PHD THESYS SUMMARY

The PHD thesys entitled ***„Researches concerning the influence of slaughtering conditions on quality of poultry meat"*** is structured into two sides: a bibliographic part and a personal research, adding conclusions and recommandations.

The bibliographic study comprises two chapters:

- *the first chapter* highlights the current state of the technology by which we can obtain poultry carcasses in an inudustrial slaughter regime throughout national and worldwide slaughter practice, the influence of the pre-slaughter operations on the resulted meat quality;
- *the second chapter* contains data extracted from the literature and follows the pH, color, technological quality, tenderness and texture variations of the poultry meat resulting from the slaughter, and some data for the sensory and nutritional values of the main categories of poultry meat that are subjected to industrial slaughter.

The research literature emphasizes the practical importance of strict observance of all stages and ethical procedures for handling pre-slaughter poultry due to slaughter, the values of the technological parameters involved in the operations of the slaughter flow varying by continent, country, unit management or used technology, by updating the literature, highlighting the research focus on the quantitative and qualitative aspects of broiler production at the expense of research correlations between slaughter technology and meat quality parameters, mainly nationally.

Given this situation it was necessary to further research and investigate, the present study being focused on determining the influence of broiler slaughter on the meat quality resulted from evaluating the effects of the *pre-slaughter factors* (distance and total transport time, chickens density during transport, ambient temperature; resting time at the arrival in the slaughter house; handling time at the loading/ unloading) and the factors involved in the slaughter *stunning* process (frequency, voltage and current intensity; conveyor speed and time of crossing water bath stunner/ chicken), *bleeding* (during blood disposal), *scalding* (scalding water temperature; scalding time and scalding capacity), *plucking* (speed of plucking machines and conveyer; plucking time; water spraying pressure; distance between plucking drums), *evisceration* (evisceration time; conveyer speed and evisceration - washing water temperature; water spray temperature used for washing the carcasses; specific water consumption/ carcass), *carcasses chilling* (initial temperature of carcasses, chilling tunnel and water temperature; air flow speed and final temperature of carcasses during chilling) and *storage method* (refrigeration / freezing) on a productive physical, chemical, technological and sensory perspective.

Thus, the research is structured into five chapters as it follows:

- *the third and fourth Chapters* present research organization, including goals and objectives, describing the institutional and descriptive data for the technological parameters applied, the summary of the entire protocol is shown in the experimental scheme, and the materials and working methods used to achieve the goals;
- *the fifth, sixth and seventh Chapters* highlight research results and focus their findings on the influence of slaughter on broiler meat qualitative productivity indicators *(flock losses during transport, weight losses during transport, slaughter yield, the proportion of cut portions in carcass composition and edible internal organs and collateral damage)*; microbiological parameters *(T.N.G., Escherichia coli, Enterobacteriaceae, Salmonella enteridis)* and physical parameters *(pH, color – L*a*b*, tenderness - Warner Bratzler shear force and textural profile)*, chemical parameters *(raw chemical composition, meat fatty acids and amino acid content)*, technological parameters *(meat water holding capacity - cooking weight losses and refrigeration weight losses)* and sensory parameters, for the chilled poultry meat from the L1, L2 and L3 experimental groups (differentiated in terms of slaughter flow technological parameters).

The collection, sampling and meat sample preparation for further physical, chemical, technological and sensory laboratory analysis included strict highlighting of studied portions, the actual sampling and forming muscle samples according to *STAS ISO 3100-1-92*. The sampling of technological water used for slaughter in different stages of the slaughter flow and the fat tissue were performed according to *STAS ISO 3100-2-92*.

Depending on the type of analysis and methodology, meat samples were subjected to the following methods of preservation: samples refrigeration at 2 - 4 °C for 24 h, frozen meat samples at -20 °C, after beeing vacuumed in polyethylene film and lyophilization (freeze drying).

