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Food safety risk management in bakeries

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Introduction

- ❑ Wide variety of bakery products are produced: wheat loafs, rye breads, buns, coffee breads, cakes, cookies, pizzas, pies etc.
- ❑ Food hygiene is vital throughout the whole food chain - from raw material to transportation of ready products



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Food safety management

- ❑ Food legislation (Local and EU legislation)
- ❑ Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP)
- ❑ HACCP (Hazard Analysis and Critical Control Point)
- ❑ Quality management system (ISO 9001, ISO 22000, BRC, other)



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Product contamination

- ❑ The main routes of contamination – surfaces, air, water, people and pests
- ❑ Physical contamination - pieces of glass, wood, metal, plastic, film, human hair and fingernails, plasters, jewellery, small personal belongings, pests, paper, cardboard.
- ❑ Chemical contamination - residues of cleaning and disinfection chemicals, machinery lubricants, synthetic preservatives, food additives, pesticides
- ❑ Biological contamination – microbiological (bacteria, yeasts, mould, mycotoxins) and pests



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Microbiological contamination

- ❑ Spoilage of most bakery products is caused mainly by moulds, yeasts and seldom by bacteria
- ❑ Most bakery products, in general, are not considered as high-risk food products because baking at relatively high temperatures (around 180-250 °C) is involved in their preparation
- ❑ Many bakery products have reduced water activity (a_w) and pH, which prevent the growth of microorganisms
- ❑ Potentially hazardous foods have a pH > 4.5 and an $a_w > 0.84$



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pH Range of Selected Bakery Products (Cauvain et al., 1999)

☐ **High Acid**

Sourdough bread 4.2–4.6

Apple pie 4.2

☐ **Low Acid**

White bread 5.7

Whole wheat bread 5.6

Chocolate nut bread 6.2–
6.6

☐ **Non-Acid**

Crumpets 6–8

Banana nut bread 7.2–7.9

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Range of Water Activity (aw) of Selected Bakery Products (Cauvain et al., 1999)

☐ Low Moisture Content

Cookies 0.2–0.3

Crackers 0.2–0.3

☐ Intermediate Moisture Content

Cake type doughnuts 0.85–0.87

Chocolate-coated doughnuts 0.82–0.83

Danish pastries 0.82–0.83

Cream-filled cake 0.78–0.81

Soft cookies 0.5–0.78

☐ High Moisture Content

Bread 0.96–0.98

Pita bread 0.9

Yeast-raised doughnuts 0.96–0.98

Fruit pies 0.95–0.98

Carrot cake 0.94–0.96

Custard cake 0.92–0.94

Cheesecake 0.91–0.95

Butter cake 0.9

Pizza crust 0.94–0.95

Pizza 0.99

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Microbiological contamination

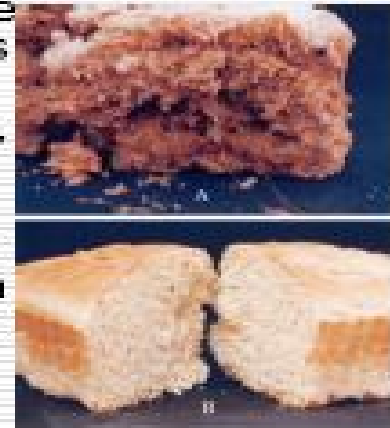
- ❑ Flour contains approximately 8000 mould spores in 1 g.
- ❑ The most common bread spoilage moulds are *Penicillium* spp. and *Aspergillus* spp.
- ❑ Both can produce mycotoxins (Ochratoxin A and Aflatoxin), which are very resistant and can survive heating process
- ❑ *Rhizopus (nigricans) stolonifer* is the common black bread mould



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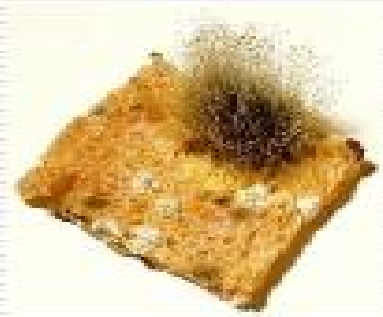
Microbiological contamination

- ❑ *Bacillus subtilis* and *Bacillus licheniformis* can cause ropiness in wheat bread, but rope is now rare because of adding preservatives and good bakery hygiene practice
- ❑ *Bacillus cereus* may survive baking process, because *Bacillus* species can form endospores
- ❑ A major reservoir of *Staphylococcus aureus* are humans and some outbreaks have been involved with bakery products (for example filled pies)
- ❑ *Listeria monocytogenes* (bakery products containing dairy ingredients), *Salmonella* spp. (cake mixes made with dry eggs).



