Improving food & health

Bactoferm™ Meat Manual vol. 2

Fermented sausages with Chr. Hansen surface cultures

Contents

Introduction

Historically, wild in-house moulds were responsible for natural colonization of sausage surfaces, and the positive effects of moulds on aroma, texture and preservation of the product were frequently observed. However, the inconsistent performance of the wild flora has led to direct inoculation of the surface in order to get a uniform quality of the end products – especially a white and even cover avoiding the product failures caused by infestation with negative flora like *Mucor* or *Rhizopus* etc.

A famous example of dry fermented and smoked salami is the Hungarian salami, which develops a weak mould cover after having been smoked. In general smoke suppresses the growth of moulds but the extremely long maturation of the sausage and the high pH in the meat batter enables this layer of moulds. Other salamis like the air dried Milano type sausages has a whitish cover, which is more or less marbled.

Obviously, the surface culture or mould should be food grade and no toxins should be developed, so food safety is another reason why direct inoculation with pure food grade cultures is advantageous to manufacturers and consumers.

Advantages of moulds in fermented sausages

The market share of air dried, mold inoculated fermented sausages has increased consistently during the last decades, and the explanation is obvious as taste and aroma are appealing to consumers and moulds offer production advantages to the manufacturer. Moulds protect the sausage surface from ventilation, diminish the formation of dry rim and enhance a more even drying. Through the proteolytic and lipolytic activity (enzymatic breakdown of proteins and fat) they influence the maturing of the meat positively and provide a soft and non-chewy texture.

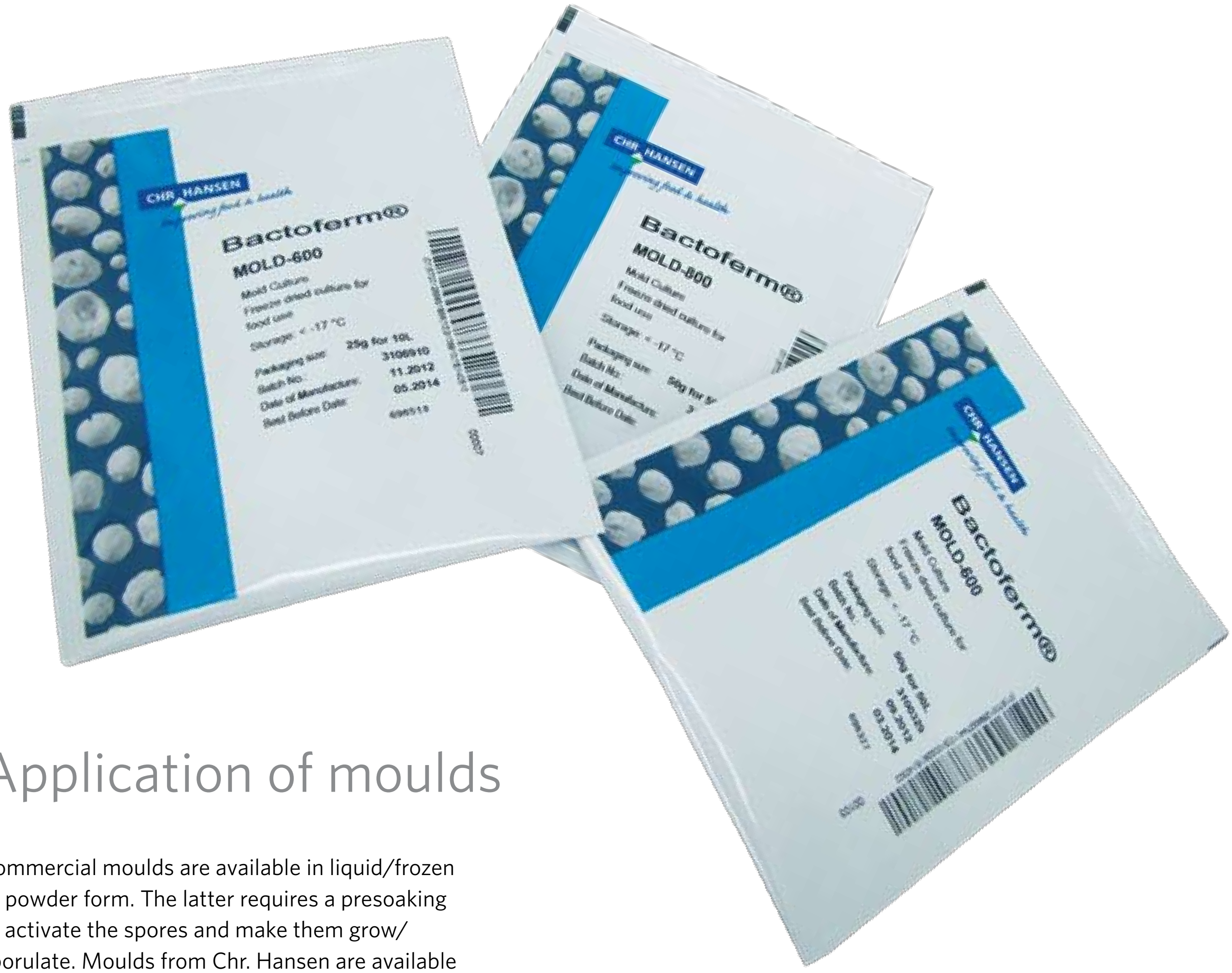
Drying is improved	• Dry rim effects are eliminated or improved • Color distribution is more even • Texture consistency is more even throughout the sausage diameter • Drying time is shortened
Aroma is typically enhanced	• By moulds/ yeast • By ammonia • By proteolysis/ lipolysis
Mediterranean aroma	• Moulds and yeasts enhance to perfection the "Italian" flavor profile • Direct inoculation stabilizes the aroma formation and the flavor profile can be more or less strong

