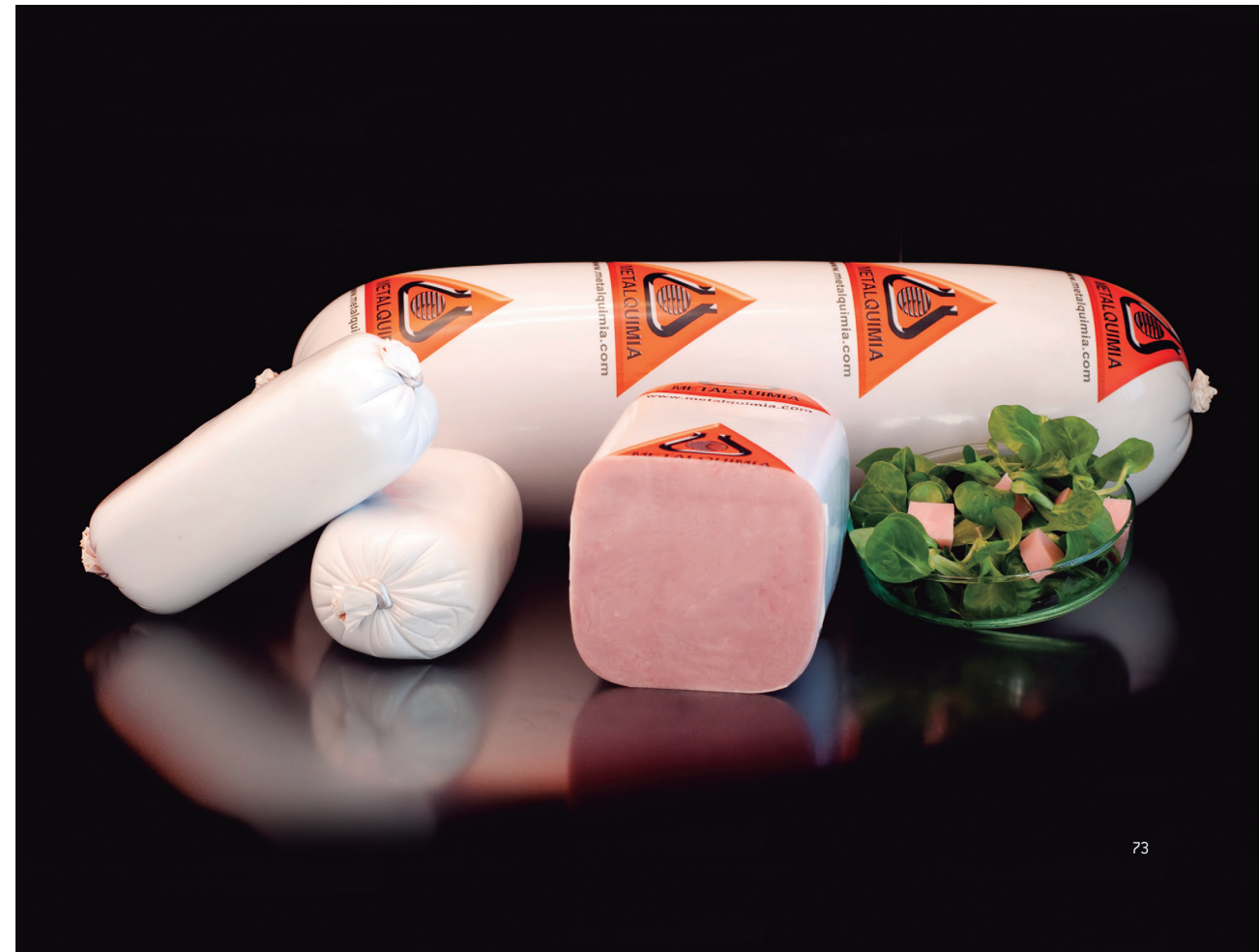


Very high-yield cooked products: **TRIPLEX, the Exponential Injection**

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Over the past 10 years, the precarious economic situation of many countries in the world has led to a decrease in the purchasing power of consumers, a fact which has forced most meat processors to offer products at a lower cost, either by increasing the yield of their products or by reducing production costs.

At the same time, the constant search for innovations that boost increased food yield on the Earth, together with the launch of new technologies that allow for extending protein and reducing its rejection, have become key factors in supplying food abundantly and safely on a planet where resources are increasingly scarce.

