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DIFFERENTIATION OF PRODUCTS MADE FROM NORMAL (RFN) AND WATERY (PSE) MEAT USING PROFILE TEXTURE ANALYSIS

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Background

It is well known that meat with quality defects is characterised by inferior technological and sensory properties. Water binding capacity and consistency or tenderness are particularly important in this respect (3, 6, 8). The above traits are, at least partially, mutually interdependent, since, as a rule, higher weight losses result in increased density of meat structure which, in turn, exerts various impacts on such meat texture traits as toughness, springiness and gumminess. Observations made so far indicate that results of different experiments regarding the evaluation of meat texture of varying quality as well as products manufactured from it are far from being unequivocal (5, 10, 12). This can, at least partly, be attributed to diverse processes applied during the processing of meat (4, 5) but it can also be the result of improper choice of measurement conditions.

Objectives

The objective of this research project was to compare texture measurements of two meat products (raw, smoked loin and cooked loin) manufactured from normal (reddish pink, firm, non-exudative - RFN) and watery (pale pinkish grey, soft, exudative - PSE) meat and to select the measurement method which would best differentiate these products with regard to their quality.

Material and methods

The material used for experiments was *m. longissimus dorsi* sampled from 10 pig carcasses after chilling. They were divided on two equal groups. Muscles collected in the first group were watery (PSE), while in the remaining case - normal quality (RFN). The muscles were allocated to one of the two above mentioned groups on the basis of the measurement of pH_1 (45 minutes after slaughter) and pH_2 values (24 hours after slaughter). Meat was considered as RFN when its pH_1 value was over 5,8 and its pH_2 - less than 6,0. PSE meat was characterised by the pH_1 value equal to or lower than 5,8 and its pH_2 was similar to the range of the RFN meat. The concentration of hydrogen ions was determined using portable pH-meter type Handylab 2 with a combined glass-calomel electrode type Schott L6880 by placing it in the muscle after cutting it with a knife. The removed muscles were cured by immersing them in brine which contained sodium chloride (6%), sodium nitrite (0,055%), sugar (1%), sodium ascorbate (0,04%) and water (92,91%). The curing time was 48 hours. This was followed by smoking (~30°C) for 15 hours. Cooked loins were heated in water until the temperature inside the muscle reached 70°. Meat products were subjected to double penetration tests on the Instron 1140 apparatus (2). The conditions of the performed measurements were as follows: range of force measurement – up to 500 N, crosshead working range – 140 mm, speed of its movement – 100 mm/min. The penetration process varied beginning with the value constituting 60% of the sample height before penetration and later increasing it to 70 and 80%. The sample was 20 mm high and its diameter – 25 mm. The diameter of flat ended rod was 11mm. From among several possible traits that can be determined using the profile texture analysis, only the following were estimated: maximum force of the first (F1) and second (F2) penetration, cohesiveness and elasticity (2). Cohesiveness expresses the ratio of work performed during the second penetration to work performed in the first one. Elasticity represents the measure of sample height after the first compression. The force of the first penetration is also named as hardness. The obtained results were subjected to single factor analysis of variance (11).

Results and discussion

Measurements of pH value show that differences between the examined PSE and RFN muscles were statistically significant with regard to pH_1 value which was 5.57 for the first group and 6.57 – for the second one. There was very little variation between muscles regarding their pH values (0,03 ÷ 0,05) after chilling.

Profile texture analysis revealed that values of the first and second penetrations often differed significantly depending on the applied raw material and the method of measurement. Data presented in the table show that from among three variability factors which could have influenced values of analysed parameters the most important were the kind of product, degree of penetration followed by meat quality. The mean value of the first penetration of cooked loin ranged from 69,97 to 93,50N. In the case of raw, smoked loin these values ranged from 20,70 to 45,20N. Therefore, it can be observed that the structure of the product, which is affected - apart from the properties of the raw material itself – by the applied technological process underwent significant alterations. The denaturation process caused its stiffening and this, in turn, resulted in higher values of the penetration force in comparison to samples which were not heated during the production process. The values concerned were almost twice higher that those observed in the case of smoked raw loin. Similarly high differences were observed when forces of both the first and second penetration applied to meat of varying quality were compared. However, in this case it was observed that changes in the value of the penetration force also depended on the applied degree of penetration. In the case of the cooked loin the difference in the extreme values for the first penetrations up to 60 and 80% of sample height was approximately 25%, while in the case of the raw loin – above 54%. Moreover, it turned out that the change in the degree of sample penetration allowed to better distinguishing between the quality of individual samples. So, in the case of raw loin differences at the penetration up to 70 and 80% of the sample height were slight but they increased considerably when samples were penetrated only up to 60% (table). A slightly different correlation was found when the cooked loin was assessed. Here the biggest differences between samples were observed at the penetration to 70%. Heating, by causing stiffening of the structure, reduced differences at the lowest degrees of penetration. One more phenomenon was observed in the course of the above described measurements. It was found that at the penetration up to

80% of both smoked and cooked loin, watery meat showed more resistance to the plunger. Almost similar development was observed in the case of measurements of cooked loin for the remaining degrees of penetration. However, in the case of smoked raw loin, beginning with the 70% degree of penetration the obtained relationships were reversed.