Moulds from Chr. Hansen

The range of moulds from Chr. Hansen is developed to cover the needs from the market with respect to industrial production and end-product attributes. The features described in the chart below are based on observations made when the tested surface cultures/moulds were exposed to the same environmental conditions. Different effects may occur when growth conditions change. Moulds and their spores are very sensitive to air speed, relative humidity and temperature.

Culture (material no.)	Strains	Features
MOLD 600	*Penicillium nalgiovense*	• Fast growing and strong suppression of wild flora • Dense, medium fluffy and uniform coverage • Traditional white coverage • Pronounced mushroom flavor
MOLD 800	*Penicillium candidum* *Penicillium nalgiovense*	• Fast growing and strong suppression of wild flora • Dense, medium to very fluffy coverage • Generates a fresh camembert aroma / Strong mushroom flavor and a typical scent of moss • Good growth potential in dry and unstable growth conditions

Moulds and yeast can be combined as cover flora for fermented sausages. Yeasts have a faster development and moulds tend to grow better in presence of yeasts. The combination of mould and yeast leads to enhanced flavor very similar to the „wild" flora formerly used but without its negative aspects.



Application of moulds

Commercial moulds are available in liquid/frozen or powder form. The latter requires a presoaking to activate the spores and make them grow/ sporulate. Moulds from Chr. Hansen are available in a freeze dried powder form.

Dry culture

The inoculation dose in the form of dry spores should be soaked for two hours prior to use. After soaking the inoculation dose is added to non chlorinated water to create the required suspension volume.

The suspension is then applied to the surface of the sausage (see Application technology p. 12)

Dosage & yield per unit

The dosage is indicated on the pouch or bottle as volume of liters of suspension to beprepared. In general the number of sausages to be inoculated per volume of suspension depends on the diameter of the sausages. Big diameter sausages give more tons per volume of suspension than small diameters. The suspension dilutes over time because the spores stick to the sausages and there are less and less spores in the suspension; this leads sometimes to less growth on sausages, which were inoculated at the end of a day or working period. It takes a short observation period in order to find out how long a suspension will last in order to give an optimal result. As a rule of thumb: 10 liters of suspension may be enough for 4 tons of 100mm diameter sausage but only for 2 tons of 26/28 mm diameter sausages. Most moulds from Chr. Hansen come in pouches for 50 liters of suspension.

Technology effects on growth of moulds

The growth of moulds is heavily affected by the environment under which the sausage is produced and the technology applied. Ideally growth should appear within 2 days (white round dots), moulds grow in a patchy form hence the importance to obtain an even distribution of spores. Yeasts grow in rod form and have a tendency to form longer chains.

If the growing conditions are adverse (cold, strong ventilation, dry) the mould spores may grow very slowly and there may be large patches without coverage; wild yeasts may take over.

In the following the most important growth factors (enhancers and inhibitors) are mentioned.

Sausage technology and type

The ratio of fat and lean meat determines the moisture transfer to the casing and hence the growth conditions of the molds. The size of the particles affects the drying of the surface and creates a more or less “bouncy“ surface. Big fat particles help create a “marbled“ appearance. Smearing due to wrong filling technique or any other cause may lead to uneven growth because of uneven evaporation. Growth of moulds helps diminishing the risks/effects of dry rims and hence improves texture.