These facts have been, and continue to be, a stimulus for technological innovation and an impetus to the search for very high-yield products with certain qualitative, quantitative, organoleptic and nutritional parameters at competitive costs and with maximum guarantees for the consumer.

This subject was discussed in a previous article (Xargayó M. et al, 2014. *Intensive accelerated massage reduces process time for cooked meat. International Meat Topics (UK) Volume 5 Number 4*), which analyzed the possibilities of reducing production costs without compromising product quality. By means of IAM (Intensive Accelerated Massage) technology, an acceleration of the production process was achieved through a drastic reduction in massage/maturation times in highly injected products, by introducing substantial improvements in the efficiency of the massaging equipment used. This article explores the transition from high-yield cooked whole-muscle products to very high-yield products with hardly any alteration in the appearance and organoleptic quality of said products.

To achieve this objective, a study and analysis of TRIPLEX technology was conducted. This is an exponential injection technology, with three heads,

which a priori should allow for injecting more brine in the meat muscle than the technologies currently existing on the market, without ostensibly affecting the quality of the finished product and even surpassing the “mythic 150% injection” in a single pass, thus avoiding having to grind the meat to absorb such large amounts of brine.

INTRODUCTION

There are multiple factors that determine the quality of a highly injected product, but those most valued by the consumer are the following:

- **Appearance.** This is the first thing that is valued in a product, so it must be attractive to the eye of the consumer, regardless of the product's technical quality. An appearance of whole muscle, regular and homogeneous color, and with little intermuscular paste consistently results in a better assessment of the product when compared to products with small pieces of muscles, a chopped look or with large amounts of intermuscular paste.

- **Consistency.** This factor is very important from two different points of view: *For the processor* because it will determine product yield during slicing; and *for the consumer* because it will determine the product's “texture” (chewiness). Depending on the texture, the consumer may have the sensation of eating meat or of eating only “paste or emulsion”. Obtaining a good consistency in this type of product is no easy task, since the proportion of brine versus to meat content is very high. In addition, it is important to note that since this water is added to the muscle matrix and subsequently absorbed, this can lead to very different consistencies.

Therefore, a key factor in this type of product is the process of introducing the brine into the meat muscle since, for the production of high-yield cooked whole-muscle meat products, it is essential not to add an excessive amount of free brine at the start of massage

to complete the injection percentage. The more free brine at this stage, the longer the massage time required to absorb it and the worse the appearance of the finished product, due to an increase in the “intermuscular paste” generated in this process.

Indeed, this intermuscular paste originates when the massage time for absorbing the free brine goes on too long, since the solubilization of meat proteins begins before all the brine is absorbed. These myofibrillar proteins are emulsifiers and increase brine viscosity, thus setting in motion a vicious circle in which the brine becomes increasingly thicker and harder to absorb, reaching a point of no return at which it can no longer be absorbed and forms a barrier of “paste” around the muscles. In this case, the only solution for avoiding said problem is the implementation of an Intensive Accelerated Massage capable of absorbing the brine as quickly as possible. But even so, the limit is imposed by a maximum percentage of added brine and can limit the final yield of the cooked meat product.

Given the above, and assuming that the maximum percentage of added brine was 10% of the total initial injection, this would mean that with traditional injection technologies [double head] with initial injections of approximately 100-110%, the final yield percentages [after adding the brine] would be from 110-120% approximately. In contrast, with a superior technology capable of injecting 130-150% brine within the muscle, the final yield could surpass 150% without affecting absorptive capacity and, therefore, keeping the formation of intermuscular paste to an acceptable minimum.

Injection process for HIGH-YIELD products

With traditional technologies, there are different options for reaching the injection levels required for current high-yield products. Depending on the type of injector used, the option chosen can condition productivity of the line and quality of the finished product:

1 - Multineedle low pressure double-head injector: this type of injector can obtain injection levels of

approximately 70-90% at most. Sometimes it is difficult to reach high injections because too many punctures are made in the product due to the ratio of number of needles / head / conveyor speed, resulting in a subsequent dripping effect that conditions the process.

