

Manufacturing process for whole muscle cooked meat products III: **Massage**

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Continuing with the previous article on the Process for manufacturing whole muscle cooked meat products, in which the preparation of the meat, brine injection and tenderizing were explained, we shall now proceed with the next phase of the process, massaging and maturation of the meat.

Two of the most important characteristics regarding the quality of cooked products are the binding of muscles and water holding capacity. The muscular components responsible for these two characteristics are the myofibrillar proteins which, once extracted and solubilized, form what is called the exudate [a kind of film on the surface of the meat] with a glue-like effect between the muscles. For water retention to take place, it is necessary that said proteins remain "open" so that water can penetrate them.

The myofibrillar proteins represent about 50 % of the total meat proteins and are responsible for muscular structure, as well as the transformation of chemical energy to mechanical energy during muscular contraction. Soluble in concentrated saline solutions, the proportion of each in the muscle is:

THICK FILAMENTS	TOTAL %
	MUSCLE PROT.
MYOSIN	25.0
PROTEIN C	1.0
PROTEIN M	1-5

THIN FILAMENTS	TOTAL %
	MUSCLE PROT.
ACTIN	12.5
TROPOMYOSIN	4.0
TROPONIN	4.0
α - ACTIN	0.5

Myofibrillar proteins retain water because they form a three-dimensional network of filaments, a structure which is kept after homogenizing the meat,

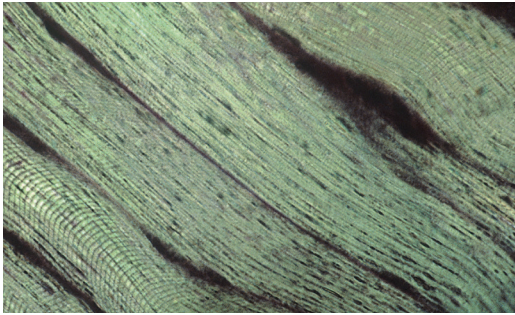
and the amount of water which remains depends on the space existing between filaments. If the muscle fiber contracts, the actin and myosin filaments pile up considerably, the space is reduced, and the amount of water immobilized diminishes.

The pH is the factor which will determine the degree of separation between said fibers. As was mentioned in the previous article, the ideal pH level for the production of meat products is between 5.6 and 6.3. High levels of pH exceed the isoelectric point of meat proteins [point of minimum separation due to equal number of positive and negative charges, so that repulsion is not produced], the positive charges disappear, leaving the negatively-charged proteins. This causes the repulsion of filaments, making space for the water molecules. These proteins also have a binding effect which, as has already been mentioned, will depend on how many of them are extracted from the muscle tissue. To a great extent this will be influenced by the ionic strength of the medium which, when sufficiently elevated [above 0.6] causes the filaments to disintegrate and the actomyosin to dissolve, if treated with the proper solutions.

How is solubilization and loosening of protein achieved during processing?

There are two methods which will lead to the formation of exudate, by means of mechanical action and/or chemical action.

• **Chemical action.** The brine which is injected during the previous phase of the process is made up of a number of ingredients whose purpose is fundamentally that of solubilizing and loosening the meat's myofibrillar proteins. These ingredients are salt and polyphosphates, both of which increase the ionic strength of the medium and the pH, making possible the swelling of chains and the extraction of proteins. These two ingredients act synergically. That is, the combination of the two increases the effect each would have separately.

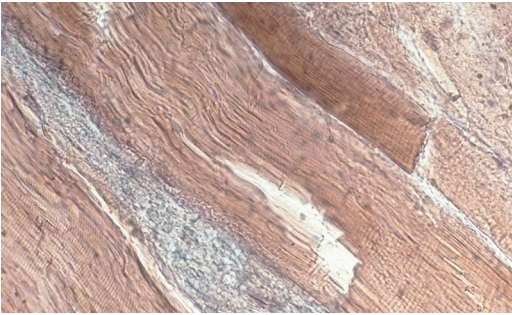
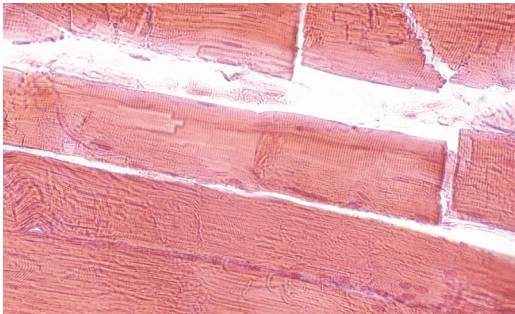


▲ Photo 1: Raw meat.