The explanation of the above described phenomena as well as of differences in the values of forces between penetration tests in the range up to 60% and 80% for individual groups of products is difficult on the basis of the performed measurements. However, it is probable that the phenomena and differences referred to above are associated, on the one hand, with changes in meat proteins and, on the other, with reactions in the water-protein system. Studies of Boles et al. (1) showed a slower degradation of cytoskeletal proteins in PSE meat in comparison with normal meat. This may explain higher values of the penetration force for the first of these meats. Smaller weight losses usually observed in the course of RFN meat processing might result in a more extensive swelling of the product structure. This may have resulted in smaller values of the penetration force observed in the PSE meat at the penetration up to 60% of sample height. When the depth of sample penetration was increased, differences in the structure of meat became apparent. Since this structure depends, to a considerable extent, on proteins, this might lead to increased values of penetration forces for the PSE meat in contrast to RFN. Smaller variability in the values of penetration forces, in the range of measurements from 60 to 80%, for the RFN meat indicates that the structure of products manufactured from it should be more uniform in comparison with the PSE meat. This appears to be corroborated by the shape of the hypothetical curve representing values of the first and second penetration forces in relation to the penetration depth. In the case of cooked loin samples, in general, a gradual decrease in values of penetration forces were observed beginning with the value of the first penetration at 80% through measurements down to 70 and 60% and finishing with the measurement of the force of the second measurement at 60%. A similar dependence was observed in the case of measurements of the raw, smoked loin that were manufactured from normal meat. However, when the samples were manufactured from PSE meat, the force of the second penetration at 80% was similar to the mean value determined at the first penetration up to 70%. Later, it decreased but the values of the penetration force were lower than in the case of the RFN meat. This differentiation in the penetration force depending on the meat quality explains partly different results from various studies (3, 4, 7, 9) especially, when sensory analyse was involved. Fox et al. (3) and Searcy at al. (10) found that PSE meat was more tender than RFN meat. Results of Kemp et al. (7) and Pospiech (9) were opposite.

Additional information concerning profile texture analysis was obtained from comparisons of cohesiveness and elasticity of the examined products. They revealed, especially referring to elasticity, that the lower the degree of penetration was applied in the course of the test, the higher quality variability for both products were obtained. The most probable explanation of this phenomenon is the fact that the dominant factor influencing cohesiveness and elasticity values is the degree of destruction that occurs during the first penetration and the response of the tissue to the plunger in the course of the second penetration. If the destruction during the first penetration is smaller, which is the case in the course of the measurement to 60% of the depth of sample, then more work is required during the second penetration. This, in turn, increases the value of elasticity. No differences in the cohesiveness were observed between the samples of PSE and RFN.

Conclusions

1. The highest texture differentiation of products manufactured from PSE and RFN meat during measurements of the penetration force for raw loins is observed in the course of measurement to 60% of the sample height, while for cooked meat – up to 70%.
2. When classifying loins according to their quality (PSE and RFN) and taking into account their cohesiveness, the best results are obtained applying penetration to 60% of sample height.

Table: Profile texture analysis of cooked and raw, smoked loin manufactured from meat of varying quality

Investigated parameter	Type of meat	Loin					
		raw, smoked			cooked		
		degree of penetration (%)					
		80	70	60	80	70	60
F1 (N) – hardness	PSE	45,20	34,90	20,70[a*]	93,50	87,22	69,97
	RFN	43,15	35,67	32,54[b]	92,18	80,99	70,92
difference		**2,05**	**-0,77**	**-11,84**	**1,32**	**6,23**	**-0,95**
F2 (N)	PSE	33,38	26,49	16,24[a]	69,05	72,09	59,62
	RFN	32,43	27,97	25,64[b]	62,87	61,72	59,60
Difference		**0,95**	**-1,48**	**-9,40**	**6,18**	**10,37**	**0,02**
Cohesiveness	PSE	0,332[A]	0,357	0,412	0,321	0,432	0,484
	RFN	0,246[B]	0,318	0,361	0,276	0,376	0,434
Difference		**0,086**	**0,039**	**0,051**	**0,045**	**0,056**	**0,050**
Elasticity (mm)	PSE	3,58	3,12	2,64[a]	6,94	6,46	6,22[a]
	RFN	3,48	3,84	3,44[b]	7,32	6,54	5,56[b]
Difference		**0,10**	**-0,72**	**-0,80**	**-0,38**	**-0,08**	**0,66**

*means with various letters are statistical differentiated at α=0,05 (small letters) or at α=0,01 (capital letters)

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