MODULE 11
BASIC PREPARATORY PROCEDURES OF MEAT- CURING AND SMOKING

11.1. CURING – Consumers associate the majority of processed meat products like hams, bacon, and most sausages with an attractive pink or red colour after heat treatment. However experience shows that meat or meat mixes, after kitchen-style cooking or frying, turn brownish-grey or grey. In order to achieve the desired red or pink colour, meat or meat mixes are salted with common salt (sodium chloride NaCl), which contains a small quantity of the curing agent sodium nitrite ($NaNO_2$). Sodium nitrite has the ability to react with the red meat pigment to form the heat stable red curing colour. Only very small amounts of the nitrite are needed for this purpose (Fig.1, 2).

Fig.1

Fig.2

Fig.1: Pieces of cooked meat (pork) 4 pieces with common salt only (right) and 3 with common salt containing small amounts of nitrite (left)

Fig.2: Two sausage cuts One produced with salt only (right) and the other with salt and small amounts of nitrite (left)

Nitrite can be safely used in tiny concentrations for food preservation and colouring purposes. Traces of nitrite are not poisonous. In addition to the reddening effect, they have a number of additional beneficial impacts (see below) so that the meat industries widely depend on this substance. Levels of 150 mg/kg in the meat product, which is 0.015%, are normally sufficient.

To reduce the risk of overdosing of nitrite salt, a safe approach is to make nitrite available only in a homogeneous mixture with common salt generally in the proportion 0.5% nitrite and the balance of sodium chloride (99.5%). This mixture is called nitrite curing salt. At a common dosage level of 1.5-3% added to the meat product, the desired salty flavour is achieved and at the same time the small amount of nitrite needed for the curing reaction is also provided. Due to the sensory limits of salt addition (salt contents of 4% are normally not exceeded), the amounts of nitrite are kept low accordingly. A great deal of research has been done with regard to the utilization of nitrite and it can be said that nitrite in meat products is safe if basic rules are adhered to. Nitrite is now recognized a substance with multifunctional beneficial properties in meat processing:

- The primary purpose of nitrite is to create a heat resistant red colour in a chemical reaction with the muscle pigment, which makes cured meat products attractive for consumers.
- Nitrite has a certain inhibitory effect on the growth of bacteria. This effect is particularly pronounced in canned meat products which are usually stored without refrigeration, where small numbers of heat resistant bacteria may have survived but their growth is inhibited by the presence of nitrite.
- Nitrite has the potential of attributing a specific desirable curing flavour to cured products.
- In the presence of nitrite fats are stabilized and rancidity in meat products retarded i.e., an antioxidant effect.

Many attempts have been made to replace nitrite by other substances, which would bring about the same beneficial effects as listed above. Up to now no alternative substance has been found. As the above desirable effects are achieved with extremely low levels of nitrite, the substance can be considered safe from the health point of view. Currently the known advantages of nitrite outweigh the known risks.

11.2. Curing of chopped/comminuted meat mixtures

Curing is applied for most chopped meat mixtures or sausage mixes for which a reddish colour is desired. The curing agent nitrite is added in dry form as nitrite curing salt (Fig.3). The reaction of nitrite with the red meat pigment starts immediately. Due to homogenous blending the meat pigments

have instant contact with the nitrite. Higher temperatures during processing, e.g. “reddening” of raw-cooked type sausages at 50°C or scalding/cooking of other products at 70-80°C, accelerate the process.

Another accelerating or “catalytic” effect is the addition of ascorbic acid, which slightly lowers the pH of the meat mixture. However, the dosage of ascorbic acid must be low (0.05%), just to provide the slightly acid conditions for the reduction of $NaNO_2$ to NO. A pronounced reduction of the pH would negatively affect the water binding capacity of the product which is not desirable.

Fig.3: Adding of nitrite curing salt during initial phase of meat mix fabrication

11.3. Curing of entire meat pieces

Besides the curing of chopped meat mixtures, entire pieces of muscle meat can be cured. However, due to size the curing substances cannot instantly react with the meat pigments as is the case in chopped meat mixes. Hence various curing techniques are applied.

The final products of curing entire meat pieces are either cured raw fermented products or cured cooked products. The curing system to be used depends on the nature of the final product (uncooked or cooked). There are two systems for curing entire meat pieces, dry curing and wet curing (“pickling”) and the type of the final product determines which system will used.

In dry curing a curing mix is prepared containing salt or nitrite curing salt, together with spices and other additives. The pieces of meat are rubbed with this curing mix (Fig.4, 5, 214, 215) and packed in tanks. The curing mix gradually permeates into the meat, which can be a lengthy process ranging from several days to several weeks.

Fig. 4: Application of dry curing mix (curing salt, curing accelerators, spices) on fresh ham (pork leg)

Fig.5: Ham is uniformly covered by curing mix

The second method of curing meat pieces is wet curing, also called pickling, which involves the application of curing brine to the meat. For the manufacture of the brine, curing salt and spices, and other additives if required are dissolved in water. The meat cuts are packed in tanks and brine is added until all pieces are completely covered (Fig. 6). A temperature of +8 to +10°C for the curing room is recommended as lower temperatures may retard curing. For equal penetration of the brine, the meat is cured for periods ranging from several days to two weeks depending on the size of the cuts and curing conditions. After completion of the curing, ripening periods for the products follow for taste and flavour build-up.

