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CHANGES OF PHYSICAL PARAMETERS OF MEAT DURING WET AGEING

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Abstract

Fresh meat quality can be improved by maturation. Maturation is ageing of fresh meat under controlled temperature conditions during a certain period of time thereby improving its sensorial and textural parameters. Ageing is a natural process and there are two maturation methods: wet and dry. Dry ageing produces a more flavourful product but wet ageing is characterized by a higher outcome of the products and a lower risk of microbial spoilage during maturation. The aim of this research was to investigate the changes of quality parameters of pork, beef and lamb meat during wet ageing. In the current research, the longest lumbar muscle (*Musculus longissimus lumborum*) of pork, beef and lamb was used. Meat was aged at the following conditions: vacuum packed in polyethylene/ polyamide pouches and stored for 35 days at 2±1 °C. During wet ageing (on the 0, 7th, 14th, 21th, 28th, and 35th day) the following quality parameters were analysed: moisture content (LVS ISO 1442:1997), water activity (Novasina LabSwift-aw, Sweden), pH value (LVS ISO 2917:2004) and tenderness using TA.HD.Plus Texture Analyser (Stable Microsystems, UK). The obtained results indicated a pH value decrease in all meat samples during ageing ($p<0.05$). Observed results showed a very strong positive correlation between moisture content and water activity. The changes of water activity were not significant ($p>0.05$), it increased in pork and lamb meat, but decreased in beef meat. The apposite results were obtained regarding the hardness of meat samples, namely, pork hardness decreased during ageing, but increased for beef and lamb meat samples. Based on the results, wet ageing process is more suitable for pork meat.

Keywords: meat maturation, wet ageing, pork, lamb, beef

Introduction

The consumers of meat and practice in meat industry have identify the importance of developing technologies improve the appearance, nutrition, to extend shelf-life and animal products safety (Yang et al., 2016). Humans carry on with to scan for ways to effectively eliminate, control, or decelerate the process of ageing. The meat ageing process is shown positively, and the specialists of storing meat for increasing periods of time after the slauthering of an animal, in order to improve its tenderness, has been a practice followed by many for a long time (Toldra, 2010). Ageing is the natural process of making meat a supply is difficult. The development of tenderness depends on the skeletal muscle cell architecture and integrity as well as on events that transform these proteins and their interplay. Namely, degradation and oxidation of proteins have been identify as processes that change protein as well as meat softness (Lonergan, et al., 2010). For improving the sensory properties of meat the process of ageing is a one of the popular method used by meat industry. Ageing is still widely used commercially successful as a *post-mortem* interventional for softenig of meat. Ageing to make better the meat tenderness through disruption by intracellular proteolytic systems of the muscle structure (Bhat et al., 2018).

After slaughtering animal muscle undergoes molecular changes, what can be subdivided in three stages – first stage – *pre-rigor*, second stage – *rigor-mortis* and third or tenderization stage – *post-rigor*.

The latter mostly depends on ageing time and temperature, type of muscles, individual genotype and species of animal, but the common focal point is the activization of proteolytic enzymes driving the destruction of muscle fibres (Longo et al., 2015)

Meat muscles undergo *rigor-mortis* stage during the conversion of muscle to meat and increase in meat tenderness that is a results of this process (Lee et al. (2016). However, the Chen et al. (2015) and Cruzen et al. (2014) in scientific publications were concluded that the *rigor-mortis* can be resolved by cytoskeletal and myofibrillar proteins degradation in meat by proteinases such as cathepsin, caspase, calpain and proteasome while ageing, which the meat tenderness can be improved. Toldra (2010) in some scientific papers was mentioned that the “ageing” of *post-mortem* has been called “ripening” or “conditioning” and is a natural process. In this time of process meat is expose to controlled storage conditions in refrigerate. While any species from meat could be aged, *post-mortem* ageing is usually finite to beef and at the slaughter time the relative youth pork, lamb and veal. For a long time, meat ageing technologies such as dry ageing and wet ageing have been used to improve meat quality (Kim et al., 2017). Fresh meat ageing process is very inportant to meet the big requirements and hopefulness of an exceptional diet experience. Agening of fresh meat to increase the palatability of the products, to enlarge the tenderness over time and to evolve the aroma, taste, smell. The common ageing methods are dry and wet ageing. Dry ageing is a process wherewith carcasses, primal, and / or sub primal of animal are stored without preventative packaging for one to more weeks in refrigeration temperatures. But during wet ageing meat is packed in a sealed barrier film and stored at a temperature over the meat freezing point (Velotto et al. 2015).

