

Manufacturing process for whole muscle cooked meat products: **injection of trimmings**

Josep Lagares



INTRODUCTION

The meat market in the United States of America is a market by the strictness of norms dictated by the U.S.D.A. [United States Department of Agriculture] and affiliated bodies [F.S.I.S. - Food Safety and Inspection Service, etc] in regard to raw material and additives as well as everything concerning machinery, technological processes, hygiene, etc. This leads to the availability of these components with a perfectly standardized quality, while the consumer has access to all the necessary information [rigorous labelling] about the final product on the shelf, allowing him to choose the one that suits him best according to his organoleptic preferences and nutritional needs.

The basic parameter which regulates the quality of a cooked-injected meat product in Spain is the Feder Index or Water/Protein Ratio, whereas in the North American market this defining parameter for the quality of cooked-injected meat products is the P.F.F. [Protein Fat Free] expressed in the following formula:

FORMULA 1:

PFF=
$$\frac{(\% \text{ Protein}) \times 100}{100 - \% \text{ fat}}$$

The products with a lower yield correspond to the products with a higher protein content and therefore a higher P.F.F. These are VIRGINIA HAM-type products [bone-in ham, injected, matured, cooked and smoked in a traditional format and low yield] which fall into the Cooked Ham category and have a P.F.F. greater than 20.5. In this type of product, considered to be of higher quality, the injection brines are simple ones and the addition of non-meat proteins, for example, is totally prohibited.

Products within the COOKED HAM or SHOULDER WATER ADDED category are those with greater injection and higher yields for which the P.F.F.

requirements are much lower [P.F.F. = 17 for HAM or P.F.F. = 16.5 for SHOULDER]. All these products share a common characteristic: the addition of any non-meat protein is absolutely prohibited. This is permitted only in the products within the COMBINATION category, products which are much more economical and of much greater final yields than the products mentioned above. At the same time, the constant and daily presence of U.S.D.A. inspectors in production centers, as well as continual analyses, assure the nearly absolute compliance with the legislative regulations.

Within this framework, it is not surprising that considerable impact was caused in said market by the U.S.D.A. approval of the system called: "Cold particle reduction and injection system" or the use of trimmings generated by cutting, boning and trimming for the preparation of a brine emulsion to be injected into the meat during the manufacturing process of cooked and injected meat products.

DESCRIPTION OF THE PROCESS

What is the injection of a brine-emulsion of trimmings into the center of the meat muscle? What does it consist of, and what advantages does it provide?

The system consists of using the trimmings that are generated in all processing centers during the cutting, boning and trimming phases, and putting them through a reduction-emulsification process at low temperature in order to obtain a perfect emulsion of them in an injection brine, followed by the introduction of this brine emulsion into the center of the meat mass by means of a multineedle injector. Said system is being used for the processing of various types of meat, principally pork, beef and poultry.

The main advantages initially claimed by the inventors to be provided by the system are:

- Making use of the trimmings generated in the plant, thus giving them a greater additional value. The F.S.I.S. permits the addition of emulsified trimmings up to 15 % above the green meat weight.
- Utilization of the brine emulsion in products in which the addition of different proteins is prohibited [under the regulations of this market, this includes nearly all products], augmenting the protein content and therefore increasing yields while reducing costs.
- Increasing the P.F.F. in products injected with this system. From the point of view of P.F.F. legislation, the more fat originating from trimmings we are able to inject into a `Fat Free` product, the higher the P.F.F. of said product will be.
- Possibility of phosphate level reduction.
- Better intermuscular binding which results in better slicing yields.
- Improved water holding capacity.
- In many products, noticeably improved appearance of slice and texture.

