Influence of refrigeration and ageing time on textural characteristics of fresh meat

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Summary

Research of the textural characteristics of pork, beef and baby beef meat samples was conducted. Hardness and adhesivity of the meat was measured immediately after slaughtering, then after 24, 48 and 72 hours. Half of the samples were kept at room temperature, while the other half were refrigerated at 4 °C. The results showed that the hardness and adhesivity suddenly dropped during the first 24 hours (up to 345 N, or 41.7 %). After next 48 hours of storage, the values of measured textural properties showed a slight decrease (only additional 15.6 %). The refrigerated samples retained their textural properties a lot better (31 % decrease in hardness during first 24 h, additional 7.4 % in the next 48 hours) than the non-refrigerated ones. In correlation with consumer and industry experience with the texture of cooked or fried meat, refrigeration is a better choice after 48 hours, while after that period, meat at room temperature, is too soft for further processing.

Keywords: meat texture, instrumental texture analysis, hardness, adhesivity

Introduction

Meat, in a broader sense, is constituted of the skeletal muscles together with fat and connective tissues, bones, cartilage, blood and lymph vessels and nerves, obtained during slaughtering of the stock and poultry. In the narrow sense, only muscles without bones, connective tissues, bigger fat layers and vessels are considered as meat (Kovačević, 2001). Table 1 presents the basic constituents of meat, while there are also other constituents, such as vitamins, minerals, enzymes, organic acid, etc.

Table 1. Basic composition of meat (Mayer et al, 2007)

Component	w [%]
Proteins	14-20
Fats	5-20
Water	60-75
Extractive matter with nitrogen	1-2

A larger share of proteins, in comparison with other constituents, usually makes meat more valuable on the market. Meat proteins are highly valued in nutrition because of their optimal amino acid composition, which makes them easily and completely usable in the human metabolism. Proteins also have the largest influence on the textural characteristics of meat.

Meat quality is an expression which is used for describing the overall meat characteristics, including physical, chemical, morphological, microbiological, sensory, nutritive and culinary properties. The appearance of meat, its texture, juiciness, tenderness, smell and taste are some of the most important characteristics of meat from the consumers' perspective and they influence their decision (Verbeke and Viaene, 1999; Martinez, 2004).

Various rheological, physical and chemical properties of meat define its texture. Specifically ageing of meat is characterised by physical and chemical reactions, which produce changes in its textural and sensory properties (Huidobro et al, 2003). Using specialized equipment (Stable Micro Systems texture analyzers, Instron analyzers, etc.) for instrumental analysis of the texture, measuring, calculating and analyzing the parameters of the texture makes work in a laboratory or industry easy and fast. Gathered data show shear, penetration and compression forces, as well as other parameters that can directly relate to the textural properties of meat. As an objective way of measuring the food properties in a strictly defined and controlled environment, instrumental analysis has many advantages over the classic organoleptic testing of meat.

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Eventual discrepancy in experiments occurs only because of heterogeneity of samples (Bourne, 1977). For the determination of meat tenderness (hardness), Warner-Bratzler or texture profile analysis (TPA) tests are usually used (Bratzler, 1932, Guerrero and Guardia, 1999). Later research indicates that the testing of the raw meat samples using the TPA predict sensory texture of cooked meat in a much better way. (Huidobro et al, 2005).
The aim of this study was to evaluate the effects of storage time with or without refrigeration, on some textural properties of beef, baby beef and pork meat.

