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# INFLUENCE OF ENZYMATIC TREATMENT AND MIXING ON HARDNESS AND COOKING LOSSES FOR PORK MUSCLE

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***Abstract***

*The production of meat products witnessed great development in recent years, a necessary condition in the context of dynamic change of the population lifestyle. On the other hand, many existing products in the market are not optimal in terms of innocuousness, multitude of additives used making consumers reluctant to be and to turn our attention to eating fresh meat. To meet the requirements, therefore meat should provide outstanding sensory properties, of which a significant relevance it is the tenderness and the juiciness. It is known that meat toughness and its ability to retain water are correlated with the phases of post-slaughter meat and biochemically changes that occurring these phases. This study aims to follow the addition of proteolytic enzymes and mixing operation influence on the development of pig muscle hardness and cooking losses, starting at 2 hours post-slaughter, over a period of 14 days. Following experiments it was found that injection of enzymes, and the association of enzymatic treatment mixing generated to reduce muscle tissue hardness, assessed by determining the cutting forces, and reducing the losses associated with heat treatment. Thus, the samples without heating treatment, the cutting force has the following evolution: on the first day post-slaughter of 13.19 kgf for the control sample and injected with enzyme sample, 10.61 kgf for injected and mixed sample; at three days post-slaughter 20.88 kgf for control sample, 16.83 kgf for injected sample and 15.49 kgf for injected and mixed sample; at 14 day post-slaughter to 10.42 kgf for control sample, 6.85 kgf for enzymatically treated sample, and 5.66 kgf for injected and mixed sample. When the meats was heat-treated, we registered similar developments but with lower values. Thermal losses increased with the evolution to the maximum rigidity, then fell to maturation, the biggest losses occurring to the controls samples and lowest in injected and mixed samples.*

***Keywords***: *cutting force, muscle hardness, papain*

## INTRODUCTION

The production of meat preparations experienced a great development in recent years, being a necessary condition in the context of dynamic change of lifestyle of the population.

On the other hand, many existing products in the market are not optimal also in terms of safety, the multitude of additives used making the consumers to be reluctant and to direct their attention to the consumption of fresh meat, which is associated with a „clean" product. To meet the demands, the meat should therefore submit outstanding sensory properties, of which the major importance are tenderness and juicy.

The study aims to assess progress of meat quality under the action of enzymes and mixing operation, resultingby determination of meat cutting force and of the valuation of losses from pasteurization, starting from 2 hours post-slaughter, for 14 days.

The cutting force and the meat ability to retain water are influenced by a number of factors such as: the post-slaughter stage, pH, the ratio muscle tissue – connective tissue-fatty tissue, water content, the boiling temperature or additives used etc (Banu et al., 1997).

Myofibrillarprotein are mostly responsible for the textural properties of the meat products (Asgharet al., 1985; Yasuiet al., 1980), while Miyaguchi et al. (2000), studying the thermal and functional properties of the sarcoplasmatic proteins of pork meat, have found that sarcoplasmatic proteins have reduced properties to retain the water, to form gels and little influence on the texture.

On the other hand, the pH of the meat also affects gelification. At the isoelectric point, the proteins have an electrical charge almost nil

and present reduced properties of water retention. This leads to the formation of low consistency gels or even prevents the formation of gel (Smith, 2001). Trout et al. (1986) considers that polyphosphates and pH are responsible for 80% of water binding capacity.
The collagen, associated with the hardness of the meat, is made up of three polypeptide chains stabilized by intramolecular and intermolecular bonds. During the process of aging of animals, the more covalent bonds within and among the molecules of collagen are formed, which helps the meathardness (Asgharet al., 1985; Kijowski, 2001).
Although pig muscle tissue shows no hardness as evident as in the case of beef meat, enzymes may be used to obtain meat with more pleasant texture.
Apart from the aspects of texture and boiling, there can be considered other issues related to the consume of enzyme treated meat.