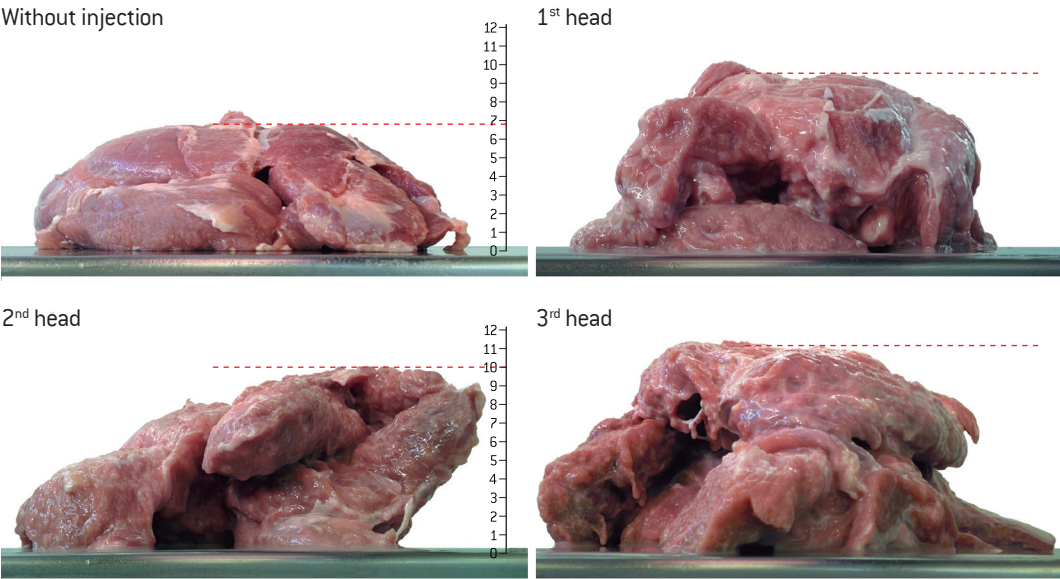
2 - Single-head spray injector: in a single pass, injections of approximately 60-70% at most can be reached. If injection of more brine is required, the product must go through the injector two or three times in order to reach the desired injection percentages [100-120%].

3 - Double-head spray injector: in a single pass, injection levels from approximately 90 to 110% can be reached, depending on the type of product being injected. In this case, products of higher yield can be produced, provided that an effective massage is subsequently applied in order to absorb all the brine added at the start of said process. But, in this case, there is also a limit to the amount of brine that can be added, after which the meat must be injected again. In addition, running the product repeatedly through a double-head injector in order to reach higher injection levels leads to a great loss in productivity, both in terms of the equipment used and the manpower required for said operation, so that it is not a common practice in most processing companies.

Injection process for VERY HIGH-YIELD products

After numerous tests carried out in recent years with high-injection products, it has been observed that during the injection process the meat muscle behaves like a sponge, the “Sponge Effect”, so that if brine injection is done gradually in various stages, the muscle tissue grows progressively and enables a greater volume of brine to be introduced as compared to a process that has only one injection stage.

The ability to introduce the volume of brine in three “injection stages” (Photo 1) provides a better adaptation of the muscle fibers to the penetration of brine and



▲ Photo 1: Gradual distension of the meat muscle during injection with TRIPLEX technology.

causes a gradual distention of the fibers that facilitates increased retention of injected brine. Thus, injection levels can exceed 130-150% in a single pass (depending on brine composition and muscle size).

TRIPLEX, the exponential injection: Tests conducted

To analyze the efficiency and capacity of TRIPLEX Injection technology developed by Metalquimia (Photo 2), testing was carried out with the production of a cooked meat product of VERY HIGH yield (final yield of 240%). Two types of tests were conducted in which two fundamental aspects were taken into consideration in regard to the manufacture of cooked injected very high-yield products: injection potential and the capacity to absorb free brine during the intensive massage phase.

Injection potential was assessed by comparing different types of injectors: multineedle low-pressure injectors, and spray injectors with one, two and three heads (TRIPLEX Technology).

Capacity to absorb free brine was assessed by comparing different combined systems of injection and massage: (1) multineedle low-pressure injector with two heads + conventional drum with a maximum rotation speed of 12 rpm and (2) triple-head spray injector (Metalquimia TRIPLEX technology) + Intensive Accelerated Massage (Metalquimia TURBOMEAT technology), with rotation speed up to 18 rpm.

