MEAT PRODUCTS WITH HIGH LEVELS OF EXTENDERS AND FILLERS

Introduction

Meat extenders are non-meat substances with substantial protein content, whereas ***fillers*** are high in carbohydrates (see page 60). Meat extenders and fillers are primarily used with the objective of making meat products ***lower-cost***. In the upmarket sector there was traditionally less demand for highly extended products as their sensory properties could not fully match "full-meat" products. However, much progress has been made in recent years in improving the sensory qualities of extended meat products by using better balanced spice mixtures or other suitable additives of plant origin such as flavouring herbs (parsley, oregano, rosemary, leeks) or bulbs, roots and tubers (onions, garlic, ginger, raddish). These facts make the low-cost market more attractive and may contribute to its further development.

Interestingly, in recent years also in the upmarket sector some ***new developments*** regarding increased utilization of non-meat additives can be noted. In this case it is not based on price considerations but on health-consciousness of consumers. New additives (coming from dairy, bakery and other food industries) have recently been introduced into the meat sector, with the intention of promoting the production of "healthy" food. Some of these additives are advertised with the potential to increase the ***fibre***[1] content (dietary fibre fortification) of meat products (e.g. wheat, bamboo, cotton seed, red beet, chicory). Also functional properties are attributed to the fibre additives (see page 60), in particular binding of water and creating a creamy product texture.

Fig. 251: Addition of non-meat ingredients (example: starches)

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[1)] see footnote page 196

Other additives are recommended to increase the level of certain ***minerals***[1] in meat products (fortified iron, magnesium enriched, calcium improved). Some of these additives are by no means cheap "fillers" and may even increase the costs of the products. Specific target groups of consumers are prepared to pay for these relatively high-priced "wellness-products", which are gaining increased market share.

In countries with low purchasing power, some meat processors intend to **reduce their production costs** by adding disproportionately high amounts of cheap extenders and fillers (e.g. flours, starches, breadcrumbs, soy concentrate, MDM, also water) to meat products.

More ***transparency*** is needed in this part of the meat sector, particularly in developing countries, where relevant food regulations are often incomplete or poorly applied. Such transparency can be best achieved by greater public access to information on the safe use of non-meat extenders and fillers. Proper labelling is therefore a key area to be addressed by national food control authorities.

In addition to *extenders* and *fillers* of non-meat origin, mechanically separated cheaper materials from animal carcasses also known as ***mechanically deboned meats (MDM)*** are widely used in meat processing. This refers in particular to poultry meat[2] (chicken, turkey). The use of such materials, separated as the remaining meat on bones, certainly contributes to the integration of all edible parts from carcasses into the food chain without wastage of valuable animal proteins. However, MDM must be hygienically generated and processed and its incorporation as raw material for meat products should be well balanced.

[1)] Additives containing fibre, minerals etc. have **prebiotic** properties, which assist the organism in creating favourable conditions for good health. It must not be confused with additives with **probiotic** properties, where living bacteria (mostly Lactobacillus strains) are added, e.g. to yoghurt and more recently also to fermented meat products such as dry fermented sausages. It is believed that the microorganisms have a direct positive impact on the human digestive system.

[2)] Mechanically separated meat from cattle, sheep and goat is not currently produced because of possible BSE-risk.

Traditional extended meat products

Various flours are primarily used in extended traditional meat products from ***Asia***. One well known example is '**Moo-Yoh**' (Fig. 252).

Fig. 252: Moo-yoh

This is the Thai name for a product popular in Thailand and some other South-East Asian countries. The roduct is manufactured using raw-cooked technology (see page 127) by finely chopping all ingredients with ice. It is composed of pork (85-90%), sugar (1.5%), fish sauce, common salt and pepper (each 1%), and flour (5-10%) is used as a filler. Due to the high flour content air bubbles are produced during the cooking, which are characteristic for Moo-Yoh. Moo-Yoh has a grey to whitish colour (Fig. 252).

In ***Africa*** the main traditional meat processing methods are meat salting, drying and smoking. In the past these three methods allowed semi-nomadic or nomadic herdsmen to preserve meat from livestock or game in higher temperatures. Such traditional products were later developed into biltong, kilishi, etc. (see page 237, 241).

The manufacture of **mixtures** containing cereals, mainly beans, grains and/or cassava (manioc) with meat, fat, blood, internal organs and even milk, falls in the category of extended products (see also page 112). Such products can on the one hand be considered as processed meats, on the other hand they are related to kitchen style cooking, as these mixtures are usually consumed as part of the meals immediately after preparation. In recent years some of these traditional cooking mixes have been commercially produced in cans and used as food supplies with extended shelf life for emergency situations, for remote regions and for refugee camps. These mixed meat/plant products offer a convenient outlet for otherwise highly perishable animal products and are nutritious, particularly due to the animal protein. The content of extenders may be high, in some cases exceeding the content of animal tissues.

More advanced processing methods were imported into Africa over the years from other parts of the world. The preparation of meat/plant mixes as fillings for samozas (dough pouch with filling) and spring rolls originated in Asia while the preparation of coarse and fine breakfast sausages (see below)and meat rolls were introduced from Europe.

In ***Europe*** there are a number of extended traditional meat products, mostly based on adding cereals to mixes of meat, fat, blood, pork skin or other carcass parts with high connective tissue content. Typical examples are the French “pate de champagne” and “boudin de bretagne”; the Scandinavian “blodpolse” and “blodkorv”; the Irish “black pudding”; the German “gruetzwurst” and “pfaelzer saumagen”; the Spanish “morcilla de calabaza” and “morcilla sencilla de arroz”, the Polish “kiszka kaszana wyborowa” and “kiszka kaszana gryczana”. All these belong to the group of pre-cooked-cooked meat products (see page 149).

The ***breakfast sausage*** is another highly extended meat product. These sausages can be categorized as raw-cooked sausages, but are sold in fresh or frozen form and heat treated in restaurants or by the consumer directly at home. One common composition is approx. 60% animal tissue (meat, fats), 15% water, 25% extenders and fillers (wheat flour, rusk, corn starch) (Fig. 253).

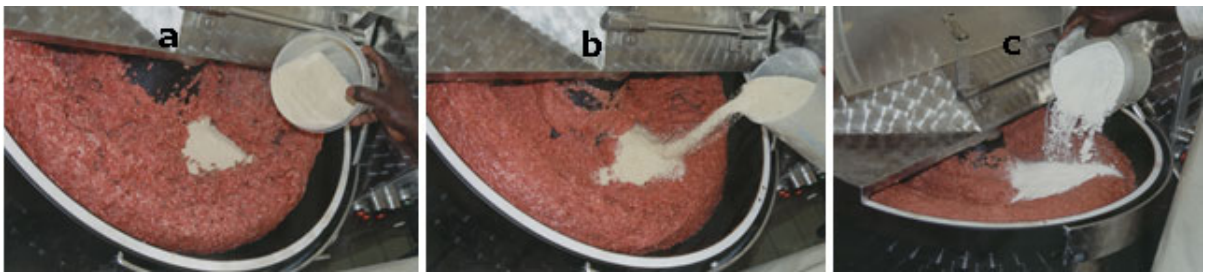

Fig. 253: Breakfast sausage
Sequence of adding ingredients to lean meat batter:
(a) salt, phosphate, spices, (b) rusk, (c) flours and starches

The most typical extended European meat product on the market is the lower quality type ***Italian Mortadella*** (Fig. 254). Its fabrication follows the principles of raw-cooked meat products, with meat, animal fats and water as basic raw materials and extenders. The meat component does usually not only include lean meat, but also offals such as spleen, oesophagus and sometimes even udder. Smaller fat dices are also often embedded in the batter in combination with green peas, pistaccio nuts or black peppers. The fillers used are usually starches and flours. The cohesiveness of the mortadella is achieved partly by the network of muscle proteins (see page 129), but to a certain extend also through the stickiness of the fillers. Mortadella is stuffed in large calibre casings (up to 200 mm). In order not to expose the outer zone of the sausage too long time to excessive temperatures, a special heat treatment (**delta-t**

cooking) is required. In the delta-t method, the heat treatment usually starts with water temperatures of +60°C. This temperature is maintained until the core temperature in the sausage has reached +35°C. From then on the water temperature is raised continuously, always maintaining a certain difference with the core temperature (usually 25°C) until the final water ("cooking") temperature (in this example +78°C) is reached. The heat treatment is continued at this water temperature until a core temperature of +68°C is reached in the product (see page 444).