Materials and methods

Fresh pork (Landrace breed, six weeks old), beef (Simental breed, 22 months old) and baby beef (Simental breed, 15 months old) meat was obtained immediately after slaughtering, from the local butcher's shop. *M. Longissimus thoracis et lumborum* muscle part was cut in 2.5 cm × 2.5 cm x 1 cm dimensions, parallel to the muscle fibre orientation. From every type of meat, 10 samples were obtained. Five samples from every type of meat were kept in plastic barrier bags at room temperature (22 ± 1 °C) and the remaining samples were refrigerated (4 ± 0.5 °C). Relative humidity of storage was kept at 50±2 % at all times. After preparation of samples, instrumental analysis of meat texture was performed at 0 h, 24 h, 48 h and 72 h after slaughtering, respectfully. Refrigerated samples had to be at the same temperature as non-refrigerated ones during analysis, so the test was performed after the temperature of 22 °C was measured in the core of the samples using a thermometer with needle (Trotec DT-131, Germany). The instrument used in texture analysis was TA.HDPlus (Stable Micro Systems, UK) with attached blade set. The penetration depth of probe was set at 20 mm and penetration speed was 5 mm/s. The acquired data were analyzed using the Texture exponent (Stable Micro Systems, UK) and Statistica 9 (Statsoft, USA) software (Sarriés, 2006).

Results and discussion

The analysis conducted of the obtained results presented in Fig. 1 shows that hardness abruptly drops during the first 24 hours of storage time in both, refrigerated and non-refrigerated samples of meat (Tables 2, 3 and 4).

Table 2. Hardness and adhesivity of beef samples

Storage time [h]	Hardness [N]	Adhesivity [N×mm]
0	831.95 ± 47.51	182.37 ± 15.31
24	486.60 ± 50,63	54.80 ± 4.60
48	452.53 ± 43.90	39.79 ± 3.18
72	410.11 ± 29.96	33.55 ± 1.46
24*	573.88 ± 44.59	67.19 ± 6,42
48*	559.32 ± 37.69	63.48 ± 3.37
72*	531.23 ± 42.12	59.83 ± 3.09

* - refrigerated samples

Table 3. Hardness and adhesivity of baby beef samples

Storage time [h]	Hardness [N]	Adhesivity [N×mm]
0	462.56 ± 51.22	46.18 ± 9.01
24	311.54 ± 71.98	35.90 ± 18.51
48	270.00 ± 41.53	28.45 ± 12.32
72	204.36 ± 35.39	24.11 ± 10.21

Table 4. Hardness and adhesivity of pork samples

Storage time [h]	Hardness [N]	Adhesivity [N×mm]
0	748.43 ± 37.25	76.56 ± 12.06
24	293.29 ± 47,98	14.77 ± 4.51
48	197.26 ± 43.82	11.39 ± 4.22
72	125.65 ± 46.34	7.56 ± 2.19
24*	431.05 ± 13.36	35.61 ± 7.76
48*	366.73 ± 10.90	29,40 ± 8.93
72*	290.87 ± 27.19	18.18 ± 6.42

* - refrigerated samples

After 24 hours the average data for beef samples show a 41.5 % increase in softness than in fresh beef samples. In the next 48 hours, all samples show a small decrease in hardness. Refrigerating of meat slows down the decrease in hardness of both pork and beef samples. As shown in Table 2, after 72 hours of refrigerating, the rigor mortis was prolonged and samples were 44.63 N harder than non-refrigerated samples after only 24 hours, while immediately after slaughtering the pork samples were 10.0 % softer than beef and 34 % harder than baby beef. No significant difference in decreasing trend for hardness was found between samples. This was also the case with adhesivity, as shown in Fig. 2. As ageing time elapsed, there was a slight increase of difference between hardness and adhesivity values in beef and pork samples.