Therefore, the aim of research was to investigate the changes of quality parameters of pork, beef and lamb meat during wet ageing.

Materials and Methods

Raw materials

In the researches was used the longest lumbar muscle (*Musculus longissimus lumborum*) from three different animal meat – pork, beef and lamb. The right and left lumbar muscles were not evaluated separately in the study. The meat was bought at specialized meat shops: pork meat – in meat market "Kunturi" Ltd., Riga; beef meat – "Jelgavas tirgus" Ltd., Jelgava; lamb meat – in "Bairons LBC" Ltd. market place "Iecenu delikateses", Ieceni.

Preparation of meat samples

The temperature of the meat during transportation did not exceed 4 °C, the transport time – 1.0–1.5 h. The meat samples were packed in vacuum bags of 200×250 mm, the sample size being 150–250 g. For the packaging material transparent PE / PA (polyethylene / polyamide) pouches (film thickness 60 µm) were chosen. The packaging material is impermeable to gases and moisture. Samples were vacuum-packed (20 mbar) using a vacuum packing machine *Multivac C300* (Sepp Haggenmüller GmbH&Co, Germany).

Maturation of meat and analysis of samples

Packaged meat samples were maturated in refrigerator 35 days at temperature 2±1 °C. Changes in physical parameters during maturation period were analysed on the 0, 7th, 14th, 21th, 28th and 35th day of storage.

Methods

Moisture content was established according to standard LVS ISO 1442:1997.

Water activity was determined using a water activity detector *Novasina LabSwift-a_w* (Novatron Scientific, Sweden).

pH value determined according to the standard LVS ISO 2917:2004.

Meat tenderness was determined using the texture analyser *TA.HD.Plus* (Stable Microsystems, UK). Warner-Bratzler shear device was used to investigate the shear test of meat hardness, which be composed of a blade and a slotted platform. Samples of meat was divided in strips of 2 cm width and set under shearing blade, which at a speed of 1 mm s^{-1}, sheared the test portion in half, parallel to the meat fibre. 10 independent measurements was finished for each sample of meat. Exponent software were used for data compose (Stable Microsystems Ltd., UK) (Sazonova et al., 2018).

Data analysis

For the calculation of mean arithmetical values and standard deviations Microsoft Excel v16 software was used. To determine the significance of research results SPSS 20.0 software was used and the impact of factors and their interaction, the significance effect (p-value) to explore with ANOVA analyses.

Results and Discussion

Moisture content

Changes in moisture content in all meat samples during maturing are not significant (p=0.68) (Figure 1). Comparison of the 0-day sample with the 35-day matured sample showed a 0.61% increase in the moisture content of the pig meat and a decrease of 1.74% in the beef. In the lamb, fluctuations in moisture content during maturation were lower than in beef and pork meat. Comparison of the 0-day sample with 35 days of matured meat resulted in a 1.45% increase in the moisture content of the lamb at the end of the ripening. The decrease or increase in the moisture content at the end of the maturing period could be caused by the action of microorganisms and various enzymes, resulting in a change in the ratio of free to bound water, which also affects changes in moisture content. The lamb and pork are characterized by a higher moisture content, which could be related to the age of the animal.

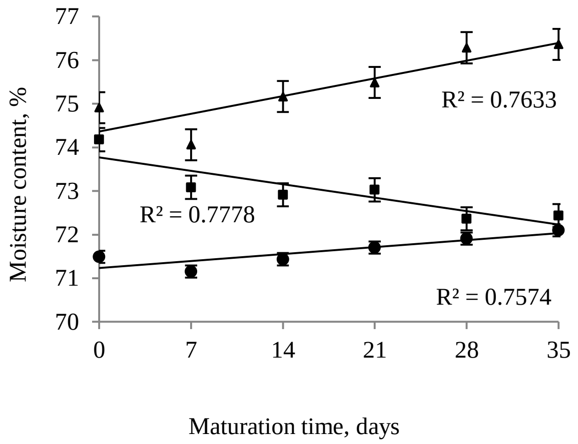

Figure 1. Moisture content change in the maturation period

● – pork meat; ■ – beef meat; ▲ – lamb meat

During the maturation process the greatest influence on the capacity of meat to preserve moisture is the activity of enzymes, especially calpains (Di Luca et al., 2011). Enzyme activity is affected by the lactic acid content that results from glycogen degradation. As shown by the results obtained, meat containing less lactic acid is characterized by higher proteolytic enzyme activity. Beef meat had a lower pH value, which decreased during maturation and which may be due to its age and higher glycogen content.

