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The Influence of Frozen Storage on Selected Physicochemical Properties of Pork

Paulina Duma*, Elżbieta Głodek, Magdalena Marchel, Mariusz Rudy

Abstract— The aim of this study was to assess the effect of freezing storage on the chemical and physicochemical properties of the longissimus dorsi muscle of pig. The assessment of meat quality involved the measurement of the pH, chemical content, water holding capacity, and cooking loss of the meat. The texture parameters measured included: hardness, adhesiveness, deformation, resilience, cohesiveness and chewiness. Findings of the study indicate that frozen storage at -20°C for 90 days did not have a significant influence on the chemical composition and pH of the meat. It was observed that frozen storage and subsequent defrosting resulted in higher rate of water loss and lower water holding capacity than was observed in the fresh unfrozen meat. There were no significant differences between the frozen and fresh meat in respect of the texture parameters studied.

Index Terms— pork meat, frozen storage, meat quality

1 INTRODUCTION

THE production of quality pigs and pork meat products depends on many factors. These factors are also significantly important in the production of other livestock and meat products. Nowadays the consumer expects products, which are not only of very high quality, but which are also safe and of high nutritional value [1], [2].

Pork is of high nutritional value, providing 20 to 30% protein in the human diet depending on the processing method. The high content of iron in pork is essential in the synthesis of haemoglobin, just as its high contents of zinc, selenium and copper constitute essential components of many enzymes. Pork is also a rich source of some of the B complex vitamins and antioxidants [3], [4], [5], [6], [7].

Freezing Technology and frozen storage provide the most common method for the preservation of meat in excess of immediate need or for future use. Freezing and frozen storage affect the quality of meat. Though frozen meat or meat product is microbiologically stable, it is still sensitive to biochemical and physicochemical reactions, which may affect its organoleptic properties. High water activity in meat, given its natural contents of protein, fat, carbohydrates, vitamins and minerals, in the presence of air and near neutral pH, provides an ideal environment for the growth of microorganisms, which results in meat spoilage. The nature and extent of spoilage depends on the quality of the fresh meat or meat product and the preservation technology in use [8], [9], [10].

PhD Paulina Duma, Corresponding Author, Department of Food Processing and Science of Commodities, University of Rzeszow, Poland, e-mail: pduma@ur.edu.pl*
PhD Elżbieta Głodek, PhD Magdalena Marchel, Assoc. Prof. Mariusz Rudy, Department of Food Processing and Science of Commodities, University of Rzeszow, Poland

Therefore, the aim of this study was to assess the effect of freezing storage on the chemical and physicochemical properties of the longissimus dorsi muscle of pig.

2 MATERIALS AND METHODS

Twenty pieces of the longissimus dorsi muscle were randomly bought from trade facilities in the Podkarpacie Province of Poland. Each of the 20 pieces of the longissimus muscle was divided into two pieces and allotted to two groups of muscle pieces such that there was one piece for each group. The two groups of muscle pieces were marked for "fresh raw meat" and "frozen meat" studies. The meat intended for studies on the effect of freezing was stored at -20^{0}C for 90 days. The defrosting of the frozen meat was done under natural environmental conditions.

Studies were done in the Laboratory of Department of Processing and Agricultural Commodities University of Rzeszow in Poland. The assessment of meat quality involved the measurement of the pH, chemical content, water holding capacity, and cooking loss of the meat.

Active acidity (pH) of muscle was measured by pH meter CPC-411, with application electrode OSH 12 – 01 with accuracy to 0,01.

The meat samples were ground in a meat grinder to 4.00 mm diameter sizes. The chemical content was analysed using the using the NIR-Food Check analyser.

Drip loss was determined according to the Grau and Hamm method [11] as modified by Pohj and Ninivaary [12].

Cooking loss was determined using the Walczak's method [13].

The profile analysis of TPA texture was done using texturometer Texture Analyser – CT3 – 25

Brookfield Company, equipped with attachment in shape of roller about 38.1 mm diameter. The determination of texture parameters was carried out using pieces of the longissimus dorsi muscle which had been cut up into cubes of 3cm sizes. Each meat sample was compressed twice under the roller, which was moving at a speed of 2mm/sec. The following parameters of the texture of the lonissimus dorsi muscle were determned: hardness, adhesiveness, resilience, elasticity, cohesion and chewiness.

The results of the study were subjected to the analysis of variance, using the STATISTICA 10 Software (StatSoft Inc.) in which the significance of differences between means was determined at $P \leq 0.05$ using the Fisher's NIR test.

3 Results and Discussion

The findings of this study are presented in tables 1, 2, and 3.

Results indicated that the freezing storage time did not have a significant influence on the content of primary chemical compound's. The water contents of both the fresh (72.41%) and frozen (71.51%) meat were not significantly different, which results are similar to those obtained in other studies [14], [15]. The protein contents of both the fresh (20.50%) and frozen (19.73%) meat were not significantly different, which results are similar to those obtained in other studies [14], [16]. It was indicated that fresh muscles contained slightly less fat and collagen (6.08%; 1.44%) than frozen ones (7.18%; 1.56%). It has been reported that collagen has a significant effect on the fragility of pork meat [17].

In the conducted research, among many indicators determining technological properties of fresh meat and meat after defrosting, were studied: acidity, drip loss and cooking loss.

