EFFECT OF GLYCOGEN AND GLUCOSE ON GRILLED PORK SENSORY QUALITY

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Abstract – Results of previous studies indicate that residual glycogen has a significant influence on meat quality, especially on sensory properties. The study aimed to determine the effect of residual glycogen and glucose on sensory quality of grilled pork. The technological quality and chemical composition of meat from 54 pigs (P76 – PenArLan hybrid pigs) was analyzed. The pH value, drip loss, specified colour parameters of muscle tissue, glycolytic potential, protein, intramuscular fat and water content was measured. Then the 30 samples of meat with different levels of glycogen were grilled in 180ºC and 200ºC and the sensory quality of pork was evaluated with scaling method, ranking test and QDA method. Meat was divided into two groups with different levels of glycogen in the *Longissimus* muscle tissue. The first group consisted 15 samples characterized by low glycogen content and the second group (15 samples) had a high glycogen level. Analysis of the mean values for the evaluates traits in both groups showed statistically significant association between residual glycogen and attributes of the sensory quality of grilled pork, especially browning level. Results of this study confirmed that higher residual glycogen level significantly affect sensory quality of grilled pork, especially the browning level.

Key Words – Glycogen, Grilled meat, Sensory attributes

I. INTRODUCTION

Biochemical changes occurring in pork *post mortem* significantly affect the sensory and technological quality of meat [1, 2, 3]. Not all glycogen in meat is hydrolyzed in *post mortem* changes. This glycogen called residual glycogen has been found in meat what is reported by Fernandez et al. [4], Immonen et al. [5] and Przybylski et al. [6] studies. Residual glycogen has a significant influence on meat quality, especially on physical and sensory properties. According to Przybylski et al. [6] high residual glycogen has a negative influence on sensory pork attributes (mainly flavour, tenderness and juiciness).

II. MATERIALS AND METHODS

This study was performed on 54 pork obtained from fatteners PenArLan hybrid French Company. All animals came from the same farm and were kept under identical environmental conditions. All animals were transported to the meat plants with the same transport conditions. The animals were slaughtered in a commercial slaughterhouse by automatic electrical stunning and bleeding in a horizontal position. After slaughter, the backfat thickness and Longissimus muscle thickness (at the height of the last rib) were measured using a CGM apparatus (Sydel, France), and the percentage of lean meat content was estimated according to the equation by Borzuta [7].

Samples of *Longissimus dorsi muscle* were collected at 24 hours after slaughter. The pH value was measured at 1h (directly in the carcass) and 24 as well as 48 h after slaughter. The meat colour was measured at 48 h using a chromameter Minolta CR310 (CIE L*a*b* system). The drip loss was determined according to Prange et al. method [8]. Intramuscular fat, protein and water content were determined according to Polish Standard. The glycolytic potential in *Longissimus dorsi* was determined in meat 48 h *post mortem*. Quantity 1g of muscle tissue was homogenized in 10 ml of 0.5 M perchloric acid. Glycogen, glucose and glucose-6-phosphate were determined on the homogenate according to Darlymple and Hamm [9]. Lactate was determined according to Bergmeyer [10]. Glycolytic potential (GP) was estimated according to Monin and Sellier formula [11]: GP = 2 x ([glycogen] + [glucose]

+ [glucose-6-P]) + [lactate]. Residual glycogen was expressed as sum of glycogen, glucose and glucose-6-phosphate. On the basis of residual glycogen carcass were divided into 2 groups (15 with a high and 15 with a low level of glycogen). Meat was grilled in 180ºC and 200ºC (up to temperature of 72 ºC in core sample).

The colour of the chops (browning level) were assessed by scaling method and ranking test and the eating sensory quality was estimated by QDA (Quantitative Descriptive Method) Method [12, 13]. Sensory eating quality was based on odour attributes (grilled, acid, fatty and burnt), colour attributes (tone of colour and its homogeneity), texture attributes (tenderness and juiciness), flavour attributes (grilled, acid, fatty, burnt), salty taste and overall quality of grilled pork. The conventional unit scales (0-10 convenience units [c.u.]) were used. The results were elaborated using Statistica 10 ver. [14]. Both group of meat samples were compared by t-Student test.

