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REGULAR ARTICLE

THE INFLUENCE OF DIFFERENT CONDITIONS ON THE TEXTURAL PROPERTIES OF MEAT DURING GRILLING

Monika Hudečková[1], *Petra Vojtíšková*[1], *Stanislav Kráčmar*[1*]

Address: [1] Department of Food Analysis and Chemistry, Faculty of Technology, Tomas Bata University in Zlín, nám. T. G. Masaryka 275, 762 72 Zlín, Czech Republic.

*Corresponding author: kracmar@ft.utb.cz

ABSTRACT

The effect of grilling for 20 minutes on the hardness, cohesiveness and adhesiveness of poultry (breast muscle), pork (chop) and beef (hind leg) was observed. Hardness of chicken meat increased by the 5th minute of grilling with subsequent stagnation to 15th minute of grilling; after this time there was a sharp rise in hardness. By analyzing the cohesiveness of chicken meat, a decrease to the 10th minute of grilling with subsequent rise was found. For pork and beef, hardness and cohesiveness increased to the 20th minute of grilling. Adhesiveness showed upwards trend throughout the grilling time for all three types of meat.

The highest weight losses in % (w/w) were exhibited, during grilling, beef (36.5); then, poultry (31.4) and the lowest values were for pork (26.5).

Keywords: poultry, pork, beef, hardness, cohesiveness, adhesiveness, weight losses

INTRODUCTION

In sensory analysis of meat and meat products the texture is assessed by kinestetic and tactile sense during cutting and handling during bite and its treatment in the oral cavity. When processing in the mouth, three phases - biting, chewing and swallowing are differentiated. At the same time, up to 20 different properties, which are divided into mechanical, geometric, and surface properties of the body, can be seen. The task of the assessor is to determine the properties qualitatively and evaluate their intensity quantitatively **(ČSN ISO 11036, 1997)**. Surface properties are related to benefits induced by moisture or fat content on the surface of the material. Moisture is the surface textural feature that describes the perception of water absorbed or released from the foodstuff; it means that not only the total amount of perceived moisture, but also the type, extent and manner of release or absorption. The fat content is the surface textural property related to the perception of general interest or fat quality (its melting temperature) in the foodstuff **(Kamdem and Hardy, 1995)**.

Although, it is difficult to precisely define meat tenderness by physical terms, this involves the ability of meat to be cut, compressed, minced, and therefore it depends on the mechanical properties of muscle. Therefore, for the evaluation of meat tenderness just the mechanical tests are used **(Lepetit and Culioli, 1994)**.

According **Pipek (1998)**, mechanical methods of texture evaluation are divided into fundamental, imitating and empirical tests. Fundamental tests measure one or more physical properties for an accurate description of the properties of the food; the results of these tests, however, correlate worse with sensory evaluation. This is understandable, because the food in the mouth breaks down into thousands of small pieces by forces. **Krkošková (1986)** states that it is usually measured shear strength, penetration of the metal tip into the meat, the force required to compress the sample to a defined deformation, electrical power needed to ground meat sample, stress the muscle in tension.

Imitating tests mimic some aspects of the chewing during the sensory evaluation. These are usually compresses simulating the initial phase of mastication. Data can be analyzed to yield the textural profile of the food. Texture profile analysis (TPA) is the best correlating to **(Pipek, 1998)** with the sensory evaluation.

Civile and Szczesniak (1973) states that for a quantitative description of textural characteristics, in addition to evaluating individual properties, the texture profile analysis is used. Profile of the texture is preferred because it provides a complete analysis of all the textural properties.

Jelínková (2003) states that the texture profile analysis (TPA) use universal testing machine to double compression of the specimen to simulate chewing. Results of TPA for meat samples include values of hardness, elasticity, cohesion, adhesion and chewiness. The technique involves compression of the sample in several (usually two) cycles under precisely defined conditions. This test of compression simulates chewing of the food. TPA is also widely used in the analysis of dairy and meat products **(Long *et al.*, 2011; Pachlová *et al.*, 2011, 2012)**.

The aim of this study was to provide information about the impact of grilling poultry, pork and beef for 20 min. on their hardness, cohesiveness and adhesiveness.