Most mortadella products are to a certain extend shelf stable at moderate ambient temperatures due to the long heat treatment and the low a_w achieved by the high share of extenders. They are often stored without refrigeration. Although mortadella is considered a low cost product, it has an attractive appearance and taste and is now considered a delicacy.

Fig. 254: Mortadella

Extended Western style meat products *(A, B, C, D below)*

The groups of *fresh* (page 103), *raw-cooked* (page 127) and *precooked-cooked* meat products (page 149) of comminuted Western style meat products are well suited for replacing part of the expensive meat by cheaper meat extenders and fillers. These practices, dictated by the need to produce ***lower cost products***, are much more common in developing regions because of the lower purchasing power. In the past few decades Western style meat products have been introduced in the meat sector of most developing regions. Western style products such as frankfurters, cooked ham, luncheon meat etc. often rapidly overtake the production and sales the traditional indigenous meat products.

Inevitably, there is the ***risk of exaggerated and unprofessional application*** of extenders and fillers. The basic rule should be that meat products with elevated amounts of extenders and fillers should be marketed as low-cost, but must still be ***recognizable as typical meat preparations*** and clearly labelled as to composition and nutrient content. Within the existing framework of experience, ***guidelines*** are given hereunder on extender and filler utilization. The ***cost*** of the individual extenders, which may widely vary from country to country, plays an important role in the economics of producing extended meat products. Extender and filler utilization can reduce the cost of full meat products by ***10-30%***. These figures refer to moderately extended products, which

still maintain the characteristics of processed meat. Where consumers are used to extended products, it is the experience of meat processors that the majority of consumers ***prefer*** slight to medium extended meat products over full-meat products. The situation is different in countries where high quality standards prevail. Here consumers usually even ***dislike*** relatively small amounts of extenders.

Apart from the overall quantity of extenders and fillers to be added, the ***right proportion*** of substances has to be used that give products a more granular texture (e.g. breadcrumbs, coarse TVP, page 64, 80) and those that provide a more soft texture (starches, flours, fibre products, page 79, 80, 81). Also the proportion of substances with higher water absorption capacity ("fillers" such as starches, flours or fibres) and lower water absorption capacity ("extenders" such as soy products or other legumes) has to be established. There are a number of product formulas available taking the above aspects into account, but they normally have to be tailored to local consumer tastes and needs.

Hereunder, selected groups of Western style meat products and their suitable extenders and fillers are discussed (see also chapter: NON-MEAT INGREDIENTS, page 59). For comparison, the common formulas of such not extended products are listed in Annex I "Recipes".

Extenders, fillers and binders suitable for heavily extended meat products:

Extenders (definition see page 61):

Soy concentrate (70% protein) is available as a flour-like product. In coarse granular form it is called TVP (Textured Vegetable Protein). It can be added re-hydrated for meat product manufacture at a re-hydration ratio of 1:3.

Fillers (definition see page 62):

Cereal flours from wheat, rice and corn
Added dry

Starches from potato, corn, wheat, rice
Added dry

Whole grains of rice
Added cooked

Breadcrumbs, rusk
Added dry, in isolated cases also re-hydrated

Cellulose fibres derived from bamboo and other plants
Added re-hydrated, re-hydration rate 1:9

Other fillers (e.g. *vegetable*) are dealt with in chapter: Non-meat ingredients (page 59).

Binders (definition see page 62):

Most binders (e.g. *isolated soy protein*, *milk protein*) used in non-extended and extended raw-cooked sausages do not serve for volume increase.

The binding substance *carrageenan* (page 71) can provide significant volume increase as it is highly water absorbent. Its positive role is mainly in the manufacture of coarse products such as burgers or coarse skinless sausage products and in cooked hams. It may also be of use for improved cohesiveness in the case of high extender utilization in raw-cooked products.

A. Fresh coarsely ground meat products - extended

Hamburgers (Burgers)

Burger products are ***simple mixtures of ground meats***, including the *traditional hamburger* consisting of pure beef only without any extender or binder and with low fat content. The name *burger* is used for all kinds of simple mixtures of ground meat and animal fats (beef, pork, poultry meat, fish, or mixes of several). Burgers have always been considered suitable for using meat extenders even in high quantities, as no stringent requirements for product cohesiveness or colour exist. In industrial meat processing of burger patties the most commonly used extender is soy concentrate in medium to coarse granular shape as **TVP** (page 80). When rehydrated it has a meat-like texture. TVP in its dry form should

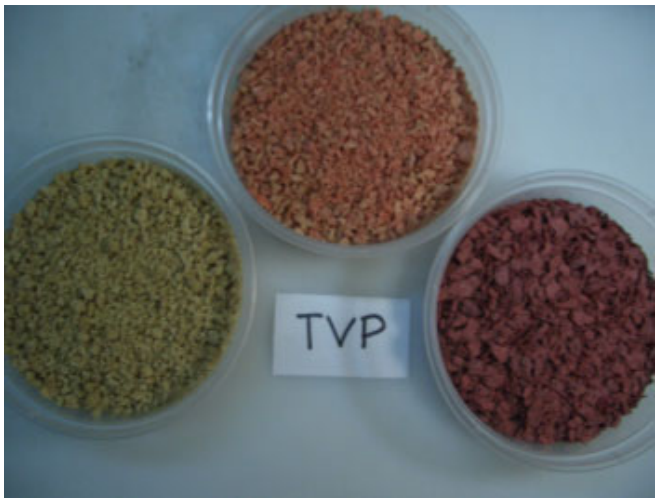

Fig. 255: TVP of different granulation and colour

be of slightly smaller particle size than the ground lean meat (3-5 mm disc), as the granules increase in size upon re-hydration.

Moderately extended burger products are softer and juicier and have a pleasant but not too intensive meat flavour. Full-meat products often have a tougher texture and in some cases the meat flavour might be too dominant. In burgers relatively large amounts of up to 15% **TVP** (re-hydrated) are tolerated even by quality-conscious consumers. But when TVP contents are in the range of 30% (re-hydrated), this causes almost complete loss of meat flavour and makes products dry.