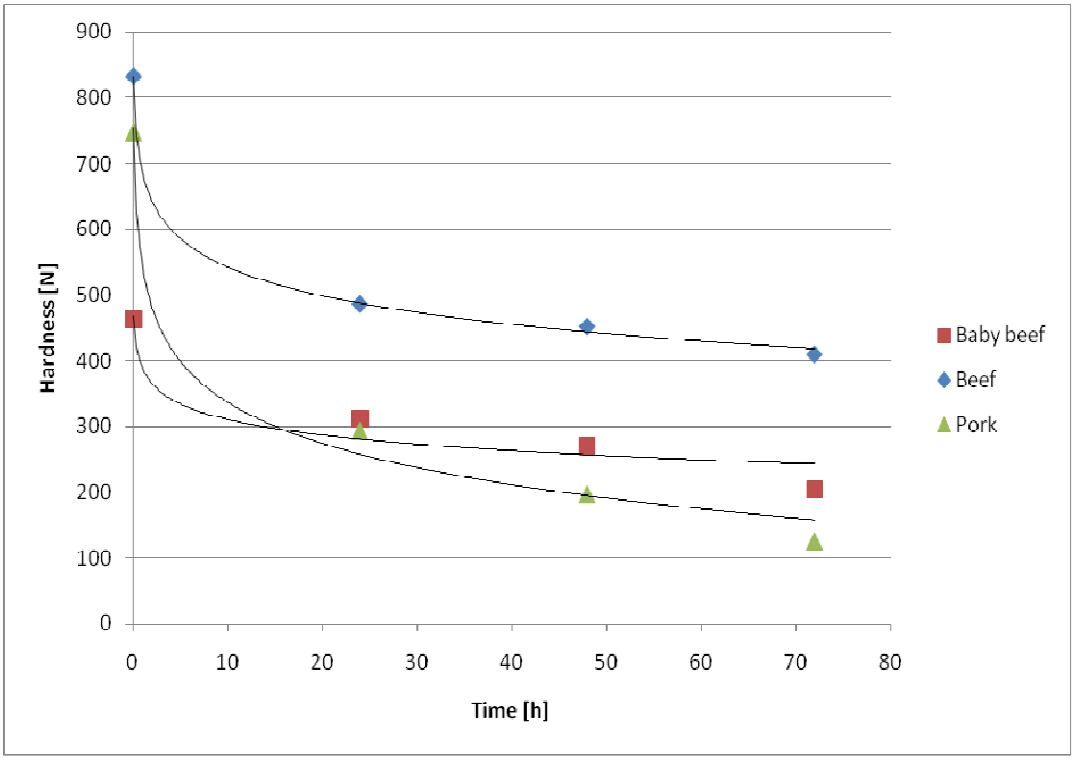

Fig. 1. Influence of storage time on hardness of meat samples

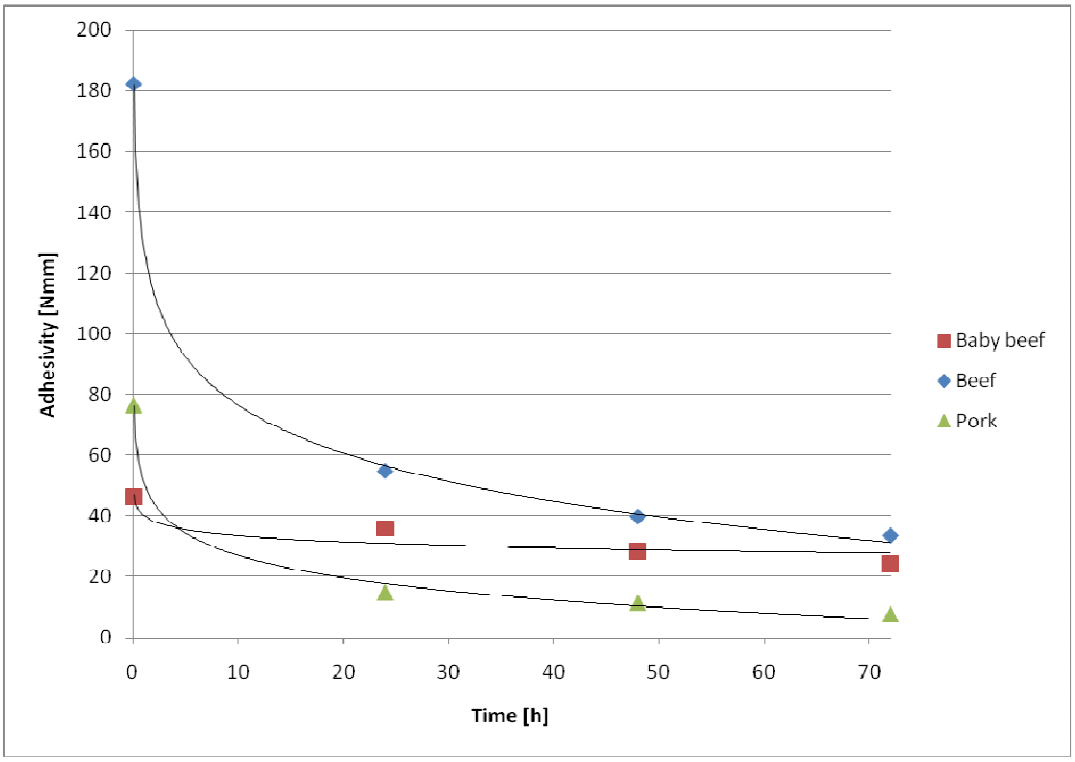

Fig. 2. Influence of storage time on adhesivity of meat samples

Baby beef samples which were, at the beginning, the softest and least adhesive of all samples, have also shown the least amount of loss of adhesivity and hardness, which can be correlated to the myofibrilar component and minimal amount of fat in young animals (Bouton et al, 1975).

Variation in values of texture characteristics for different meats is also influenced by post-mortem proteolysis of myofibrilar proteins (Soltanizadeh et al, 2008). Hardness and adhesivity of raw meat are directly correlated to each other as shown in Fig. 3.