Parameters determination was performed using standardized methods and techniques and modern devices, calibrated in order to minimize possible errors that can occur during the analysis, thus ensuring the scientific value of the results. The analytical methods used in the personal researches are included in the legislative framework set out in the Romanian standards, harmonized with the European Community legislation and the international standards or in accordance with the methods used in the reference works.

In order to determine the productive parameters specified literature formulas were used. The determination of the physical parameters included chickens meat analyzes of experimental groups with the following standards / references: for 0.25 pH, 12 and 24 h post-slaughter and after meat thawing: *SR ISO 2917:2007*, for color: *CIE (1976)* and *Honikel, (1998),* for Warner Bratzler shear force: *BS EN ISO 7500:1999* and *Honikel (1998),* for profile texture: *Bourne, (1978)* and *Gunasekaran and AK, (2003)*. Working methodology used to determine the chemical parameters followed the standards / references: for dry matter and moisture: *UNI ISO 1442:2010,*

ISO 1443:2008, ISO 1444:2008, ISO 936:2009 and *ISO 937:2007*, for raw ash: *ISO 936:2009*, for raw protein: *SR EN ISO 937:2007* and *AOAC 2000 – 928.08*, for raw fat*: ISO 1443:2008*, for fatty acids determination: *Folch et al., (1957), Christie (1998, 2003)* and *Ruiz et al., (2004)* and for amino acid determination *AOAC,1985, Fengchang et al., (2001), Bosch et al., (2006) and Liu, (1994)*. In determining the technological parameters - refrigerating losses and cooking losses, the methodology followed the specifications described by *Honikel, (1998)* and the meat samples sensory evaluation (chickens breast muscles for L1, L2, L3 groups) harvested 24 h post- slaughter and frozen at -20 °C followed the methodology described by *Meilgaard et al., (1991), Sebranek et al., (1979), Civille and Lyon, (1996), McFie et al., (1989), ISO, 1988 and Ruiz et al., (2001).* The microbiology analysis of chicken carcasses on slaughter and water flow methodologies included compliance standards specified for the following parameters: for T.N.G.: *SR EN ISO 4833 - 2003, ISO 6887-1-2002*, for the quantitative determination of *Enterobacteriaceae species*: *ISO 21528 - 2:2007*, for the quantitative determination of the *Escherichia coli species*: *STAS ISO 4832: 1992, EN ISO 7251: 2009* and in order to identify colonies of the *Salmonella spp species*: *SR EN ISO 6579/AC/2006; Koyuncu Sevinc, et al., (2009).*

In terms of technological parameters, the results obtained from the evaluation of the quality aspects for chicken meat from the three experimental groups slaughtered under three different regimes, revealed the following:

a. Chicken carcases technological quality parameters

Poultry transport from the three farms to the slaughterhouse indicated that the main factors influencing the distance between farm and slaughterhouse are transport time, loading and unloading time and ambient temperature on arrival at the slaughterhouse, L1 group is characterized by an increased mortality followed in descending order of experimental flock losses in the L2 and L3 groups. These data are within the limits described by the industrial practice (≤ 0.5 %).

Results on slaughter yield (62.83 – 88.43 %) and comparing cut proportions from the carcasses of the three experimental groups showed direct growth technology effectiveness for each unit, the *SIMILA* farm being the biological material supplier, with the best results in terms of cut portions percentage. *DOINA* farm (L2) broiler carcasses have been characterized by satisfactory values of chest bone participation in carcass composition, average percentages for upper thighs and lower values for drumsticks and wings participation, while broiler carcasses from the *HENCI* farm were characterized by unfavorable values for muscle parts with great economic value. Variations between body mass groups, from the whole carcass or on each cut part, highlighted the need to maintain a strict control of growth technology, keeping a constant feed quality and continuous personnel training regarding poultry welfare, both in the growing halls and during poultry transfuse to the slaughterhouse.

