Profitability of cooked ham production lines: adaptation to different maturation cycles

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INTRODUCTION

The growing market demand for products of higher quality at lower cost, the need for greater productivity and profitability in processing lines, increasingly strict food regulations, as well as greater consumer concern about food safety and sanitation, among other reasons, have forced manufacturers of machinery for the production of cooked meat products to look for new solutions and offer new processes (more automation, more productivity, more control, more traceability, more ergonomics, more safety, easier sanitation and maintenance, etc ...).

In particular, all processing plants for cooked whole muscle meat products are seeking a way to automate and achieve a maximum reduction in the time used in the various phases of the process, with the goal of a maximum increase in productivity and profitability of the line. Throughout the history of cooked ham and shoulder production, the productive process has undergone many changes due to the development of technology (chemical and technical), consumer preferences and the unstoppable evolution towards globalization of markets.

Not all the technical and technological changes proposed in the sector over the years have been adopted as standard processes applicable to most products and markets. Many have ended up being mere ideas without contributing anything of significant value, others have been relegated to very specific productions and areas, and a few have gradually been introduced until finally becoming widely accepted as real processing improvements applicable to a global market.

One of the most important matters pending in the production of cooked whole muscle products, and where most processing companies are channeling their efforts and investments in order to discover future competitive advantages, is the question of whether or not a maturation phase is necessary between massaging and cooking, and, if so, what the duration and temperature of this phase should be. This controversy (most arguments, both pro and con, are lacking any scientific basis) has been going on ever since industrial meat-processing machinery first appeared on the market, and is today one of the main lines of research being pursued by the major suppliers of equipment and technology.

MATURATION and PRODUCTIVITY

Ever since the start of industrial production of cooked whole muscle meat products (cooked ham and shoulder), maturation phases have taken as long as up to 4 to 5 days. This excessive processing time has now been reduced, thanks to the development of spray injectors and massaging reactors, which, combining gentle and energetic massaging cycles with resting cycles, have made it possible to achieve universal processing times of 24 hours, which means *"inject today, cook tomorrow"*. In this case, real maturation time usually varies from 12 to 18 hours, depending on work shifts and production lines. However, there are some exceptions for certain products and it's worth noting that some markets still prefer to work with maturation times of up to 48 hours in order to obtain better organoleptic characteristics (color, texture and flavor), even when having at their disposal the most advanced, state-of-the-art technologies. While in other countries, due to product requirements (Central European countries, for example), processors have been working for years without any maturation phase at all, using exactly the same equipment as the processors working with maturation times of up to 48 hours.

As can be observed, the duration of maturation depends considerably on the customs of each particular area and consumer acceptance of the product. There is a minimum time respected by all processing plants, which is the time needed to prevent the meat from having a "boiled meat" or greenish-brown color. But once this period has elapsed (some 5-6 hours for whole tenderized muscles), the duration of maturation will depend as much on social factors (tradition, mentality) as on technical factors (machinery and technology available).

In this way, and in relation with the maturation phase, both manufacturers of processing equipment and meat producers have been carrying out research and working towards optimizing this operation cycle, with the goal of eliminating or reducing to the maximum this resting period, freeing up processing time and, therefore, increasing productivity and profitability of the production line.
So, if the benefits are so obvious, why, after so many years and so much effort, has only a part of the global meat sector eliminated or drastically reduced the maturation phase?

The answer to this reality can be found in the fact that, in industrial practice, this process cycle reduction is not easy to implement in already-existing processing plants, and to this one might add that some organoleptic aspects of the product, favored by longer maturation times, cannot be achieved simply with efficiency of the equipment nor with the help of additives.
Furthermore, the global meat industry is dominated by quite a conservative outlook, with strong resistance to the idea of changing processes that have worked well for years and, obviously, if changing to a new system involves major reorganization of the plant without bringing considerable improvement in product cost, the company often opts not to modify the system.

OBJECTIVES OF THE MATURATION PHASE

In order to understand what was described in the above paragraphs, the objectives which the maturation phase hopes to accomplish are outlined below:

▲ **Photo 1:** Dual action TWINFILOGRIND Tenderizer.

1-Extraction of myofibrillar proteins to achieve water-holding capacity and binding of muscles.
The protein extraction that takes place during the ***tenderization + massaging*** process is completed with a resting phase (maturation), during which a certain degree of protein extraction will continue as well as a muscle-relaxing action effected by the presence of phosphates and salt. These actions, however, can be compensated for in part by increasing the mechanical action of ***tenderization*** (Photo 1) ***and massage,*** obtaining a product technologically similar and/or the same, notably reducing said maturation phase and changing only some parameters in the same processing equipment. In some high-yield products where appearance is less important and a sufficiently

effective massaging reactor (*tumbler*) is unavailable, a mixer or blender can be used as a substitute, though this is never advisable for processing high-to-medium-quality meat products since it results in damage to muscle structure and has a negative impact on the slice in the finished product.

