Study of physical and chemical parameters and sensorial characteristics changes occurred in chicken meat thermic treated

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Abstract
The aim of this study was the identification and the analysis of the weight losses, structure, texture and microbiota changes appeared in thermic treated chicken breast.

The experiment was structured as a comparison between the effects of cooking meat using two kinds of heating medium - water and oil. The chicken breast water boiling treatment has been developed at various temperatures and periods 70, 80, 90°C/5, 10, 15 minutes and the sunflower oil frying process has performed at 100, 105, 110°C/1, 3, 5 minutes). The technological loses for frying (110°C/5’ were 17.45%) denote that this is more suitable for the chicken breast than the boiling (90°C/15’ were 34.40%) in order to maintain the cellular juice and the nutrient compounds into the product. The meat with the best texture is the boiled one at 80°C/10 minutes. The microbiota of the thermic treated meat was inactivated under the standards inferior limits or it was absent.

Keywords: chicken breast, texture, structure, microbiota, thermic treatment

1. Introduction
Due to the evolution of chicken meat production all over the world and also in Romania and the increasing consumption, the study of the possible effects of the thermic treatment on meat structure and texture is an important issue for research.

One of the most common issues facing the meat and poultry industries today is an increase in the incidence of tough meat. This problem seems to stem from higher consumer demand for increasingly processed products, which in turn forces producers to increase production. The development of methods to increase processing efficiency includes the goals of reducing energy and labor costs, increasing volume, and improving yield [1].

With that in mind, methods used to attain these objectives must be evaluated in terms of validity for maintaining or improving final product quality. Many processing factors are known today to affect the overall tenderness of chicken breast. To understand better all the routes since the slaughtering point to fork, there is presented the traceability. Chilling carcasses in a two-stage chilling system which allows for maximum efficiency in core body temperature reduction for approximately 1 to 1.5 h. Carcasses are then aged on ice for an additional 4 to 6 h to achieve maximum tenderness, from here there are three possibilities: the meat is distributed to the sales, maintaining the same temperature operating for maximum 3 days;
the meat is deep-frozen for a longer conservation and is guided to a special storage; the meat is processed in industry or gastronomic purposes.

In these periods, some biochemical processes may occur, associated with the completion and resolution phases of rigor mortis development.

An important factor linked to the biochemical processes is meat tenderness, which is described as a major sensory characteristic of chicken breast meat.

Some of the most important sensory attributes of meat are appearance, juiciness, flavour and texture [2]. Texture values depend on zootechnical characteristics of the poultry such as breed, age and sex, on anatomical characteristics such as type of muscle [3], on factors external to the animal, as handling and feeding characteristics [4], or meat cooking methods.

For certain when we talk about texture we take into account some special characteristics as: crisp, hard, soft, juicy, chewy, greasy, viscous, slippery, creamy, fatty, crunchy, sticky, smooth, dry, stringy, watery, and tough.

Because of the big variety of the definitions regarding the texture profile, food texture can be expressed as a sensory manifestation of the food structure and manner in which this structure reacts to applied forces, the specific senses involved being vision, kinestheties and hearing [5]. Also texture means those perceptions that constitute the evaluation of a food’s physical characteristics by the skin or muscle senses of the oral cavity, excepting the sensations of temperature and pain [6].

As a conclusion of the multitude of definitions is that the food texture has the following characteristics: it is a group of physical proprieties determined by food structure; it is pursued by the mechanical, rheological and physical proprieties; it is made by a various category of proprieties; it is felt in the mouth by the sensory receptors, but it can be also felt by the hands; to be determined by analytical methods it can be used function of mass, distance, time, force and flow proprieties.

Texture includes a variety of characteristics, such as hardness (some authors call it toughness), springiness, chewiness, and some authors also include juiciness [7,8], and even greasiness [9].

Among texture attributes, hardness is the most important to the consumer, as it decides the commercial value of a meat [10]. Texture is by definition a sensory parameter that only a human being can perceive, describe and quantify [11]. Instrumental texture assessment on meat is made by means of a texturometer, a device that allows tissue resistance both to shearing and to compression to be measured.

Meat tenderness is a key factor in determining consumer acceptability of cooked meat. Therefore, the occurrence of a low but appreciable incidence of tough broiler and turkey breast meat has stimulated research in this area [12]. Froning et al. showed that turkeys exposed to pre-slaughter stresses, such as struggling or heat, exhibit an accelerated pH decline which later resulted in tougher breast meat.

In broiler meat, [13] reported that plants, sex and season had a significant effect on meat tenderness. They also mentioned that breast meat pH values appeared to be higher in the winter.

The current poultry grading system used around the world is based on aesthetic attributes (tears, bruises, missing parts) and no consideration is given to the meat's functional properties (water holding, texture). Using aesthetic criteria for grading is beneficial to the consumer of fresh meat but is of no use to the processor who is looking for meat with high water holding capacity for use in products such as chicken rolls and roasts [14-20].

