy this article from The Times & The Sunday Times archive

From The Times

September 16, 2008

Chinese milk powder contaminated with melamine sickens 1,253 babies

Salmonella in pepper

Black pepper to blame for salmonella outbreak

Tests strongly suggest it's the cause of at least some of the 250 illnesses

USA, march 2010

EHEC in vegetables



La consejera de Agricultura andaluza visita un invernadero

Europa 2011

E.Coli in cookie dough



Micotoxine in nuts

Noticias da Anvisa



envi

Brasília, 25 de março de 2009 - 18h20

Doce de amendoim com aflatoxina é interdito

Radiation in food

18/03/2011 09:21 - Atualizado em 18/03/2011 10:00

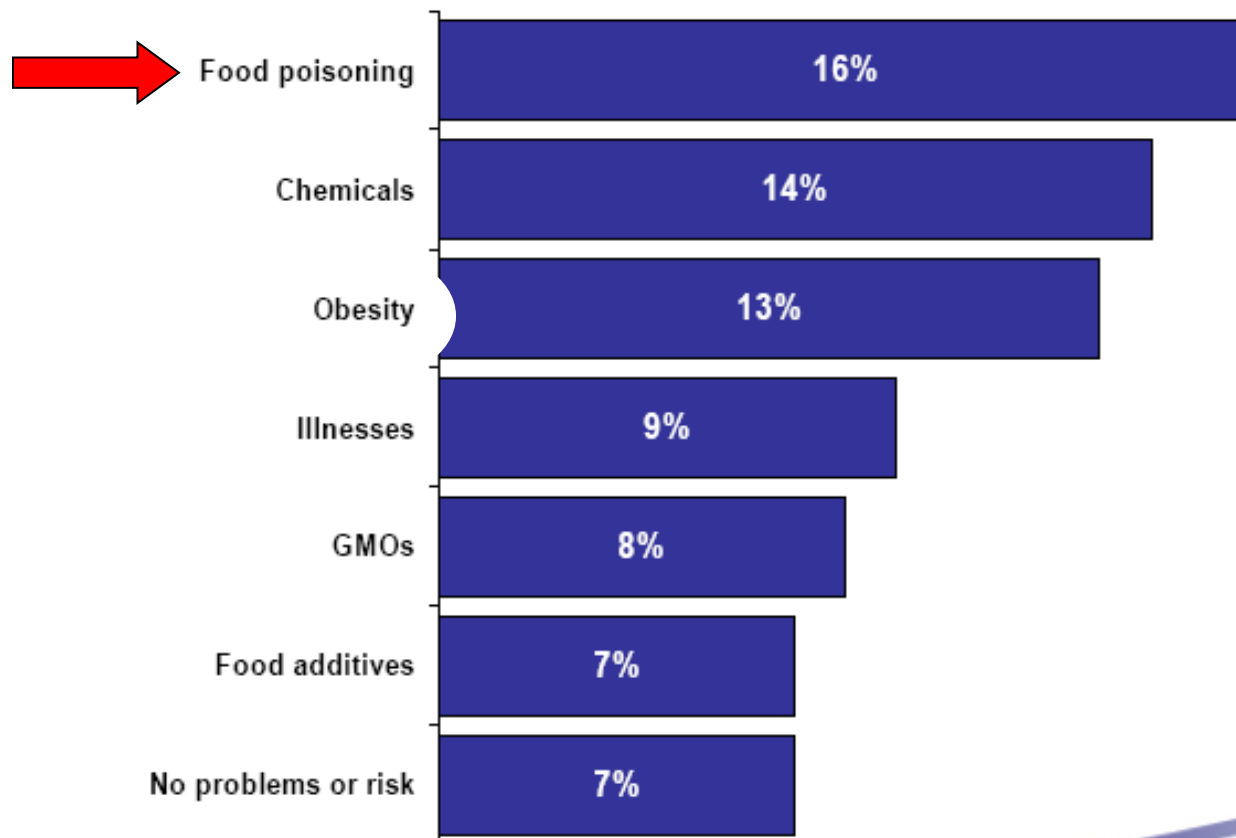
Japão detecta excesso de radiação em leite e espinafre

Todo radioativo surgiu nos alimentos coletados em Fukushima e Ibaraki. Água de Tóquio também foi contaminada, mas em nível não nocivo à saúde.

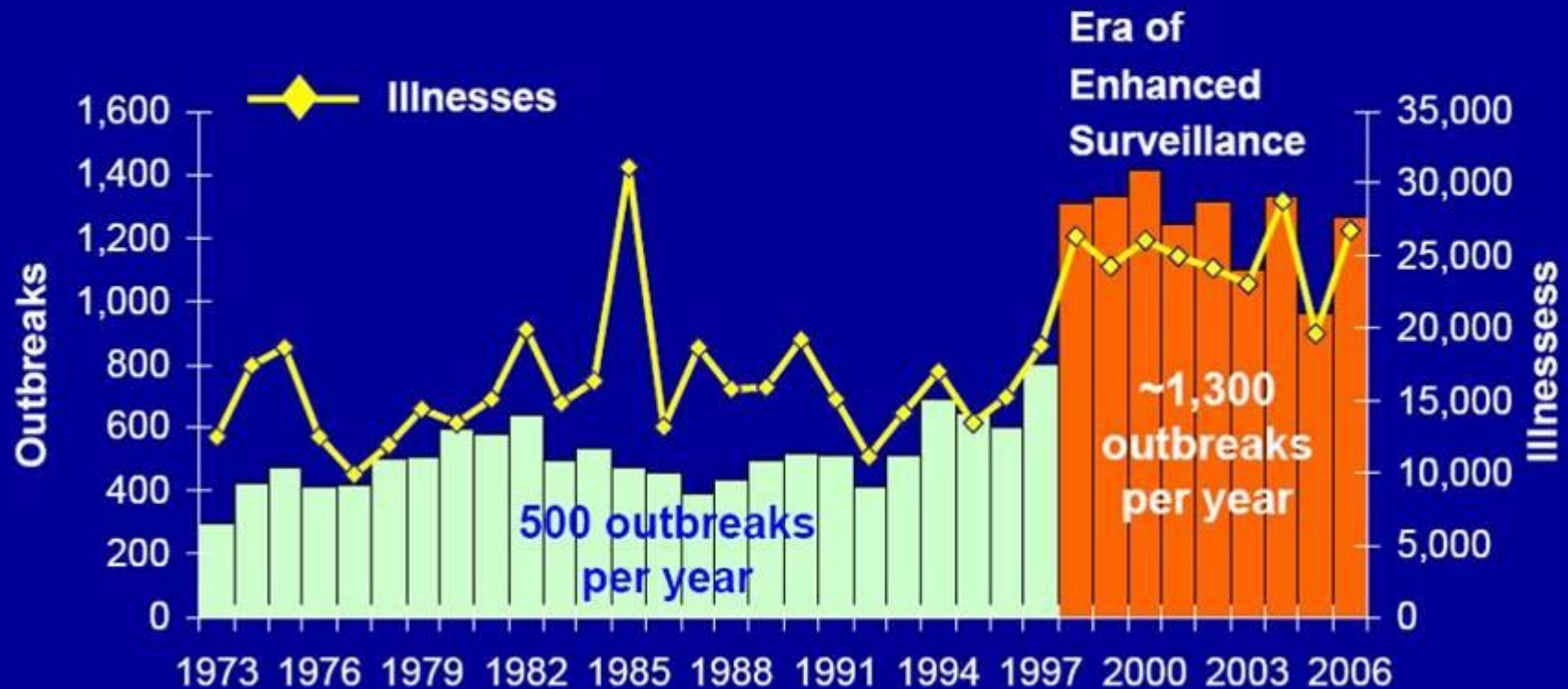


Food-related risks - spontaneous

Question: What are all the things that come to mind when thinking about possible problems or risks associated with food?