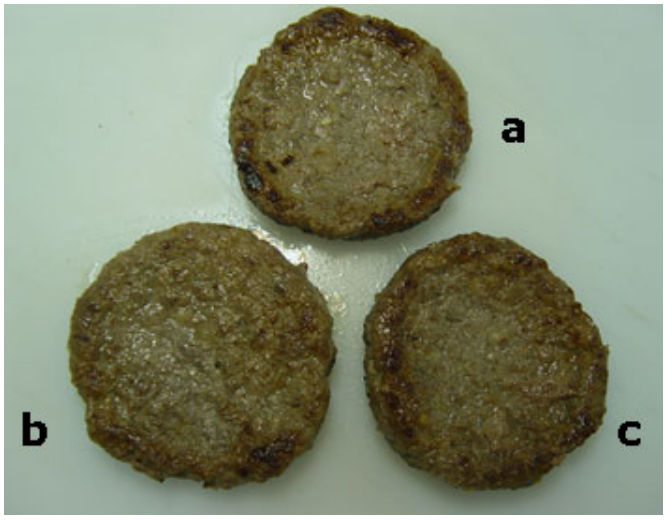

Fig. 256: Burger patties, cooked, (a) with meat only, (b) with TVP and cassava, (c) with TVP. Up to a certain level no sensory differences

In some low-cost burger formulations ***breadcrumbs, cassava***, ***potato***, or ***rice*** are used as fillers, often in combination with TVP as extender. In regions where most consumers are used to extended meat products, hamburgers with 7.5% TVP, or 7.5% TVP plus up to 10% cassava starch were still rated equal to full-meat burgers in consumer acceptability tests. Products with cassava starch also showed reduced cooking losses. Also the addition of ***carrageenan*** in low doses (0.5%) to low-cost burgers contributes to higher yield and less cooking losses without altering the sensory attributes.

Cellulose fibre additives, such as bamboo and potato fibres are also increasingly used for burger type products, mostly in combination with extenders such as TVP. Moderate quantities up to 2.0% (dry) facilitate a smoother mouth-feel, as long as enough water for re-hydration is added. Instead of TVP some regional recipes use fibres (up to 2.0% dry) together with potato (mix of fresh pieces, flakes and flour) and water as extenders for burgers. In this case the re-hydration potential of fibres of 1:9 can be helpful in absorbing most of the excess water.

Chicken burgers

Due to recent consumer concerns about red meat, chicken burgers have become more popular, in particular in the fast-food market. Top quality products are preferably made of leg meat, which is juicier than breast meat and without significant quantities of extenders or fillers (Fig. 246).

For lower-cost products, substantial amounts of extenders and fillers are common and are basically the *same as for* ***red meat burgers*** described above. In addition, some manufacturers incorporate certain levels of mechanically deboned chicken meat (***MDM***) (page 196) in the mix. Chicken burgers are of pale colour and ***food colouring*** (page 73) may also be used but is not a general practice.

Extended chicken burgers, like all other burgers, are usually moulded fresh and stored and distributed frozen. Alternatively, burger mixtures can be stuffed into artificial casings of a desired diameter (65-90 mm), frozen and sliced to individual patties of desired thickness (5-10 mm).

Meat balls (coarse)

Coarse meat balls have a similar composition as burgers and are mainly added to and consumed with soups. The round-shaped mixture (30-40 mm diameter) is stabilized when the meat balls are cooked in water or steamed. The additional heat treatment differentiates the meat balls from burgers (sold uncooked) and also limits the amount of extenders. Meat balls need a more cohesive texture, hence the extender content is usually kept lower than in burgers, but fillers in particular ***starches*** and ***flours*** are used at high levels. Due to the heat treatment (cooking/steaming) of the meat balls, high amounts of extenders would result in an atypically pale colour and lead to loss of meat flavour.

The moderate use of ***cellulose fibres*** as a filler for coarse meat balls can be useful as these fibres re-hydrate at a ratio 1:9. However, excessive use of cellulose fibres in meat balls results in dry “sandy” products, as much of the water absorbed is probably lost during cooking. Coarse meat balls are sometimes also extended with green and red ***vegetables***, such as parsley, carrots and bell pepper. Apart from the slight extending effect, smaller particles of such colourful ingredients can make the usually grey-coloured meat balls more attractive (Fig. 237).

Meat rolls, ground kebabs

Also meat rolls (meat mixes in a cylindrical shape) and ground kebabs (see page 106) are made as extended products. Some of them are sold **frozen raw** and others are **heat treated** prior to marketing. Production processes and the selection of suitable extenders, fillers and binders are based on the same technologies as ground burgers and ground meat balls.

B. Raw–cooked meat products - extended

Raw-cooked meat products made of finely comminuted meat batter (see page 127) are particularly well suited to incorporate certain amounts of extenders and fillers for cost reduction and are always used in combination with binders. The most commonly used *binders* are isolated soy protein (***ISP***) and milk protein (***caseinate***), both usually added as water/fat/protein emulsion (see page 69, 80). In typical extended western-style products, especially in larger calibres used for cold cuts, only ***flours*** and ***starches*** are used as *fillers* and to a rather limited extent also ***cellulose fibres***. TVP is not used as its light-brown colour and granules would show in slices of cold cuts. Similarly also small calibre sausages such as extended hotdogs or frankfurters are mostly fabricated using this technology and composition.

In less demanding markets, where mainly ***low-cost hot dogs*** are the most common extended products, several other *extenders* and *fillers*, often combined with flours and starches, are used. If available, soy concentrate (***TVP***) is the preferred extender, due to its standard quality, user-friendly properties and relatively high protein addition to the product. In many places, manufacturers have resorted to other, readily available and cheaper fillers for low-cost hot dogs such as breadcrumbs, rusk, gari, cassava and boiled rice (see page 64, 78, 81).

Phosphates (see page 69), are particularly useful common additives for raw-cooked meat products. They assist in the development of comprehensive protein network structures. In this respect some **fillers** will develop complementary functions, for example some starches (e.g. potato starch) start absorbing increasing amounts of moisture at the temperature range of 50-70°C, at which some of the loosely bound water is expelled from the protein structure networks. Hence, liquid purge can be decreased or avoided.

Negative effects of extenders and fillers can arise when excessive doses are applied, particularly in terms of appearance, cohesiveness and taste. Limitations have been indicated for the individual products discussed hereunder, but consumer expectations vary widely.

Hot dogs, Vienna sausages

Both sausage types are of a small-calibre, i.e. characterized to be filled in narrow (18-22mm) casings. Hot dogs usually contain ***high amounts*** of extenders. In contrast, in demanding markets, Vienna sausages are known as ***pure*** meat/fat products. In many places around the world this quality pattern is not strictly adopted and various extenders and fillers are used, always in combination with binders.

Naturally, these products cannot be extended up to such levels possible for burgers. The addition of up to 3% (re-hydrated) ***TVP*** as extender combined with up to 2.5% ***starch*** as filler with binding potential[1] will improve the cohesiveness and results in reasonable products ***not very different*** from full-meat products. Levels of TVP up to 6% (re-hydrated) result in ***less "meaty"*** products and demanding consumers may dislike them. But even levels of up to 10% (re-hydrated) TVP could be acceptable to certain consumer groups, in particular when sold at a lower price and consumed as part of a sandwich or in soups.