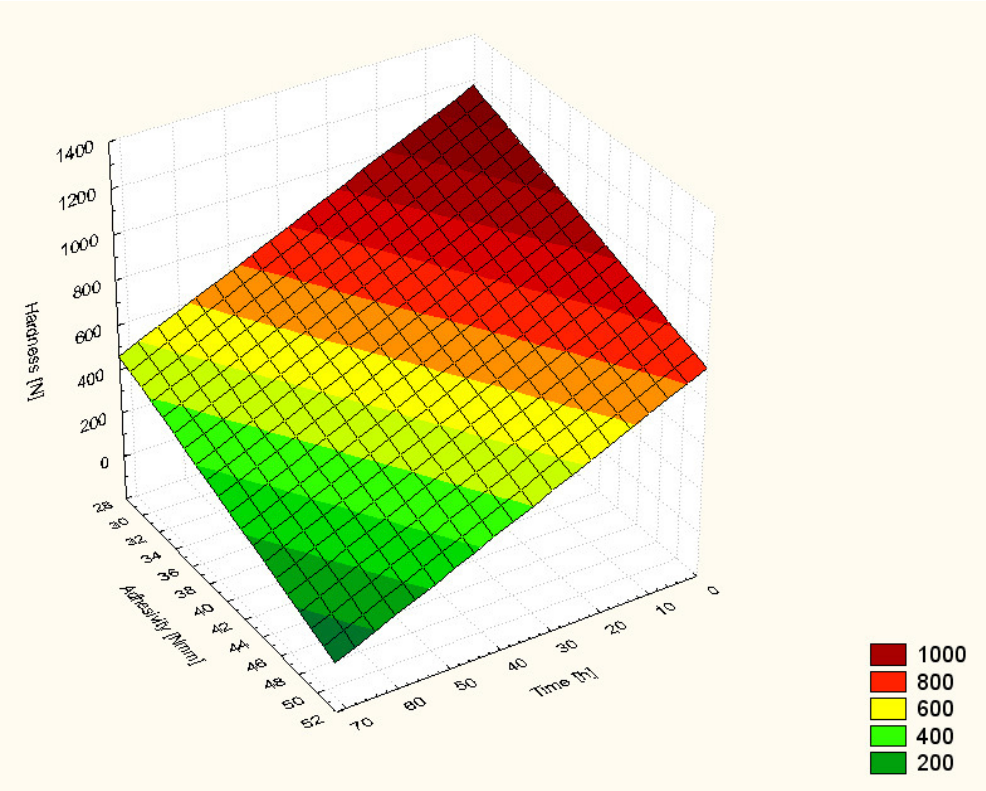

Fig. 3. Dependence of hardness and adhesivity during storage of meat

Significant correlation is also found with textural characteristics of meat after frying or cooking. Increase of hardness leads to linear increase of adhesivity of meat. This in turn have significant influence of chewiness, as it is calculated multiplying hardness, adhesiveness and springiness of meat during texture profile analysis. As hardness is the main factor deciding the commercial value of meat (Chambers and Bowers, 1993), everything below circa 450-500 N can be considered tender enough to fulfil the quality conditions.