• **Mechanical action.** This includes tenderizing and massaging. The muscular structure is loosened by means of mechanical processing, breaking up the cells and making the cellular membranes more permeable, facilitating the distribution and absorption of the brine. This process increases the mobilization of fibrillar muscle protein, the protein increases its water content and is activated in the intercellular spaces and on the surface for the fixing in place of water and the binding of muscles.

These two processes are integrally related since the second one will contribute greatly to the absorption of brine, thus assuring that the ingredients have the desired effect in the muscle in the shortest possible time. There are numerous studies which demonstrate the poor results achieved when one of the two processes is not employed. According to Siegel et Col. [1978], polyphosphates play an important role in the extraction of actin, myosin

▼ Photo 3: After second massage.

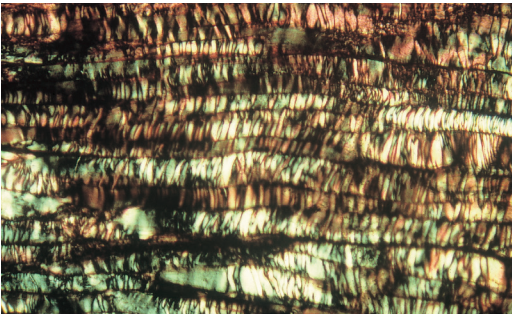


▲ Photo 2: After injection and first massage.

and tropomyosin. The action of phosphates in the surface of muscles begins before massage. Massaging clearly enhances extraction and solubilization of protein, but the result will vary depending on the ionic strength of the medium and the presence or absence of polyphosphates.

Theno et al. [1978] found that the myofibrils separated several hours after having carried out the massage, enormously increasing the surface of contact between components of the meat, salt and polyphosphates. After 24 hours of massaging and maturation, the breakdown of the structure and the integrity of fibers is already much more pronounced, and ruptures can be observed between the myofibrils. The evolution of the myofibrils throughout processing can be seen in the photographs: [1, 2, 3, and 4]. The rapid absorption of brine is also important in the formation of color. It has been proven that the

▼ Photo 4: After end of third massage and before cooking.



percentage of sodium nitrite conversion increases in relation to the increased effectiveness of the massage.

As can be observed, the massaging and maturation phase plays an important role within the manufacturing process of cooked meat products. Therefore it is necessary when choosing a massaging machine to be very familiar with the possibilities offered, above all, the machine's effectiveness and versatility in processing a variety of products, since each product will require a special message cycle, which can be altered considerably according to the finished product's category.

There are basically two models for massaging:

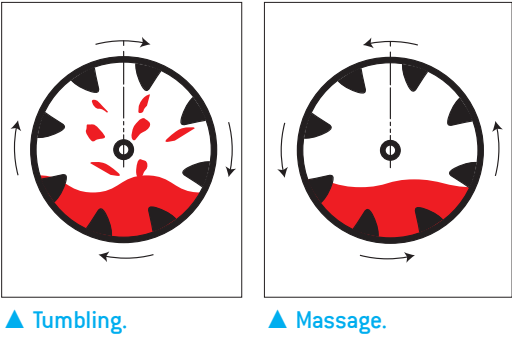
Fall massage: Also called TUMBLING, in which the pieces of meat are lifted by baffles up to the upper part of the machine. From there they fall, striking the meat mass below and producing an intense mechanical action, suitable for high-yield products and those low-yield products where the only method of softening the meat is mechanical. This type of massage results in great cellular breakage and therefore optimum solubilization and extraction of proteins.

Friction (MASSAGE): the mechanical action is through friction between different muscles, with the walls and baffles of the massaging machine, producing a much gentler massage effect than the tumbling system. This type of massage is very suitable for products in which the pieces and the fibrillar structure must be kept intact, but with the feature of achieving sufficient solubilization of proteins for muscular binding.

These two models of massaging correspond to very different types of products and there are many others to which an intermediate process, or a combination of the two, must be applied.

