

Cooking systems for whole-muscle products

The manufacture of whole-muscle cooked meat products is composed of a whole series of steps. Part 1 of a closer look at the characteristics and peculiarities of the last phases of the process, which are: cooking, cooling and final preparation.

By Josep Lagares, general manager, Metalquimia

After the process of injection, tenderizing, massage/ maturation, stuffing and/or moulding, whole muscle meat products will go through a phase of cooking, cooling and final preparation (in the case of products with cooking loss) and will result in the cooked product, ready for dispatch and sale.

The cooking process can be defined as the thermal processing the meat undergoes, involving a whole series of physico-chemical, biochemical and microbiological phenomena, which will define the quality and the organoleptic properties of the finished product.

The main objectives that are pursued with said thermal processing could be summarized in the following points: development of sensory characteristics (colour, flavour, structure, texture, etc.), microbiological stabilization of the product and limiting the effects of overcook-

ing (cooking loss, degradation of organoleptic characteristics).

Coagulation of muscle proteins

The two muscular constituents responsible for the development and stabilization of the cooked product's structure are: myofibrillar proteins (actin and myosin) and collagen.

The muscle proteins solubilized by the combined effect of certain ingredients (phosphates and salt) and by the massage process undergo a process of denaturalization due to the effect of heat which brings about a reduction of the intercellular spaces (see photographs 1 and 2), a compacting of the denaturalized fibres and the formation of a three-dimensional network able to hold water, giving the finished product consistency, firmness and muscular binding.

In certain products (for example polyphosphate-free products), hydrolysis

of the muscle collagen by means of heat, followed by its subsequent gellification, will be the determining factor in ensuring a good degree of binding between the different muscles.

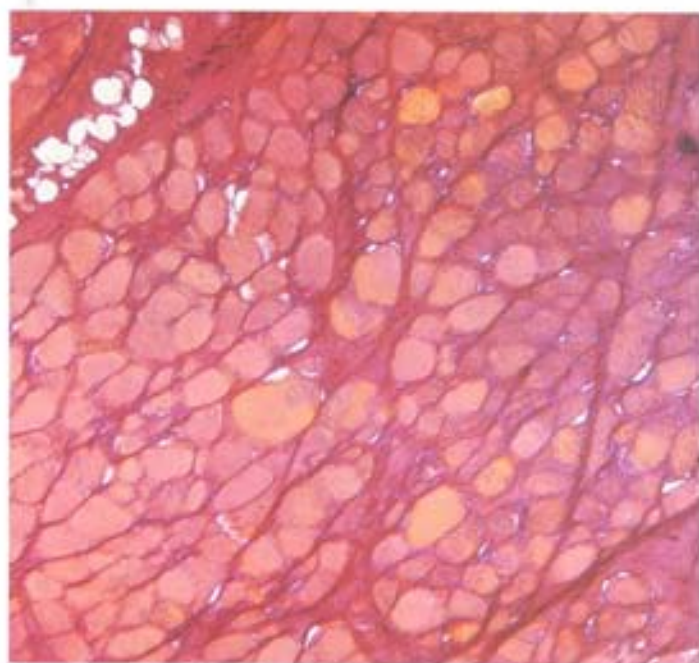
Flavour, aroma and colour

The aromatic aspect of meat is developed and stabilized in two consecutive stages of the manufacturing process:

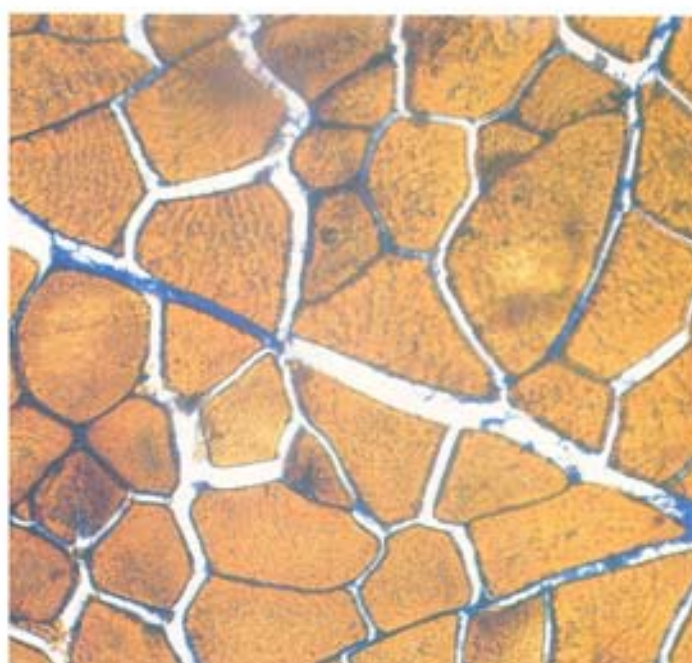
- The operative phases prior to cooking give rise to the formation of the aromatic precursors (fatty acids, triglycerides, phospholipids, peptides, acid amines, sugars, etc.).

