Effects of maturation time on the quality of “Delikatessen” type cooked and smoked meat products

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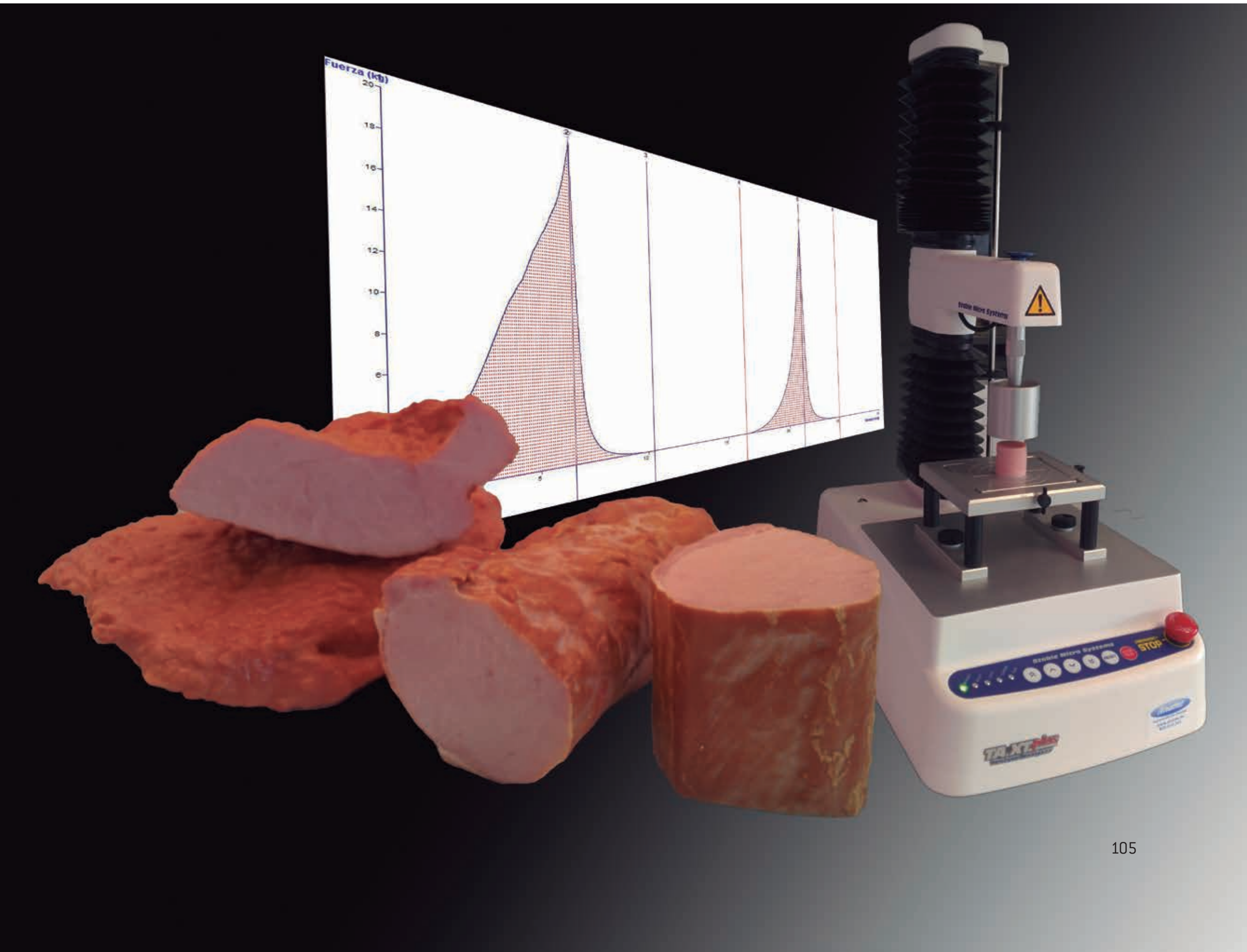


The maturation time of a cooked whole-muscle meat product is a constant topic of debate because it conditions both the end quality of the product as well as production cost. Most of the studies carried out to date have focused on color and yield, with little attention to the product's texture. This article describes a series of tests intended to determine the effect of different maturation times on the texture of cooked and smoked whole-muscle *delicatessen* type products and their relation to yield and uniformity of color in the slice.