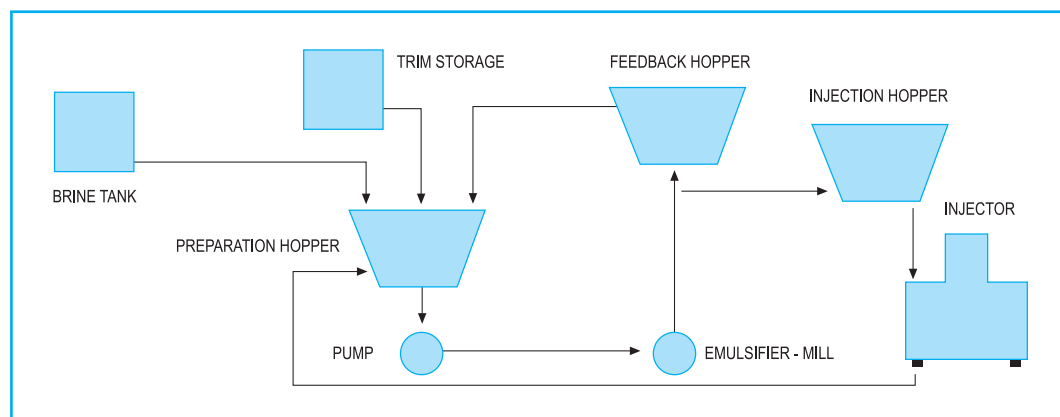
Once we have seen what the system consists of and the potential advantages it can offer, the question arises: How does the emulsification injection process actually work?

The preparation of the trimmings, their emulsification to form the brine emulsion, as well as their injection into the meat is a complex procedure consisting of

a series of steps which must be followed carefully and carried out in strict order. Otherwise, serious problems can arise, especially during the injection phase. The basic steps to be followed are:

- Selection of the trimmings which, as was previously mentioned, can be from various sources [pork, beef, chicken, turkey ...] depending on the type of meat to be processed. Useable trimmings are those whose lean/fat ratio oscillates from 90/10 to 50/50. Either a single type of trimmings or a mixture of them is used in the emulsification process, depending on the final product and the surplus generated by the plant.
- Freezing of the trimmings at temperatures near -8º C and their subsequent grinding through 8 mm hole-plate while trying to minimize any thermal increase.
- Determining the trimmings content of the finished product, and therefore the percentage of trimmings to be added to the brine. The brine: trimmings ratios which have been worked with are 2:1, 3:1 and 4:1.
- Brine preparation in a separate tank and its subsequent cooling to -8º C. The brines used are simple ones containing only: salt, nitrite, sugar, glucose and phosphates. Chart 1 presents a typical injection brine formulation for a product belonging to the Cooked Ham Water Added category -P.F.F.= 17%.
- The standard brine at -8º C is automatically weighed and added to the preparation hopper [See

CHART 1		
INGREDIENTS AND ADDITIVES	g/Kg (*)	Brine %
Salt	20.0	7.45
Sodium tripolyphosphate	3.00	1.12
Sodium nitrite	0.18	0.07
Sodium erythorbate	0.40	0.15
Saccharose	7.00	2.61
Dextrose	15.0	5.59
Trimmings	67.0	25.0 (**)
Water		58.0
		100
Injection % = 33 % Final yield = 122 - 124 Category = Cooked Ham Water Added PFF = 17		(*) g of additive each Kg of finished product (**) Lean: Fat Ratio = 80:20



▲ Scheme 1.

Scheme 1). Then the frozen trimmings (-8° C) are added, in the previously determined amount, to the brine in said hopper. Next, these ingredients are stirred manually so that the trimmings absorb brine and thus give the solution a more homogeneous viscosity preventing the lighter particles from becoming concentrated on the surface. When this has been completed, the first step for emulsification can be taken.

- The mixture prepared in the previous step goes through the Force Fed Mill system, consisting of a rotary lobe pump that receives the mixture and forces it through the emulsifier-mill, emptying the preparation hopper and dumping the preemulsion into the feedback hopper [See Scheme 1). Once all the pre-emulsion is inside the feedback hopper, after having gone through the mill, it is emptied again into the initial preparation hopper and once again all the preemulsion is Forced through the emulsifier. This operation is carried out in such a way that at the end of the preparation, the emulsifier-mill three or four times. The final temperature of the emulsion must never exceed -4° C, and no more than 2-3 minutes are needed for a complete preparation. In this way, a brine-emulsion is prepared which, after having gone through the mill three times, is sent directly to the injection hopper.