In terms of edible organs proportion of broilers live weight, we developed an ascending hierarchy, as it follows: heart (0.41 to 0.42 %), gizzard (1.49 to 1.54 %) and liver (1.88 to 1.98 %), the hierarchy and the variations between groups were similar to those described by carcasses structure and were statistically secured.

Losses caused by pre-slaughter and slaughter technological operations were identified as punctate hemorrhages in the chest and wings and carcass open fractures. The incidence of fractures was dominated in the wings region, as a consequence of transport density, pre and post-slaughter handling management and lack of correlation between stunner width and broiler weight, the L3 carcasses were most affected by the defects, followed by L2 and L1 groups.

b. Chicken carcasses microbiological quality parameters

Poultry transport from the growing farms to the slaughterhouse proved to be an important factor, that contributed to the quantitative growth of the carcass micoflora, especially for the parameters from the poultry digestive tract, as evidenced by the determinations made during the bleeding stage.

Within slaughter, plucking and evisceration are cross-contamination development "risk" stages on poultry carcasses, due to microflora air variation and technological water from the scalding tanks, plucking being the stage which generated a great microbial augmentation, mainly because of the running peculiarities of the plucking machine and because of the microbial water load from the scald tank.

The highest bacterial load on the surface of the carcasses from the experimental groups examined for T.N.G. (7.05 to 7.82 $\log_{10}$ cfu/g) was detected immediately after plucking and evisceration, stages with a very intense microorganisms contamination, the lowest rates being the results obtained after washing the carcasses (5.19 - 5.66 $\log_{10}$ cfu / g).

The total number of *E.coli* bacterial species, determined during technological slaughter flow, provided values between 1.67 $\log_{10}$ ucf/g and 6.32 $\log_{10}$ cfu/g, the highest rates were recorded during evisceration and plucking, and the lowest rates were those obtained during the final stages of processing, after washing, cooling and packaging. Regarding the differences between experimental groups for each stage of the slaughter flow, studied in varying degrees of significance, there was a small number of bacterial species *E. coli* on carcasses L2, followed by the L1 and L3 ascending groups.

Isolation, identification and quantitative determination of total *Enterobacteriaceae* bacteria species for slaughtered broiler groups defined a variation range situated between 2.23 $\log_{10}$ cfu/g and 8.54 $\log_{10}$ cfu/g, with averages varying according to the slaughter flow stage and L1 group carcasses between 3.72 – 5.40 $\log_{10}$ cfu/g, L2 group between 3.86 – 5.91 $\log_{10}$ ufc/g and L3 group 3.84 – 5.85.

The results obtained from the analysis of 108 carcasses revealed an isolated degree of *Salmonella enteridis* contamination for the broiler meat from the L2 and L3 experimental groups (1 carcass / experimental group), after 24 h refrigeration the percentage decreased by 50 %, leaving a single contaminated carcass in the L3 experimental group.

Evisceration was the stage which eliminated most of the microorganisms from the carcass surface, a frequent cause underlying such results being biting the digestive tract by the evisceration facility, even if the pollution content of the digestive tract was not visible. The final wash has greatly reduced the carcasses microorganisms number by the mechanical effect exerted by the water. Carcasses cooling has influnced the microflora present in quantitative terms, cold acting selectively on microorganisms, increasing *T.N.G.* and decreasing *E.coli* and *Enterobacteriaceae*.

Overall, it has been highlighted the increased risk of cross-contamination on the technological flow, just in case of a water supply breakdown in the deplucking system, the scalding tank or the washing nozzles, all along the slaughter flow, the microbial load of each experimental group depends primarily on the technical features of operating the equipment and strict technology observance.

c. Physical quality parameters of the meat

During meat chilling (breast, upper thigh, drumsticks), pH dynamic showed a downward trend during the first 24 h postmortem for all studied anatomical parts, pHu values from the L3 group muscles having a more pronounced decrease compared to that observed in the L1 and L2 groups. Post-slaughter pH dynamics framed the muscles from the L1 and L2 groups in the safety interval, while some samples collected from the carcasses of the L3 group showed PSE signs. A possilble causality-effect explanation may be the corroboration between transport ambient temperature (24.55 to 24.8 °C), insufficient pre-slaughter resting time (30 min.) and moderate transport density (32 broilers/ drawer), althoguh the distance was the shortest (4 km).