Test 1: Evaluation of the Injection Potential of different technologies

The meat used to carry out this test was boneless pork shoulder trimmed of nerves and fat, with a maturation period of approximately 48 hours from the date of slaughter. The brine used contained the usual ingredients for high-yield products, including salt, phosphates, sugars, vegetable proteins and starches, among others. In all cases the batches were processed in identical conditions (in regard to meat and temperature) in each machine. The results obtained from said test can be seen in **Table 1**.



▲ Photo 2: MOVISTICK TRIPLEX Injection Technology.

TABLE 1					
INJECTOR	PASSES	% INJ 1st PASS	% INJ 2nd PASS	% RETENTION	% DRIPPING LOSS
LOW PRESSURE 2 HEADS	2	72%	96%	70%	26%
SPRAY EFFECT 1 HEAD	2	70%	98%	83%	15%
SPRAY EFFECT 2 HEAD	1	103%	-	91%	12%
TRIPLEX TECHNOLOGY 3 HEADS	1	134%	-	114%	18%

▲ Table 1: Comparative results of different injectors.

The injection percentage was calculated immediately after injection, and the retention percentage was calculated 5 minutes after injection.

The results obtained show that TRIPLEX technology achieves the highest injection percentages, reaching almost 30 points above the double-head machine

with *Spray Effect* and almost 40 percentage points above a conventional multineedle low-pressure injector, even when passing the meat twice through the injection equipment. These differences can largely be explained by the fact that the multineedle low-pressure injector with two heads compensates for the few injection points per needle by a greater number of needles per head. As explained above, this design has a drawback when working with high-yield products which is, due to the large number of puncture points in the muscle, in the second head more brine is lost through dripping than is retained. The final result leads inevitably to a lower injection percentage.

In addition, it can be seen that, for this type of products, the results are favorable for injectors with *Spray Effect*, due both to the hydraulic pumping system itself, as well as to the particular design of its needles, whose number per head is less because of the high concentration of injection points in each of them.

Among the injectors with *Spray Effect* it must be kept in mind that a double pass in a single-head injector simulates the effect of a single pass in a double-head injector, but because the process is discontinuous the dripping is always slightly greater. Therefore, the injection levels

reached are slightly lower when comparing injectors with single or double head.

Finally, it's worth mentioning the reduction in dripping that comes with working with machines capable of providing the *Spray Effect* in comparison with low-pressure systems, which practically duplicate the amount of free brine for the same injection percentage (Photos 3 and 4).

Test 2: Evaluation of Absorption Capacity during the massage phase

This test was carried out using the same meat and brine as in test 1, applying two different types of massage:

- In the first test, the process applied was with a conventional multineedle low-pressure injector with two heads + conventional drum with a maximum rotation speed of 12 rpm. To obtain very high injection percentages the meat had to go through the injector twice, achieving a final injection of 97% and adding the rest of the brine to complete a final yield of 240%.
- In the second test, the process applied was with a triple-head injector with *Spray Effect* (Metalquimia TRIPLEX technology) + Intensive Accelerated Massage (Metalquimia TURBOMEAT technology),



▲ Photo 3: Shoulder 140% injection coming from a multineedle low-pressure injector with double head (2 passes): Injection 97%, Brine added 43%.



▲ Photo 4: Shoulder 140% injection coming from a TRIPLEX spray injector with 3 heads (a single pass): Injection 134%, Brine added 6%.

TABLE 2		
	TEST Nº1 CONVENTIONAL MESSAGE	TEST Nº 2 INTENSIVE ACCELERATED MESSAGE
TIME 0	Free brine: 35%	Free brine: 15%
TIME 1 (60')	Free brine: 25% Slight increase in viscosity. Muscle structure similar to that at start.	Free brine: 4% Slight increase in viscosity. Muscle structure begins to soften.
TIME 2 (120')	Free brine: 20% Slight increase in viscosity. Muscle structure begins to soften.	Free brine: 1% Increase in viscosity, but almost no free brine left. Muscle structure soft.
TIME 3 (150')	Free brine: 17% Brine very viscous, impossible to be absorbed. Muscle structure soft, although insufficient.	Free brine: 0% Large amount of protein extracted. Muscle structure soft, with whole muscles.
TIME 4 (270')	Free brine: 15% Muscle structure soft.	-

▲ Table 2: Comparison between different injection and massage processes.

with a rotation speed of up to 18 rpm. The yield of the process subsequent to injection was 234%, and was adjusted up to 240%.