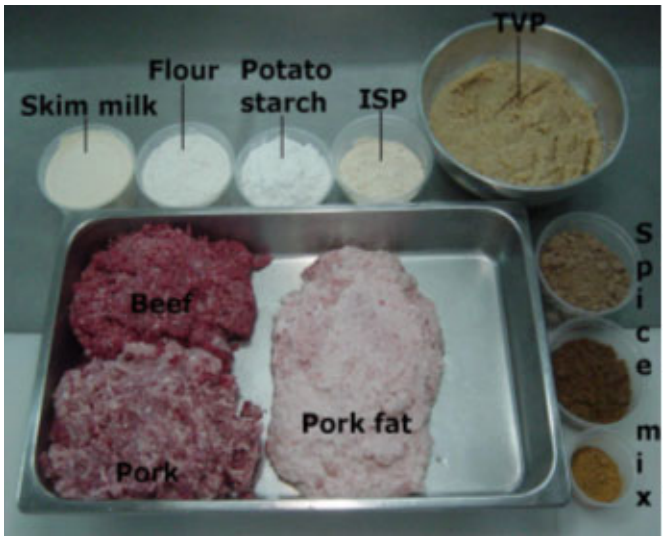

Fig. 257: Raw materials for extended

Fig. 258: Extended hotdogs (no colorant). Colour pale, for more attractive appearance food colouring is commonly used (see also Fig. 260, 265)

When using ***cellulose fibres*** (see page 195) in combination with TVP and starches/flours/skim milk, only moderate quantities of such fibre products (not exceeding 2.5%) should be applied. This is due to the fact that the cellulose fillers are re-hydrated at a ratio of 1:9, which means that 200 g dry powder (= 2% of a 10 kg batch of sausage mix) result in a wet mass of 1800 g in the 10 kg sausage mix. During the heat treatments (reddening, smoking, cooking) of these small-calibre sausages, part of this water may be released, leading to dry "sandy" final products. For the same reason, TVP, which is also a re-hydrated ingredient, should be reduced in quantity, when used in combination with cellulose fibres.

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1) Potato starch is the most common, followed by corn starch, sometimes cassava starch is used.

Chicken viennas, Chicken hotdogs

Poultry products in small-calibre casings are recently in highly ***demand*** as snacks or whole meal foods particularly in regions where for cultural or religious reasons beef and/or pork are not eaten (Fig. 259, 260). In such products, the fat component also derived from chicken in the form of the fat-rich chicken skin. Alternatively vegetable oil may be used. From the socio-cultural point of view filling the sausage mix into removable cellulose casings does not raise any concerns regarding the animal tissues involved. Many of the regions with preference for chicken sausages are in the developing world with low purchasing power. Hence addition of extenders and fillers is widespread.

For better quality products mainly chicken leg meat is used. In ***low-cost*** formulations the major or entire part of lean meat derives from mechanically deboned chicken (or turkey) meat (***MDM***). Mechanically deboned chicken meat is not entirely lean but contains on average 20% fat, therefore quantities of fat-rich chicken skin or replacement vegetable oils need to be adjusted. The binding capacity of chicken meat is only slightly inferior to beef or pork. Therefore the application of extenders and fillers is possible in practically the ***same way*** as for beef/pork hotdogs and viennas.

Up to 3% (re-hydrated) ***TVP*** as extender combined with 2.5% ***starch*** results in attractive chicken sausages. ***Vegetable oil*** as a fat component produces slightly juicier products than ***chicken skin*** added as the fat component (non-extended formula see Annex I, page 402). More intensive meat flavour can be achieved by replacing some of the lean chicken meat with lean beef. However, this option can be considered only if consumers accept beef and local regulations permit certain amounts of red meat in food labelled as chicken meat products.

Chicken meat is very pale and higher amounts of extenders will also have an additional adverse effect on good product colour. In many countries it is common practice to use ***food colourings*** (red or red and yellow type combined) to give the products a more attractive appearance (Fig. 260, 265).

In some countries, highly extended chicken hotdogs are produced in order to cater for consumers with very limited purchasing power. Formulations with more than 20% of extenders and fillers (mainly ***TVP***, balanced amounts of ***breadcrumbs***, ***flours*** and ***starches***), up to 25% ***water*** and ”lean” chicken meat (***MDM***) in the range of 30% and fats (fat-rich chicken skin, vegetable oil) in the range of 20% are common. In such mixtures, the meat protein network cannot integrate the whole amount of extenders, fat and water (see page 127). The absorptive

functions of the fillers play the major role to limit fat and water separation in these cases. This can usually be managed to a satisfactory level, but sensory properties (taste, texture) remain ***atypical*** in meat products.

Fig. 259: Raw materials for extended chicken vs pork/beef hotdogs. Above left chicken skin/chicken meat. Above right pork fat/lean beef, centre TVP

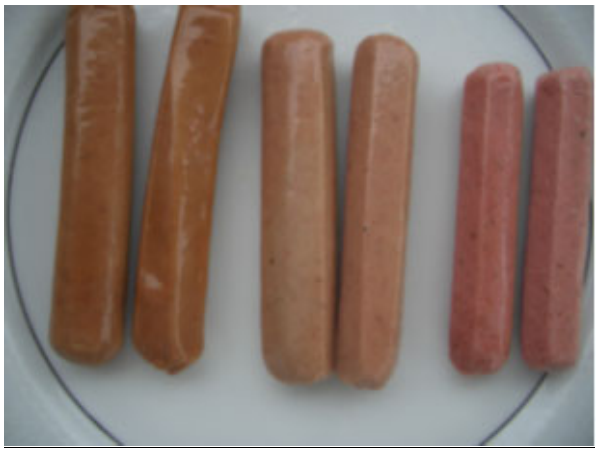

Fig. 260: Extended chicken viennas (cellulose casings removed). Left smoked, centre unsmoked, right unsmoked with food colouring

In Fig. 261 the **different manufacturing stages** of such a heavily extended product are shown. During the first stages the quality of the semi-fabricated product remains high. At the stage of adding the bulk of the extenders, which is instrumental for lowering the product price, the drop in quality occurs. (In order to clearly demonstrate the different stages of the batter, the batter was filled into wider casings than those normally used for hotdogs. All samples were heat-treated.)

For reasons of cost reduction, the quality decrease particularly from step d) to e) (Fig. 261) is unavoidable, but such products can still play a vital role in ***basic animal protein supply*** for low-income population groups, as long as they are made available at a low and affordable price. The animal protein content may still be kept in the range of 7-8%. To improve the sensory quality of such products, parts of their cheapest ingredient, which are the breadcrumbs (besides the water), can be replaced by other cheap locally available foods such as *cassava* (*starch, gari*) or *rice (flour, boiled)*. This contributes to softer texture and better taste.

The *processing* ***technology*** will also contribute to the improvement of heavily extended meat products. In particular coarse extender particles should be further reduced in size. Sharp and efficient bowl cutter knives are essential (page 304). After chopping all ingredients in the bowl cutter, passing the mixture through colloid mills (page 30) will further promote the better integration and binding of all extender and filler materials.