## MATERIALS AND METHODS

The research material was meat pork after slaughter, derived from adult animals slaughtered in the slaughterhouse Romsuintest Peris S.A.
From the chosen meat of the coarse connective tissue and fat have been formed three groups: the control group represented by pork pulp, a consignment consisting of pork pulpinjected with papain, and a third group was composed of pork pulp that has been subjected to injection with papain and also mixed. Thus prepared, the samples packaged under aerobic conditions in polythene bags, were stored in refrigerated conditions (from 0...2°C) and their evolution was monitored over a period of 14 days.
Injection and blending of meat were made under laboratory conditions. The enzyme preparation was added in the amount of 10 mg/100 g meat, in the form of solution using a syringe, and mixing was done in series of 10 min alternated with breaks of one hour, for 8 hours.
For the determination of meat rigidity, appreciated by the cutting force, from each group were made parallelipipedic samples of 2 × 2 cm in section and about 20 g, which have been cut at the texturemeter TA-XT Plus. To highlight the differences between the three analyzed groups, for each sample were made minimum 5 cuts.
For every group of meat, daily treatment has been carried out, samples being placed in sealed containers and subjected to pasteurization at a temperature of 70...75°C for 10 minutes in the heat center of the product. After heat treatment, the samples were tempered at $2^0$C and weighted, settling losses, which were expressed in the form of juice and fat.

## RESULTS AND DISCUSSIONS

### The evolution ofuntreated meat hardness

In order to assess the evolution of cutting forces for the groups: control, injected and injected-mixed (Figure 1) there were sampled daily for 2 weeks.
On the first day, cutting force recorded an average of 13.19 kgf for control, 13.11 kgf for injected sample, respectively 10.611 kgf for injected and mixed sample. These values have started to grow up in day three, when it reached an average of cutting force of 20.88 kgf in the control, 16.83 kgf for injected sample, respectively 15.49 kgf for the injected and mixed sample, value associated with the moment when the meat has reachedthe point of maximum rigidity.

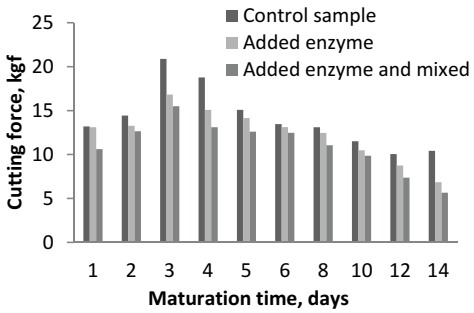


Figure 1. Cutting force variation during maturation

In this period, the pH correlation was inversely proportional to the meat cutting force, respectively immediately after slaughter was registered pH of 7.14 coming up on the third day to drop to 5.55 (considered the ultimate pH of the meat, at which point also theglycolysis ceased).

After the period of rigidity, with the entry of meat in the maturation phase, cutting forces started to decrease gradually, as the last day to register averages of 10.42 kgf for control sample, 6.85 kgf for injected sample, respectively 5.66 kgf for injected and mixed sample.

Throughout the research, between the three groups of meat there was a continuous correlation of cutting force, so that the highest values were recorded in the control sample, followed by enzyme-treated sample values, while the lowest values were recorded in case of injected and mixed sample.

The cutting forces decrease during maturation, correlated directly proportional to meattenderizing, is due to proteolytic enzymes of muscle tissue from cathepsin group, but also to enzymes produced by saprophytic microflora, which act on the myofibrillar and connective tissue proteins generating a decrease of its hardness. The addition of papain enhanced the proteolysis and helped the process of maturation, favoring the tenderness compared to uninjected samples.

In the case of the third group, injected and mixed, besides the meat tenderizing action generated by enzymatic treatment, the mixing process has led, on the one hand a better distribution of enzymes in the muscle tissue and has facilitated their action, and on the other hand there was a mechanical destruction of fibres that have become softer and more exposed to the action of enzymes by destroying the protective membranes.

**The evolution of pasteurized meat hardness**

In each of the groups analyzed (control, enzyme-treated and enzyme-treated - mixed) were made samples which have been subject to the heat treatment at 70...72°C and after for each sample was determined the cutting force, in conditions similar to those of raw meat.

The development of cutting force values recorded in the case of pasteurized samples for the three groups is shown in Figure 2.