TABLE 1
EFFECT OF FREEZING ON THE CHEMICAL COMPOSITION OF PORK MEAT

Specification	Statistical measure	Fresh meat	Meat after frozen storage
Water (%)	$\bar{x}$	72.41	71.51
	SD	2.57	2.42
Protein (%)	$\bar{x}$	20.05	19.73
	SD	0.62	0.66
Fat (%)	$\bar{x}$	6.08	7.18
	SD	2.99	2.94
Collagen (%)	$\bar{x}$	1.44	1.56
	SD	0.25	0.25

TABLE 2
EFFECT OF FREEZING ON SELECTED PHYSICOCHEMICAL PROPERTIES OF PORK MEAT

Specification	Statis-tical meas-ure	Fresh meat	Meat after frozen storage
pH	$\bar{x}$	5.69	5.68
	SD	0.24	0.17
Drip loss (%)	$\bar{x}$	15.72	14.70
	SD	5.67	5.73
Cooking loss (%)	$\bar{x}$	20.70	19.43
	SD	2.87	4.36

Acidity is one of the most objective informative features of meat quality. The maturing process is connected with decomposition of

glycogen in muscle tissue. Its suitable level in muscles before slaughter determines keeping appropriate meat pH after slaughter. Correctly acid meat presents pH values between 5.5 – 5.8 [18], [19]. The results (Table 2) indicate that there were no significant differences in the pH values between the fresh (5.69) and frozen (5.68) meat types. Similar pH values have been reported for pork meat by other studies [15], [20]. Some studies have indicated that pH 5.6 to 5.8 is best for meat, which is intended for processing and consumption, and that lower pH values result in meat of lighter color [21], [22].

Important indicator of technological value and usefulness of pork meat is water absorption, characterized by ability of water keeping through protein structure of meat tissue [23]. Feature connected with pH and water absorption is cooking loss. Marking the amount of cooking loss is very important, because it informs about loses of muscle juice, which can come into existence as a result of meat thermal processing [24].

The results indicate that differences between the fresh and frozen meat types in respect of drip and cooking losses were not statistically significant.

Also texture parameters were used to assess meat quality. That term is difficult to define explicitly, because it has multiple meanings. Very often the notion of texture is understood as set of properties, which results from natural structure of storage elements of food, their mutual organization and the way how they are taken by human senses. Meat belongs to the food group, for which texture near taste is a dominant quality feature [25], and it states very important sensory feature of meat.

The results (Table 3) indicate that there were significant differences (P≤0.05) between the fresh (5.62±1.15) and frozen meat (4.29±1.44) types in respect of springiness, while differences between the fresh and frozen meat types in respect of hardness, adhesiveness resilience, chewiness and cohesiveness were not statistically significant.

TABLE 3
EFFECT OF FREEZING ON THE TEXTURE PARAMETERS OF PORK MEAT

Specification	Statistical measure	Fresh meat	Meat after frozen storage
Hardness I (N)	$\bar{x}$	212.77	209.90
	SD	36.04	55.66
Hardness II (N)	$\bar{x}$	144.95	140.55
	SD	27.89	39.76
Adhesiveness (mJ)	$\bar{x}$	1.55	1.21
	SD	1.26	0.76
Resilience	$\bar{x}$	0.08	0.09
	SD	0.02	0.04
Springiness (mm)	$\bar{x}$	5.62	4.29*
	SD	1.15	1.44
Chewiness (mJ)	$\bar{x}$	205.40	171.27
	SD	88.63	109.02
Cohesion	$\bar{x}$	0.16	0.18
	SD	0.04	0.08

** significant difference $p \leq 0.05$*

Hardness proves about meat fragility and its resistance on acting strengths of pressure. While analyzing obtained values covering hardness it must be stated, that fresh pork meat 212.77 N was characterized by significantly higher hardness, whereas the frozen one (209.90 N) was characterized by lower hardness. Both in the first cycle of compression and in the second one the hardness of studied fresh meat was higher than in case of frozen meat. While analyzing next values presented in the table 3 it must be stated, that fresh meat was characterized by bigger adhesiveness, springiness and chewiness in comparison with meat after

freezing storage. Adhesion is the strength acting on the sample surface with other surfaces, which comes into the contact [26]. Average value of adhesiveness for fresh meat was 1.55mJ ±1.26, and in the frozen meat was 1.21mJ ±0.76. Another indicator creating texture profile is springiness, that is elasticity presented in mm – it is the speed of return of studied sample from deformed state to the starting one. Based on values presented in the table 3 it was stated, that the average value of springiness for fresh meat was 5.62±1.15, whereas for the frozen meat it was 4.29±1.44. It has been reported that intramuscular greasing significantly increases meat fragility, and that intramuscular fat has an influence on springiness of meat [27]. Chewiness, presented as product of gumminess and springiness, is necessary work to destroy internal connections of studied sample. It was not stated statistically significant differences concerning chewiness in studied samples of both groups, and average values of that measurement were 205.40 mJ – for fresh muscles, 171.27 mJ – for muscles after freezing storage. Values concerning resilience in both groups were shaping on similar level and also it was not stated statistically significant differences for that feature.

4 CONCLUSION

The findings of this study indicated that freezing for 90 days at -20^{0}C did not significantly affect the chemical content and pH value of meat from the longissimus dorsi muscle pig. Except for springiness, which was significantly affected, other texture parameters, such as adhesiveness, resilience, chewiness and cohesiveness of the meat were not significantly affected, by freezing for 90 days at -20^{0}C. Therefore, it was concluded that frozen storage for 90 days at -20^{0}C would not significantly affect the chemical and textural qualities of meat from the longissimus dorsi muscle of pig.

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