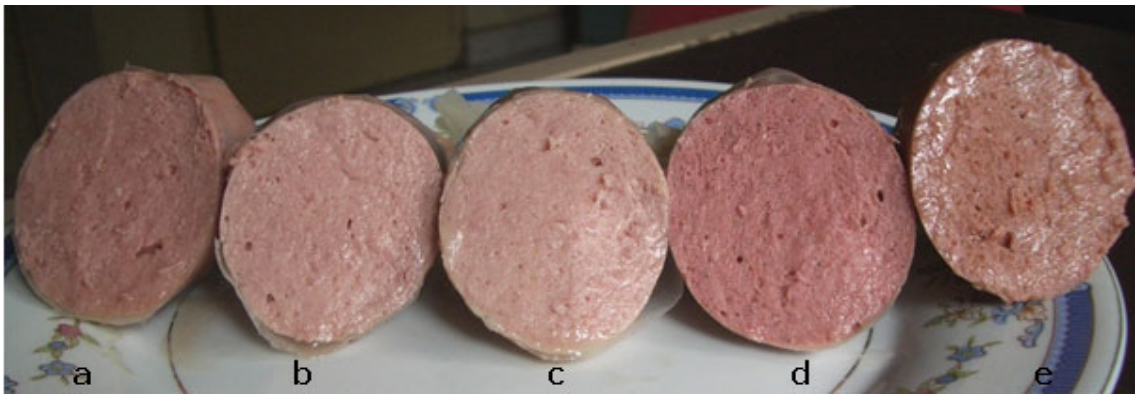

Fig. 261: Different stages of production of highly extended chicken raw-cooked product.
a) **Mix of lean meat, phosphate, salt and water**. Compact texture, pink colour, no purge of fat and water.
b) **Addition of binders** (isolated soy protein, milk protein). Texture remains compact, colour becomes significantly paler.
c) **Addition of fat** (chicken skin). Texture becomes slightly softer, colour slightly paler.
d) **Addition of starch and flour, some vegetable oil and artificial colouring.** Colour turns pink but not like typical curing colour, texture softer but still good.
e) **Addition of high amounts (15%) TVP and breadcrumbs.** Significant change in colour to brownish-yellowish, water exudation, change in taste towards only slightly meat-like.

Larger-calibre sausages of the raw-cooked type

There are different product names for larger calibre raw-cooked sausages depending on their origin, size and sensory properties (appearance, colour, taste etc.). Products such as ***Lyonese*** or ***Bologna*** are finely comminuted and stuffed in casings of 40-80 mm diameter; ***Polony*** can contain some coarse material and is stuffed in casings of 30-40 mm diameter. Often the name “Salami” is also used around the world for a more coarse product, but this may be misleading as this definition has been used for centuries for the European type dry-fermented sausages (see page 115).

The large-calibre products contain *basic* ***sausage mixes*** (lean meat, fat and water) manufactured with the same technology and raw materials used for hot dogs. They share the same characteristic protein network structure (see page 127) and the typical firm-elastic texture. Similarly to extended hotdogs, this protein network is often supported by an emulsion made with isolated soy protein (ISP) or milk protein (caseinate) (page 69, 80) and has the capability to embed and keep in place not only fat and water droplets but also particles deriving from non-meat additives. In these types of products, the addition of ***extenders*** (e.g. soy concentrates) and ***fillers*** (e.g. starches, flours, cellulose fibres) must be carefully balanced and overdoses avoided in order to retain meat products characteristics as much as possible (Fig. 261, 262, 263, 265).

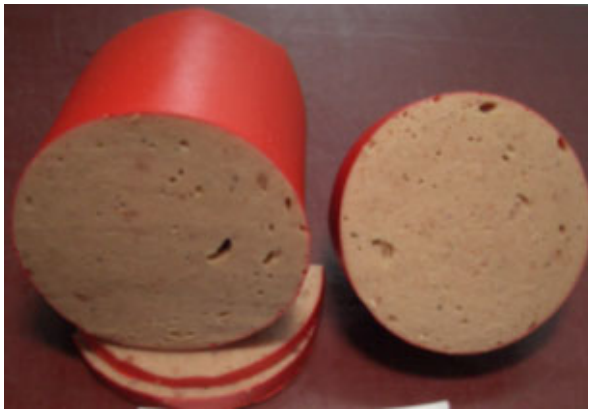

Fig. 262: Extended bologna
Good appearance and cohesiveness

Fig. 263: Highly extended bologna type sausage Excessive levels of extenders and insufficiently comminuted, visible coarse TVP particles

Moreover, an effective ***comminuting technology*** (use of a higher number of chopper knives, additional use of colloid mill for the fine batter component of the sausage mix) is crucial for larger calibre extended products, as for their consumption they are usually cut up into thin slices. In these slices any deficiencies in colour or cohesiveness become rapidly apparent and can be easily detected. Lumps of excess extender would be visible and also result in separation of fat and/or jelly after cooking and insufficient texture combined with dry and coarse mouth-feel. Therefore extender and filler quantities in large diameter sausages are usually kept more moderate than in hotdogs (Fig. 262, 263).

Experience shows that for satisfactory large-calibre raw-cooked sausages the overall level of extenders and fillers ***in dry form*** should not exceed ***10%*** and an adequate proportion of various filler, extender and binder substances is helpful (see page 204). As some substances with high re-

Fig. 264: Large-calibre raw-cooked sausage with higher (centre) and lower (right) levels of rice grains and with rice flour (left)

Fig. 265: Colouring of heavily extended product. Use of food colorant (left)

hydration ratios (e.g. TVP, cellulose fibres) are used, the dry extender level should be kept slightly below the 10% mark to avoid excessive overall extender contents. In Asia, precooked rice (Fig. 264) is used not only in hotdog type products, but also for medium-calibre raw-cooked sausages, as ***rice grains*** have strong cohesive properties. In order to make the rice grains less visible in slices of larger calibre sausages, colloid mills are very useful in the manufacturing process.

The addition of small quantities of carcass parts rich in connective tissue, such as ***pork skin***, ***tendons*** or ***gelatine*** (product derived from skin or bones) in the recipe will also facilitate efforts to make products with high quantities of extenders and fillers appear more acceptable. Connective tissue proteins swell and take up water and enter a gelatinous phase upon heating. This helps product components to stick firmly together after the process of cooking and cooling is completed.

Luncheon meat

Luncheon meat is known worldwide as a ***canned product*** (Fig. 266). (see page 127). The product mixes are in principle similar to the ones used for the above described extended sausages of the raw-cooked type. But while those are usually manufactured from pork and/or beef, luncheon meat may also contain other meat types. Cheap luncheon meat products often contain mechanically deboned meat (***MDM***), mostly from chicken, as part of the lean meat ingredients.

Fig. 266: Luncheon Meat

Canned luncheon meat, also in its cheapest versions, should not show excessive separation of water and/or fat after sterilization. Therefore, absorbing non-meat ingredients are used such as ***starches***, ***flours***, ***soy proteins*** (concentrate and isolate) and also ***carrageenan***.

C. Cooked ham

In its ***original manufacture***, cooked ham is made of one large piece of meat or few combined entire muscles (see page 182, 183). It does not undergo any comminuting process and is traditionally produced without any extender or filler. No yield is expected from such products as the curing brine injected will be lost again during cooking.

In moderately priced industrial cooked hams made of one large piece of meat or few combined entire muscles, the yield is usually increased using modified fillers and binders in the curing brine, which allow retention of some of the injected brine even after cooking. These products still meet the expectations of quality-conscious consumers but enable manufacturers to reduce costs and adjust the pricing.

Reconstituted cooked hams (see page 183) are produced in large quantities. These products are made of muscle meat, which is trimmed, cut or ground into medium to small chunks and reshaped to resemble an entire larger piece of meat. In such products modified soluble ***binders*** including isolated soy protein, gelatine, carrageenan and modified starches (Fig. 225) with a high binding capacity have become popular production ingredients. Before reconstitution through heat coagulation, curing salt, spices and substances assisting in water-binding (commonly phosphates and optionally the mentioned binders, see pages 69-72, 80, 180) are injected or mixed into the lean meat components and the entire mix is mechanically treated by tumbling (see page 184).