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Microbiological contamination



- ❑ It is very important to keep the cold chain of frozen bakery products
- ❑ Many ingredients, such as fresh and synthetic cream, cold custard, icings, spices, nuts, and fruit toppings or fillings, are added after baking and may be a potential source of contamination.
- ❑ Using preservatives (sorbic acid, calcium propionate), sourdough, modified atmosphere packaging (MAP), vacuum packaging, microwave and infrared radiation are methods to control the microbiological spoilage.

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MAP

- ❑ Modified atmosphere packaging (MAP) using CO₂-enriched gas atmospheres can extend the mold-free shelf-life and keeping quality of a wide variety of bakery products stored at ambient temperature.
- ❑ Because *S. aureus* can grow facultatively, MAP will not inhibit its growth or enterotoxin production

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Raw materials

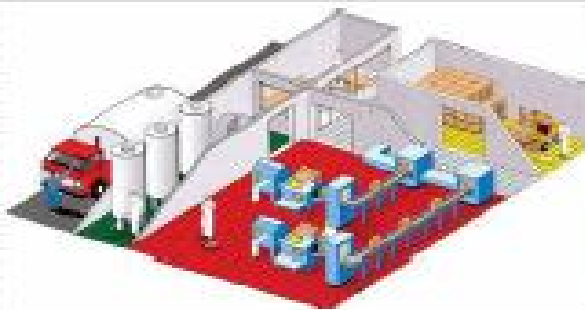
- ☐ Quality and safety of baking ingredients – flour, yeast, other ingredients
- ☐ Cold-chain for fast-spoiling ingredients (transport)
- ☐ Visual control (broken and dirty package, shelf life)
- ☐ Controlling the temperature of fast-spoiling ingredients
- ☐ Quality sheets and certificates
- ☐ Safe handling and storing
- ☐ FIFO (First in, first out) principle



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Cleaning and sanitation programs

- ☐ Documented and monitored programs for building, utilities, plant and all equipment
- ☐ Appropriate, effective and regular cleaning methods
- ☐ Cleaning and sanitation materials – where appropriate, confirmed suitability for food use
- ☐ An average shelf life of bread is 3-5 days, but if the hygiene and sanitation of a bakery is poor, the shelf life of bread, especially some wheat bread, can be shorter



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Cleaning and sanitation programs

- ❑ Proofing cabinet needs to be cleaned regularly, because proofing conditions (temperature 30-40 °C and humidity 60-80 %) are appropriate for the growth of bakery yeast, but also for moulds.
- ❑ Conveyor belts, cooling conveyors – regular cleaning is needed!
- ❑ It is recommended to disinfect slicing and packing machines



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Disinfection



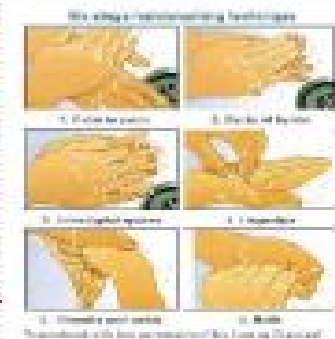
- ❑ According to literature Benzalkonium chloride was efficient against most fungi.
- ❑ Some fungi (*P. roqueforti* and *P. carneum*) showed to be resistant towards alcohols, but 3% hypochlorite efficiently eliminated them.
- ❑ Quaternary ammonium compounds, 70% ethanol, 70% isopropanol and 30% hypochlorite were effective on yeasts.
- ❑ It is suggested to use different types of disinfectants at the same time to prevent resistance problems.
- ❑ Problems with mould usually occur more in spring and summer.