Foodborne disease outbreaks reported per year, US 1973–2006



Source CDC

Controlable risks against non controlables



The consumers view about FOOD SAFETY

I want to eat this food and be sure that...

-it is not harming me!
- that there is no contamination in.
- that it is healthy and its nutritional properties are well balanced.
-it is “natural” and does not contain any useless additives.
-it was processed in a hygienical manner.
- it was seriously checked.
-all the needful information are on the label.
-that I do know the provenience of it.



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Bear in mind

- Detect biological contamination in food is like finding a needle in the haystack
- To detect contamination an appropriate methodology for sampling must be applied
- Food safety is not created only by analyzing the final product
- To reduce the risk, it is essential to manage the entire food production chain

Peanut company lied on salmonella testing, FDA finds

Some batches were not retested for the bacteria before shipping, the agency says -- though Peanut Corp. of America said it did.

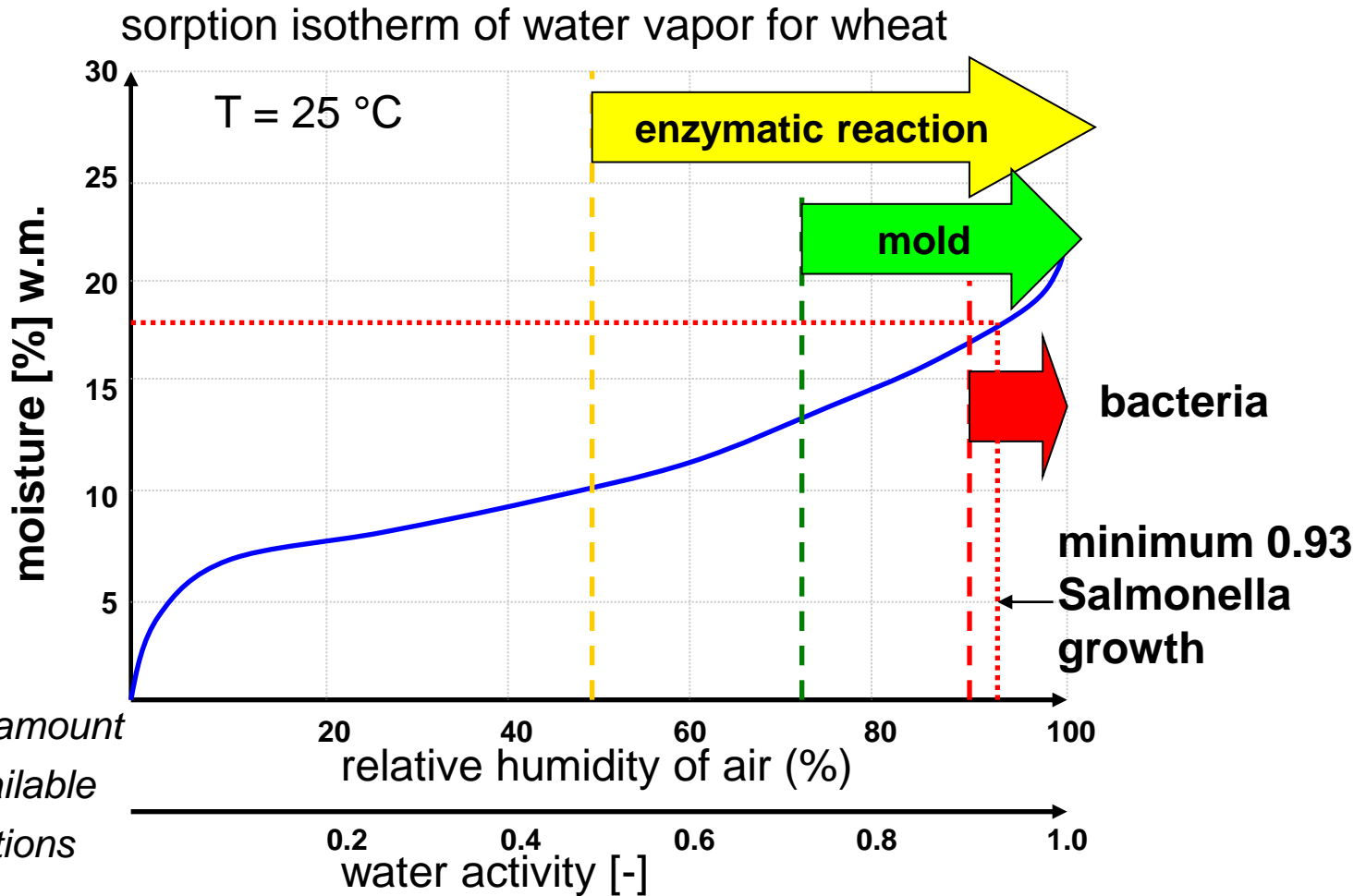
February 07, 2009 | Thomas H. Maugh II and Mary Engel

Peanut Corp. of America, the company that produced the contaminated peanut butter now being widely recalled, lied to Food and Drug Administration investigators about shipping batches of the food known to be tainted with salmonella bacteria, the agency said Friday.

The company had previously told the FDA that some lots of peanut butter had initially tested positive for the bacterium, then were retested and found to be negative before they were shipped. But further investigation showed that the company actually shipped some of the lots before the second tests were completed. Other lots were shipped without testing and, in some cases, no second test was performed even after the first one came back positive.



The reactivity of water in food is measured by the water activity



Water activity is the amount of reactive water available for biochemical reactions

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What are Mycotoxines?