MATERIAL AND METHODS

Representative samples of 1 kg of poultry, pork and beef were purchased at retail in the day of the experiment, transported in insulated boxes at 4-6°C. Poultry represented breast muscle, pork - chop, beef - hind leg. The meat samples were first pre-portioned into cubes of size 2x2x2 cm and then to the size of 1x1x1 cm which were analyzed. The meat samples for texture analysis were, before the experiment, tempered to the temperature of 6 ± 1°C. Each experiment (with every type of meat) was initiated by the measurement of raw meat (n = 4; before grilling: 0 min.).

To grilling, an electric grill Philips HD 4419/20 with a constant temperature (temp. value) was used. Grilling was running for 20 minutes with sampling after each 5 min. (totally 5 samples taken at time 0 to 20 minutes). Experiment with every kind of meat was repeated 4 times. Samples were turned upside down after 2.5 min.

Textural properties were determined with texture analyzer TA.XT plus (Stable Micro Systems, UK). The analysis was performed in two consecutive compressions (strain: 50% of the height of the sample) where a sample with dimensions 1x1x1 cm is placed between two plates. Cylindrical probe with a diameter of 50 mm was used for analyzes. Following textural parameters were calculated from the deformation curves: hardness (Fmax; force needed to attain a given deformation - maximum force penetration during the first cycle; N), cohesiveness (strength of the internal bonds of meat – ratio of the positive force area of the second peak to that of the first peak; unitless) and adhesiveness (strength of adhesiveness between the meat and the probe surface – ratio of the value of the negative force area to the positive force area of the first peak; unitless).

Laboratory scales KERN PCP 6000-0 KERN PCP 6000-0 (Kern & Sohn GmbH, Germany) were used for the weight loss determination.

The results were statistically evaluated (ANOVA) SNEDECOR & COCHRAN (1967) and with the help of Microsoft Excel and Unistat ver. 5.5

RESULTS AND DISCUSSION

The results of changes in the textural analysis of poultry, pork and beef during 20 min. of grilling are presented in Table 1.

Strength (Fmax) of chicken meat grows up to 5 min. of grilling with subsequent stagnation within 15 min. of grilling, after this time there is a sharp rise in strength. For pork and beef, the hardness increases up to 20 min. of grilling. Analyzing the consistency of chicken meat, we found its fall to 10 min. of grilling, with subsequent rise. The cohesiveness for pork and beef grew with the length of grilling. Adhesiveness trended upwards throughout the grilling time for all three types of meat.

Table 1 Average statistical values of hardness, cohesiveness, elasticity and adhesiveness for poultry, pork and beef (mean ± SD)

Grilling time [min.]	Texture parameter	meat poultry	pork	beef
0	Hardness	19.60±2.469	11.91±2.001	23.21±3.162
	Cohesiveness	0.47±0.064	0.40±0.167	0.44±0.079
	Adhesiveness	-0.02±0.072	-0.01±0.044	-0.01±0.022
5	Hardness	21.01±5.594	16.04±2.722	25.01±3.328
	Cohesiveness	0.45±0.069	0.44±0.049	0.53±0.070
	Adhesiveness	-0.07±0.090	-0.02±0.001	-0.02±0.004
10	Hardness	18.65±2.150	21.11±2.264	25.75±4.172
	Cohesiveness	0.43±0.087	0.56±0.143	0.64±0.030
	Adhesiveness	-0.55±0.338	-0.03±0.017	-0.03±0.013
15	Hardness	18.90±5.924	22.15±2.311	30.67±2.523
	Cohesiveness	0.54±0.131	0.58±0.042	0.72±0.085
	Adhesiveness	-0.65±0.490	-0.03±0.006	-0.05±0.044
20	Hardness	26.02±5.215	26.26±6.183	34.58±6.217
	Cohesiveness	0.58±0.084	0.63±0.031	0.77±0.047
	Adhesiveness	-0.66±0.871	-0.04±0.033	-0.14±0.222

S. D. – standard deviation

Percentage expression of weight losses in poultry, pork and beef during 20 min. of grilling is presented in Table 2. The highest weight losses during grilling of beef hind leg showed 36.5%, then chicken breast muscle 31.4% and the lowest values for pork chop 26.5%. Induced losses in poultry and beef are consistent with values reported by **Paulus and Cidlinský (1987)**. For pork, lower weight losses than by **Paulus and Cidlinský (1987)** were found. The analysis showed that the greatest weight losses occur in the first five minutes of grilling. The main cause of weight losses can be considered water evaporation.