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Personal Hygiene



- ☐ Documented hygiene rules communicated to all personnel
- ☐ Regular and effective hand washing (before starting work, regularly during work, after eating/smoking/using toilet)
- ☐ Appropriate and clean clothing is critical to the safety of products
- ☐ Jewellery and watches shall not be worn
- ☐ All cuts and grazes on skin should be covered with coloured plaster (blue where possible)
- ☐ Fingernails – short, clean, unvarnished
- ☐ Scalp hair should be fully covered
- ☐ Gloves (blue where possible)
- ☐ It is permitted to work while being sick!
- ☐ Rules for mechanics, subcontractors and visitors



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Pest Control

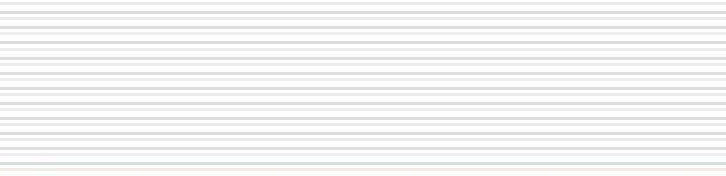
- ❑ **Birds, insects and rodents are potentially a major contamination problem in bakeries**
- ❑ **Appropriate design of production building, ceilings and walls – to keep pest out and not allow them to live there**
- ❑ **Written preventive pest control program and regular inspection for all areas of the site to minimize pest infestation**
- ❑ **Flour dust spreads easily everywhere - regular cleaning is very important!**
- ❑ **Silos, ingredient dosing systems, mixers, curling chains, conveyor belts, ovens, cooling conveyors, packaging machines, walls etc. should be properly cleaned to prevent infestation outbreaks**



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Pest control

- ❑ Fumigation for silos – a method of pest control that completely fills an area with gaseous pesticides - or fumigants - to suffocate or poison the pests within
- ❑ Pheromone insect trap
- ❑ UV lamps – electric trap for flying insects
- ❑ Insecticides - a pesticide used against insects in all developmental forms
- ❑ Rodenticides - pest control chemicals intended to kill rodents (should be used outside of building)



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Pest control



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Process control

- ❑ Foreign body detection - sieves, magnets, metal detectors, x-ray detectors
- ❑ Control of preservatives and food additives - the use of preservatives and food additives should be under control
- ❑ Process control – baking temperature, cooling time
- ❑ Control of cooling and freezing temperatures



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Process control

- ❑ Microbiological samples from production air, water, product, equipment, crates and hands of employees.
- ❑ Raw material, pies, pizzas and cakes should be stored according to the instructions and kept in fridge if needed
- ❑ More than 90% of contamination of bread occurs during cooling, slicing or wrapping operations.



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Process control



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Equipment and maintenance

- ❑ All equipment should be constructed of appropriate materials and have a suitable design so that they can be effectively cleaned
- ❑ Buildings (floors, walls, ceiling, non-contact surfaces) should be maintained to minimize the risk of product contamination
- ❑ Regular maintenance program for equipment to prevent product contamination by foreign bodies arising from equipment failure
- ❑ Paints and lubricants shall be suitable for intended use
- ❑ Cleaning of ventilation system (tubes, filters) – inside and outside surfaces



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Training

- ☐ Food hygiene training for bakers, packers, other operators, warehouse workers, mechanics, supervisors, cleaners, dispatch workers, drivers
- ☐ Understanding of HACCP, CCP-s (Critical Control Points), critical limits, GMP, GHP
- ☐ Cleaning and sanitation process
- ☐ Housekeeping rules
- ☐ Employees should be trained to understand the risk associated with cross-contamination from raw foods and dirty surfaces coming into contact with equipment, clean surfaces and ready product



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Storage and transport

- ☐ Procedures to guarantee product safety during storage, loading and transportation
- ☐ Cleanliness of storage areas and vehicles
- ☐ Controlling temperatures, cold-chain (Frozen bakery products)
- ☐ Use of castors or pallets under crates
- ☐ Do not leave products outside - BIRDS!
- ☐ Maintenance for vehicles



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Conclusions

- ❑ Food safety risk management in bakeries is to implement practices based upon food storage and handling, cleaning and sanitation, pest control, personal hygiene, maintenance program, safe transportation etc.