- Mycotoxins are toxic substances produced by mold
- Molds are multicellular and filamentous microorganisms. The main molds that produce toxins are of the genus *Aspergillus*, *Penicillium* and *Fusarium*
- Cereal grains can be infected during cultivation or after harvest
- Temperature and high humidity favor the growth of mold
- FAO estimates that 25% of the global food harvest is affected by mycotoxins
- Aflatoxin B1 is one of the most potent toxins in nature



Aspergillus flavus on a maize cob (risk of aflatoxine)

There are many types of mycotoxins that contaminate our food



Deoxynivalenol
Zearalenone
Ochratoxin A



Aflatoxin M₁



Ochratoxin A



Patulin



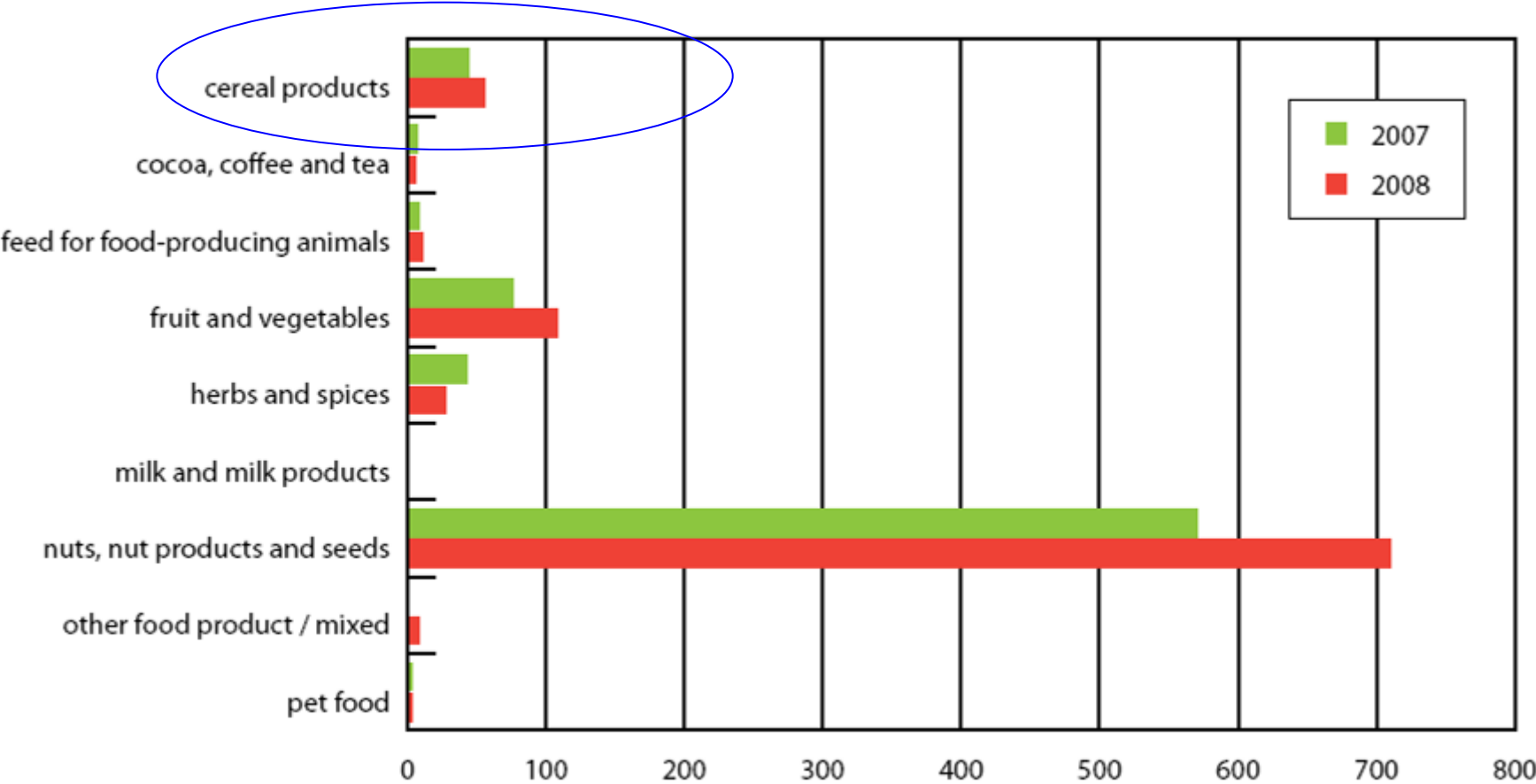
HT2 and T2 in oats
Ochratoxin A in dried fruit and cereals
Aflatoxins in nuts



Fumonisin

Mycotoxins are toxic to humans and animals!

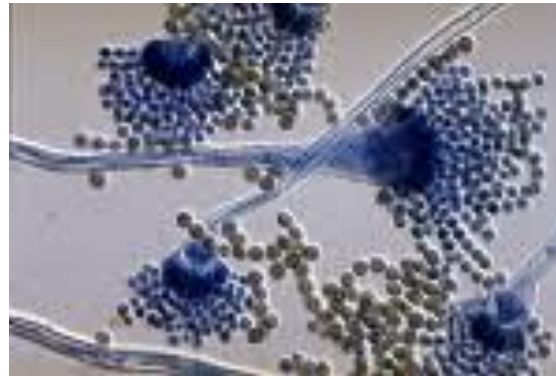
Mycotoxines alerts within the CE



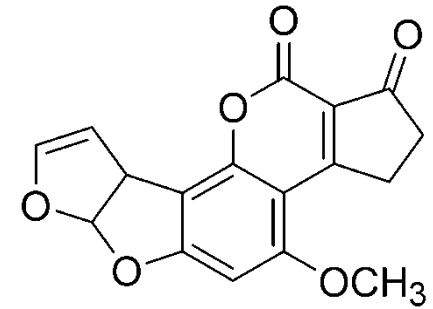
Aflatoxine



Peanuts and corn
with fungi



Aspergillus flavus



Aflatoxine B1

Acute toxicity

In 1960 some 100,000 British small turkeys died in a few months, a seemingly new disease called "Turkey X disease". A careful examination showed that they were all associated with portions of peanut flour from Brazil.

Chronic Toxicity

Aflatoxin B1 shows up on the list of human carcinogens. Several epidemiological studies have shown a causal relationship between aflatoxins in foods and liver cancer.

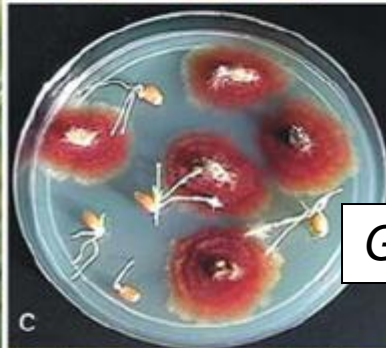
Fusariosis is a major wheat disease causing damage to the productivity



Wheat spike
Fusariosis



Infected kernels

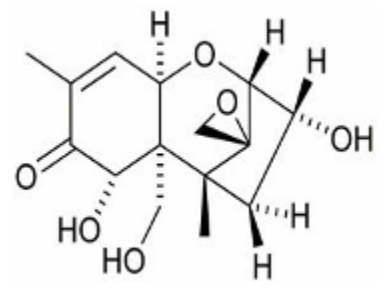


Gibberella zeae



Fusarium graminearum

100 µm



The image shows the chemical structure of Deoxynivalenol (DON), a tricyclic sesquiterpene lactone. It features a decalin core with a lactone ring fused to one of the rings, and various hydroxyl and methyl groups attached to the structure.