Table 2 Weight losses (% w / w) of poultry, pork and beef during 20 min. of grilling

Grilling time [min.]	meat poultry	pork	beef
0	0	0	0
5	19.4	10.1	26.9
10	22.0	16.1	33.6
15	28.3	24.9	34.7
20	31.4	26.5	36.5

CONCLUSION

Based on the analysis we came to the following conclusions. Hardness (F_{max}) of chicken meat grows up to 5 min. of grilling with subsequent stagnation within 15 min. of grilling, after this time there is a sharp rise in hardness. For pork and beef, the hardness increases up to 20 min. of grilling. Analyzing the cohesiveness of chicken meat, we found its fall to 10 min. of grilling, with subsequent rise. For pork and beef, cohesiveness grew with the length of grilling. Adhesiveness trended upwards throughout the grilling time for all three types of meat. The highest weight losses in % were exhibited during grilling of beef (36.5), then chicken (31.4) and the lowest values were obtained for pork (26.5). The analysis showed that the greatest weight losses occur in the first five minutes of grilling. The main causes of weight losses can be considered water evaporation during changes in protein structures.

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REFERENCES

CIVILE, G. – SZCZESNIAK, A. S. 1973. Guidelines to training a texture profile panel. In *Journal of texture studies*, 1973, no. 4. p. 204-223.

ČSN ISO 11036 *Senzorická analýza – Metodologie – Profil textury.* Český normalizační institut, 1997.

JELÍNKOVÁ, J. *Textura masa a masných výrobků.* [Disertační práce]. Praha: VŠCHT, 2003, 141 p.

KAMDEM, A. T. K., – HARDY, J. 1995. Grinding as a Method of Meat texture Evulation. In *Meat Science*, 1995, no. 39. p. 225-236.

KRKOŠKOVÁ, B. 1986. *Textúra potravin.* 1.vyd. Bratislava: Alfa a SNTL, 1986, 200 p. ISBN 63-003-86.

LEPETIT, L., – CULIOLI, J. 1994. Mechanical properties of meat. In *Meat Science*, 1994, no. 36, p. 203-237. ISSN 0309-1740.

LONG, N.H.B.S. – GÁL, R. – BUŇKA, F. 2011. Usage of phosphates in meat products. In *African Journal of Biotechnology*, vol. 10, 2011, no. 86, p. 19874-19882.

PACHLOVÁ, V. – BUŇKA, F. – BUŇKOVÁ, L. – WEISEROVÁ, E. – BUDINSKÝ, P. ŽALUDEK, M. – KRÁČMAR, S. 2011. The effect of three different ripening/storage conditions on distribution of selected parameters in individual parts of Dutch-type cheese. In *International Journal of Food Science and Technology*, vol. 46, 2011, no. 1, p. 101 – 108.

PACHLOVÁ, V. – BUŇKA, F. – FLASAROVÁ, R. – VÁLKOVÁ, P. – BUŇKOVÁ, L. 2012. The effect of elevated temperature on ripening of Dutch type cheese. In *Food Chemistry*, vol. 132, 2012, no. 4, p. 1846 – 1854.

PAULUS, J. – CIDLINSKÝ, L. 1989. Ztráty při kuchyňské úpravě pokrmů. 2.vyd. Praha: Merkur, 1989, 160 p.

PIPEK, P. 1998. *Technologie masa II.* 2.vyd. Kostelní Vydří: Karmelitánské nakladatelství, 360 p. ISBN 80-7192-283-8.

SNEDECOR, G.W. – COCHRAN, W.G. 1967. *Statistical Methods*. Iowa: 6th ed. Iowa State University Press, 1967, 534 p.

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