Insoluble extenders or fillers in dry powder form (flours, starches) or re-hydrated (TVP, cellulose fibres) are not suitable as they would hamper the reconstitution process which is based on “gluing” together the individual muscle particles by means of heat-coagulated protein (see page 184). Hence the main filling substance for cost reduction used for cooked hams is ***water***. As cooked ham is made of *pure muscle meat*, the water binding capacity is relatively high. The water absorption is further increased by the *tumbling process*, which releases additional amounts of myofibrillar protein with strong water binding capacity. The utilization of *phosphates*, *soy isolates* etc. strengthens this process further. Such products can achieve yields up to 150% and are, with corresponding pricing, affordable also for low-income consumers.

Maximum water retention can be achieved, if, in addition to the above treatments, ***carrageenan*** is used as a binder. Carrageenan powder (see page 71) dissolved in hot water, has the potential to absorb and hold moisture and significantly reduces cooking losses. Tests revealed 4% cooking loss with 1g carrageenan per kg meat mixture, 1.8% with 2.5 g/kg and very low 0.5% with 5 g/kg. Use of carrageenan up to 5g/kg ham gives a neutral taste.

The ***transglutaminase*** products recently introduced in the food sector are particularly efficient in cooked ham as their main function is strengthening the linkages between proteins (see page 72). Small quantities (0.1%) dissolved in the curing brine injected or added to the mix in the tumbler are sufficient to significantly improve cohesion between the meat pieces.

D. Corned beef

There are two groups of Corned beef

- ***Original Corned beef*** fabricated from cooked beef only and canned/sterilized (see page 169).
- ***Corned beef with jelly***, fabricated from beef and gelatinous substances such as gelatine or carrageenan or carcass parts with high connective tissue content (skin, tendons) and small amounts of water added, filled in casings and pasteurized or filled in cans and sterilized (see page 168). In particular carrageenan is a popular ingredient for corned beef in jelly, as it forms a gelatinous matrix, which can absorb substantial amounts of water. This jelly remains stable also at higher storage temperatures, where gelatine jelly could become liquid.

Although *corned beef with jelly* is considered the extended low cost version, many people prefer this product over the *original corned beef*, which is, due to the intensive cooking and sterilizing, dry and not particularly tasty. In contrast, corned beef with jelly is due to its gelatinous texture much juicier and suitable spices contribute to good flavour and taste, in particular when products were processed with moderate heat treatment (pasteurized). In sterilized products product quality can also be maintained.

A small up-market niche exists in Europe where *corned beef with jelly* is produced with such a high quality and firm jelly texture, that it is usually sold and consumed as cold cuts.

In some countries, ***low-cost corned beef in jelly*** is produced, which however still has a satisfactory protein content due to the fact, that the lean meat content is still relatively high and the extending substances (TVP) also contain protein (Fig. 267).

Fig. 267: Corned beef in jelly

TRADITIONAL / ETHNIC MEAT PRODUCTS

Introduction

Meat plays an important role as a high protein food in most cultures and societies. The situation is different when it comes to further processing of meat to meat products. **South-East** and **East Asia**, and in particular China, have a rich tradition in further processing of meat dating back several thousands of years. **Europe** is also famous for a great variety of processed meat products. In both regions the desire for variations in taste and flavour, but also the need of producing food with a longer shelf-life than the fresh meat, was the reason for deviating from consuming heat treated meat only and exploring new processing methods.

The other regions took a different approach. In **Africa**, the requirement for longer shelf-life was met by ***drying the meat***, whereby besides simple sun drying (see page 224) other quite attractive products such as ***Biltong*** or ***Kilishi*** (see page 237, 241) emerged. A harsh meat processing method practised in West Africa is the ***hot smoking*** of large pieces of fresh meat or of entire eviscerated carcasses of small mammals or poultry in dense smoke and at high temperatures. This is basically done for meat preservation purposes, as the smoking reduces the moisture content of meat and the smoke substances add to the preservation effect. However, meat treated this way is of reduced sensory quality. Apart from drying and smoking, the only traditional meat products popular in Africa are ***mixtures of meat with vegetables*** (see page 113). This kind of processing was not so much for taste variations, but owing to the lack of sufficient quantities of meat, which was tackled by “diluting” meat with plant products. This way lower-cost, but still protein-rich extended meat preparations where achieved. Some of these products also had a longer shelf-life if they were properly heat treated immediately after production.

In **South and Central America** and in **South Pacific countries** no significant own traditions existed in the meat sector and European meat manufacturing traditions were adopted initially. However, afterwards some specific developments took place in large meat producing and consuming areas in particular in South-America, where a number of local products became very popular for meat barbecues (see page 219).

Asia

The tradition of meat processing in Asia, especially in China, is much older than in Europe. From China, the manufacture of raw-fermented hams is known (called ***Jinhua hams***), which are similar to the European raw-fermented hams of the Parma (Italy) or Serrano type (Spain) (see page 176). Apart from the hams, other traditional Chinese or Asian processed meat products are completely different from the European ones. Most traditional Asian meat products are fermented for extension of their shelf-life and achievement of desired flavour and taste. The typical characteristic of most products is the utilization of *sugar* as an ingredient. This is practised for the following reasons:

- Achievement of slightly to moderately sweet taste commonly desired in Asia.
- Lowering of the water activity a_w in the presence of sugar and improvement of bacterial stability.
- Only in case of fermented products: Enhancement of fermentation processes, as sugars serve as "food" for fermentation bacteria (see page 120).

The most popular product available throughout East and South East Asia is the ***Chinese Sausage***, locally called *kunchiang, yuen chang or lup-cheong* (Fig. 268, 269, 270, formulation see page 424). It is not a raw-fermented product and the utilization of sugar serves only for taste and low water activity. Fresh raw pork and pork fat are the principal ingredients. The pork fat must be solid, preferably back fat, in some cases also jowl fat, and is prepared by cutting it into small cubes. The lean meat, preferably from the hind quarter with tendons and fat removed, is ground through a 2 mm plate. Non-meat ingredients include curing salt, sugar, pepper, garlic and optionally some Chinese seasonings including cinnamon, ginger, soy sauce (1-6%) and Chinese rice wine (1.5-3.5%). Sugar contents may vary from 1.4% in the cooler north of China to 4% in central China to 6% in the hot southern areas adjacent to South-East Asian countries, where similar products with high sugar content are fabricated. In some places, customers require sugar contents of more than 10%. The higher the sugar content the better the microbial stability due to the lowering of the water activity (a_w). Fat contents vary from 30-65%. Some cheap variations of Chinese sausage may also contain starch and food colouring.

The sausage mix is filled into pig casings or more recently also into collagen casings (page 263). Chinese sausages are neither fermented nor ripened. They are dried products and their flavour results basically from the ingredients used. The drying is different to all other comparable meat products. The products are subjected in a first stage of two days to

temperatures of approximately 60°C, usually produced by charcoal (alternatively wood and electricity) and in a second stage of 2-3 days at approx. 50°C. The internal temperature in the sausages must not exceed 50°C. Dry heat and **not** smoke is essential in Chinese sausage manufacture.

Fig. 268: Chinese meat products
(Chinese sausages and flat flavoured meat pieces)

Fig. 269: Chinese sausages
(different sizes and recipes)

Fig. 270: Typical view of East Asian food market

Chinese style sausages are never spread or sliced for sandwiches or eaten directly. They are usually cut in small pieces and **always cooked** before eating, sometimes steamed with rice, noodles or other dishes, giving them the characteristic flavour. The same applies to the Chinese Jinhua ham (see above), which is usually used as a soup ingredient.