Micotoxine DON

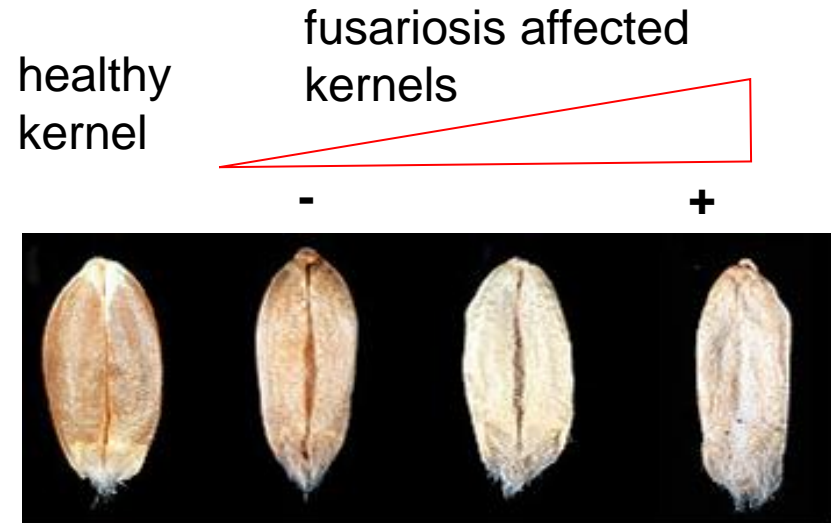
Desoxinivalenol (vomitoxine)

Ocurrer on wheat and maize. Harmfull to humans and animals

Del Ponte et al., Fitopatol. bras., 29, 2004

The properties of mycotoxines

- Mold growth (and mycotoxine formation) is sensitive to variations in temperature and humidity.
- Mycotoxins are very unevenly distributed in agricultural products
- Contaminated grains also gets hard on the inside. Grain shows changes in color, appearance and density.
- Mild to moderate contamination especially in the outer layer of the grain. Kernels show changes in color and appearance.
- Mycotoxins are quite thermostable and difficult to inactivate by heat treatment.



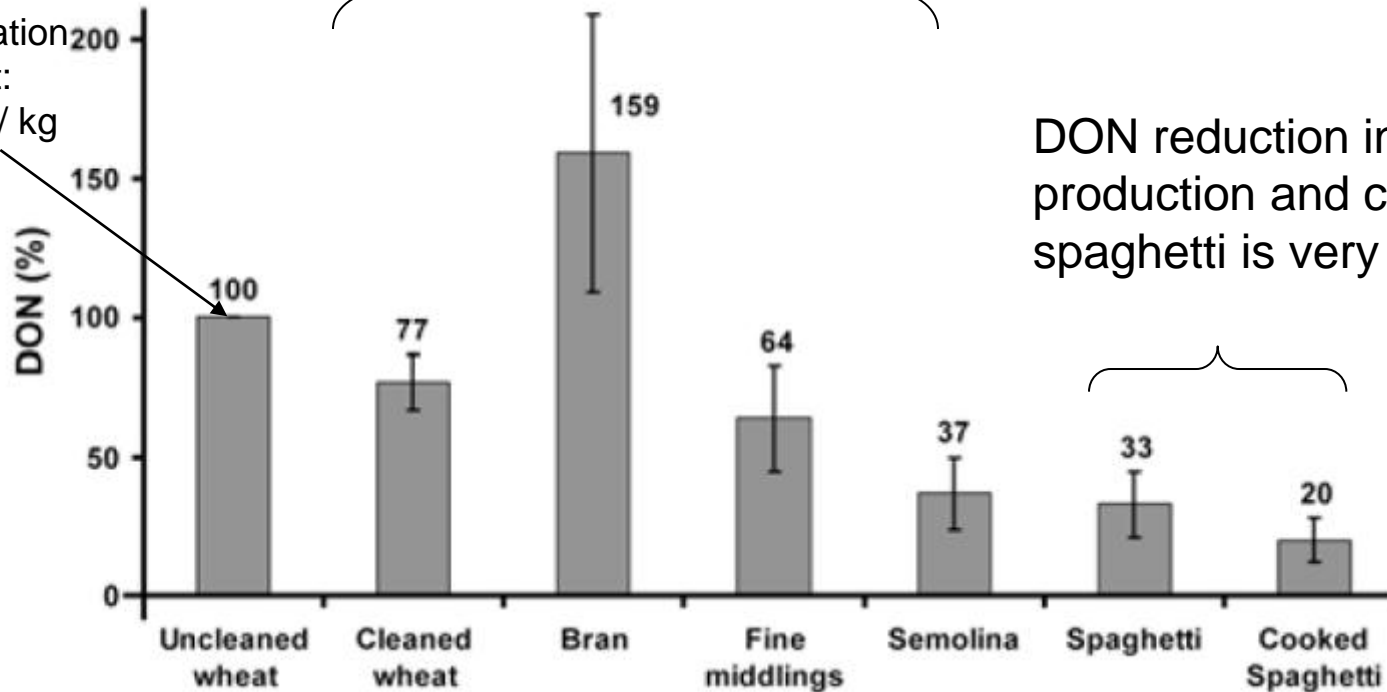
Risk containment measures for mycotoxins

- The best prevention is rapid drying of grain after harvest at moderate temperatures (<60 ° C) to grant storage @ water content below 14% wb
- Control of temperature and humidity during storage. Optimal conditions: T <25 ° C, water content ≤ 14.0% (relative humidity <65% at 25 ° C).
- Decontamination / separation:
Detection and separation of contaminated kernels; according density, color and appearance.
Elimination of the outer layer of the grain. At least outer pericarp, 0.4 -1.0% of the wheat.
- Monitoring the concentration of mycotoxins in raw material at the intake. Due to the inhomogeneous distribution of mycotoxins it is essential to have an appropriate sampling procedure.