2. Materials and methods

2.1. Materials. The materials used were: chicken breast, scissors, cylindrical shape, aluminium (Al) foil, tap water, sunflower oil, Berzelius glasses and paper towel, Petri plates, culture medium, incubator, distilled water.

Used gear: thermometer AMPROBE TPP1-C1 AND, digital scale Partner type AS110/C/2, mercury thermometer, chronometer, stereomicroscope LEICA EZ40 and penetrometer Texture Analyzer.

2.2. Methods. The chicken breast has been bought from supermarket as refrigerated, and then it was deboned and washed under cold spray water and dried with a paper towel. The chicken breast has been cut with a scissor as a cylindrical shape (Ø=20 mm, h=10 mm). The samples were weighted on aluminium foil using a digital scale Partner type AS110/C/2 in order to set the initial weight of the samples, before thermic treatment.
For the study there were used two kinds of cooking treatment, in tap water and in sunflower oil. The choice was made in order to compare two common processes with a large use in practice and also to compare the effects of the both treatments on chicken breast.

Chicken breast is an anatomic part of chicken characterised by a low content of cholesterol and a high content of calcium, also it is a white meat and in this order it is very useful in food diet.

The temperatures chosen for the study are connected to times intervals depending on the type of thermic treatment, for tap water boiling at 70, 80, 90°C/5, 10, 15 minutes and the sunflower oil frying process was performed at 100, 105, 110°C/1, 3, 5 minutes.

The temperatures were measured with a mercury thermometer in the cooking medium and the time intervals were determined with a chronometer.

The samples were submerged into the liquid medium after the boiling point was achieved in order to prevent a large amount of technological losses. After the cooking time, the core temperature of the samples was measured with thermometer type AMPROBE TPP1-C1 AND and weighed to identify the technological losses with a digital scale Partner type AS110/C/2.

To evaluate the efficiency of the thermic treatment there were made microbiological analyses of the processed meat. This determination consists in total number of germs developed on a specific culture medium (MMA for yeasts and moulds and BCA for bacteria) in specific conditions (incubation at 37°C/48 h for bacteria and 25°C/3-5 days for yeasts and moulds).

To determine the structure modification of the thermic treated samples were analyzed with stereomicroscope LEICA EZ40 4.4:1 zoom with 3 MPixel digital camera.

The stereomicroscope has an 8x...35x amplifying field. For these determinations there were used two kinds of samples, the entire one and the sectioned one (the section was practice over the fibre length) and an amplifying field of 8x.

Due to the aim of the study to determine the sensorial modification it was used also the penetrometer Texture Analyzer for texture characteristics comparison.

This test measures the compression force (Newtons/kgf) developed by the penetrometer when compressing a piece of meat depending on the depth. When the probe first came in contact with the sample, the thickness of the sample was automatically recorded by the software. The probe continued downwards a prefixed percentage of the sample thickness (0-14 mm), returned to the initial point of contact with the sample and stopped.

3. Results and discussion
The aim of this study was the identification and the analysis of the weight losses, core temperature variation, structure, texture and microbiota changes appeared in thermic treated chicken breast.

In the first figure is represented the core temperature variation for the chicken breast as an anatomical part of the body.
In this figure is represented the weight variation of the boiled chicken breast.

![Figure 3. Weight variation of the boiled chicken breast](image)

The weight variation is depending on the medium temperature and time processing, as it can be seemed the weight variation is lower for the smallest temperature and time (70°C/5’) and bigger for the highest one (90°C/15’).

The boiled chicken meat at 70°C/5’ has a 18.93% losses than the initial sample and for 90°C/15’ it has a 34.40% losses.

In figure 4 is presented Core temperature variation for fried chicken breast.

![Figure 4. Core temperature variation for fried chicken breast](image)

The allure of the core temperature curve is similar for medium temperature (sunflower oil) 100/105°C and is a little bit different for the 110°C. Also at 3’ all the curves have a modulation, even growing or decreasing.

The core variation is dependent on the medium temperature and time processing, at the medium smallest temperature and time treatment the core temperature 61.8°C is the lowest, on the other hand the highest core temperature 94.1°C is linked to the biggest medium temperature and time treatment.

The curves’ modulation at 110°C/3’ described as an opposite reaction (increasing) in comparison with the 100/105°C/3’ can be given by the processing depth efficiency.

The Figure 5 is presented the weight variation of the fried chicken breast.

![Figure 5. Weight variation of the fried chicken breast](image)

The weight variation of the fried chicken breast is depending on sunflower oil temperature and time treatment as at 100°C/1’ the weight losses were 11.42% as for 110°C/5’ were 17.45%.

The technological losses are very low and the differences between them are small. The technological losses for 1’and 3’ time processing are almost similar or very nearly, a bigger change occurred at the final time treatment 5’.