2- Flavor: Flavor needs time to develop, but good aroma and flavor can be attained with proper flavor enhancers. In high-quality products with very low injection rates, greatly accelerated maturations may represent an additional problem for this parameter, but additives can be used as compensation for most meat products on the world market.

3- Texture: Duration of the maturation phase has a definite influence on the texture and slice of the finished meat product. For high-yield products, maturations that are accelerated by means of mechanical action will have little influence on said parameter. In contrast, for high-to-medium-quality products omitting the maturation phase can have an impact on said variables.

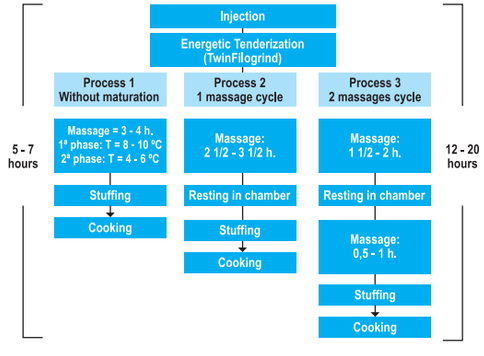
4- Color: This is perhaps the most critical point in which maturation plays a role. Development of color occurs due to chemical reactions taking place in the meat between nitrite and myoglobin. Nitrite is transformed into nitrous oxide (a reaction accelerated by the presence of reducing agents such as sodium ascorbate), which reacts with the myoglobin to form nitrosomioglobin, which will decompose into globin and nitrosomiochromogen, which is ultimately responsible for the pink color characteristic of cooked ham.

Needless to say, an energetic and efficient massage will favor acceleration of these chemical reactions because the brine will be distributed faster and more uniformly, so that the additives responsible for color development will be able to react with the myoglobin more efficiently. However, these reactions require a certain amount of time and can only be accelerated by increasing the temperature. This option is not very advisable due to the microbiological problems that may occur as a result, but it is possible to effect temperature combinations that can speed up chemical reactions without endangering the finished product's microbiological safety. In some cases and in certain products, an acceptable color has been obtained without having to submit the product to excessively long maturation times.

VERSATILITY IN THE DESIGN OF PRODUCTION LINES

It is for the reasons described above that when planning the design of a new production line for cooked whole muscle meat products, and with the final goal of maximizing the profitability of said line, one should pay attention to the criterion ***"versatility depending on maturation"***, so that in a single line high/medium quality products requiring relatively long maturation times can be processed, as well as high-yield products in which the maturation phase can be reduced/eliminated, thereby increasing productivity of the line and maximizing profitability of the initial investment.

Therefore, it is of utmost importance when planning said production lines to take into account the fact



▲ **Diagram 1:** Processing possibilities with a Metalquimia line.

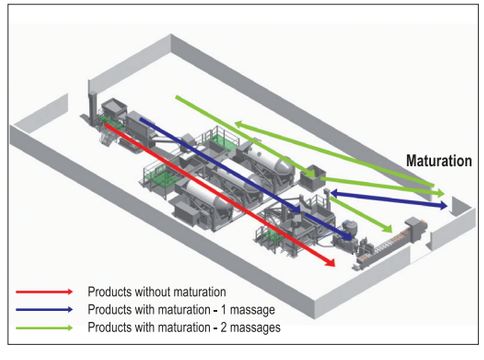
that with the same processing line three different and independent types of production processes can be effected:

- Process 1: Process without maturation
- Process 2: Process with maturation and a single massage after injection
- Process 3: Process with maturation and two massage cycles (the second one before stuffing)

This type of production line has been designed with the criteria of maximum versatility and profitability in mind, so that it is capable of adapting to varying market requirements and able to produce all product types without the need for additional equipment.

Diagram 1 is a production flow diagram of one of said lines that make it possible to work indifferently without maturation, with reduced maturation periods, or long maturations, thereby combining the production of cooked meat products within the *Delikatessen* range with high/medium quality products, medium quality and/or high-yield products.

The three-dimensional design and *lay-out* of a processing plant that takes into account the above-mentioned criteria can be observed in the following drawing:



▲ **Diagram 2.** Traditional design and plant *lay-out*.