Relative change of concentration of DON in durum wheat processing

The cleaning and grinding of wheat (bran separation) substantially reduce the concentration of DON

Initial concentration in durum wheat:
300 - 1310 mg / kg

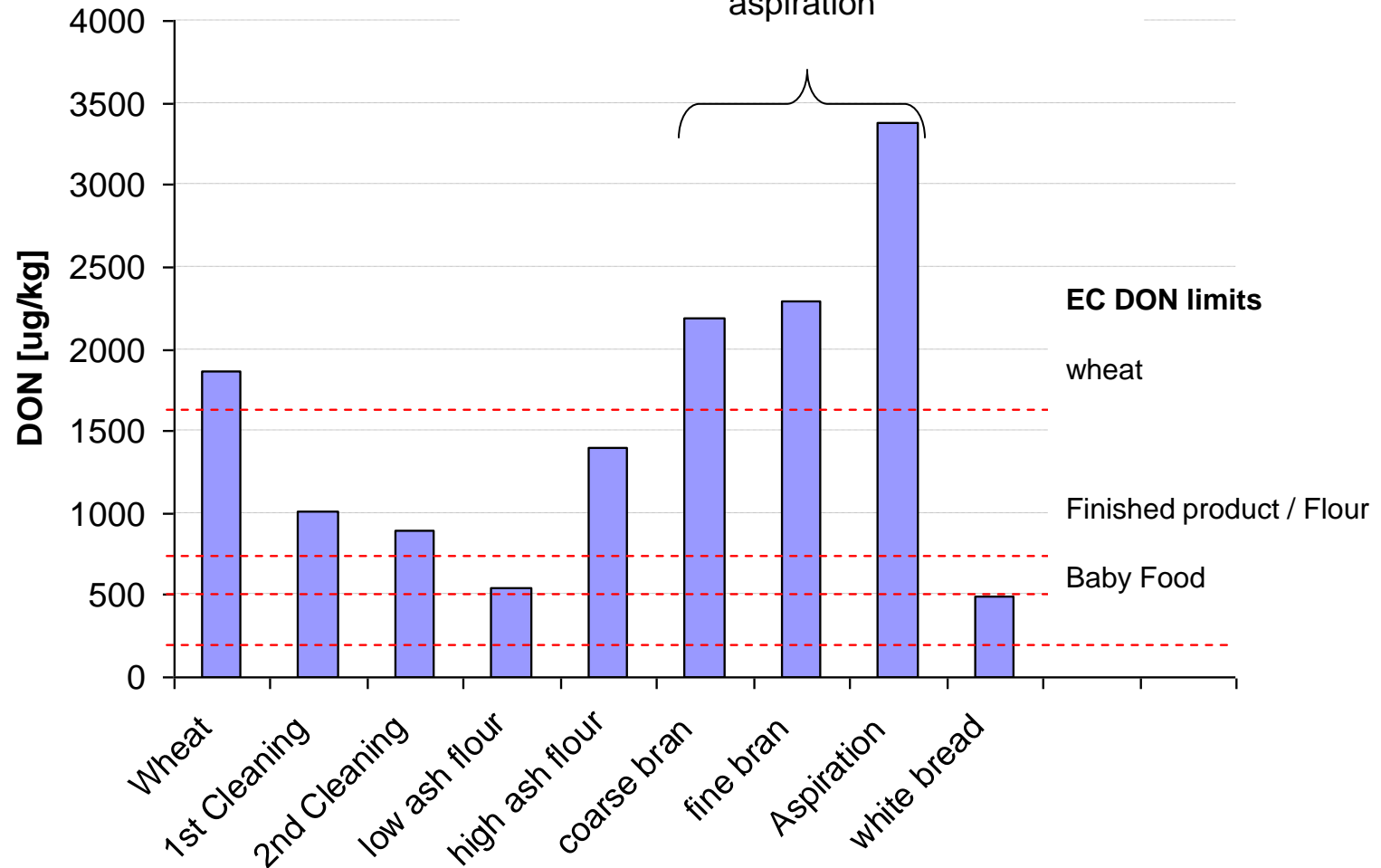


DON reduction in the production and cooking of spaghetti is very limited.

Visconti A. et al, Cereal Chem. 87, 21-27 (2010)

The cleaning and grinding of wheat contribute to the reduction of DON.

The highest DON contamination was found in wheat bran and products separated by aspiration



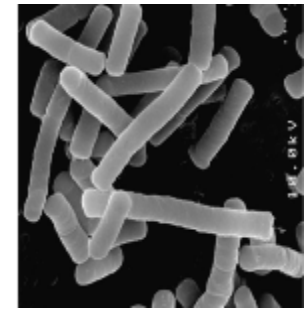
Wolf, Mycotoxin Research 21, 2005

Microorganisms: Bacteria

Bacteria are part of our life and our ecosystem

+

- there are more bacteria in the human gut than cells in the human body
- probiotic microorganisms (alive) are favorable to health when absorbed in adequate amounts
- Lactobacillus bacteria are applied in food fermentation