From a colorimetric perspective, comparative description of exprimental groups meat, according to the technological parameters of slaughter regime, showed the following: average brightness values for the fresh anatomical cut parts ranged from 50.02 and 60.36 units, L3 poultry meat was characterised by a greater brightness than that of the samples from L1 and L2 groups, the variations corresponding to this parameter from the L3 group were influenced by pHu variations, by the voltage applied during stunning, by the total blood removal time and by the conveyor bleeding speed, altghough they were not decisive factors for the final meat colour.

From a muscle region perspective, it was observed a deeper breast meat brightness, followed in descending value by the upper thigh and drumstick brightness.

Chilled poultry meat ***texture*** from the experimental groups assessed through Warner Bratzel shear force, ranged between 9.05 – 18.29 N / cm², existing minima describing the meat

harvested from the L3 poultry carcasses within the same cutting area. Regarding breast and upper thigh muscles, the mean shear forces placed the L1 muscles on an intermediate range, followed by that from the L2 group, while regarding the drumsticks, L1 muscles had a greater shear force, followed downward by the L2 and L3 groups.

From a ***textural profile*** perspective, comparing the groups, breast muscles from the L1 carcasses have been favorably characterized due to their adhesion, gumminess and great elasticity combined with an intermediate toughness and chewiness and minimum adhesion, being the first from a textural quality point of view, followed downward by the textural quality of the L2 and L3 meat groups, the data being statistically ensured. The differences between thigh meat groupswere not signifiant, altghough the literature gives an explanation of the phenomena occurring during the heat treatment of the muscle samples, the loss of liquid takes place simultaneously with the production of a gel, texture profile analysis parameters having lower values for PSE meats.

d. Meat textural quality parameters

Weight lossess in chilling muscle samples form poultry carcasses collected from the experimental groups showed values beteween 0.49 – 1.12 %, the L3 group had expansive chilling weight losses, followed by the L2 and L1 groups. Concerning the carcass, the highest weight losses were seen in the upper thigh muscles, followed downward to small differences by the breast muscles and then by the drumsticks muscles.

When talking ***about weight losses during cooking***, the anatomical cut parts from the chicken carcasses of the experimental groups subjected to chilling had values between 14.41 – 26.66 %, the L3 group expressing higher technological losses than the homologous regions of the other two experimental groups. The intermediate mean values were assigned to the breast and upper thighs collected from the L2 carcasses, respectively the drumsticks from the L1 group. The range of averages variation obtained for weight losses from cooking the muscles samples from the experimental poultry were similar to those specified in the literature at 24 h post-slaughter (11.25 to 29.19 %).

e. Chemical quality parameters

The analytical data regarding the composition of the three anatomical cut parts harvested from broiler carcasses from the experimental groups revealed the following:

- ***raw chemical composition of the meat***

In all the muscle groups examined, muscle dry matter showed values between 24.11 – 29.98 %, L3 thighs are positively described in relation to the system's slaughter parameters, being descending preceded by the average values of the homologous regions of the L1 and L2 groups. Breast carcasses from the L1 groups were characterized by the highest content of dry matter, preceded downward by the homologous anatomical part of L3 and L2 groups.

By determining the total protein in all meat samples analyzed, we managed to identify higher content in breast muscles, their distribution in the thighs showing small differences between experimental groups in the cut parts, the range of framing in the three anatomical parts studied is bounded between 16.02 – 20.64 %.

