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STATE OF THE ART IN THE PROCESS OF DEBONING AND SLICING OF MEAT IN THE FOOD INDUSTRY

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ABSTRACT
In meat processing at food industry, it's well known that the stage of cut and the shape of cut have a direct influence on the economic yield of the processing.
In this paper we proceed to study the state of the art in the field of food industry regarding the cut of meat, especially in cutting of rabbit meat. This study verifies that there is little information about this animal.
The study conclusions will enable us to know the major factors that will influence the cut of rabbit meat .The knowledge of this factors leads us to design and build a testing station to allow quantify them.
Keywords: rabbit meat, mechanical boning, cutting forces.

1. INTRODUCTION
The cutting of the rabbit meat, today it is a process that is performed manually in food industry, the aim is to find how to increase the yield of this process through analysis of cut.
After a data collection process, there was found little information in the field of mechanical rabbit meat processing, however, there were enough information about another farm animals, especially poultry.
In this paper, we will examine what has been investigated on mechanisms and cutting machines for processing other types of meat such as poultry, beef, pork, lamb ... to draw conclusions applicable to the study of meat rabbit cutting.

2. MECHANISM OF CUTTING MEAT

2.1. Cutting factors

We will discuss studies that exist with respect to mechanisms that apply for cutting the meat in the industry of foodprocesing generally, and as these investigations can be adaptable to the case of rabbit meat.

In the meat industry, cutting is known to have a direct effect on profitability. Cevger, Sariozkan and Güler showed that the improvement in the cutting of poultry joints could increase the benefits of a poultry plant by up to 15.6% and there was an improvement of almost 2% when manual cutting was replaced by a machine.[1]

The boning and slicing of rabbit meat is done by hand in the industry, the aim is to build a machine for mechanical cutting of rabbit meat, increasing the process speed and obtain yields greater or similar to manual process.

In his investigation the author M.J.King measured the forces, and the energy required to cut frozen meat. He used a slicing knife to cut horse meat in a temperature range of 1.5 C to 30 C and oscillation frequency between 0 and 1000 Hz. the decrease in force was proportional to the slicing speed.[2]

Many meat cutting operations take place at temperatures above the initial freezing point of -1,5ºC. In this case, the temperature range that is used in test is between 15ºC and -5ºC, a range that cover most of the range of interest for industrial processing.[3]

In cutting trials that have been made, it has been found that, the increasing forces, resulting from higher speeds and lower temperatures. They also revealed sources of variability due to inherent product characteristics and movement and distortion of samples.

Temperature and speed have a direct influence in cutting forces increasing, therefore in cutting performance, and they will be the most important variables that we bear in mind.

About the cutting blade, the following three main intrinsic technical characteristics of the knife are likely to play a part in cutting performance.

- Blade steel grade: a compromise should be found to incorporate steel that facilitates honing/sharpening and ensures best possible cutting edge retention.
- Blade inclination with respect sample; in a field study [4], is said, in knives with curved blades is needed less cutting force than straight blades.
- Edge angle (sharpened part of blade): a compromise should also be found to obtain both high initial cutting capacity (acute angle) and good cutting edge retention (obtuse angle).

The main problem in studying the influence of a given knife parameter on cutting performance resides in quantifying these effects. Analysis of the literature has allowed different methods of measuring the two criteria governing cutting performance to be identified [5]. These methods are distinguished by the physical quantity measured as well as the sample material used for cutting. Szabo measured the area (mm^2) cut by a knife following controlled impact on a carrageenan target [6]. The CATRA1, a machine which measure sharpening level, defines this physical quantity as the thickness (mm) of test media (strips of card) cut at each forward and backward stroke of the blade.

These proposed methods did not seem appropriate to this study because of the physical quantity measured (area, thickness), the blade movement (impact, sawing, etc.) and the type of sample used. Bishu [7] and Mc Gorry evaluated cutting performance by measuring the force (N) required for cutting a sample material (a piece of bologna steak and polypropylene-covered fiberglass mesh material, respectively). It was decided to measure this physical quantity (force) because a cutting force reduction approach necessarily embodies the notion of improved cutting performance. They also studied the influence of steel grade of blade and the incidence angle on cutting performance [8,9,10].

The cutting forces for different food types and how forces vary depending on factors such as the reduction of temperature, cutting speed, type of cutting device for example, the profile and angle of the blade edge, we are going to study how this factors can affect in rabbit meat cutting.

This study propose build a testing station, which provides data on the required cutting force applied to the rabbit meat and the study of the main factors influencing the cutting, such as cutting blade geometry, temperature, maturation of the meat carcass, etc.