REDUCTION OF MATURATION IN GLOBAL MARKETS

To what degree cooked whole muscle meat products are currently being processed while reducing or completely eliminating the maturation phase varies enormously depending on the different world meat markets, their technological evolution and their gastronomical culture.

Some examples of the degree of implantation of this method are outlined below:

United States of America and Central America

In the United States of America, one of the characteristics consumers most appreciate in meat products is uniformity of color. To obtain this effect, the different muscles of the ham are separated and used separately, giving a color that is always more uniform. In general, products are made with the muscles called silverside and topside, eliminating the zones with a darker or more intense color. Working with reduced maturations in this case poses fewer problems with regard to uniformity of color, since the raw material the product comes from is already very uniform. In addition, in many products a high percentage of ground meat or emulsion is added, which helps to compensate for the lack of maturation and to obtain a much more homogeneous slice (Photo 2).

▲ **Photo 2.**

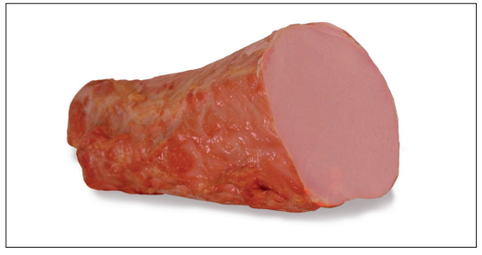
Central Europe

In this area, processes with reduced maturations are quite well established for low-to-medium injection (10-30%), generally phosphate-free products, packaged with traditional netting (Photo 3) or packaged in slices. Maturation times vary from 0 up to 4-6 hours, depending on the product and production flow. In regard to raw material, in this type of products all the ham muscles can be used, with the natural differences in meat color slightly more pronounced in the cooked product, or sometimes the same system as for American products is used, separating out the darker muscles and obtaining a finished product of more uniform color.

▲ Photo 3.

Eastern Europe

In Eastern Europe and countries of the former Soviet Union, many of the typical products are processed with medium injections (40-60%) and are usually smoked. These are whole products cooked without stuffing, with the muscles hung directly in the oven trolley (Photo 4). These products cannot be tenderized and, therefore, acceleration of the maturation period is achieved by means of a more effective massage. Since a considerable increase of mechanical action cannot be applied, the total reduction of maturation does not appear to be a good option, since this could affect uniformity of color, but through combinations of more effective massage, technology and temperature, good results have been attained with processing times between injection and cooking of under 6 hours (keeping in mind that approximate massage time for these products is from 2-3 hours).



▲ Photo 4.

Other markets

There are also some isolated cases in other markets (some in Latin America) where maturation is being eliminated for lines of high-injection products, with very energetic tenderization (generally dual tenderization) in order to accelerate brine penetration and protein solubilization. In these cases, it is advisable to effect the massage at a temperature above what is considered to be standard (4-6° C) to accelerate the meat's biochemical reactions. But it is absolutely indispensable to operate in impeccably hygienic conditions before, during and after the process to eliminate the risk of microbiological contamination.

CONCLUSIONS

Obtaining a cooked whole muscle meat product, technologically correct and with maximum food safety guarantees, is not the fruit of chance but rather depends on endless processing variables that cannot be modified in a haphazard way. Growing market demand for meat products of higher quality and greater safety for lower cost has impelled manufacturers of processing equipment for cooked meat products to look for new solutions and offer their customers new processes that make profitable product viability while respecting and increasing the possibilities of the basic quality parameters of said product.

It is within this contextual framework that the search for new technological processes is taking place, processes that will optimize and minimize maturation cycles as a means of improving productivity and profitability in meat processing plants. At the present time, apart from increasing mechanical action (dual tenderization and massaging reactor efficiency), the use of certain additives and/or increasing maturation temperature, no other means have been found to accelerate the reactions that take place in the center of the meat muscle during this important phase of the production process, and this is why many meat processors still prefer to work using the conventional system, thereby minimizing bacteriological risks and ensuring a safe end product of stable quality, except when dealing with certain technological demands such as in the case of Central Europe.

As can be seen in this brief summary, if for the time being the reduction/elimination of maturation cycles in the production process for cooked whole muscle meat products cannot be considered as a change consolidated on a global scale, it certainly is a determining factor of utmost importance to keep in mind in the planning of new structures and new processing plants for the production of said products, making the criterion ***"versatility depending on maturation"*** a priority in these designs, in which it is possible to combine, indifferently and independently, processes without maturation, processes with maturation and a single massage cycle, and processes with maturation and two massage cycles, allowing for the production of cooked meat products within the *Delikatessen* range, high-to-medium-quality products, and high-yield products, all with the same production structure.