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Optimization in the sliced bread area

The hygiene-climatic operating status was linearly recorded, assessed and incrementally optimized from baking-off onwards over a period of three months in a leading German industrial bakery business focusing on the production of toast bread and mixed bread.

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++ **Monitoring the surface inflow temperature between baking-out and the cooling room**

The task remit was to analyze how and where mold can enter the process area, and how this can be permanently eliminated by suitably adapted measures. Here one encounters two "old acquaintances" that are chiefly responsible for visible product infestation: the mold fungi Rhizopus and Monascus ruber.

The following scenarios are a repeating (temporary) reality in an example area producing sliced / packed toast bread and sandwich bread, e.g. unsliced mixed wheat breads. Rhizopus forms a spider's web-like brownish to black mold film with long sporangiophores. Monascus ruber appears as an orange to reddish growth on infested surfaces. Both of these species are often already easily visible on the product after 24 hours, and often make the goods unsaleable. Because Rhizopus spreads very quickly over a large area once it appears within the production zones, particular care and attention is advisable here. The special characteristic of Monascus ruber is that it is highly temperature-resistant, which is why this species also often survives pasteurization.

Risk identification and analysis

As a basis, the hygienic risk to food safety/shelf-life is taken as an example for baked goods. Subdivision takes place according to the hygiene sensitivity of the respective products. The basis is always an assessment of the respective product, and the accompanying classification as to the processing step after which risk potentials are present, and their expected magnitudes. Risk assessments/analyses carried out by analogy with IFS/BRC Food demonstrate:

Hygiene sensitivity of the respective products		
1 = low	e.g. shelf life >3 months	wrapped and packed foods/ baked goods
2 = medium	e.g. shelf life >1 week	stabilized, or consumed immediately after manufacture
3 = high	e.g. shelf life <1 week	suitable for consumption as intended, without heat treatment, and for consumption raw/uncooked

- the existing hygienic foodstuff quality and safety/security
- the company's existing HACCP concept (adequate?)
- and the existing hygiene (hygiene management) in the company
- the hygienic risk basis for audits
- They also create the basis for a BCR Balance between Chance & Risk

Guideline for a cluster study of the hygienic weak points in a process sequence

- Production logistics with production technology and building conditions (recording the building's condition and process technology)
- Process operations after the baking process (linear process environment as far as packing)
- Process technology in the make-up area, e.g. slicers, conveyor belts etc. (occurrence of internal contamination burdens such as dusts in the slicing area or at belt-to-belt transfer points)
- Process environment technology, e.g. cooling, ventilation etc. (air production units with filter stages and internal air distribution)
- Procedure for purification/disinfection (cycles and methods)
- Employee behavior (e.g. unauthorized opening of doors and windows, uncontrolled movement between hygiene zones etc.)

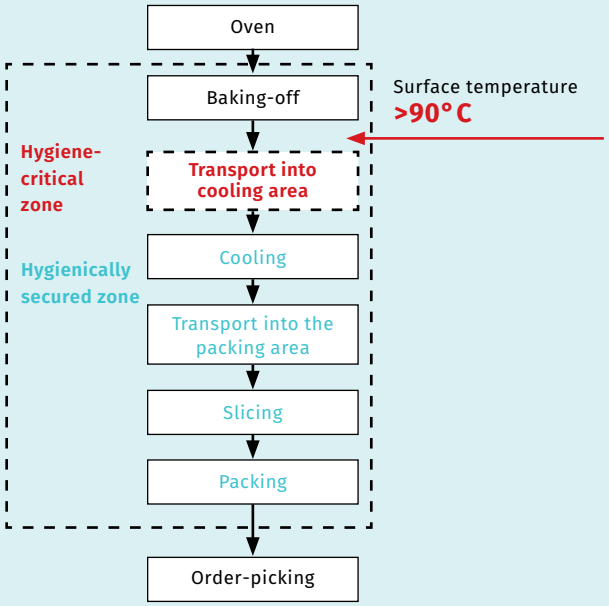
Practical implementation

When the process sequence after baking-off toast/sandwich breads, as well as mixed wheat breads, is considered as a step system of its own, a cybernetic consideration of both the hygiene/air-conditioning and the structural environmental conditions quickly yields indications as to where and how hygienic risks arise.