2.2. Conclusions about cutting meat factors

In agreement with the previous studies, the aim is to build a machine for mechanical cutting of rabbit meat, increasing the process speed and obtain yields greater or similar to manual process.

The cutting forces for different food types and how forces vary depending on factors such as the reduction of temperature, cutting speed, type of cutting device for example, the profile and angle of the blade edge, we are going to study how this factors can affect in rabbit cutting. The most important factors will be speed and temperature, because there is a direct relation between these and cutting force, that is, the yield of the process.

This study propose build a testing station, which provides data on the required cutting force applied to the rabbit and the study of the main factors influencing the cutting.

3. LINES FOR THE STUDY OF RABBIT PROCESSING MACHINE

3.1. Materials and method

Different types of rabbit meat from different origins will be use for testing, because some factors such as habitat and diet have influence in the composition of meat and therefore they may affect the tests.

The types of meat that will be use:

- Rabbit meat from industrial farm
- Rabbit meat from traditional home farm
- Rabbit meat from wild animal hunted

It's important the traceability of meat, in other words, know the current condition and provenance of tested meat to standardize this input as much as possible. We are interesting in know the state of maturation and the physical and chemical characteristics of each test sample.

The period of maturation also affects the characteristics of the meat; maturation is defined as the time elapsed since the slaughter of the animal to the test in the testing station. In this section, appears the factor of maturation in camera, that is to say, if the rabbit meat has received a cold treatment of post-slaughter.

It is also important to consider in tests, which the composition of the tissue varies depending on the study anatomic region in the same rabbit. This leads us to distinguish three different elements in rabbit anatomy, forequarters, hindquarters and loins. Even where the element is the same, measurements depend on if the cut is made parallel or perpendicularly to the muscle fibbers.

In the side of the cutting element, will be use different blade geometries of a blade commonly used in the food industry, supplied by a commercial distributor.

3.2. Sample preparation

To standardize the test, is used a rectangular box of samples. In this box is made a slot in the walls of wide 5mm to allow the blade cut the flesh.

A piece of rabbit meat cut to size of sample holder, is introduced in it for testing cutting forces. Fig. 1

In order that the temperature will be constant and there will be no variations between the experiments, due to environment, the meat is kept in camera.

3.3. Equipment

There is a commercial steel blade, which is placed in a blade-holder, the blade is completely fixed. Before the blade fixation, the blade-holder this allows us to vary the angle at which the edge of the blade impact on the sample. The blade-holder is fixed in XY plane permitting some regulation in Z axis, to accommodate in the test bank to different geometries of the blade. In this test bank, the sample goes to the blade with a constant and known velocity. This movement forward is produced by a linear actuator, in this case a ball screw, driven by a servomotor.

Placed in blade-holder are two load cells, to measure the cutting force on the blade, both in direction of cut as on the vertical direction.

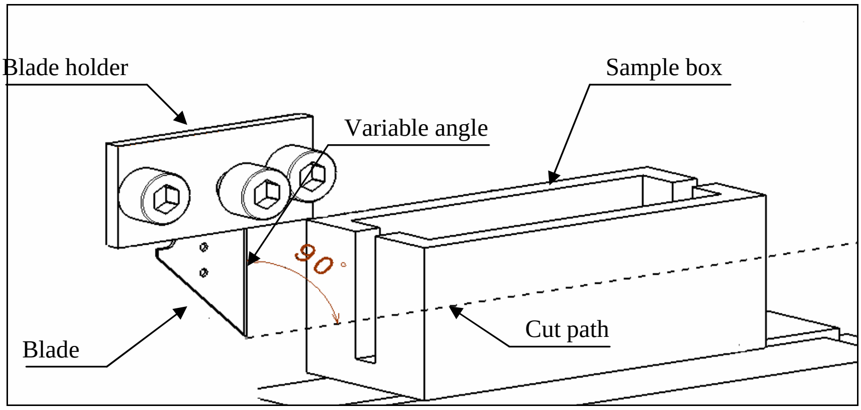

Figure 1. Schematic of holders and cut path.

4. CONCLUSION

The study of the state of art that are mentioned in this paper, allow us to define and design a machine and next fabrication of a prototype , which aims to measure the cutting forces that happen on different geometries of blades, during rabbit meat cutting at different speeds and temperatures.
The fabrication of this testing station allows us to quantify principal parameters in cutting rabbit meat as a first step towards the automation in the boning and slicing of rabbit meat.

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