Water activity

During meat maturation, water activity changes (Figure 2) in all meat samples were not significant (p>0.05). In pork and lamb meat, water activity increased during the entire maturation period, but in beef decreased. By comparing the 0-day samples with 35 days of matured pork, beef and lamb meat, water activity changes were not significant (p=0.10).

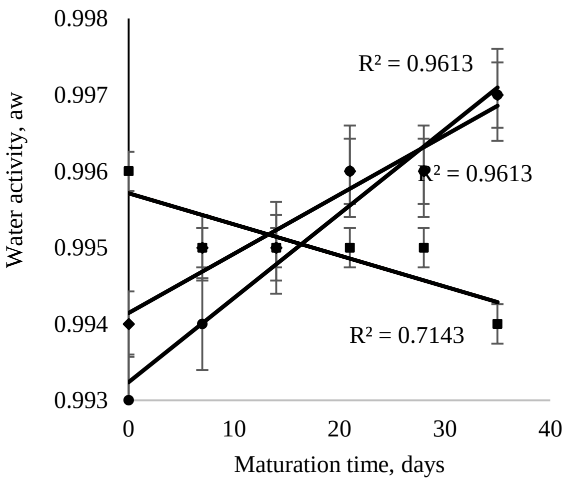

Figure 2. Water activity change in period of maturation

● – pork meat; ■ – beef meat; ▲ – lamb meat

Water activity is influenced by moisture content, amount of preservatives, and type of maturation. During dry maturation, moisture from the product evaporates faster than in the case of wet maturation and thus the water activity in the product decreases faster. As maturation was carried out in vacuum-packed meat in air- and moisture-tight material and no osmotically active substances or bacterial cultures are added to the raw materials used, the reduction in water activity is only possible in the meat and on the surface of the meat on the microflora.

In the present study a very strong positive correlation between moisture and water activity was determined. For different meat samples correlation coefficient was following: pork meat r=0.792; beef meat r=0.844; lamb meat r=0.813.

pH value

During period of maturation, all meat samples showed significant ($p<0.05$) changes in pH values (Table 1). In all meat samples, the pH value decreased during the maturation period. The lowest pH was observed in beef meat and during maturation period value change from 5.39 to 5.23. From the other hand, the highest pH value was detected in lamb (5.77) meat and in the time of maturation, it decreased and reached 5.72.

The one of the most important meat quality indicators is pH value. It is closely related to many other characteristics of meat, affecting the suitability of their processing and culinary applications, such as colour, tenderness and self-life (Daszkiewicz et al., 2016; Hamoen et al., 2013; Glamoclija et al., 2015). As reported by Rammouz et al. (2004) an easy-to-measure parameter of meat is pH that provides information on *post-mortem* muscle glycolysis, which makes it possible to detect meat quality defects. That is as pale, soft, exudative or PSE meat, and dark, firm, dry or DFD meat. Knox et al. (2008) mentioned that the rate of *post-mortem* glycolysis may be too rapid, leading to a rapid decrease in the pH value (typical for PSE meat) or too slow, resulting in a too high pH value (characteristic of DFD meat). In both cases, abnormal physico-chemical properties of meat (colour, water-holding capacity) are developed. The authors Adzitey and Nurul (2011) note: "Such meat has limited processing suitability and low consumer acceptance, which generates vast economic losses". The meat pH can markedly influence meat quality, such as softness (Bidner et al., 2004). The researcher Silva et al. (1999) was describe that softness had a linear relation with pH value in meat, while Pulford et al. (2009) was found low and high pH values beef to be gentle than intermediary pH samples. The experimental data reported that the toughest beef become in intermediary pH samples (Lomiwes et al., 2014). The initial pH value of the meat depends on the glycogen quantity in the muscle of animals. Because the glycogen content of the animals muscle tissue is higher, as its decomposition results in a higher lactic acid content and a lower pH value. As can be seen from the data in Table 1, the higher the glycogen content in the beef but the less it is in the pork and lamb meat. The high pH value in pigs and lambs could be explained by the age of the animal, because high levels of glycogen in the meat of these animals have not been able to accumulate and therefore the pH is higher.