Throughout the study, for all the three analysed groups the cutting forces values of heat-treated samples were lower than those of untreated samples, but keeping the same trends in evolution. This can be explained by protein denaturation (between 60 and $80^0$C sarcoplasmatic and myofibrillar proteins are completely denaturated), gelification of collagen. At $60^0$C begins the thick filaments coagulation (myosine), disintegration of thin filaments of actin and the loss of the line M, at $70^0$C massive disintegrate the thin filaments and continue the coagulation of the thick ones.

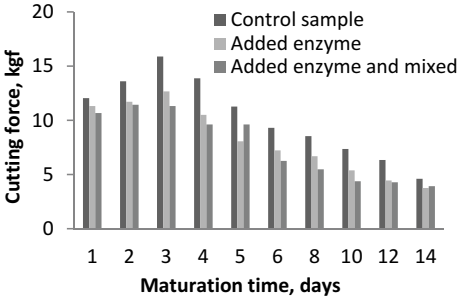


Figure 2. Cutting force variation for boiled meat

Cutting forces ranged from 10.04 kgf control sample, 11.32 kgfenzyme treated sample, respectively 10.67 kgf enzyme treated-mixed sample in the first day, to 15.88 kgf control sample, 12.67 kgf enzyme treated sample, respectively 11.32 kgf enzyme treated-mixed sample in the third day and up to 4.60 kgf control sample, 3.75 kgf, enzyme treated sample, respectively 3.92 kgf enzyme treated-mixed sample in the last day.

**Cooking losses**

Losses to heat treatment at atmospheric pressure are dependent mainly on the type of meat, the temperature and duration of heating, which cause denaturations in the proteins level.

Analyzing the loss from thermal treatment (Figure 3), results that they vary in direct proportional to the values of the cutting forces, both analyzed parameters being influenced by the post-slaughtertransformations of the meat. Thus, in the first three days, losses have an increasing evolution because the meat enters in muscle stiffness, the pH decrease to 5,4, then evolution is descending on the rest of the analysis period, simultaneously with the gradual increase of pH.

The temperature is one of the most important factors in the formation of gels, for that is the driving force that determines the unfolding of proteins (Totosaus et al., 2002).

The thermal denaturation of a protein is usually accompanied by several conformational transitions in structure (Lesiów et al., 2001).

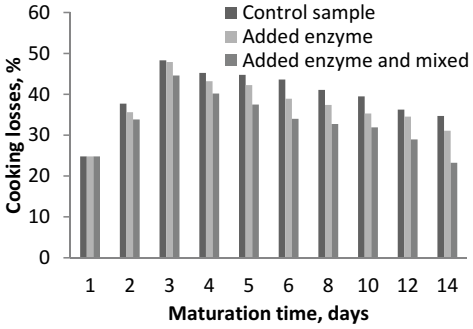


Figure 3. Cooking losses depending on the treatment applied and maturation time

At present, it is generally accepted that the myosin molecule undergoes two major transitions during heating: the first is the denaturationand the second is the formation of aggregates (Burke et al., 1973; Samejima et al. 1981). It is essential that the aggregation rate remains lower than the denaturation to get quality gels (Totosaus et al., 2002).

Several studies have reported an increase of hydrophobic character during the first part of the warming, followed by a decrease in the second stage of gelification (Wang et al., 1994). Wang and Smith suggested that the low temperatures (low heating rate) have favored the aggregation process, while high temperatures (rapid heating rate) have weakened the intramolecularbonds and the cross bonds between myosine gels.

Losses from heat treatment ranged from 24.78% on the first day, to 48.31% for control sample, 47.9% for the enzyme-treated sample, respectively 44,6% for the enzyme-treated – mixed sample in the third day and up to 34.68% for control sample, 31.07% for the enzyme-treated sample, respectively 23.23% for the enzyme-treated – mixed sample in the last day.

## CONCLUSIONS

Muscle hardness and losses at thermal treatment are closely related to the post-slaughter stages of the meat, the temperature and duration of heat treatment.

Adding ofenzymes helps proteolysis and thus the hardness and capacity of water retention. The use of enzymatic preparations in the meat maturation flesh presents the advantage that helps shorten maturation period, improves digestibility, reduce the culinary cooking time, and the nutritional value of the meat is improving.

The association of enzymatic treatment with mixing was also effective in improving the analyzed properties.

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