Fig. 6: Wet curing

An alternative and quick way of wet curing is to accelerate the diffusion of the curing substances by pumping brine into the meat tissue ("injection curing"). For this purpose brine injectors with perforated hollow needles are used. The injection of brine into the muscles can be done manually by using simple pumping devices (Fig. 6, 7). At the industrial level semi-automatic multi-needle brine injectors (Fig.8) are used which achieve very even distribution of the curing ingredients and can reduce the curing period (equal distribution of the curing substances or "'resting period") to less than 48 hours.

Fig.7: Manual brine injection using a large syringe

Fig.8: Brine injection with a manual curing pump

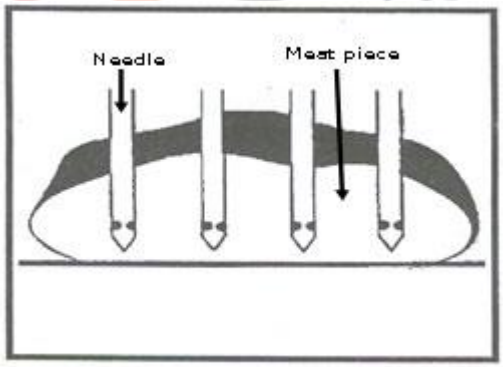

Fig.9: Multi-needle brine injection (principle)

In addition, most injection cured meat pieces which are to be processed into cured-cooked products (such as cooked hams etc), are submitted to a tumbling process. Tumbling further accelerates the brine penetration throughout the meat prices and "resting periods" are not necessary.

11.4. Smoking

Smoke for treatment of meat products is produced from raw wood. Smoke is generated through the thermal destruction of the wood components lignin and cellulose. The thermal destruction sets free more than 1000 desirable or undesirable firm, liquid or gaseous components of wood.

These useful components contribute to the development of the following desirable effects on processed meat products:

- Meat preservation through aldehydes, phenols and acids (anti-microbial effect)
- Antioxidant impact through phenols and aldehydes (retarding fat oxidation)
- Smoke flavour through phenols, carbonyls and others (smoking taste)
- Smoke colour formation through carbonyls and aldehydes (attractive colour)
- Surface hardening of sausages/casings through aldehydes (in particular for more rigid structure of the casing)

The most known undesirable effect of smoking is the risk of residues of benzopyrene in smoked products which can be carcinogenic if the intake is in high doses over long periods. With normal eating habits, a carcinogenic risk is normally not associated with moderately smoked food such as smoked meat products.

Depending on the product, smoke is applied at different temperatures. There are two principal smoking techniques:

- Cold smoking
- Hot smoking

The principle of both methods is that the smoke infiltrates the outside layers of the product in order to develop flavour, colour and a certain preservation effect.

11.5. Cold Smoking – This is the traditional way of smoking of meat products and was primarily used for meat preservation. Nowadays it serves more for flavour and colour formation, for example in sausages made from precooked materials such as liver sausage and blood sausage.

The combination of cold smoking and drying/ripening can be applied to fermented sausages and salted or cured entire meat pieces), in particular many raw ham products. In long-term ripened and dried hams, apart from providing colour and flavour, the cold smoking has an important preservative effect as it prevents the growth of moulds on the meat surfaces.

The optimal temperature in "cold" smoking is 15 to 18°C (up to 26°C). Sawdust should be burned slowly with light smoke only and the meat hung not too close to the source of the smoke. Cold smoking is a long process which may take several days. It is not applied continuously, but in intervals of a few hours per day.

11.6. Hot Smoking – Hot smoking is carried out at temperatures of +60 to 80°C. The thermal destruction of the wood used for the smoking is normally not sufficient to produce these temperatures in the smoking chamber. Hence, additional heat has to be applied in the smoking chamber.

Fig.10: Hotdogs are placed in the smokehouse for hot smoking (pale colour before smoking)

Fig.11: After completion of the smoking process (brown-red colour after smoking)

The relatively high temperatures in hot smoking assure a rapid colour and flavour development. The treatment period is kept relatively short in order to avoid excessive impact of the smoke (too strong smoke colour and flavour).

Hot smoking periods vary from not much longer than 10 minutes for sausages with a thin calibre such as frankfurters to up to one hour for sausages with a thick calibre such as bologna and ham sausage and products like bacon and cooked hams.

11.7. Products and smoking – Cold smoking is used for fermented meat products (raw-cured ham, raw-fermented sausage) and precooked-cooked sausage (liver and blood sausages). Hot smoking is used for a range of raw-cooked sausages, bacon and cooked ham products. Smoke treatment can only be applied, if meat the products are filled in casings permeable to smoke. All natural casings are smoke permeable, as are cellulose or collagen basis synthetic casings.

Smoke permeable casings can also be treated using a new technology, where a liquid smoke solution is applied on the surface. This can be done by dipping in solution, showering (outside chamber) or atomization (spraying inside chamber). Polyamide or polyester based synthetic casings are not permeable to smoke. If smoke flavour is wanted for products in such casings, small quantities of suitable smoke flavour (dry or liquid) are added directly to the product mix during manufacture.

Suggested readings:

1. Title: Meat processing technology for small- to medium-scale producers... Produced by: Regional Office for Asia and the Pacific