Apart from the classical Chinese sausages made of pork meat and fat, there is also the option of replacing some of the meat and fat by approx. 20% ***pork liver***. Manufacture and consumption are the same as above.

Spleen-liver sausage (Fig. 271) is a unique product of South-East Asia. It does not contain meat nor fat but the offals, liver and spleen only, which are minced together with 10% garlic, possibly also with 1% rice and salt and spices. The mix is filled in small or large cattle casings and dried at room temperature. Heat treatment during manufacture does not take place. The high garlic content prevents spoilage during the drying phase. The products remain soft for up to seven days and are eaten raw or fried. After seven days the sausages are dry and can be stored over longer periods.

Fig. 271: Spleen-liver sausage

Fig. 272: Herb sausage

Herb sausage (Isaan sausage) (Fig. 272, recipe page 426/427)) is a product from North-East Thailand with a very typical taste due to its herb components. Coarsely ground pork plus 20% fatty tissue are mixed with seasonings (amongst them garlic, soy and fish sauce, chilli paste, shrimp paste, glutamate) and herbs such as lemon grass and bergamot leaves. The mix is filled in small natural casings (pig casings) and fried for consumption.

Longganisa (Fig. 273, recipe page 384) is a product from the Philippines based on the Chinese tradition. The products are made of ground pork meat and fat, cured and seasoned with a typical sweet taste. They are filled in fresh/dried pig casings, artificial casings or formed into sausage using plastic paper/paperlyne (skinless

Fig. 273: Longganiza
shaping skinless longganisa

longganisa). It is usually consumed fried except for one variety that is fermented for a few days, but mostly also fried for consumption.

For the manufacture of ***flossy shredded pork*** (Fig. 274) meat pieces cut along the grain are boiled for four hours and then dried at 60°C in a pan by stirring and pounding the content until the meat desintegrates into its muscle fibre bundles (see page 2). In larger operations specific pounding machines have been developed. During drying 1% sugar, 1% seasoning sauce and 1% salt are added. The final product looks like a bundle of wool and is used as an ingredient for soups, rice dishes etc.

Fig. 274: Flossy shredded pork

A fermented product popular in many South East Asian countries either as snack or ingredient for Asian style meals is ***Naem*** (Fig. 275, 276). It is a mix of minced lean raw pork, precooked pork skin cut into long thin strips and cooked rice at a ratio of 2:1:1. Apart from salt and pepper, generous amounts of ground fresh garlic are added. Traditionally small portions of the mix were wrapped in banana leaves. Now it is mostly filled in strong transparent synthetic casings (approx. 35 mm). The products are left at room temperature, where immediate fermentation starts through bacteria producing lactic acid, thus suppressing spoilage bacteria present. The antimicrobial effect of garlic also helps to maintain microbiological stability despite the high ambient temperatures. The

Fig. 275: Raw materials for Naem

Fig. 276: Naem packed in banana leaves and plastic bags

synthetic casings used can have tiny perforations to let the gas which is produced during fermentation escape. Alternatively two not perforated synthetic casings, one inside the other, are used, which resist the pressure of the gas produced. Naem is ready for consumption from the third day of fermentation. It can be kept under ambient temperatures for up to five days, after that it should be refrigerated to slow down the fermentation, which, if continued at high temperature, would make the products too sour.

Another traditional Asian meat product on the basis of pork is ***Moo-yoh*** (see page 197).

A popular non-pork traditional Asian and North African meat product is ***Pastirma*** (see page 238).

Europe

Meat processing in Europe started centuries ago with the manufacture of shelf-stable fermented meat products. Examples are raw-fermented hams such as the air-dried ***Parma hams*** (Italy) and ***Jamon Serrano*** (Spain) or the heavily cold-smoked ***Black Forest*** and ***Guestphalia hams*** (Germany) (see page 176). Examples for dry-fermented sausages are the ***Hungarian*** or ***Italian Salami*** or ***Spanish Chorizo*** containing pork only or other ***European dry fermented sausages*** made of lean beef and pork mixes and pork fat (see page 115). Similar to hams, dry fermented sausages from southern Europe are mostly air-dried, while the ones from Central and Northern Europe are in many cases cold-smoked. The time-consuming manufacture of raw fermented hams and sausages was done mainly in the cooler winter season to avoid spoilage and to take advantage of optimal climatic conditions for curing, drying and fermentation (see page 116).

Apart from the dry fermented products, meat mixes were developed to be consumed immediately after fabrication. These included minced meat products similar to ***burgers*** (see page 105) and ***fried sausages*** (see page 108), some of them with vegetable ingredients or special spices. Precooked-cooked products were also popular, which can contain internal organs in addition to meat and fat such as ***liver sausages*** and ***blood sausages*** (see pages 154, 161) and vegetable or grains such as ***black pudding*** (see page 164).

More than one century ago the technology for the manufacture of ***raw-cooked products*** (see page 127) was invented in Germany. This technique was based on the principle that lean raw meat, when finely chopped, is capable of absorbing water and develop a protein network structure (see page 128), which coagulates and solidifies upon moderate

heat treatment above 60C. Comminuting the lean meat was originally done manually using large curved knives or by shredding and battering the meat. With the emergence of comminuting equipment such as bowl cutters and emulsion mills the technology for raw-cooked products was refined and improved. Products of this group, like ***hotdogs***, ***viennas***, ***lyoner*** or ***meat loaves*** (see Fig. 159) are now produced in large quantities in most countries and have become the most consumed processed meats worldwide.

South-America

In large meat producing countries, in particular in Argentina, some local products have been developed. As part of barbecues a type of sausage is used called ***Chorizo criollo***, which is a fresh sausage for frying unlike the Spanish chorizo, which is a raw-fermented product. The chorizo criollo is usually composed of ground pork (75%), beef (20%) and pork fat (5%). Additives include salt, sugar, garlic, red wine, nutmeg, ground pepper and pepper in grains. The mix is filled in pork casings and is for immediate consumption after frying.

A composition entailing more pork fat and beef than for the chorizo criollo is used for the manufacture of a raw-fermented sausage called ***Salame*** (Fig. 277) (approx. 53 % pork, 33% beef and 14% pork fat). The other ingredients are similar to the chorizo criollo including stuffing in pig casings. Salame is a fast ripened product (approx. 10 days). Ripening and fermentation usually take place in cool rooms.

Fig. 277: Argentine salame

Another speciality used for barbecues is a blood and offal sausage called ***Morcilla***. These sausages often contain pork (approx. 11%), pork skin (66%), pork fat (10%), liver (8%), tongue (5%), milk, common salt and as seasonings pepper, garlic, oregano and green and white onions. Blood is added in quantities of 30 litres referred to 100 kg of the sausage mix.

MEAT DRYING

Introduction

In physical terms, drying is the lowering of the water activity a_w (see page 324) in meat and meat products. Water activity is the measure of free unbound water available for microbial growth. Microorganisms need certain amounts of free water for growth, and their growth is halted below defined minimum levels of moisture. Minimum levels vary from species to species of microorganisms.

Meat drying is not a clearly defined technology. Drying may be done for the single purpose of dehydrating fresh meat for extension of storage, but it may also be one of various processing steps during the manufacture of specific meat products.