5 μm

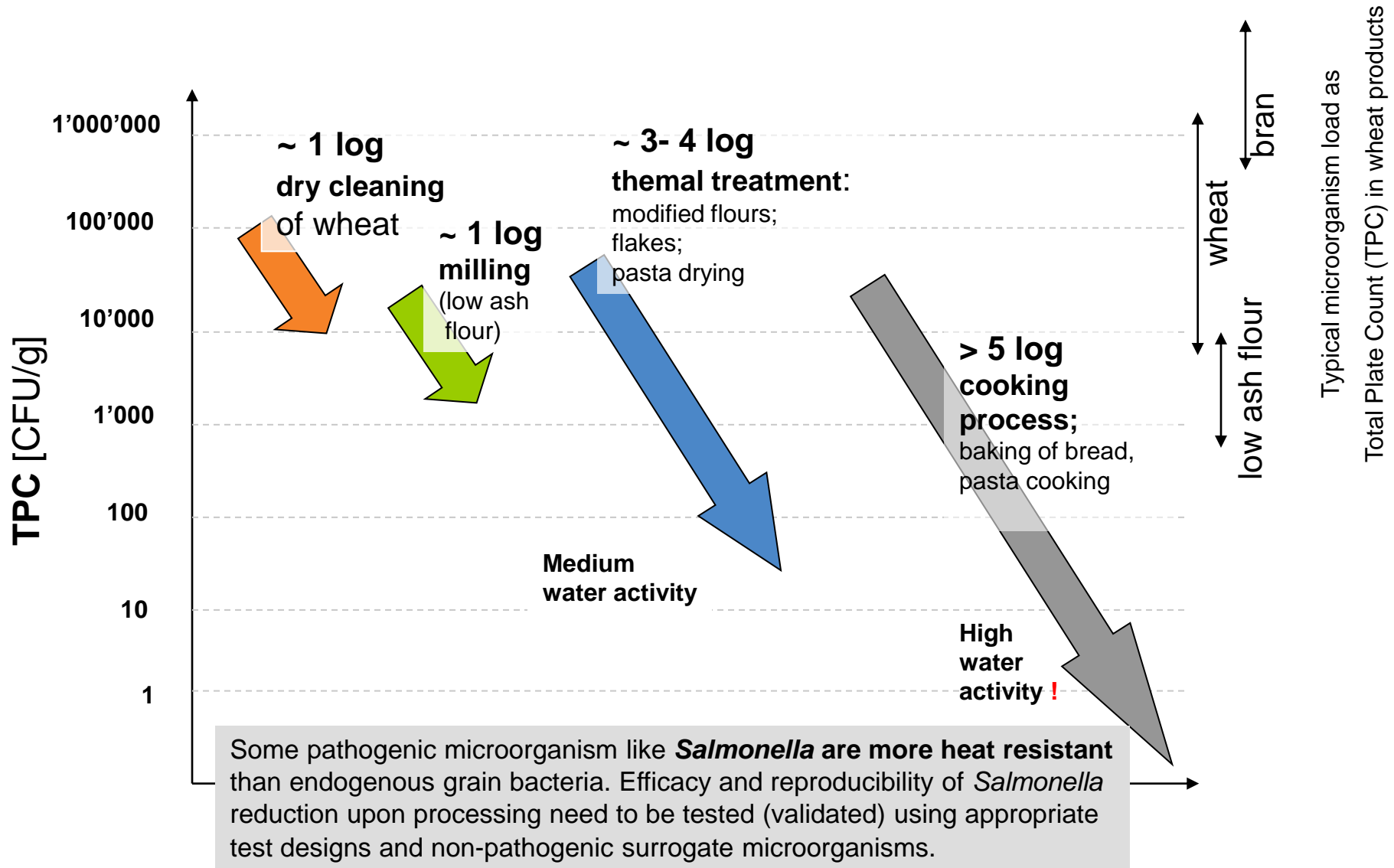
-

- microorganisms decompose organic matter and are responsible for food spoilage
- pathogenic bacteria are the leading cause of foodborne illness
- Salmonella, E. coli, listeria, staphylococcus, etc., are often to the source of foodborne disease



5 μm

Typical reduction of endogenous bacteria upon cereal processing



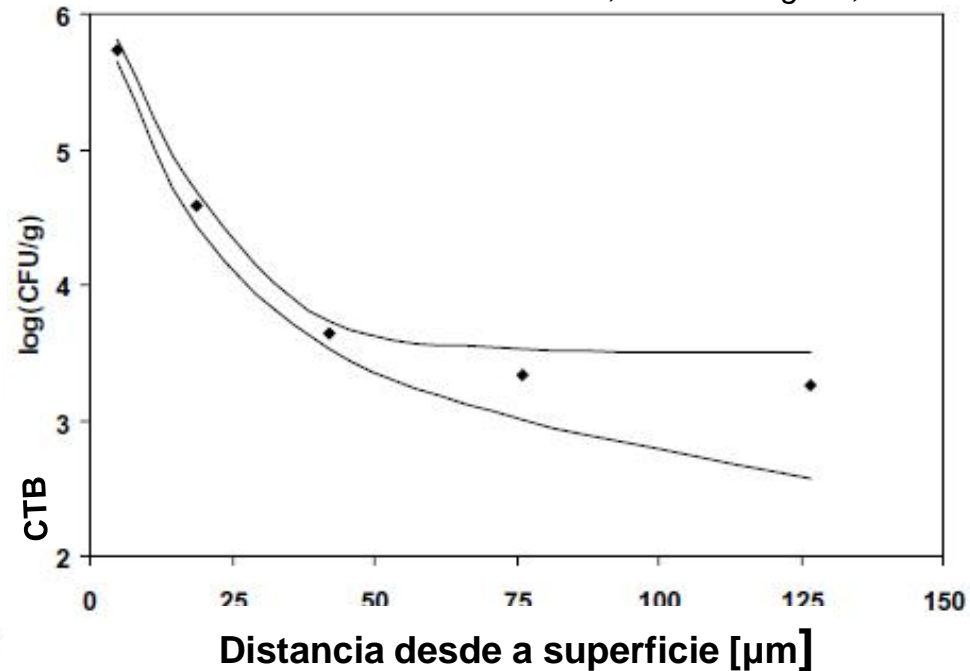
Wheat is inhabited by bacteria

Laca et al., J. Food Eng. 72, 2006

APC* 10^4 - 10^6 UFC/g



10 mm



- Microorganism concentration is high at the surface and decreases toward the interior of the grain.
- Endogenous bacteria are not pathogenic on cereals, but pathogenic bacteria may be present

* APC: total mesophilic aerobic bacteria

Salmonella multiplies in the presence of water (water activity > 0.93) and may represent a hazard in dry food



Example:

Salmonellosis case in the U.S. in 2009 caused by breakfast cereals

March 2009: The Minnesota State Health Department has launched an investigation to determine if the latest salmonella poisoning outbreak is linked to the cereals manufactured by Malt-O-Meal.

On April 5, 2009 Malt-O-Meal made a voluntary recall of unsweetened puffed wheat and puffed rice cereals after a routine testing has shown that they had been contaminated cereals..

Pathogenic forms of E. coli can cause foodborne illness

| Nestlé Cookie Dough Recall

© Nestlé Commercial Photo



June 2009

Nestlé announced the recall of refrigerated cookie dough.

According to FDA there were 66 cases of illness in 28 U.S. states since March 2009.

Bacteria can multiply rapidly in food containing water (fresh dough) when the cooling is insufficient.

Multiplication is exponential!

The Codex Alimentarius does not establish specific limits for bacteria in wheat flour

Codex Standard 152-1985
revised 1995

CODEX STANDARD FOR WHEAT FLOUR

CODEX STAN 152-1985

3.1 Quality factors – general

- 3.1.1 Wheat flour and any added ingredients shall be safe and suitable for human consumption.
- 3.1.2 Wheat flour shall be free from abnormal flavours, odours, and living insects.
- 3.1.3 Wheat flour shall be free from filth (impurities of animal origin, including dead insects) in amounts which may represent a hazard to human health.

It is the responsibility of the food processor to analyze hazards and establish control measures as necessary

Containment measures to reduce hazards of allergens and gluten

- **Avoid cross contamination**
- **Guarantee traceability**
- **Proper and correct labeling**

Products made out of **Wheat, Oats, Rye, Barley or Malt** contain gluten!

Gluten: maximum limit for gluten-free products is 20 mg of gluten per kg (20 ppm)

Allergens: there is no limit to allergens

La 'crisis del pepino' deja pérdidas millonarias a los agricultores españoles

La ministra de Medio Ambiente, Rosa Aguilar, urge a Alemania a concluir la investigación para determinar el origen de la intoxicación por 'E.coli', que ha dejado 14 muertos

- Rusia prohíbe la importación de verduras españolas
- Sube a 14 el número de fallecidos por la bacteria
- "La causa puede estar en el manipulado"
- La alarma desborda las fronteras de Alemania



La consejera de Agricultura andaluza visita un invernadero. / F. B.

El Pais, 31st May 2011

The EHEC crisis has shown..

...the impact if the medias within communication

...the consumer uncertainty

...the hasty reactions of the authorities

...the difficult search for scientific answers

...the economic damage

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Product safety.