The data analyzed indicate that different results are attained depending on the type of muscle used because of their differing behavior. In the more tender muscles (such as loin) the texture tends to become rubbery with more resting time, which increases toughness in the finished product. In contrast, the muscles that are initially tougher (such as the ham muscle used, silverside) tend to soften during the maturation phase, resulting in a more tender finished product. In regard to the final appearance of the slice, and thanks to the action of the equipment used both to perform injection (homogeneous brine distribution) and to effect massage (gentle and low intensity for the loin and intensive mechanical action for the tougher muscles), only slight differences in color were observed between maturation times when compared with each other, but these differences were barely noticeable when seen separately.

INTRODUCTION

As a result of the article published by Marta Xargayó and Josep Lagares, "Profitability of cooked ham production lines: adaptation to different maturation cycles." (2008. Eurocarne, 172. 56-62), which describes how with the proper equipment and technology maturation times can be reduced for most products without affecting quality, a decision was taken to expand this study to a broader range of products and delve deeper into this line of research.

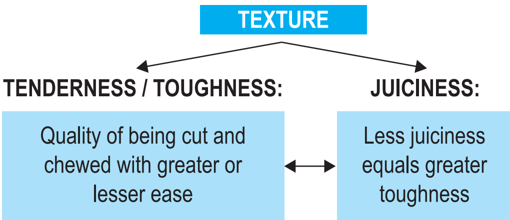
During the maturation phase, the processes taking place in the meat muscle are basically the extraction of myofibrillar proteins and the development of aromatic compounds due to the reactions produced during this process.

Another process that takes place during the resting period is the development of color, in which the nitrite in combination with the meat's myoglobin forms nitrosomyoglobin, responsible for the typical pink color of cured cooked products.

In the early days of industrial production of cooked whole-muscle products, the maturation times were very long, lasting up to 5 days for high-quality products. Thanks to the evolution of processing equipment and commercial demand for obtaining products more quickly, these time periods were gradually reduced down to a standardization of 24 hours, which actually corresponds to maturation times of between 10 and 18 hours. Although some processors maintain maturation times of up to 48 hours in their high-quality products to obtain better organoleptic characteristics in regard to color, flavor and texture, these practices are becoming ever less common.

Texture

Texture is a sensory attribute that encompasses the sensations you have when you contact the product surface with your fingers, tongue or teeth. The concept of texture has been changing throughout history and is clearly a characteristic that only humans and animals can experience, but it is also true that there now exist more or less sophisticated devices for measuring certain parameters that can be interpreted a posteriori in terms of perception. On the other hand, texture is considered to be a multi-parametric attribute derived from the food structure (molecular, microscopic or macroscopic) which is ultimately and basically detected by the sense of touch. Because these characteristics are so subjective, it is difficult to agree on the interpretation of results in texture analysis. For this reason, the analyses in this study were performed using a texture analyzer that quantifies a series of parameters objectifying them and making them comparable in order to reach conclusive results.



▲ **Figure 1:** Texture vs Juiciness (Drainsfield et al., 1984).

Meat texture, according to Weir (1960), can be considered to be the sum of three elements: the ease with which the teeth penetrate the meat at the start of mastication, the ease of meat fragmentation and the amount of residue remaining in the mouth once mastication is completed.

The parameters used in this study are those that the TPA (Texture Profile Analysis) method provides on firmness, and are the following:

- Toughness: force required to compress the food between the molars.
- Elasticity: measure of how much of the initial sample is broken on the first mastication (compression).
- Cohesiveness: force the internal bonding exerts upon the food.
- Chewiness: energy required to disintegrate a solid food so it can be swallowed.
- Resistance: ability of the sample to return to its original shape.

Together with the TPA method and to complete the analysis, the Warner-Bratzler test was also conducted to determine cutting resistance of the samples.

TESTS

For a better interpretation of the results, it was decided to conduct the study with products made of a single muscle, which is a longstanding tradition in the markets of Russia and Central and Eastern European countries. The muscles chosen were loin (*longissimus dorsi*), and the toughest muscles of ham, commercially known as "silverside" (*bíceps femoris*) and окорок as a product in the Russian market.

The raw material was purchased from a single local supplier, with post-slaughter maturation times of some 48 hours. The injection used was at 60% and was done with a Metalquimia spray injector (model Movistick 120/3000), with massage performed in a Metalquimia tumbler (model Turbomeat pX500). Comparison was made of resting times before cooking/smoking of 0, 24 and 48 hours after massage. The cooking process was the same for all samples: 50 minutes of drying at 65ºC, 60 minutes of smoking with natural smoke at 65ºC and cooking at 74ºC up to 71ºC in the center of the pieces. Then the pieces were refrigerated and kept at temperatures between 2 and 4ºC during 3 days before analysis, to ensure full stabilization of the product.