The manufacture of *fermented meat products,* such as **raw hams** or **dry sausages** (see page 115, 173), is an example, where drying is one processing component amongst several others. To have an extended shelf life, fermented products need to lose moisture during their fermentation, they are dehydrated or "dried" to a certain extend. Drying and fermentation must go hand in hand to achieve the desired flavour and shelf life. The drying of such products is mostly done in climatized chambers with exact temperature and humidity parameters. Drying under natural conditions is increasingly rare. Another example is the drying of meat preparations in ovens with temperatures in the range of 70-80°C, to become fast-dried products such as **beef sticks** formed of ground, salted and flavoured meat. Furthermore, for a number of indigenous meat products, moderate drying is part of the manufacturing technique with the aim of lowering the water activity (a_w), thus curbing microbial growth. A good example is the **Chinese Sausage**. This product becomes shelf-stable through various a_w-lowering measures, namely its relatively high fat content and use of certain additives including a high sugar content, in combination with drying and light smoking at temperatures of +50-60°C (see page 214). Other dried Chinese products commonly found in open markets are the flat

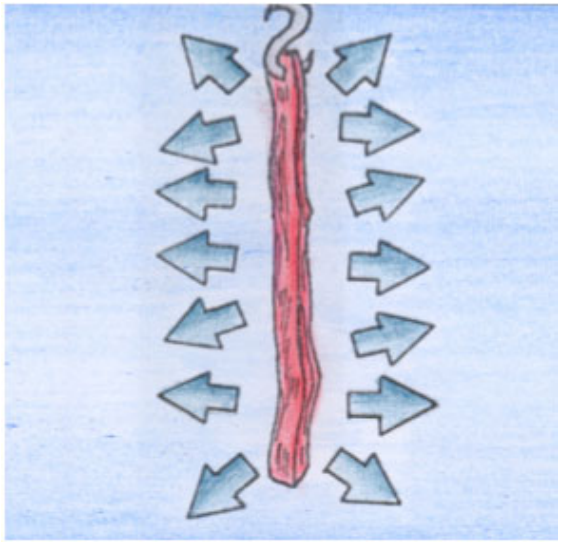

Fig. 278: Dehydration of meat
Evaporation of tissue fluid out of a flat piece of meat

flavoured meat pieces (Fig. 270). The meat is rubbed with a mixture of sugar, salt and spices and subsequently exposed to heat for drying. The heat is generated by charcoal fire or in hot air ovens.

Besides such more complex drying techniques, the simple ***dehydration*** or ***drying of lean meat*** under **natural conditions** has been practised for centuries. It is still a popular method in many developing countries, in particular where no cold chain is available. It is predominantly carried out for meat preservation, based on the experience that dehydrated meat will not spoil easily. Pieces of meat are cut to a specific uniform shape that permits the gradual and equal drying of whole batches of meat. Physically, the reduction of the moisture content is achieved by continuous migration of water from the deeper layers of the meat to its peripheral zone and the evaporation from there into the air (Fig. 278).

Continuous evaporation and weight losses during drying cause changes of the **shape** of the meat through shrinkage. The meat pieces become smaller, thinner and to some degree wrinkled and darker in **colour**. The **texture** also changes from soft to firm to hard.

The fact that dried meat is no longer comparable to fresh meat in terms of appearance and sensory and processing properties, has to be weighed against the significant extension of the shelf-life (see page 233). Under certain circumstances, in particular in the absence of refrigeration, these disadvantages have to be accepted particularly where the alternative might be loss of the valuable meat by spoilage. Most **nutritional properties** of meat, in particular the protein content, remain unchanged through drying.

Types of meat suitable for drying

Meat drying is a simple but efficient food preservation activity. Dried meat can be stored under ambient temperatures for many months. Due to the low water content, microbial spoilage of the muscle proteins can be safely prevented. However, deterioration of adhering fatty tissue through rancidity cannot be stopped. It is therefore advisable to use lean meat only. ***Beef*** and ***buffalo meat*** as well as ***goat*** and certain ***game meats*** (deer, antelopes) are best suited. The same applies to meat of livestock used in some regions for meat production, such as ***camels*** or ***yaks***. The suitability of ***mutton*** is ranked slightly lower. ***Pork***, even from very lean muscle parts, is less suitable, as it contains higher amounts of intermuscular and mostly invisible intramuscular (within the muscle cells) fat, which is prone to oxidation and hence turns quickly rancid.

Preparation of meat for drying

The meat is exposed to the open air and intermittent solar radiation and quickly loses substantial amounts of its tissue moisture. The drying process will be faster the shorter the distance from the centre of the meat piece to its surface. In order to accelerate the drying process in particular from the inner layers of the meat, it is therefore common practice to cut the meat in ***narrow strips*** or in ***flat pieces*** (Fig. 279, 280, 281).

Recommended shapes for meat pieces to be dried are:

- strips with a rectangular cross-section of 1 x 1 cm
- flat- or leaf-shaped pieces with cross-sections of 0,5cm x 3 to 5cm.

Fig. 279: Cutting of meat in lengthy strips (approx. 1-2 cm width)

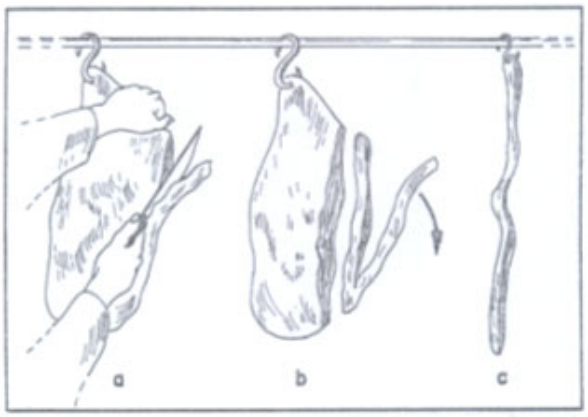

Fig. 280: Special cutting technique to obtain long meat strips for suspension

Fig. 281: Cutting of meat in flat pieces in preparation for drying

In large thick meat pieces, the moisture content in the centre would remain high for too long and, given the high ambient temperatures, could easily lead to microbial ***spoilage***, as microorganisms still would find good conditions for growth. Hence flat meat pieces should always be used for successful drying. Spoilage through chemical reactions can occur when fat turns rancid. Adhering visible fatty tissues need therefore to be carefully trimmed off from the lean meat in order not to limit the shelf life of dried meat.

Meat drying techniques

For the traditional drying of meat, the natural conditions ***sunshine*** and ***air circulation*** are used. Two drying techniques can be distinguished with both using prevailing natural conditions but differing in the impact of the solar energy. These techniques are called ***sun drying*** and ***solar drying*** and are described hereunder.

Sun drying

The basic traditional drying method is called ***sun drying***, characterized by direct solar radiation and natural air circulation on the product. Meat pieces are cut into strips or flat leaf-shaped pieces as described above. They are then ***suspended*** in the open air or ***spread*** on drying trays made of fibre or wire mesh with a wooden or metallic frame (Fig. 282 - 285). For sun drying, in particular for the suspension method, the meat is sometimes ***dipped in salt solution*** (approx. 14% common salt). This helps to limit microbial growth on the meat surfaces and protects to some extend against insects.

The sun drying method is known to have certain disadvantages, such as exposure to ***contamination*** from sources such as dirt, wind, rain, insects, rodents and birds. Quality deficiencies, such as changes in colour, off-flavours, foreign contaminating substances such as dirt and sand and even high surface microbial contamination may occur. Heavy microbial contamination can affect the meat after rehydration, when sufficient moisture for renewed bacterial growth is available, as this will lead to product deterioration and even possible food poisoning.