Clues and where to take influence.



- Monitoring and control of RM and FP
- Defined and standardised processes
- Sanitation optimised production environment
- Up to date equipment
- Continuous online observation
- Preventive maintenance and Housekeeping
- Information and Training of employee

Recommendations for flour mill building design.

Building



- Minimize windows to reduce emissions and imissions
 - Noise
 - Dust
 - Insects
 - Rodents
- Window insect screens
- Spring loaded doors
- No level window sills

Air make-up



- Control humidity and temperature of process air
 - Avoid condensation
- Slight overpressure in mill building

Cleanability



- Epoxy flooring
- Round corner finish
- Grated cable trays – preferably vertical orientation

Implementation of high sanitation design concepts.



**Easy access for cleaning
Example MDDR Roller Mill**



**Use of stainless steel
Example MPAK Sifter**

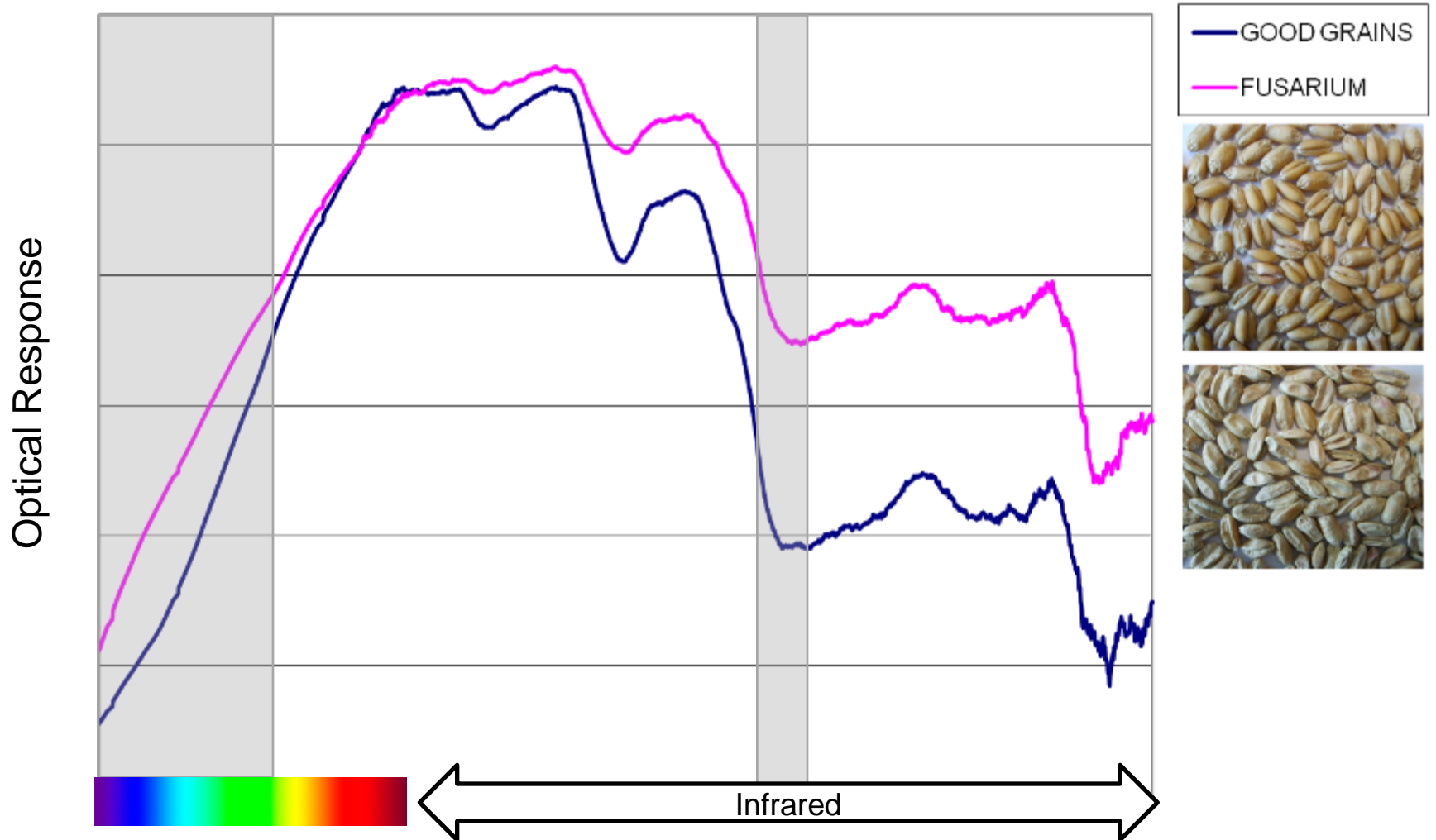


**Smooth profiles
Example Novapur Sieves**



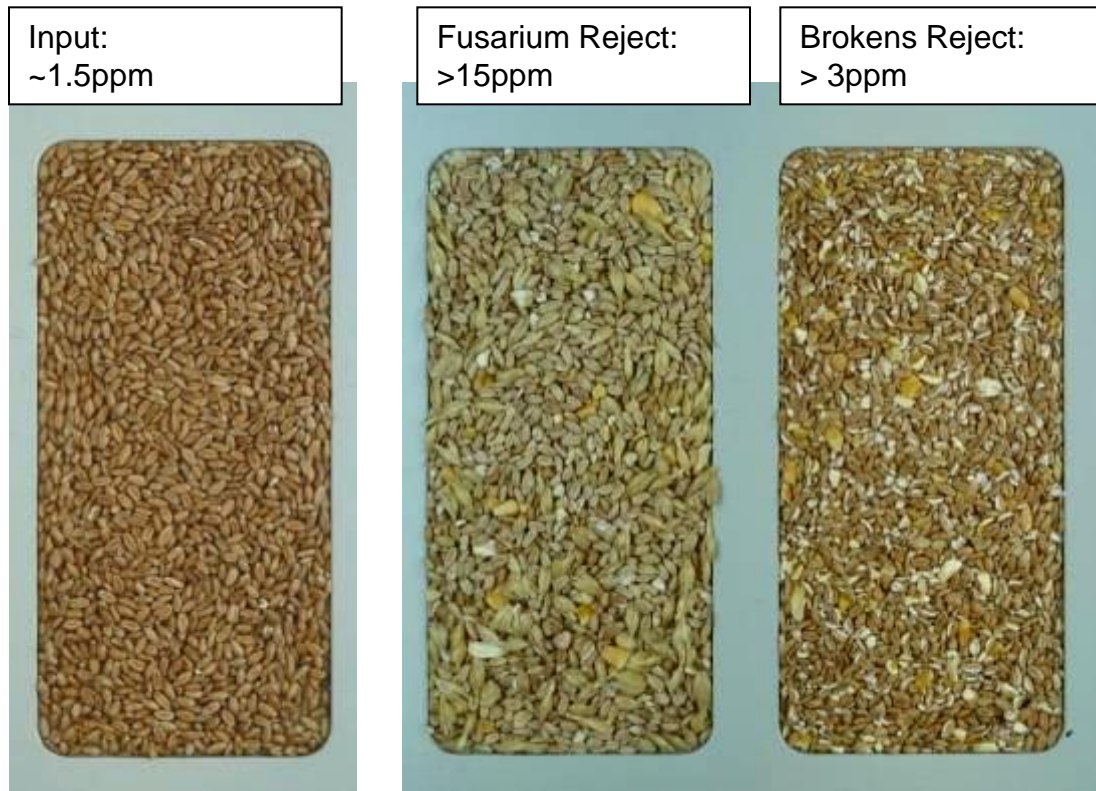
**Closed design
Example MQRG Purifier**

Optical Signature Comparison



Defect Removal Segregated





- Contamination tests were carried out on specific elements of the rejected product.
- This confirmed that the majority of contamination lies in the fusarium affected grains, but that the broken grains also have a higher contamination than the input product.

Light peeling process to remove surface contaminants.