Influence of type of casing

A great number of casing types are used in the industry (natural, fibrous, collagen types etc). These different casing types have a significant influence on the growth performance of the moulds and this is mainly due to the humidity of the casing and its value as a growth “substrate“ (see table below).

Cellulose casings	Not ideal for moulds because it is relatively dry; should be soaked before stuffing if possible; growth may need more time to reach adequate cover than on natural casings. Sometimes wild moulds and yeasts show cellulase activity which may lead to partial dissolution of casing (holes appear at peeling step;casing looks rough).
Peel able cellulose casings	Same as above, but casing has in addition a layer of peeling agent on the inner side of the casing, which may influence the growth of the moulds.
Collagen casings **(filled manually orautomatically with filler horn)**	Less growth potential for moulds then on natural casings but better than cellulose casings. Collagen casings have a good evaporation capacity hence they influence the growth of moulds positively
Collagen casing **(Co-extrusion system in continuous formation of sausage and casing simultaneously)**	The application of the moulds may have to be postponed to after the formation of the casing layer and after the initial fermentation and drying period. In some cases the use of moulds may be difficult because the time span is too short.
Natural casings	Natural casings come in a great variety and shape and type (sheep, horse, pig, etc). The degree of preparation is highly variable and the micro-biological quality is not always excellent. Natural casings should be well prepared (cleaned and soaked) prior to use. Natural casings are ideal for moulds and very often give densely covered sausages. It may be necessary to be more restrictive with the fermentation scheme in order to limit growth of moulds

Growth of mould and degree of coverage after 2, 7, and 14 days (from left to right) on natural casing, cellulose casing and collagen casing.

Coverage of mould after 2 days: Collagen (left), cellulose (middle), natural (right)

Coverage of mould after 7 days: Natural (left), cellulose (middle), collagen (right)

Coverage of mould after 14 days: Natural (left), cellulose (middle), collagen (right)

Fermentation technology

Successful mould application depends on good regulation of relative humidity, which is responsible both for good growth as well as for inactivation of the moulds. In addition, it requires fine tuning of air speed and temperature control.

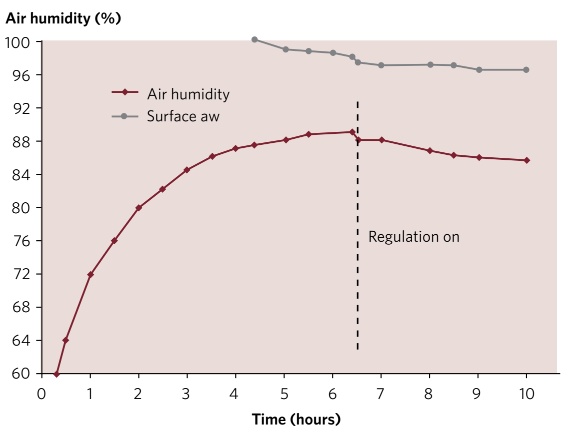
In general:

- Ideal growth takes place at a relative humidity of > 90 %.
- Air speed should be very moderate to moderate.
- Temperature should be between 24–30°C

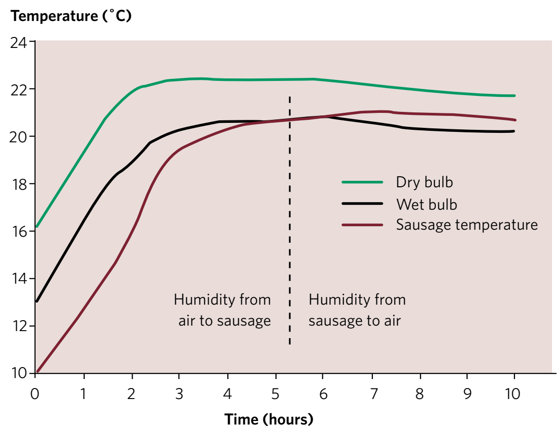
Humidity

The difference in relative humidity (r.H.) between the sausages and the air used in dry fermented sausage production can vary a lot depending on technology and local customs. It is important to note that a small change can have a big influence on the outcome; e.g. when the difference in r.H. between the sausage and the air is too big the evaporation/flow of humidity becomes discontinuous and this leads to a dry rim.

Trial observations have shown that r.H. 4% below optimal conditions delayed the full development of the white cover by 6 to 8 days when artificial cellulose casings were used. In addition, non optimal growth conditions lead to higher infestation by wild contaminants and enhance dry rim characteristics. See also chapter *Influence of type of casing*, on page 8.