The analyses of texture were performed using a Stable Micro Systems TA-XTplus texture analyzer with a 30kg load cell. The TPA test consisted of a double compression and decompression of the sample mimicking the action of the jaws when chewing food. The level of compression used was 70% of the height of the sample where the aluminum cylindrical probe of 50mm in diameter (P/50) was used at a crosshead speed of 2mm/s both in compression and decompression, leaving a time of 2 seconds between compressions. For the WB, blades in "V" (HDP/WBRV) were used, with a cutting speed of 2mm/s until cutting of all the samples was completed.

Before analysis the samples were selected for an objective comparison of the results, cut into cylinders of 3cm in diameter and 1.5cm in height for the TPA analysis and 1x1x7cm for the Warner Bratzler (WB) cutting test, leaving them at room temperature (20±2ºC) for an hour before the tests. In order to obtain a homogeneous sample population, cutting was done in the usual slicing direction, leaving the product fibers at an oblique angle for

▲ **Picture 1:** Sample in texturometer.

the TPA test. For the test the samples were tested perpendicularly to the fibers. The data were collected by Exponent Lite software of the same manufacturer and subsequently analyzed statistically.

Product yield with respect to the initial meat weight was calculated after one day of refrigeration. Color analysis was performed visually by a panel of trained experts.

RESULTS

1)Texture

- Loin (*longissimus dorsi*):

The central part of the muscle was selected because it is considered to be the most representative area of the piece. The results show that longer resting time tends to increase toughness slightly (Table 1). In the TPA, an increase is observed in compression toughness, chewability and resistance. As for elasticity, although the maximum value is found at 24hr, the result at 48hr is still higher than the product without resting. The value for cohesiveness is maintained at similar values in all the samples. When the results of the WB tests are observed, it can be seen clearly that resistance is directly proportional to the resting time: the more resting, more resistance.

(1) A piece of loin with 24hr of rest is 3.14% tougher than the reference (sample without rest and with value 0). With 48hr, toughness increases by 7.97%. However in silverside, toughness decreases by 2.83% in 24hr and by 6.24% in 48hr of rest with respect to the reference.

(2) Chewability in loin at 24 and 48hr of rest increases by 9.12% and 12.7% respectively with respect to the reference (sample without rest and with value 0). In silverside chewability decreases by 5.58% and 11.96% at 24 and 48hr with respect to the reference.

		LOIN			SILVERSIDE		
		without rest	24hr rest	48hr rest	without rest	24hr rest	48hr rest
TPA	Toughness (1)	0%	3,14%	7,97%	0%	-2,83%	-6,24%
	Elasticity	0%	8,45%	3,85%	0%	11,22%	1,63%
	Cohesiveness	0%	-1,57%	0,62%	0%	-0,75%	-6,03%
	Chewability(2)	0%	9,12%	12,70%	0%	-5,58%	-11,96%
	Resistance	0%	3,30%	10,21%	0%	-0,27%	-9,75%
WB	Cutting resistance	0%	16,11%	22,04%	0%	4,05%	2,85%
	Cutting energy	0%	13,36%	20,97%	0%	-3,28%	-11,27%

▲ **Table 1:** Results TPA and WB in longissimus dorsi and biceps femoris (% with respect to without maturation).

- Silverside (*bíceps femoris*):

The data obtained shows that maturation time directly influences product texture. The results of the TPA performed on the bíceps femoris indicate that with longer resting time the compression toughness of the finished product decreases, and the same occurs with cohesiveness chewability and resistance. With regard to elasticity, it was seen to increase but lessened at 48hr, though it was still greater than without rest. Although the cutting resistance received higher values at 24 and 48hr, the energy required to cut the sample was less with more resting time.