According to the obtained data, fats from broiler meat of the three experimental groups were the highest amplitude component of variation between anatomical cut parts, the averages being from 1.90 to 7.68 %.

- ***fatty acid composition of the meat***

Description of the qualitative and quantitative profile of fatty acids from meat lipids of the refrigerated broilers revealed a wide range of variation, the average values of the main lipid fractions showed a predominantly C16: 0 and C18: 0 to SFA, C18: 1 ω-9 and C16: 1 for MUFA and C18: 2ω-6 cis, C18: 3ω-3 and C20: 4ω-6 to PUFA content.

The parallelism between the groups according to the anatomical cut part highlighted the higher PUFA ω-6 / ω-3 reports for breast and upper thigh from the L3 group, respectively for the drumsticks of the L2 group, while the minima characterized the breats from tle L1 group, the upper thigh from the L2 groups and the drumsticks from the L3 group.

During the development of fat deposits it is observed that AGS and MUFA have a more pronounced enhancement compared with PUFA, showing repercussions such as the decline of PUFA content and automatically on the PUFA / SFA ratio. These differences are under the influence of genetic factors and poultry diet, which are observable by the range of values obtained at higher fatty acid analysis of lipid constitution. The PUFA / SFA proportion ranged from 1.03 to 1.17. Current research results, which detailed the fatty acid profile of lipids extracted from samples of the three anatomical parts, described a meat rich in PUFA, indicating the superior quality of the constituent lipids of the breast muscles from the L3 carcasses and the L1 upper thigh muscles, as they recorded the lowest SFA content.

- ***amino acids meat composition***

Regarding meat carcasses harvested from chickens undergoing chilling, it was noticed the superiority value of essential amino acids found in breast muscles than in thighs, showing high values for leucine, tyrosine, threonine, phenylalanine and lysine, while the averages described little valine, isoleucine and histidine quantity. Through the compaarison between the experimental groups according to the anatomical cut part, the breast muscles from the L1 poultry carcassses evidenced itself by higher average quantities than those from the L3 and L2 groups, which is highlighted by the mean amount of essential amino acids determined for each experimental group (255.88 mg AA.E / 100 g sample (L1) vs. 249.52 (L3) and 243.26 (L2)

AA.E mg / 100 g sample). Nonessential amino acid profile showed higher average for glutamic acid and arginine in each anatomical cut part from each experimental group.

Following the nutritive evaluation of chickens meat from the three experimental slaughtered groups, it was found a superior level in AA.NE and AA.E content for the breast muscles than the thighs irrespective of the storage, slaughtering system is a factor that can influence chemical composition of meat protein.

f. Sensory quality parameters of the meat

Following the whole picture on the sensory characteristics analyzed we can appreciate the superior quality of breast muscles from L2 broiler carcasses due to favorable scores of color and its uniformity, coupled with the intensity of the flavor, for the fried one and peanuts, filled with sweet and savory taste, of umami, almost imperceptible salty, acid and bitter andintermediaries texture parameters. The second place was given to meat samples from L1 carcasses, followed by the L3 group.

At the same time, the pre-slaughter stressors, specific ways of stunning each experimental group, subsequent procedures during processing combined with chemical exposure throughout the processing flow, including packaging, storage conditions and cooking temperatures may have effects on the intrinsic quality parameters of the meat and they should be limited on contingency by continuously optimizing the technological parameters of the flow of slaughter in a pilot center, small scale, to highlight the quality limit points.

Following the current experiment it has been highlighted the qualitative specificity of the resulted chicken meat, quality which was influenced by a number of factors over the slaughter flow, obvious observation is the existence of a margin of error as to the parameters specific to each stage of flow and to those regarding chicken welfare, the synergism of these factors contributing to the conglomerate of global quality parameters that define meat quality, L3 meat samples were described by negative values of the technological, microbiological, physical and sensory quality parameters.

These results are needed for further processing in the department of economic cost-benefit balance for accurate reporting of profits and losses and adjustments.