Table 1

pH changes in period of maturation

Sample of meat	**Maturation time, days**					
	0	**7**	**14**	**21**	**28**	**35**
Pork meat	5.74±0.05	5.60±0.03	5.63±0.02	5.36±0.01	5.30±0.02	5.53±0.03
Beef meat	5.39±0.01	5.32±0.07	5.22±0.01	5.20±0.02	5.08±0.03	5.23±0.02
Lamb meat	5.77±0.02	5.87±0.04	5.77±0.04	5.67±0.03	5.55±0.02	5.72±0.04

Tenderness

During the maturation period, the pork tenderness (Figure 3) decreased, but the tenderness of beef and lamb increased and changes are not significant ($p=0.32$).

The tenderness changes and dynamics of changes were different and depending on the type of meat. Largest fluctuations in tenderness during maturation were observed in lamb and beef, but smaller in pork meat. During the 35 days of maturation, pork tenderness decreased from 159.78 to 119.51 N or fell by 25.21%. The opposite results were obtained by analysing the beef and lamb meat tenderness. Beef meat tenderness increased from 301.83 to 525.42 N or by 74.08%, and lamb increased more than 2 times or from 163.19 to 334.38 N.

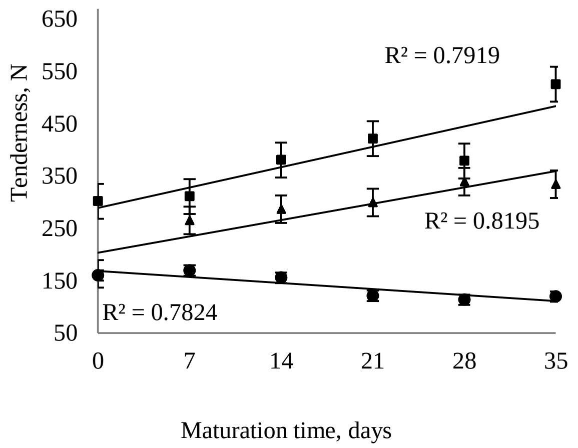

Figure 3. Tenderness change in the period of maturation

● – pork meat; ■ – beef meat; ▲ – lamb meat

The increase in tenderness could possibly be caused by temperature fluctuations during maturation, thus affecting enzyme activity and inhibiting myofibrillar protein degradation. Increase in tenderness could also be affected by an increase in lactic acid bacteria in beef and lamb (Kim et al., 2017). During the maturation process, the meat's tenderness is affected by pH value. In some cases (Wu et al., 2014) it is claimed that meat tenderness is linearly dependent on the pH of the meat. An increased meat tenderness indicates that meat has low proteolytic enzyme activity, especially calpan activity. In some literature sources was mentioned that the meat tenderness may be affected by the beakdown of myofibril protein by *post-mortem* period proteolytic activity. The authors Muroya et al. (2010) and Li et al. (2014) research have concentrate on determining the contribution of various myofibrillar proteins to meat softness. It has been systematically reported that tender meat compared to solid meat has a quicker and wide degradation of titin, desmin, troponin-T, nebulin. The degradation of these proteins during ageing process was observed. Therefore researchers have tried to prescribe the suitable ageing time to acquire acceptable softness. The results of the studies are consistent with Marino et al. (2013) who noted meat hardness is also affected by the fat contend of meat. Increased intramuscular fat during maturation helps reduce hardness. The amount of intramuscular fat in the meat depends on the animal sex, breed, age, quality and growing conditions. As we know, the fat content of beef and lamb is lower than that of pork. Therefore, pork meat may be softer and become softer during maturation.

Conclusions

The results showed a very strong positive correlation between moisture content and water activity. For different meat samples correlation coefficient was as follows: pork meat r=0.792; beef meat r=0.844; lamb meat r=0.813.

During meat maturation, the changes of moisture content, water activity and tenderness in all meat samples were not significant ($p>0.05$).

Pork, beef, lamb meat samples showed a significant ($p<0.05$) decrease in pH value during maturation period.

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