- Transformation of these precursors, by means of heat, into aromatic compounds (aldehydes, ketones, lactones, saturated and unsaturated alcohols, furans, etc.)

The application of heat gives rise to a series of reactions (oxidation, esterification, Maillard reaction, etc.) among the components of the meat mass, forming



Maturated meat after third massage and before cooking. Photos: Metalquimia.



Meat after cooking.

new compounds of greater digestibility while giving the cooked meat product its characteristic "Flavour".

Heat is the cause of the denaturalization of the red pigment in cured meat (nitrosomyoglobin) transforming it into the pink pigment characteristic of these products (nitrosomyochromogen). Stabilization of this pigment is produced basically in the final phase of cooking, and the minimum temperature for this to occur is 65°C. For this reason the optimum working temperatures will be between 65-75°C, to ensure a good development and colour stabilization.

Microbiological stabilization

During the preparatory phases prior to cooking, the meat will be acquiring a certain microbiological contamination, which conditions the product's salubrity and its expiration date. The objective of thermal processing will be to reduce this contamination to a sufficiently reliable level to ensure stability of the finished product.

Thermal processing is governed by the parameters of temperature and exposure time, which will correspond to a determined degree of destruction. If the initial microbial load is very high, more

severe heat treatments must be applied, keeping in mind that the product's sensory qualities will also be affected.

In the case of cured cooked products, to obtain an optimum degree of destruction it will be necessary for the centre of the product to be heated at a constant temperature of 68°C or 70°C for 30 to 60 minutes. Another factor that must be taken into consideration is the speed at which the temperature increases during cooking, since slow speeds can give rise to phenomena of bacterial stress and the development of thermal-resistant strains. Therefore, one must try to limit or reduce the time a product remains exposed to temperatures favourable to thermal tolerance (40-50°C).

Control of cooking loss

An uncontrolled cooking process can generate high water losses that can be detrimental both for the consumer (sensory aspect) and for the product (economic aspect). The two phenomena that regulate this water loss are: liberation and migration.

The liberation of water depends essentially on the temperature, in that an increase in temperature produces an acceleration of the free water's molecules

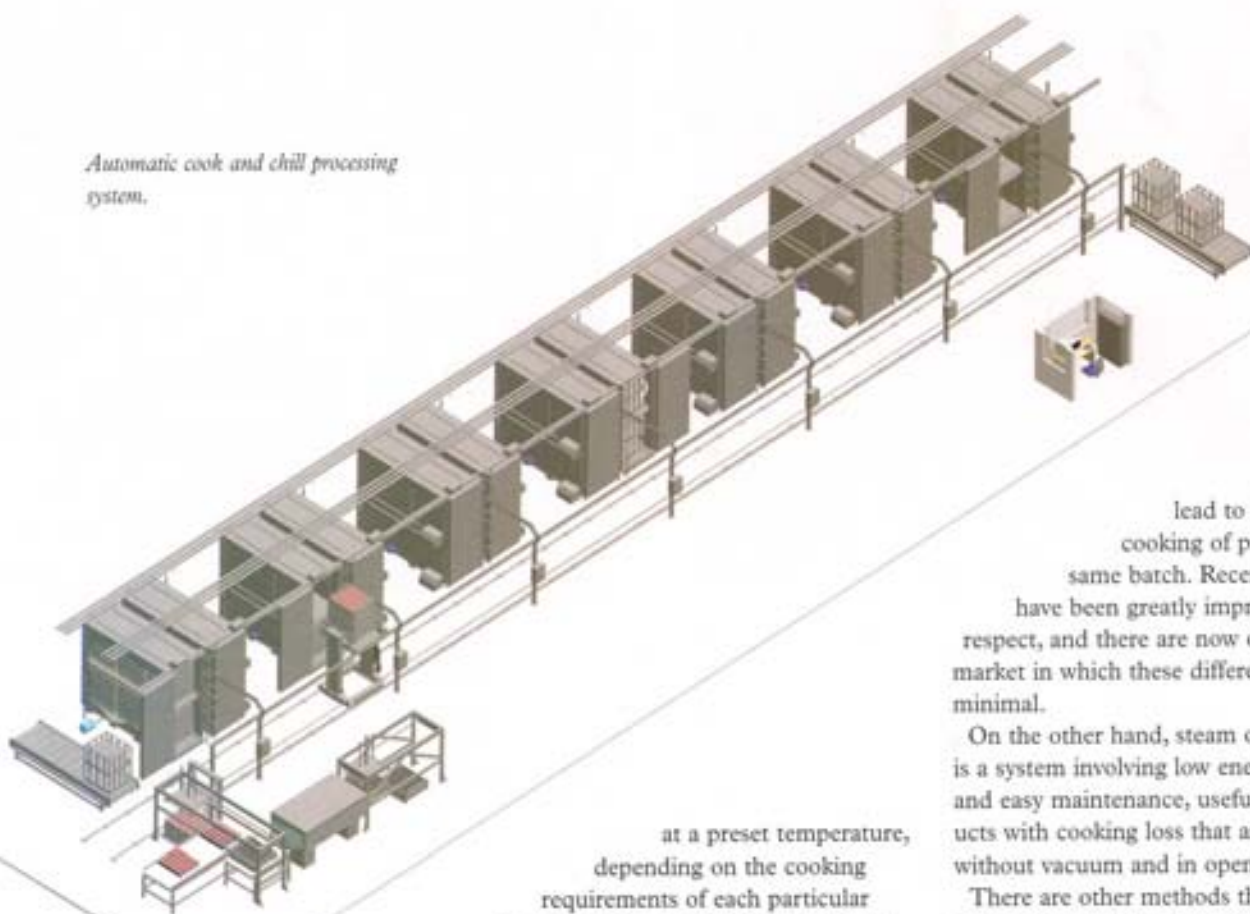
(water not bound to the proteins). This phenomenon is practically instantaneous. At the same time, a certain amount of bound water is also transformed into free water in motion, as a consequence of the reduction of water-holding capacity and the increase in temperature to above 45°C. In this way, the total quantity of free water is increased.