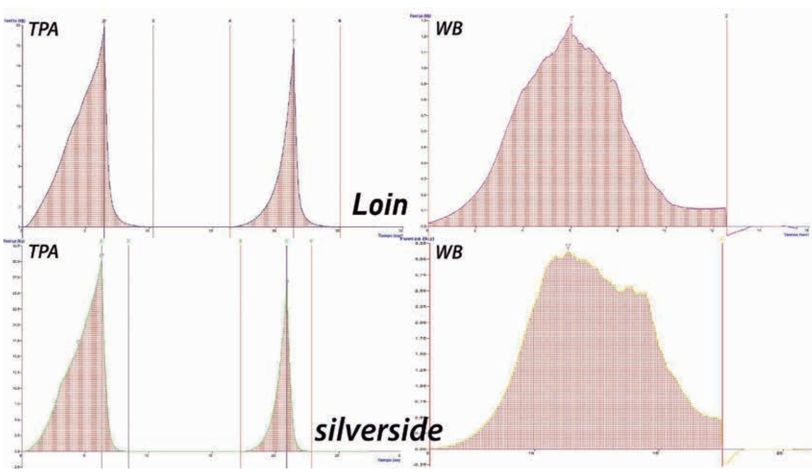
2) Color

The reactions occurring in the meat muscle to obtain a homogeneous color in the piece are favored when maturation time is increased. As mentioned above, the reduction/elimination of this phase is possible through the application of a more efficient process that accelerates the speed of the chemical reactions required for nitrification of the product. In images 2 and 3 it can be seen that in both muscles, with the right combination of time/type of massage and processing temperatures, it is possible to achieve this goal, as the visual difference between the samples with different maturation times is minimum.

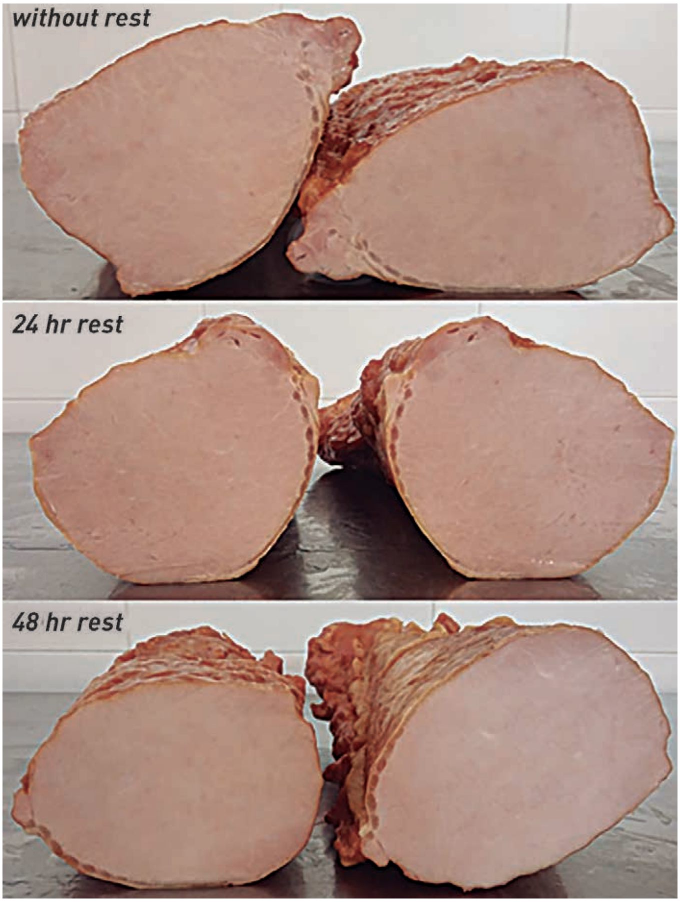
3) Yield

Data of losses and yields of the different phases of the process are shown in Table 2.

The values obtained show that the different maturation times slightly affect the product's final yield, being more evident among those products cooked immediately after the massaging phase and those products cooked after 24 hours of maturation. Apart from a certain percentage of loss due to losses that occur during processing and that naturally increase during maturation, a logical explanation for this difference in cooking losses was not found, since one would expect the opposite effect. More extensive studies are needed to confirm these differences in yield and their causes.



▲ **Figure 3:** TPA and WB analysis.



▲ Image 2: loin.

▲ Image 3: silverside.