Before proceeding to the massage phase, and with the goal of increasing the muscle's absorptive surface, the meat underwent a tenderization process in a tenderizer with roller knives of 1 mm (Mod. Filogrand 360 3-option).

Table 2 shows the evolution of the absorption of free brine during the massage cycle in the two types of processes.

For the calculation of free brine percentages, the weights were taken for the meat and the free brine at the end of each of the times indicated.

The final result demonstrates the synergetic efficiency of the Intensive Accelerated Massage process at 18 rpm, combined with the very high injection provided by the triple-head injector with TRIPLEX technology. With a single pass through the injector and at a total massage time of 150 min, the product obtained has no dripping loss, a whole muscle appearance and a minimal amount of intermuscular paste (see photo 5).

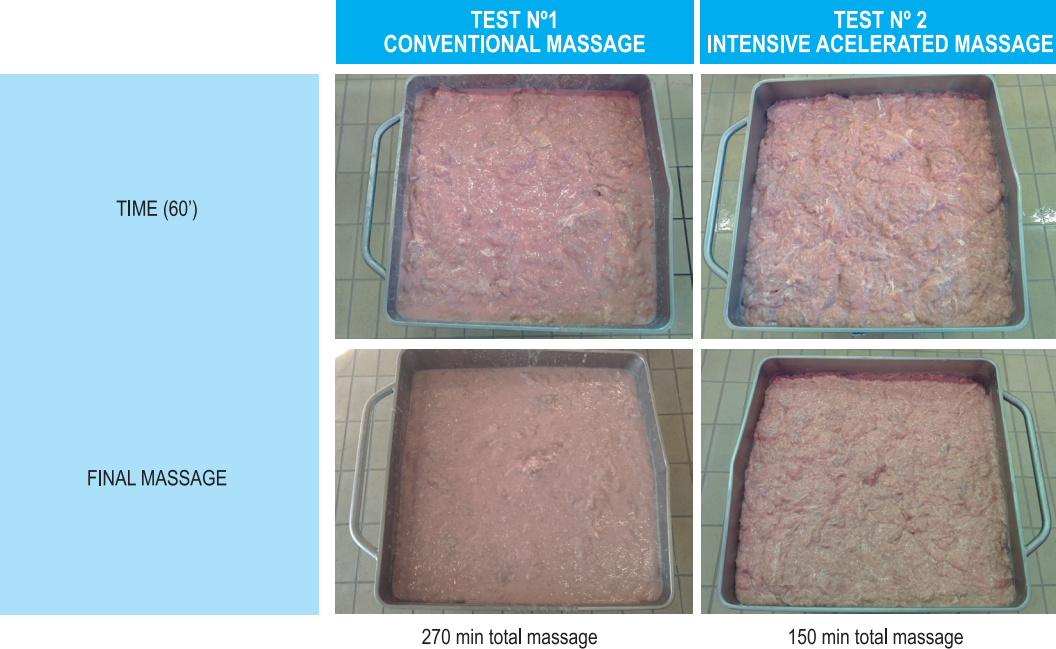
In comparison, the product made with a conventional massage process (test nº 1) requires two passes

through the low-pressure injector and a total of 270 minutes massage time in order to obtain a consistent finished product without dripping loss. However, the main difference between the two products lies in their appearance and consistency, since the cut of the product from test nº 1 reveals muscles that are much smaller, chopped up, with a less uniform color and a large amount of intermuscular paste.

CONCLUSIONS

The injection capacity of a triple-head injector (incorporating Metalquimia TRIPLEX technology) enables you to produce very high-yield products with ample guarantees, due to the possibility of injecting a much greater amount of brine into the meat muscle, while reducing the amount of added brine and minimizing the volume of free brine in the massage process, which is the cause of most defects in this type of products.

TRIPLEX injection technology working in tandem with Intensive Accelerated Massage technology provides interesting synergies that greatly facilitate the absorption of free brine, thus preventing the formation of intermuscular paste whose viscosity progressively



▲ Photo 5: Appearance of the meat after different times and types of massage.

hinders said process. It is also possible to efficiently produce this type of very high-yield products at lower rotation speeds in the massage, although in this case longer total massage times are required and an unwanted increase in intermuscular paste is obtained.

Obtaining cooked injected whole-muscle products of high quality, with very high yields (230-260%) and attractive to the consumer is now possible, only if you have the proper technology and machinery.

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