Taking the production of toast-bread and unsliced wheat mixed breads as an example, and by using a simple examination/ analysis linearly relative to the process sequence, a manifesting hygienic risk examination can take place, including by analogy

with IFS/BRC, to already identify possible risks at the preliminary stage and to adopt suitable measures before damage occurs. This involved analytically recording all the process steps after baking (airborne germ measurements, surface germ measurements, air flow visualization, surface temperature measurements). The remit for this also included structured risk identification. Here, the individual process steps downstream of the baking process were considered and divided up into critical zones. The crucial question is where does the re-contamination risk start in the bread production process? Are preserving agents used, or is there a downstream pasteurization step? Basically, freshly baked-off bread has thermal self-protection to a surface temperature of >90°C; if the temperature falls below this value, the thermally-dependent air flow out of the bread (depending on the porosity) can change to the reverse direction. By this time, however, the product should already be in a controlled hygiene/air-conditioning environment.

Diagrammatic representation of the hygiene-critical zone after baking-off



Targeted risk minimization

After completing the hygiene/air-conditioning process environment data recording/risk assessment, however, secure optimization measures can also be deduced from the results, and these measures are coordinated in accordance with the internal requirements, e.g. limit values. A few examples relating to optimization are illustrated below.

Integrating the measures into the expanded HACCP

A targeted analysis of the process environment as a parameter of the linear process sequence allows a secure, transparent assessment of existing hygienic risk potentials, and contributes, through the coordinated optimization measures, to ensuring increased hygienic food safety. Based on the results, it is possible to technically and operationally design and evaluate hygiene- and climate-improving measures/changes at the measurement points previously taken. The master air management & hygiene management were taken into account and divided up separately from one another in their economic implementation in an industrial operation producing toast-breads and sandwich breads.

Air management through controlled climate

+ Incoming, outgoing and circulating air (filtered)
+ Conditioning (cooling/heating) the air
+ Removing internal contamination loads (e.g. slicing dusts) by vacuum
+ Air flows from clean to dirty

Air management was implemented by a ventilation/air-conditioning plant in the cooling/slicing and packing area, with a controlled positive pressure in the respective regions. The air change rate was 3.5/hour with three-stage removal by filters (M5, F7 & F9). Abrasion and slicing dusts arising are to the largest possible extent removed from the room via a high-vacuum suction exhaust system (-25,000 Pa) with the smallest possible air volume per exhaust suction point, which had a positive effect on the cleaning of the plant and of the room space.

Hygiene management through tailored hygiene procedures in ongoing operation

+ Alternative, natural ingredients
+ Sanitization, including during production
+ Automatic distribution via simple hygiene system technology

Hygiene management was implemented separately through the use of a new, alternative hygiene technology, 'food protect', based on natural constituents and dispersed into the room via simple cold nebulization (without increasing the air humidity). The 'food protect' method is based on physical laws by which the surfaces and the air are simultaneously reached and sterilized. Airborne germ collections and surface germ tests were carried out to examine the sustained hygiene safeguarding in the areas downstream of baking-off and through cooling and make-up. These were evaluated before and after treatment using the new hygiene technology.

Hygiene transition areas

As a critical transition area, mold contamination levels were recorded in the region downstream of baking-off by hygiene analysis via airborne germ measurements and surface contact plate tests in the initial state and after treatment using natural sanitizing. Here there were two especially important species that spread very quickly over a large area (Rhizopus) and also show a certain level of thermal resistance (Monascus ruber).

Clean-room zones

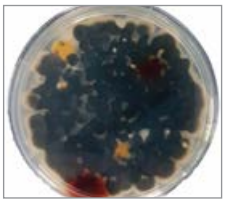
Operational limit values for airborne germ and surface germ contaminant loading were taken as a basis in these areas, and tests were carried out using the 'food protect' alternative hygiene process. The prescribed limit values in the toast/sandwich areas were:

- Airborne germs related to mold: 5 cfu/m³
- Surface germ contamination load related to mold: cfu/25 cm² (cfu = Colony-forming units)
- There were no limit values for GKZ (Total Colony Count) due to its slight relevance.