The migration process is influenced by the temperature as well as by the exposure time to heating. In the most outer parts of the product, this migration takes place in the form of evaporation (in the case of unpackaged products) or liquid freed into the exterior environment. It must be kept in mind that not only water is lost, but also other elements dissolved in it such as proteins, collagen, salt, polyphosphates, flavourings, etc.

The cooking processes that limit evaporation phenomena are, for example, cooking in water, steam, vacuum, etc., but the temperature must also be controlled with these methods (low temperature to prevent liberation) and not too long cooking times (due to its effect on migration).

Excessive cooking systematically leads to degradation of sensory qualities.

Automatic cook and chill processing system.



Development of flavour is optimum at temperatures of around 60-65°C. At higher temperatures, the appreciation of flavour becomes unfavourable, worsening proportionally as cooking time gets longer.

Cooking systems

Traditional or classic cooking systems are based on the heating of an external fluid (air or water) by means of steam injection, electric resistance, etc. In these cases, heat is transmitted to the surface of the products and is diffused to their interior by conduction. The characteristics of the fluid, mainly the relative humidity, have a strong influence on the result obtained.

Cooking in water consists of the discontinuous loading of cooking baskets containing the packaged and/or moulded product into a water boiler, which is set

at a preset temperature, depending on the cooking requirements of each particular product. Water cooking has the advantage of an excellent exchange and transmission of heat, resulting in a shorter cooking time while allowing for a good homogeneity and regulation of the temperature. However, it is also somewhat inconvenient in terms of hygiene, especially in products with cooking loss in which the meat can come into direct contact with the water. In addition, the space occupied by water baths is a clear disadvantage when compared to oven cooking.

When cooking in steam oven the product to be cooked is placed in cooking trolleys provided inside the cooking cells. As in the above system, the operation is discontinuous. There are certain disadvantages compared to water cooking, among which we could mention the following:

- Heat exchange and transmission lower than water (longer cooking times).
- Imperative need for a good heat homogenization design and system, in order to prevent possible temperature differences inside the oven that would

lead to the irregular cooking of pieces of the same batch. Recently ovens have been greatly improved in this respect, and there are now ovens on the market in which these differences are minimal.

On the other hand, steam oven cooking is a system involving low energy costs and easy maintenance, useful for products with cooking loss that are cooked without vacuum and in open bags.

There are other methods that are still in the research and development stage (infrared, microwave, ohmic heating), with the goal of achieving the fastest possible transmission of heat without the need for preheating. So far, none of these methods is used for this type of products, due to the lack of uniformity and because it is impossible to effectively control the processing temperature.

At present, the most modern cooking equipment is still based on the classic systems, but with a high degree of automation for better control of the process. The cooking and cooling phase can be carried out in the same receptacle, eliminating unnecessary transport. The phases of loading and unloading the moulds or cooking baskets can be automated, which cuts down on manpower and facilitates the work of the operators. All the operations (cooking, cooling, loading, unloading) can be integrated in the same program that will automatically manage the cooking/cooling phase with total product control/traceability. **MI**