Further thermal processing of meat usually does not reach the temperatures needed for collage solubilisation which generally increases its hardness (Kamoun and Culioli, 1988, Huidobro et al, 2005). In the scope of this information, while recommended ageing time for tenderizing of meat is 6 days (Shackelford et al, 1995), all non-refrigerated meat is of good quality after 48 h of ageing time. The refrigeration of all three tested meat types leads to increased values of hardness and adhesivity and prolong the time needed for softening of meat to desirable levels, as shown in Fig. 4.

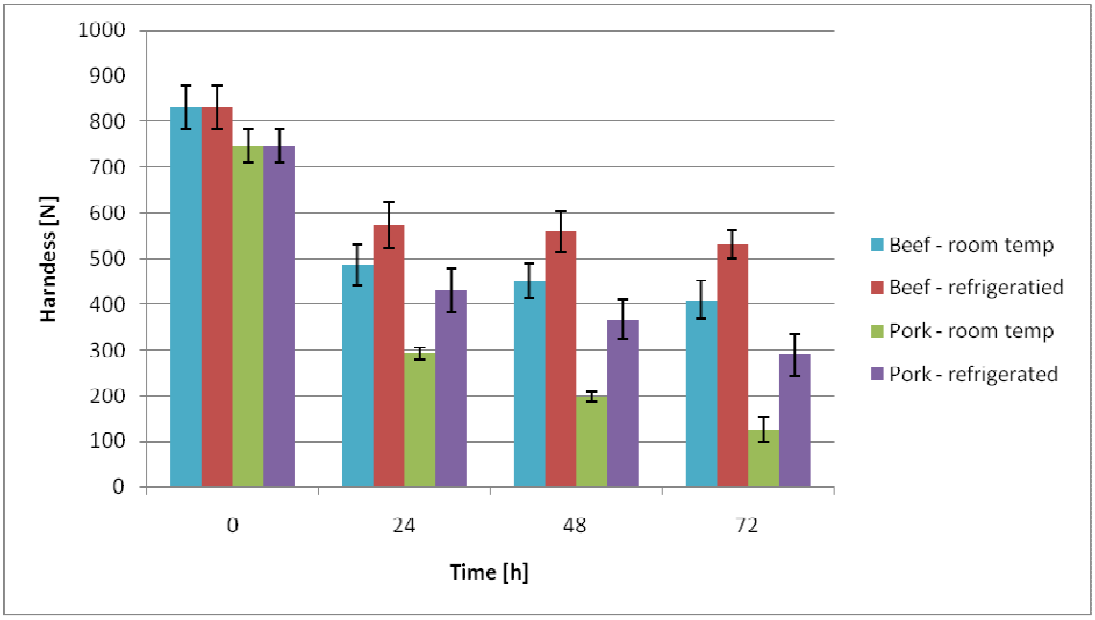

Fig. 4. Comparation of hardness of refrigerated and non-refrigerated samples

Conclusions

As meat textural parameters show progressive softening of meat, hardness of samples decreases during ageing, while the most significant increase of softness occurs during the first 24 hours. Chewiness, as factor calculated on the basis of measured texture properties, consequently had significant losses. Lower chewiness is directly correlated to softer meat and contributes to better consumer perception of final product. This leads to 48 hours of minimum time for the ageing of non-refrigerated meat, while refrigerated meat does not soften enough during 72 hours of the ageing time to satisfy the quality criteria. Adhesivity of samples is directly correlated to hardness of meat, and consequently decreases during storage. However, only beef samples show a large loss of adhesivity during the first 24 hours and the largest decrease in adhesivity after 72 h. On temperatures around 0-4 °C minimum aging time is 72 hours. This is in accordance with relatively new short-time high-temperature method of 12 h ageing at room temperature followed by the ageing at refrigeration temperatures, which speeds the whole process. From textural properties point of view, optimal range for meat aging is 48 hours on room temperature; however this raises the question about bacterial growth, odour absorption and water loss, which are not yet fully investigated for HTST aging.

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