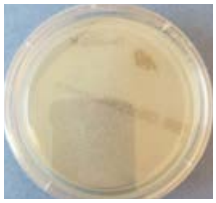
Airborne germ measurements in the baking-off area and transport into the cooling area

	August 1, 2018 before treatment	August 3, 2018 with treatment (2 days)
	Yeasts & molds	Yeasts & molds
Contact plate test	cfu/m³	cfu/m³
Oven exit/Depanner	Overgrown	15
Between oven and cooling tower entry	Overgrown	0

++ Before treatment: Rhizopus



++ Before treatment: Monascus ruber



++ After treatment

Surface germ measurements in the baking-off area and transport into the cooling area

	August 1, 2018 before treatment	August 3, 2018 with treatment (2 days)
	Yeasts & molds	Yeasts & molds
Contact plate test	cfu/25 cm²	cfu/25 cm²
Conveyor belt after baking-off	Overgrown	3
Conveyor belt to cooling tower entry	Overgrown	0

++ Before treatment: Rhizopus

++ Before treatment: Monascus ruber

++ After treatment

Surface germ values

	August 1, 2018 before treatment		August 3, 2018 with treatment (2 days)	
	GKZ	Y+M	GKZ	Y+M
Contact plate tests	cfu/25 cm²	cfu/25 cm²	cfu/25 cm²	cfu/25 cm²
Cooling tower base	30	15	0	0
Machine 1 infeed belt	0	3	0	0
Line 2 spreader jaws (packaging)	0	1	0	0
Line 3 transfer belt slicing machine	2	2	0	0

To record the airborne germ contamination load, an impact method via an airborne germ collector with a 200-liter collection volume was used, and the values counted after incubation were extrapolated to 1 m³. At the same time, for extended hygiene safeguarding in the ongoing process, smaller amounts of 'food protect' were finely nebulized through a simple binary nozzle without increasing the air humidity.

Conclusion and outlook

Use of a prior hygiene-climatic process environment analysis, including the existing process and environment technology, enables points of weakness in the ongoing process to be identified with certainty in a simple, targeted way, and assessed according to IFS/BRC. Based on the results, optimization measures can be derived and budgeted. A division into air management and hygiene management also enables improved hygiene security together with a reduction in expenses to be achieved in a very short time. The technical optimization can then be described in functional specification documents and can be integrated into the production sequence stepwise and very economically by structural engineering means. +++

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Evaluation of airborne germ values

	August 1, 2018 before treatment		August 3, 2018 with treatment (2 days)	
	GKZ	Y+M	GKZ	Y+M
Airborne germ collections	cfu/m³	cfu/m³	cfu/m³	cfu/m³
Line 1 machine 3, toast-bread	0	5	0	0
Line 1 machine 2, sandwich bread	5	10	0	0
Line 1 machine 3, toast-bread	25	0	5	0
Cooling tower 1	0	5	0	0
Cooling tower 2	0	15	0	5
Materials airlock	10	25	10	5
Personnel airlock	15	35	5	10
Outside measurement	350	over-grown	200	over-grown
	August 1, 2018 before treatment (7 days)		**August 3, 2018 with treatment (19 days)**	
	GKZ	Y+M	GKZ	Y+M
Airborne germ collections	cfu/m³	cfu/m³	cfu/m³	cfu/m³
Line 1 machine 3, toast-bread	0	5	0	0
Line 1 machine 2, sandwich bread	5	0	0	0
Line 1 machine 3, toast-bread	0	0	5	0
Cooling tower 1	0	0	0	0
Cooling tower 2	0	5	0	0
Materials airlock	5	5	5	0
Personnel airlock	0	10	0	5
Outside measurement	400	over-grown	1,300	over-grown