- The next step to be carried out is injection of the prepared emulsion. The temperature of the

meat to be injected must be between 1° C and 3° C, while the temperature of said preparation must be maintained at -2 to -4° C during the injection process, as has been previously mentioned. Higher temperatures will cause a number of problems which will be explained later on. Any excess of uninjected brine is not filtered, but sent back to the initial preparation hopper and pumped through the emulsifier-mill to the feedback hopper in which it is mixed with the recently prepared brine and its temperature brought back down to -4° C. In this way, the excess brine can be recycled and used again.

- Once the meat has been injected in this way, it undergoes the usual processes of massage/ maturation, stuffing/ moulding and cooking which are characteristic of these types of products. Having arrived at this point, the reader of this article may formulate a number of questions, such as:

- Why are such low working temperatures used?
- What is the reason for putting the brine-trimmings through the mill three times?
- What advantages are offered by working with a Force Fed Mill?
- What is considered to be the optimum injection system for working with this process?

Obviously, each of these considerations is of vital importance for the process to work smoothly and

the improper carrying out of said operations will lead to a defective brine-emulsion preparation, incorrect injection and consequently, an overall loss of quality in the finished product, from an analytical organoleptic point of view as well as in terms of final production yields (having a direct impact on the costs of the finished product). We shall now deal briefly with each of the above mentioned questions and outline the correct procedure to be followed in each area (scheme 1).

PROCESS TEMPERATURE

The emulsion process involves a previous phase of breaking up the muscle fibers in order for the complete extraction of myofibril proteins to take place, as well as to minimize the size of filaments originating from the connective tissue. The broken up muscle fibers will allow for a perfect emulsion of the trimmings fat with the brine. The filaments must undergo a reduction in size, and more importantly, their subsequent cross-linking must be prevented. As has previously been explained the initial preparation temperatures are around -8° C. Each time that the brine trimmings goes through the mill blades, its temperature rises by 1° C or 2° C, so that after having gone through the mill three times, the final brine-emulsion temperature is somewhere between -4° C and -2° C. Higher temperatures will allow the tiny collagen fibers, reduced during the emulsification process, to link up again and form fibers which will clog any type of injection needle, thus impeding a proper penetration of the brine into the meat mass center and seriously hindering the entire production process.

NUMBER OF TIMES THROUGH THE MILL

After working with said system several times, and with emulsions of varying composition in terms of the brine/trimming ratio, it is easily verified that putting the raw material through the mill fewer than three times can result in a number of problems that jeopardize continuation of the production process.

Among these, the most important are:

- Incomplete emulsion leading to the inevitable separation of the insufficiently blended preparation. Even before beginning injection, a thin, creamy layer can be seen on the surface.
- Insufficient reduction of collagen fibers resulting in their cross-linking which rapidly generates filaments of a size unsuitable for the process. It is important to point out here that if putting the brine-emulsion through the mill too few times can cause said problems, doing so more than four times will result in temperature increase of the brine-emulsion which can lead to the same kind of problems.

FORCE FEEDING

This is accomplished by means of a rotary lobe pump fitted between the preparation hopper and the emulsifier-mill (see Scheme 1). The pump feeds the raw material (brine trimmings) into the mill in a constant and nearly homogeneous way so that great effectiveness is achieved, both in terms of the fiber reduction process and the formation of emulsion. This system prevents concentration in the preparation hopper of floating trimmings, providing a steady and homogeneous flow of raw material to the emulsifier-mill.

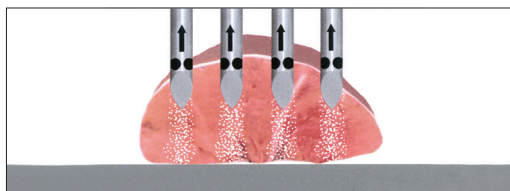
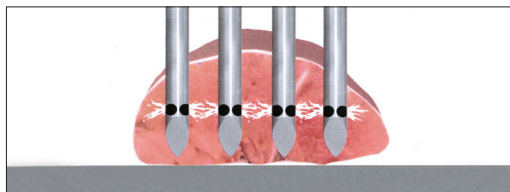
INJECTION SYSTEM