PRODUCT	HOURS OF REST	% INJECTION	% PROCESS LOSS (rest + cooking)	FINAL YIELD (%)
	0		-12,1%	137,6
SILVERSIDE	24	60,8%	-13%	136,4
	48		-13,8%	135,5
	0		-8,2%	140,1
LOIN	24	60%	-10,1%	137,2
	48		-10,5%	136,9

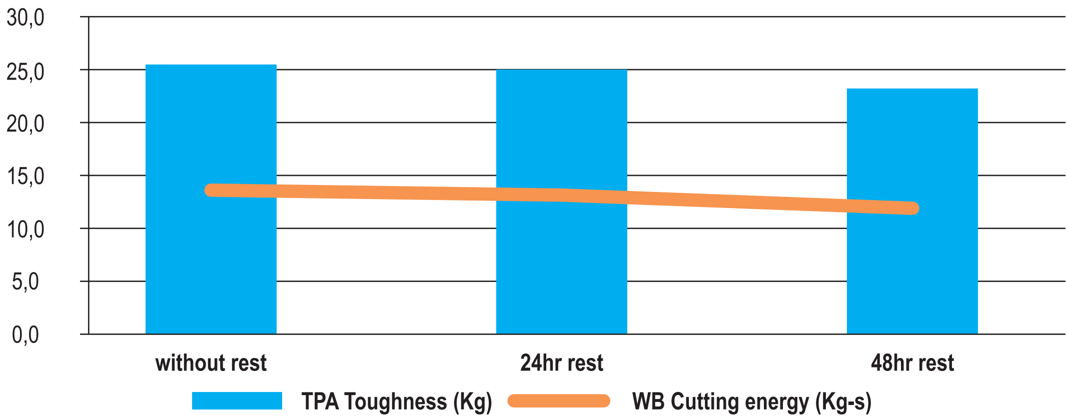
▲ Table 2: Yields.

CONCLUSIONS

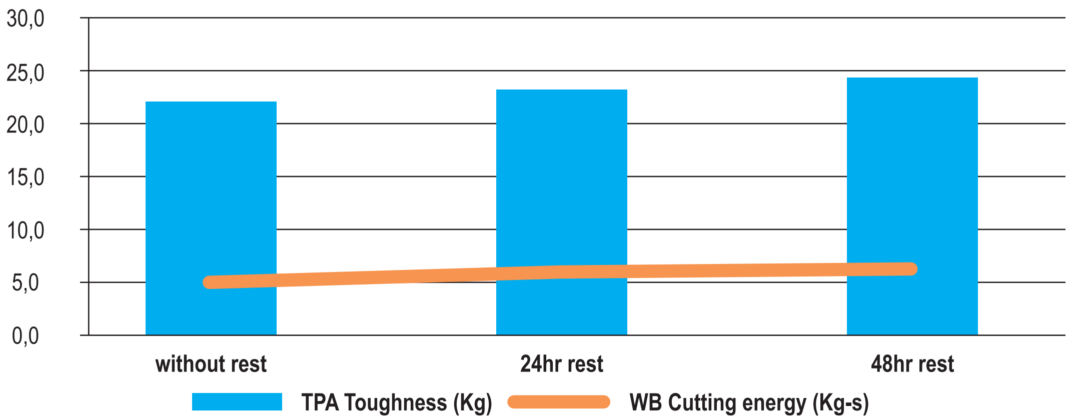
It was found that maturation time directly affects cooked and smoked whole-muscle products, but not always positively and the nature of the muscle is a very important factor in determining the scope and direction of this influence.

The *bíceps femoris* muscle (silverside) is the muscle with the toughest texture of the ham. As was shown by the results of the texture analysis, the solubilization of proteins that takes place during the maturation phase results in a more tender finished product. This was observed, by means of the texture analyzer, in most of the parameters analyzed such as toughness, cohesiveness, chewability, resistance to compression and the energy required to cut the muscle. This increase in tenderness may also be due to a greater water content in the finished product, but considering the yields obtained in the three resting times, one can conclude that they are influenced by the structure of the fibers rather than the differences in water content.

The *longissimus dorsi* muscle is more tender than the *bíceps femoris*. The process performed to obtain the product differs from the one used for ham because it requires a much gentler massage than in the case of the silverside muscle to maintain the pieces whole. Because the muscle structure has a smaller amount of collagen and fat and due to the chemical reactions



▲ **Graphic 1:** Silverside toughness.



▲ **Graphic 2:** Loin toughness.

that take place during the maturation phase, a more plastic and therefore tougher texture is obtained after cooking. This would explain the results of the tests where both the toughness and the other parameters increase with more resting time. The yield results were similar among the samples with different maturation times, and therefore not considered to be significant for the difference in product texture.

This study demonstrates that performing the maturation phase or not in the process of manufacturing cooked whole-muscle meat products is valid in both cases depending on the type of muscle used, the equipment available for the manufacturing process and the desired characteristics in the finished product, from an organoleptic as well as an economic point of view.

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