The small technological losses can be explained because of the water evaporation speed of the samples surfaces stopped by a crust done by the thermic treatment changes which has a protective role for the rest of the sample, so the mass transfer is slowed.

The specific microbiota of the thermic treated meat was inactivated under the standards inferior limits or it was absent.

The boiled/fried meat texture analyses were done with the penetrometer and the samples used were around 14 ccm. This equipment is measuring the texture, which represents the basic sensorial characteristic. Indeed a good texture represents the consumer’s acceptability criteria for a product. Particularly a meat with a poor texture is for sure a rejected product for the consumers.

The texture analyses were done at room temperature. There were followed the mastication parameters especially involved in texture characterization.

For the force compression and the depth penetration the equipment has generated some graphics.
Here is expressed the compression force applied over the sample to break the piece of meat to settle its sensorial characteristics. There were done three determinations for each sample. For everyone the soft have generated three curves depending on the firmness of the sample (kg/J) and the depth (mm).

Even for the both graphics the slope curves are similar; it can be seemed that for the boiled meat treated at 70°C/5’ the texture firmness is bigger than the boiled chicken breast at 90°C/15’, so the sample boiled at the highest temperature for long time is more elastic, is more slowly to masticate and to swallow than the sample thermic treated at the lowest temperature for short time.

So for the sensorial aspect the highest thermic treatment is better than the lowest one. Two main sensory dimensions can be drown from these profiles: juiciness and tenderness with a third related to the determination of elasticity. Juiciness was better related to mechanical parameters at low strain rather than high strain and to initial muscular activity rather than later muscular activity.

Firmness was better related to high compression mechanical properties and to measurements in the middle or later part of the mastication process suggesting that tenderness assessment requires structural disintegration of meat.
The firmness for the same depth such as 1kg for 9.5-10 mm for 100°C/1’ and 110°C/5’ fried chicken breast is similar, but the slope of the curve and its variations are different. In the first figure it was found that the variation of the curve is due to the thermic treatment penetration effect, as for the surface it was created a crust from the denaturated proteins and conjuctive tissue, while the core statement of the meat is nearly unpenetrated by the thermic treatment.

The linear curve representative for frying at 110°C/5’ represents a constant firmness of the chicken breast tested by the force necessary to attain a given deformation. It represents the hardness of the sample at first bite and while mastication. This constant slope is determining the energy required to chew the piece of meat to a steady state of swallowing. Regarding the structure transformations produced by the thermic treatment the results are represented as pictures made by the stereomicroscope.

Figure 10. Structure of the boiled chicken breast at 70°C/5’ and at 90°C/15’

Figure 11. Structure of the fried chicken breast at 100°C/1’ and at 110°C/5’

The structural elements of meat are that group of physical characteristics that arise from texture characteristics, are sensed primarily by the feeling of touch, are related to the deformation, disintegration, and flow under a force, and are measured objectively by functions of mass and distance.

Chicken breast processing has the role to change texture proprieties, generally in the direction of weakening the structure in order to make it easier to masticate. The quality level of the texture is pointed out by the structural organization of food. In this order it exist a basis interaction between food structure and texture.
Some textural or structural characteristics don’t match with the rheological proprieties due to the physical and chemical proprieties changing happened during mastication process. In the above pictures there can be found that processing losses increased with increased heating temperature for boiling sample. Relationships between changes in sarcomere length and fibre diameter are notable and correlated with springiness characteristics.

It seems that during the boiling, meat, by coagulation of muscle proteins, exudes free water from the muscle tissue. The sarcomers seems to shorten less at 70°C than 90°C, so the contraction state of muscle seems to be less at first temperature than the last one.

The thermic treatment causes shrinkage to muscles. The shrinkage of the tissue may be developed also in muscle as well as in connective tissues and also it is remarked the macroaggregate gel formed by the collagen, elastin and reticulin depreciation.

4. Conclusions

It can be asserted that frying in sun flower medium is more efficient for the structural and textural characteristics and also from the technological losses point of view.

For boiling process it can be concluded that the temperature of the water medium is allowing the mass transfer, the protein and connective tissue losses and coagulation reflected on the weight power.

As a final conclusion the thermic treatment both in water medium and sun flower oil depends on the medium temperature and time processing.

Chicken breast frying is more feasible than the boiling treatment due to the low technological losses and also the small variation between frying and boiling core temperatures, even the medium temperature has significant differences (70°C /100°C for the minimal thermic treatment) and (90°C /110°C for the maximum thermic treatment).

The boiled chicken breast treated at 70°C/5' remained hard and springy, and at 90°C/15' the juiciness and the entire texture were affected.

For the frying samples the diameter decrease in muscle fiber is connected to the denaturation of proteins and water losses, while the decrease in length was more connected with the actual coagulation of the muscle proteins.

References