III. RESULTS AND DISCUSSION

The study meat samples were divided into two groups with different levels of glycogen in the *Longissimus* muscle. The first group were characterized with low level of glycogen mean values 3 µmol/g, the second group has high glycogen level with an average of 10 µmol/g (Table 1). According to results Meadus and MacInnis [15] these values of glycolytic potential indicate that the pigs were free from the RN^- gene. Also the level of glucose is the same as rn^+ pigs. Similar values are reported by Meinert et al. [16]. The level of glycolytic potential was about 97 µmol/g and 118 µmol/g in two different groups respectively. Meinert et al. [17] observed a large individual variation in glycogen concentration in SM *(Semimembranosu*s) muscles in pigs. Results presented in Table 1 shown that raw meat from pigs with higher level of residual glycogen characterized by significantly lower values of pH_{24} and pH_{48} and higher content of protein and water. It is worth emphazized that the investigated pigs had a rather high slaughter mass and a relatively high content of intramuscular fat (IMF). Regarding the sensory quality a significant differences in chosen attributes (in 180ºC) (Fig. 1) was obtained. Probably higher temperature, as was shown by Wood et al. [18], decreased the sensory quality and removed differences in case of chosen properties. Meat with higher level of residual glycogen characterized higher intensity of burnt odour, lower juiciness and higher intensity of burnt flavour.

Table 1 Characteristics of slaughter and meat quality of pigs with different muscle glycogen level

Specifications	Level of glycogen	
	Low	High
Number of animals	27	27
Hot carcass weight (kg)	98.45 ± 8.71	98.22 ± 11.79
Meat content (%)	55.18 ± 4.18	57.03 ± 4.01
Thickness of *Longissimus* (mm)	62.44 ± 6.86	63.08 ± 6.42
Thickness of backfat (mm)	19.00 ± 5.46	16.19 ± 5.09
pH_1	6.30 ± 0.31	6.36 ±0.25
pH_{24}	5.72A ±0.14	5.57B ±0.20
pH_{48}	5.59A ±0.10	5.43B ±0.08
Colour at 48 h L*	54.31 ± 4.33	55.16 ±1.49
a*	16.79 ± 1.30	16.57 ± 0.93
b*	6.03 ± 1.60	6.09 ± 0.94
Drip loss 48 h (%)	4.07 ± 1.86	4.62 ± 1.71
Protein (%)	22.44a±1.20	23.33b ±1.43
Intramuscular fat content (%)	5.15 ± 2.86	4.06 ± 2.07
Water content (%)	70.24a±2.01	71.60b±1.32
Glycogen (µmol/g)	2.89A ±1.59	9.63B ±3.18
Lactic acid (µmol/g)	90.74a±11.61	98.72b±13.16
Glycolytic potential (µmol/g)	96.52A±13.40	117.97B±16.59
Glucose (µmol/g)	5.24A ±1.33	6.65B ±1.84

The tables shows arithmetic means ± standard deviation.
A,B – means P≤0.01; a,b – means P≤0.05.

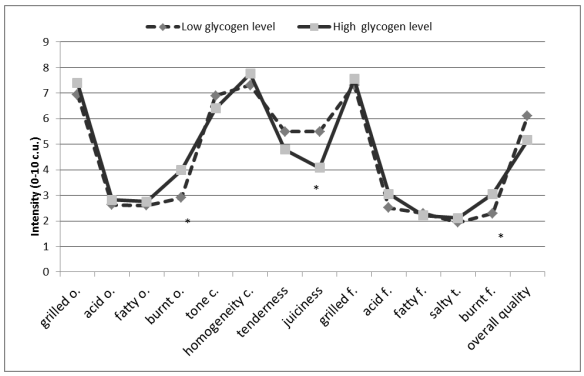

Figure 1. Effect of residual glycogen on sensory quality of grilled pork at 180ºC, QDA method: o.-odour, c.-colour, f.-flavour, t.-taste; *P≤0.05.