Norms for massaging

The main factors that must be taken into consideration in order to obtain an efficient



massage are the reactor or massaging machine available, the type of product desired (quality, yield, appearance of the slice, etc ...), the manufacturing technology employed and the characteristics of the meat. A precise technique must be employed for each particular product so that it is impossible to speak of fixed universal norms for all of them. But we can outline the parameters that influence the final result to be kept in mind when choosing a process:

- **Quality of the meat:** Prematuration time, the age of the animal, the cut of the pieces and the degree of trimming will all influence the effectiveness of the massage. This can vary from one region or country to another even when dealing with very similar products.
- **Brine:** depending on the composition of the brine, the massage to be applied will vary. As was previously mentioned, salt and phosphates will greatly contribute to the solubilization of proteins, and their effect will be increased by massaging. A greater effectiveness will be achieved when adequate amounts of these ingredients are present than when the brine is lacking in one of them.
- **Time:** the longer the massaging time applied, the greater the effect because increased solubilization and extraction of myofibrillar proteins will be obtained. But said time must be regulated because an excess of massaging time can produce results contrary to those desired, affecting the water



holding capacity as well as the appearance of the slice.

- **Rotation speed:** apart from the different effects produced by the types of massage previously mentioned, its effectiveness will be influenced by the velocity at which the machine spins. Obviously, a higher speed will result in greater solubilization of proteins, but also in greater breakage of the muscles. For this reason, it is necessary to find a point of balance for each product.
- **Internal environment:** the meat's movement produces the appearance of foam, principally due to the emulsifying effect of the meat's proteins themselves. This foam will hinder the muscular binding and will cause air bubbles to appear between and even inside the muscles. Therefore most massaging is carried out under vacuum, to prevent emulsion of air as well as to enhance protein solubilization and the development and stabilization of color.
- **Temperature:** the mechanical action produced by massaging tends to increase the temperature of the meat and although efficiency of massage is greater at higher temperatures, there is also a risk of bacterial contamination. The ideal working temperature is between 4° and 8°C, but that requires working with very cold brines and meat, which makes injection difficult, or having a cooling circuit in the machine itself (circulation of a coolant



through coils around the machine). This guarantees that the meat will come out of the massage at the required temperature, avoiding contamination risks and allowing the operator to work more comfortably during the injection phase. In some exceptional cases, it is recommended to work with lower temperatures, 2-3°C, to prevent excessive extraction that could dry out the meat surface too much.

- **Maturation:** The combination of massaging and maturation will produce the desired extraction and solubilization of proteins. The most standard maturation time is 24 hours, with which good results in massaging and color distribution are obtained. The combining of a certain massage time with several hours of repose has given excellent results, allowing the solubilization of proteins which form the exudate to take place. This maturation time can be reduced when working with small muscles, if the necessary measures are taken to compensate for said time (effectiveness of massage and tenderization).
- **Batch size:** The result, mainly in the case of strong massage or Tumbling, will depend on the height from which the meat falls, so that the quantity of meat in the machine will be a factor taken into consideration when carrying out a massage. This means there are more opportunities to be able to apply the massage necessary for each product with different effects in the same machine.