Delta (Aw - % r.-H.) =/ < 0.05 would be an ideal parameter for optimal drying



Ideally the adaptation time should be used at r.H. of 92% or higher to start growth of mould

Temperature

Good sporulation temperatures are above 24°C. Lower temperatures slow down growth, very low temperatures impede sporulation. Temperatures should not exceed 30°C.

Air speed and fresh air control

Air speed should be low in the beginning (0.1 to 0.2 m/s) and high speed air ventilation should not exceed 0.6 m/s to avoid extreme turbulence, which can make the hanging sausages swing. High air speed is mainly used on purpose to give a “crust” to the sausage and to slow down the drying speed. When applied too early, high air speed will lead to dryrim often with negative consequences.

Most fermentation equipment relies on combined regulation; i.e. the equipment uses recycling of air and introduction of fresh air in order to obtain the required condition. This means that there may be a source of contamination of the sausages by negative flora like rizopus or mucor etc. from the fresh air. Micro filter systems can avoid these unwanted contaminations by way of purification of the incoming air. The filters should be cleaned and sterilized from time to time in the same way as the fermentation equipment; special care should be attributed to the cleaning of the ducts and the area around the condensation unit.

Application technology

As mentioned a good result depends on equipment or processes that enable regulation of relative humidity, temperature and air speed, and secures uniform and effective coverage with moulds. The absence of effective coverage increases the risk of wild flora to propagate.

Dipping in vats or tubes (manually)

This system is simple and very effective for small units. The suspension has to be stirred from time to time to avoid clotting of spores; i.e. spores accumulating around solid materials fallen into the suspension. The suspension should not be carried over from one day to the next due to the risk of propagation of wild yeasts. The sausages should be completely immersed in order to get an even cover. The dipping area and the rest of the facility should be separated in order to avoid accidental spread of the spores to the rest of the factory. In addition, installation of disinfection baths in the floor is recommended.

Application by shower (whole trolleys)

A shower unit with multiple shower heads is used to sprinkle the suspension over the sausages and an agitation and pumping unit secures a uniform suspension. This unit should be in a separated area of the facility to avoid spread of spores. A dripping area with run-off collector and recycle drain feed the excess suspension back to the pumping system. After sufficient dripping time trolleys are passed through pediluve or disinfection baths in the floor to clean the lower parts and avoid the spread of spores to the fermentation area and the rest of the factory.

Application by spray (individual sausage)

A conveyer belt system moves the sausages into an enclosed area with an overhead spraying system being linked to a recycling pump and a collector tank for the run-off. The sausages are kept in motion and turned continuously by mechanized rollers, which move the sausages through the enclosed area. The inlet and outlet of the enclosed area is "sealed" by flexible plastic strips. This technique has the advantage of being highly productive, efficient in distributing the spores, occupying very little space, protecting the environment of the facility from contamination and it is easy to clean and sterilize.

Application by spray in fermentation room

This method is used in small production units. The application equipment is a simple spraying unit used in plant/vegetable spraying. It has some inconveniences like uneven distribution, and infestation of ducts and condenser units happen quite often and the spores are spread by the feet of workers.

Handling precautions

Small pieces of solid matters like pieces of meat, string etc may fall into the suspension during operation. Spores have tendency to clot up on these solid materials and the suspension is heavily diluted. The spraying nozzles may be blocked by the solids and less/no spores may be applied. Simple, relatively coarse filters limit the risk of solids in the suspension.

How to avoid spread of moulds and spores in factory

Micro filter systems can avoid these unwanted contaminations by way of purification of the incoming air. The filters should be cleaned and sterilized from time to time in the same way as the fermentation equipment; special care should be attributed to the cleaning of the ducts and the area around the condensation unit.

- by separating the application area from the rest of the factory
- by using pediluves/walk-through floor baths
- by avoiding drafts of air (air streams) between the factory and the application area