As was explained in the article “ Manufacturing process for whole muscle cooked meat products II”, there are two basic injection methods by means of multineedle injectors:

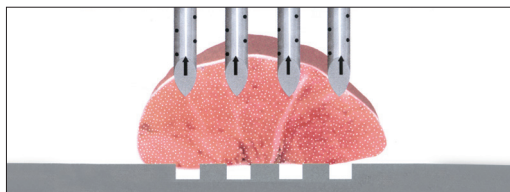
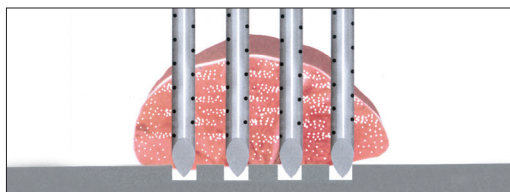
- Low Pressure System.
- Spraying System at Constant Pressure.

The difference between the two types of machines is the method used to introduce brine into the meat mass. Traditional Low Pressure injectors deposit the brine while the needle stroke is penetrating the meat, with needles that usually have from 2 to 4 holes of more than 1 mm. in diameter forming

Low pressure system



"Spraying" system



▲ Figure 1.

brine deposits which must then be distributed mechanically [see chart 2]. At the same time, this injection system will provoke an excessive drainage of brine so that at the end of each batch, the tank of injected meat will contain a considerable amount of free brine.

In contrast, the injectors which use the Spraying System introduce a volumetrically measured dosage of brine released in spray form when the needles have completely penetrated the meat piece and have come to a stop at the end of their stroke, the brine is injected into the meat mass by means of a spray. The brine injected by this method is distributed homogeneously throughout the entire



▲ Spray System injection Head.

piece of meat. The special design of the needles, the injection holes (from 8 to 10 of 0,6 mm. in diameter) and the way they are arranged along the needle, as well as the high pressure existing in the brine circuit, all combine to ensure that the brine enters the muscle fibers in the form of micro-drops without damaging them, preventing brine-emulsion deposits between fibers and minimizing drainage.

As has been demonstrated in the above paragraph, the injection system used is of utmost importance for this new processing technology (injection of a brine emulsion of trimmings). It is so important, in fact, that the success of the process depends to a large extent on this factor. The first trials which were carried out without an adequate injector seemed to point to a total failure, and numerous companies abandoned the project after having performed a great many trials in their plants.

Among other objectives, a proper introduction of said brine-emulsion between muscles must aim at:

- Avoiding the formation of brine deposits or pockets.
- Preventing excessive drainage during injection.

The formation of brine pockets between muscles during the brine-emulsion injection process is synonymous with the appearance of fatty concentrations, making the finished product unattractive to the consumer, caused by the

separation of the brine-emulsion inside the meat mass during the massaging process. A proper and uniform distribution of emulsion during the injection phase eliminates this problem.

Separation of the emulsion, during the massaging phase, is also caused by brine that has not been absorbed by the meat mass, generating concentrations of fat, resulting in a loss of yield and the diminished quality of the slice in the finished product. That is why it is so important when injecting to have a machine you can rely on to minimize the above mentioned drainage.

FINAL REMARKS

Since its presentation at the 89 AMI SHOW and its subsequent approval by the U.S.D.A. - F.S.I.S., the system presented in this article has been making a place for itself in the productive process of numerous North American meat processing plants, being used for all types of raw material (pork, beef, chicken, turkey...) Working with said system has produced enviable results in some of the plants where it has been introduced, while the results have been less spectacular in others, depending on a number of factors, such as: type of meat processed, brine: trimming ratios formulated, injection levels desired, injection system used, etc...

▼ Double Head High-Productivity Injector: MOVISTICK 5500.



In addition to this list of technological factors other different factors could be added, for example: extreme care must be taken not to waste excess brine during injection, making sure it is used again after reemulsification with the original brine, except for the final excess at the end of a working day, otherwise brine costs will be very high. In a system as complex as the one described in this article, in which a whole series of variables continually come into play, it is clearly necessary to exercise total control and careful precision at each and every phase of the process. It is only in this way that one can aspire to attain the technological improvements claimed by the inventors and described at the beginning of this article.