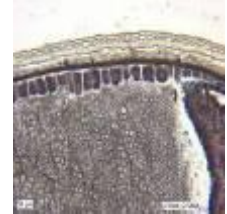
Application

- Peeling process to remove surface contamination

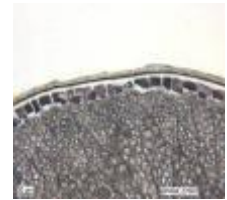
Features

- Gentle removal of surface contamination such as sand, bacteria and pesticides
- Contaminants are removed by friction between kernels and rotor and screen jacket, as well as kernel to kernel

Before
Light
Peeling

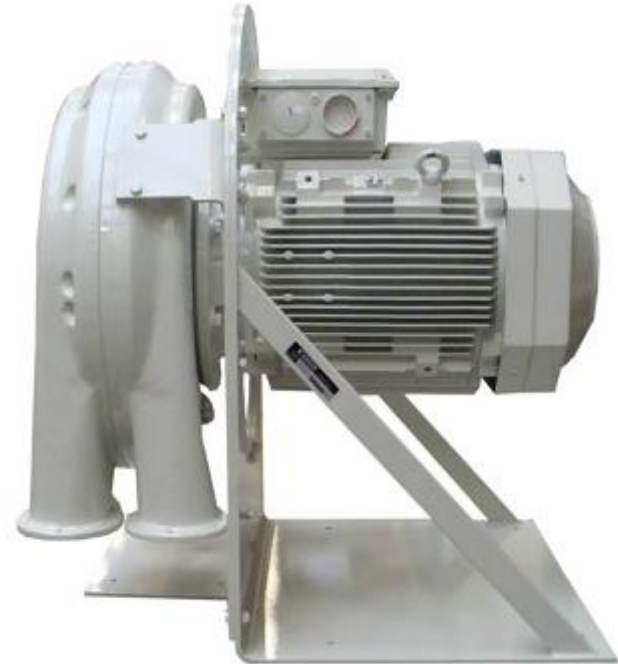


After
Light
Peeling



Why mechanically sterilize flour?

- Improvement of shelf life of wheat flour
- Ministry of Health started to communicate in September 2010 that BPO (Benzoyl peroxide) will be outlawed as a flour additive
- Chinese government emphasizes the production of hygienic and safe food with the implementation of the new Safe Food Legislation in June 2009
- Large international flour consumers operating in China start to demand that Chinese flour mills treat their flour with an impact machine before shipping
- Use of MJZG is standard practice in the flour milling industry both in Europe and USA

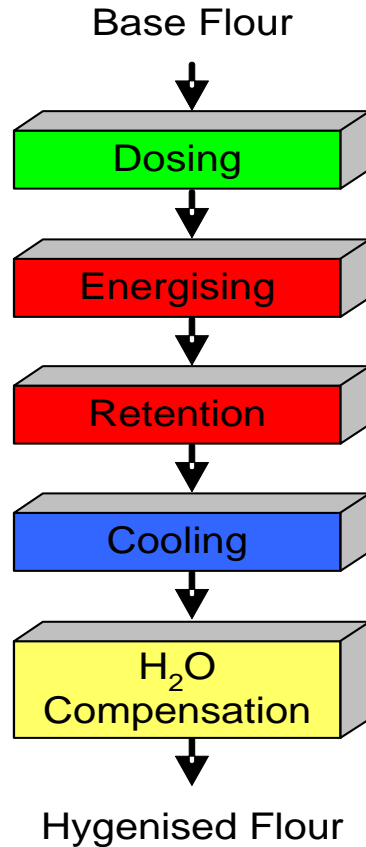


Food Safety / Sanitised Food

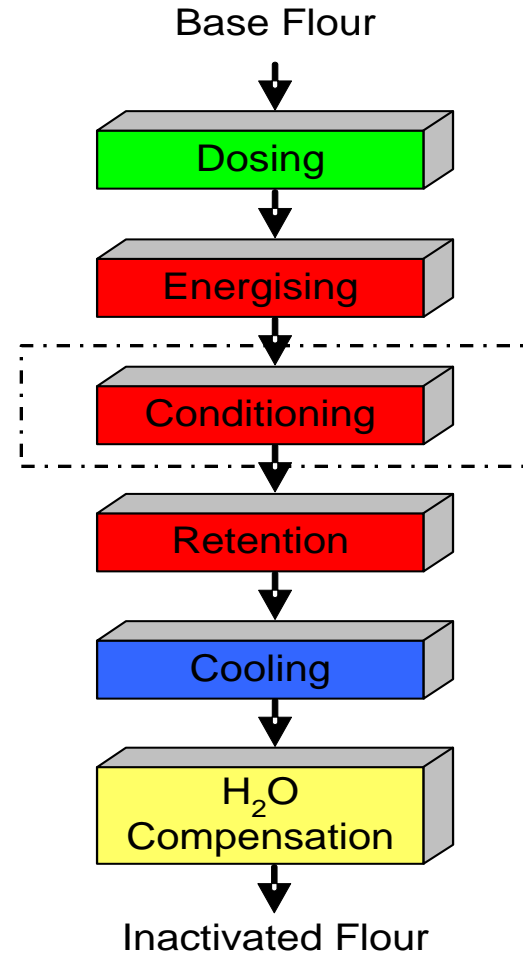
- **Reduction of total plate/germ count**
- **Minimised impact on flour properties**
- **Flour suitable for:**
 - Fresh (refrigerated / frozen) Doughs
 - Yeast-risen Doughs
 - Cookie Doughs
 - Soup Flours
 - Carrier Flour for Premixes
 - Infant Food

Thermal and Hydro-Thermal Process

Flour Hygienisation



Flour Inactivation



Process Layout – Hygienisation