Similar observation was noticed in study of Le Roy et al. [19], however in study of Josell et al. [20] the opposed relationship was obtained. Moreover Toldrá and Flores [21] did not find any effect of ultimate pH, on the tenderness or juiciness of meat. Certain effect on the sensory quality (in the analyzed studies) can be refer to relatively high levels of intramuscular fat. Hocquette et al. [22] stated that IMF directly affect juiciness and flavour, but tenderness was influenced indirectly. Meinert et al. [23] shown that pork, which contained a naturally higher level of glucose, had a more intense fried flavour compared to pork with a naturally lower content. Flavour is mainly generated during the heating process and the Maillard reactions involving reducing carbohydrates and amino acids, are one of the most important routes to flavour formations [17]. In results presented in Table 1 the meat with high level of glycolytic potential and residual glycogen have also higher level of glucose. As Meinert et al. [17] mentioned, higher level of glucose would incearse the formation of Maillard reaction products and thus the flavour. Meinert et al. [23] found a clear correlations between glucose and glucose 6-phosphate concentration and the intensity of fried attributes. Meinert et al. [16] concluded that glucose and glucose 6-phosphate appeared to be important flavour precursors in pork. The study of Żelechowska et al. [24] indicate that meat with higher glycogen level and lower pH showed higher rates of proteolysis. So the meat with higher glycogen can contain more free amino acids.

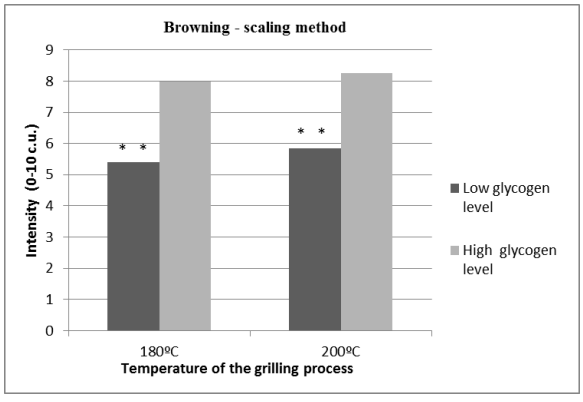

Figure 2. Effect of residual glycogen and temperature of grilling on browning pork assessed by scaling method (**P≤0.01).

Results presented in this study shown a significant difference between studied groups in browning level of meat during grilling in both temperature: 180ºC and 200 ºC. Meat with higher level of glycogen characterized higher browning level assessed scaling method and the same results obtained by ranking test (Fig. 2). Instrumental measured parameter meat colour (L*) confirmed statistically significant influence of glycogen level in 200^{o}C on the reducing of brightness of colour meat in grilled process. Olsson et al. [25] shown that glucose and glycogen could have a significant influence on browning level meat in heat process. Higher browning could suggest formation in meat unhealthy compounds, for example heterocyclic aromatic amines [25] [26] [27]. The obtained results also shown a significant correlation between glycolytic potential (residual glycogen and glucose) and browning level estimated in scaling method and ranking test. Correlation values were between r=0.53 and r=0.60 (P≤0.05) respectively.

IV. CONCLUSION

The results shown that raw meat with higher level of residual glycogen characterized by significantly lower of pH_{24} and pH_{48} and higher content of protein and water. Grilled meat with higher residual glycogen level showed higher browning level at 180ºC and 200ºC. Grilled meat in 180ºC with higher level of glycogen and glucose showed higher burnt odour, lower juiciness and higher burnt flavour. The study showed significant effect of glycogen and glucose on raw and grilled pork quality.

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