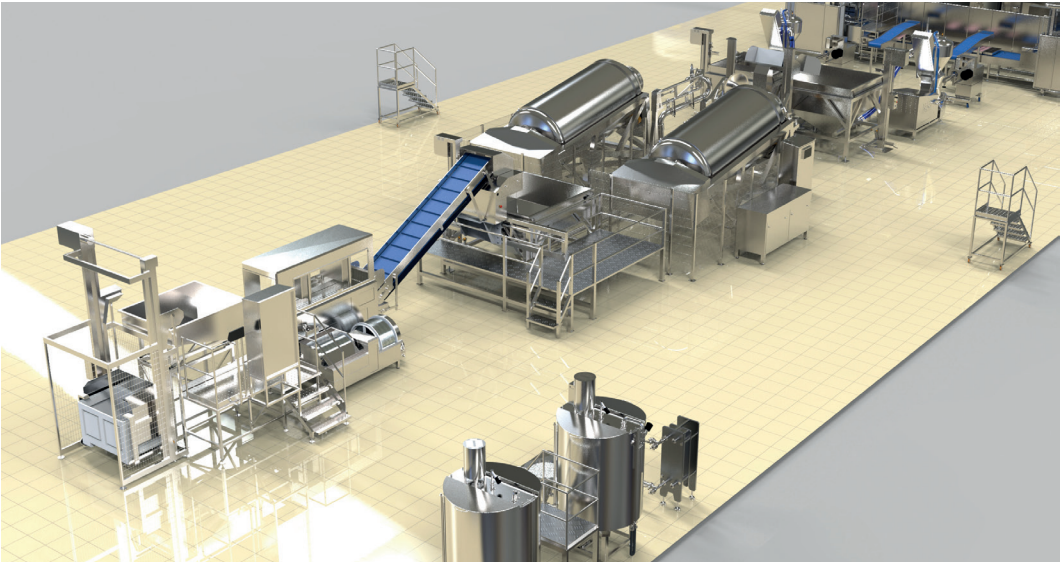
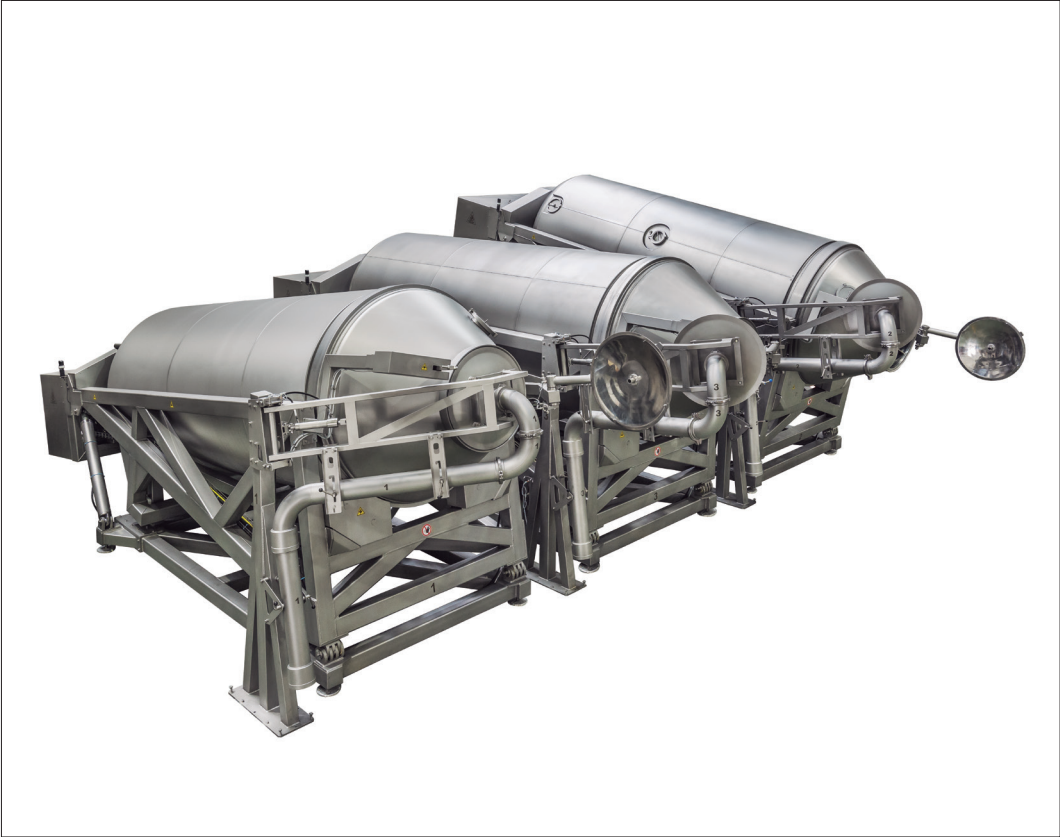
Evolution of massaging

Massaging machines or reactors have evolved in response to the needs and demands of the products and the market. Nowadays all machines have a vacuum system but they are still very limited in versatility and automation, which makes factory production difficult. Because of the wide range of products and the different requirements of each one, it is important to select a machine model which can cover all these possibilities, not only for the products manufactured at the time of purchase but also with foresight for possible changes in the market.

Automation of massaging is important in order to avoid unnecessary waste of time and, above all, to

prevent human errors by storing all the massage data in the memory of a computer (massage time, rotation speed, maturation time, internal environment, etc.) which will regulate the machine's operation throughout the day as well as control the temperature of outcoming meat, the cleaning in place when incompatible products are processed (products with and without starch, difference of flavors, etc...), the mechanical maintenance of the machine (giving information as to when oil changes and lubrication are necessary), and with a system of alarms which permits the detection of possible errors at all times, not only technical malfunctions but also incorrect operation on the part of the operator.

▼ Automatic Tubling/Massaging Reactors: TURBOMEAT 9X.



▲ Semi-automatic Injection / Massaging Line: BBV LINE.

It is also important to obtain information about the work carried out by the reactor or massaging machine during the periods of time when it is not monitored by operators. Information must be available on a daily basis about the processing done during the night or weekend when the machine has been left on complete automatic cycle.

As we have seen, in recent years a high degree of automation has been achieved which, together with the advanced technology employed in said machines, has allowed for the evolution of products toward a higher esthetic and nutritional quality and, above all, offering greater security to the investor and to the consumer (control, traceability) at a considerable saving since it allows for optimum production and automation with minimum labor costs.

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