Troubleshooting

Appearance of greening	• Wild moulds have outgrown inoculated ones • Second and third sporulation happens
Appearance of mucor	• Contamination by environment • Contamination by workers or contaminated casings
Appearance of wild yeasts	• In-house flora exists • Ventilation with fresh air, no filters (see figure 1)
The contamination by the hanging devices and transportation equipment	• The trolleys (rolling or overhead rail equipment) should be cleaned on a regular basis after each production cycle • All wooden framing should be banned from the fermentation area and drying rooms • Wooden sticks are the most frequent vectors of negative outside flora on sausages hence their use should be banned as well • Metal tubes are difficult to clean and these should be banned • The best solution is the use of y-shape metal alloy sticks and these should be cleaned and dried after each production cycle (in a separate room and by machine if possible)
"Baldiness" of sausage	• New sporulation kills lower layers of mould • Layers of wild bacteria impede moulds which do not attach to sausage surface
Mould cover is too strong	• Relative humidity was too high • Natural casings were not correctly processes • High humidity periods too long
Mould cover is too weak	• Not enough relative humidity during growth period • Ventilation speed too high • Temperature too low
Wild moulds outgrow inoculated molds	• In house flora needs dilution by thorough cleaning • Contamination by fresh air from the outside world • Bad growth conditions for inoculated molds • Wrong fermentation and drying scheme
"Ammonia" aroma too strong	• Too much use of Penicillium Candidum • Too much presence of yeasts • Wrong fermentation & drying cycle kills first growth of molds; dying moulds create more ammonia • Use more penicillium nalgiovense
Sticky sausage surface	• Contamination by bacteria • Wrong fermentation scheme; late drying • Bad casings • Bad or absent ventilation (cold spots; condensation etc) (see figure 2 and 3)

Figure 1: Typical appearance when using inadequate fermentation scheme. See yeast infestation as well

Figure 2: Late growth of moulds due to low initial rH. Sausages fold up after inadequate fermentation. Center is badly colored due to slight smear problems

Figure 3: Poor stuffing technique. Smear and bad drying leads to bad color and bad aroma

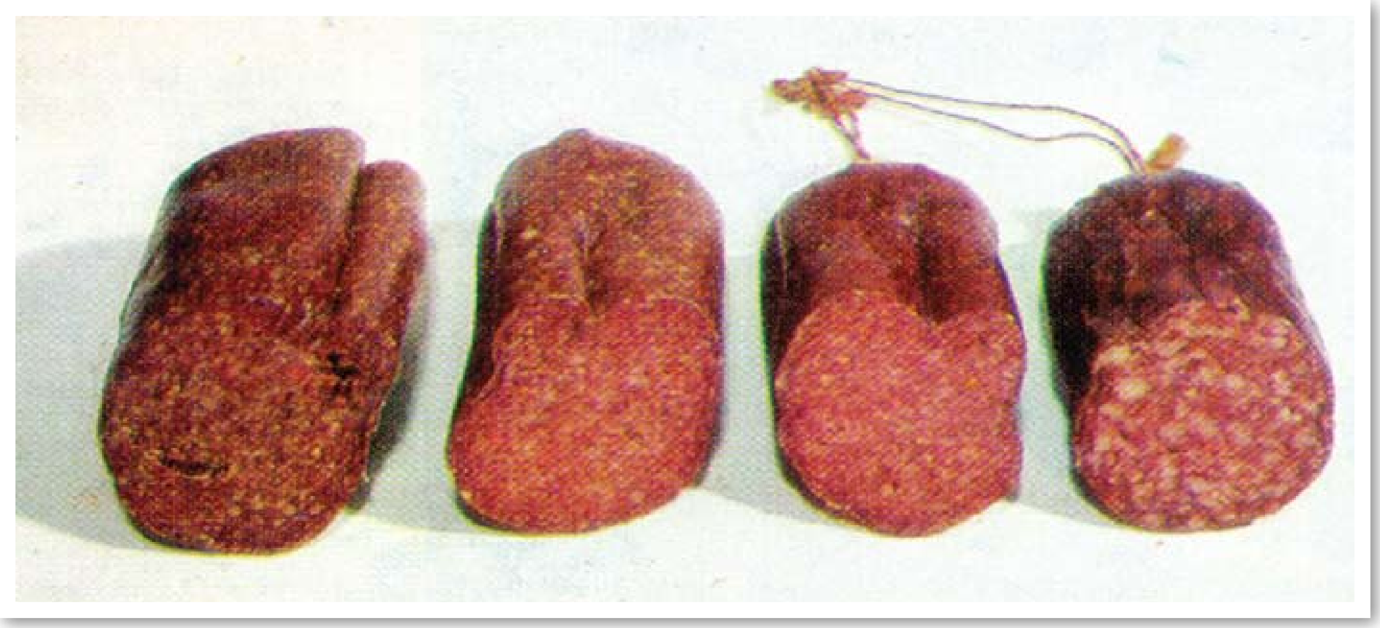


Figure 4: Wrong drying parameters in four sausages

Creating innovation through working partnership

We believe the best results are achieved when we work closely with you. Clear dialog between the customer and Chr. Hansen is a natural forum for creativity and innovation, which are key to standing out in the marketplace. Our experienced application and industry specialists provide you with the knowledge, inspiration, support, and customized solutions you need to be successful. Partner with our experts to develop functional foods with strong consumer appeal and confidence.

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