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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
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 (aw) and pH, which prevent the growth of microorganisms.
- Potentially hazardous foods have a pH > 4.5 and an aw > 0.84.
## pH Range of Selected Bakery Products (Cauvain et al., 1999)

<table>
<thead>
<tr>
<th>High Acid</th>
<th>Non-Acid</th>
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<tbody>
<tr>
<td>Sourdough bread 4.2–4.6</td>
<td>Crumpets 6–8</td>
</tr>
<tr>
<td>Apple pie 4.2</td>
<td>Banana nut bread 7.2–7.9</td>
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<tr>
<td>Low Acid</td>
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<tr>
<td>White bread 5.7</td>
<td></td>
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<tr>
<td>Whole wheat bread 5.6</td>
<td></td>
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<tr>
<td>Chocolate nut bread 6.2–6.6</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Range of Water Activity (aw) of Selected Bakery Products (Cauvain et al., 1999)</th>
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</thead>
<tbody>
<tr>
<td><strong>Low Moisture Content</strong></td>
</tr>
<tr>
<td>Cookies 0.2–0.3</td>
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<tr>
<td>Crackers 0.2–0.3</td>
</tr>
<tr>
<td><strong>Intermediate Moisture Content</strong></td>
</tr>
<tr>
<td>Cake type doughnuts 0.85–0.87</td>
</tr>
<tr>
<td>Chocolate-coated doughnuts 0.82–0.83</td>
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<tr>
<td>Danish pastries 0.82–0.83</td>
</tr>
<tr>
<td>Cream-filled cake 0.78–0.81</td>
</tr>
<tr>
<td>Soft cookies 0.5–0.78</td>
</tr>
<tr>
<td>Pizza crust 0.94–0.95</td>
</tr>
</tbody>
</table>
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
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).
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.
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
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
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.
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 pests 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
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
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.