Glycolytico –Energetical Resources As Determinants Of Physico-Chemical Criteria Of Pork Meat Quality

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Abstract— **The aim of this study was determination of diagnostic value of glycolytico–energetical resources expressed by glycogen, lactate content, R_1 indicator (IMP to ATP ratio) and pH_1 on determinants and criteria of pork meat quality. The investigations covered 110 stress resistant fatteners 50 crossbredings of (Landrace x Yorkshire)xDuroc and 60 (Landrace x Yorkshire)xHampshire. The results of canonical analysis performed in this work shown that among analysed five sets ($x_1 – x_5$) of determinants (x_1 - R_1 & glycogen; x_2 - R_1 & lactate, x_3 - pH_1 & R_1; x_4 - R_1 glycogen & lactate and x_5 - pH_1 R_1 & glycogen) the best diagnostic value has a set x_4 involving R_1, glycogen and lactate parameters. We shown that in both groups of crossbreedings, x_4 set in highest degree explains variability of traits used as a criteria in verification of pork meat quality - pH_1 pH_{24}, pH_{24} EC_2, EC_2 EC_{24}, pH_1 pH_{24} EC_2, pH_1 pH_{24} EC_2 EC_{24} and pH_1 pH_{24} EC_2 EC_{24} L* respectively. For (Landrace x Yorkshire)xDuroc crossbreedings composed determination coefficients (R_C^2) were from 0.48 for pH_1 and pH_{24} set to 0.56 for pH_1 pH_{24} EC_2 EC_{24} L* set while for (Landrace x Yorkshire)x Hampshire were from 0.64 to 0.81 respectively.**

The preliminary results creates the argument that R1, glycogen & lactate content measurements may be useful to early *post mortem* diagnosis of meat quality.

Keywords— **canonical analysis, glycolytico-energetical resources, pork meat quality.**

I. INTRODUCTION

Muscle glycogen content at slaughter plays a major role in the in the *post mortem* conversion of muscle to meat. The anaerobic glycolysis involves the breakdown of glycogen to glucose and then to lactic acid. Anaerobic glycolysis also produces H^+ protons and heat. Because *post mortem* muscle does not have the means to remove waste products, lactate and H^+ accumulate and lower the pH. In pig, meat quality is usually described by a large number of traits such as pH, colour, water holding capacity or drip loss. [6]. Numerous experiments have shown that the rate and the extent of the pH decline *post mortem* are of a major importance to ultimate meat quality [2; 9]. A hastened pH decline exhibit rapid glycolysis leading to increased expulsion of water and paler of pork meat [13, 12]. In contrast, meat with slow pH fall and ultimate pH greater than 6.0 after 24 h has restricted application because is dark, firm and prone to microbial contamination. Glycogen level at the slaughter is responsible for pH value, however the relationship between these two traits is non linear [14] Also, the R-value is useful parameter for examining the glycolytic rate in the early *post mortem* period [7; 16]. The previous investigations of [8] and [10] shown that measurement of glycogen combined with a measure of lactate, is a way of predicting quality attributes of meat.

The aim of this study was determination of diagnostic value of glycolytico–energetical resources expressed by glycogen, lactate content, R_1 indicator (IMP to ATP ratio) and pH_1 on determinants and criteria of pork meat quality.

II. MATERIAL AND METHODS

The investigations covered 110 stress resistant fatteners 50 crossbredings of (Landrace x Yorkshire) x Duroc and 60 (Landrace x Yorkshire) x Hampshire. The animals were kept under the same environmental conditions and fed a full bath feed. The animals were slaughtered 2-4 hours after transportation using electrical stunning method and recumbent bleeding out (Midas system, Inarco). The carcasses were chilled using the three-phase chilling tunnel (-10ºC - 15 min, -15ºC - 25 min and -5ºC - 40 min. with air velocity 3m/s). The following meat quality characteristics were determined: pH of meat measured directly in

Longissimus lumborum (LL) muscle (45 min and 24 h after the slaughter) using pH-Master apparatus produced by Draminski, electrical conductivity (EC) measured with a LF-Star conductometer (Ingenieurbüro Matthäus, Noblitz, Germany) 2 h and 24 h *post mortem* (EC_2, EC_{24}), colour lightness (L*) of the muscle tissue, was assessed 24 h *post mortem* with a Minolta Portable Chroma Meter (model CR 310, Minolta, Osaka, Japan) using D65 illuminant and 50 mm orifice. Rate of ATP breakdown, expressed by R_1 = IMP/ATP indicator, determined 45 min *post mortem* on meat samples taken after last rib, according to the method of [7]. The RYR1 genotypes were established according to [5]. At 45 min *post mortem*, samples from LL muscle were collected into the tubes with 0.5M PCA for determination of glycogen [3] and lactate [1]. On the basis of them the glycolytic potential (GP) was calculated according to formula proposed by [11]. The estimation of the usefulness glycolytico–energetical resources expressed by glycogen, lactate content, R_1 indicator (IMP to ATP ratio) and pH_1 for the determination of pork meat quality was performed on the basis of coefficients of canonical correlation (C_R) and composed determination coefficients (R_C^2) (respective squared value) [18].

III. RESULTS AND DISCUSSION

The results of canonical analysis performed in this work shown that among analysed sets of determinants (x_1=R_1 & glycogen; x_2=R_1 & lactate, x_3=pH_1 & R_1; x_4=R_1, glycogen & lactate and x_5=pH_1 R_1 & glycogen) the best diagnostic value has a set involving R_1, glycogen and lactate parameters. We shown that in both groups of crossbreedings, that set in highest degree explains variability of traits used as a criteria in verification of pork meat quality - pH_1 pH_{24} (y_1), pH_{24} EC_2 (y_2), EC_2 EC_{24} (y_3), pH_1 pH_{24} EC_2 (y_4), pH_1 pH_{24} EC_2 EC_{24} (y_5) and pH_1 pH_{24} EC_2 EC_{24} L* (y_6) respectively. For (Landrace x Yorkshire)x Duroc crossbreedings composed determination coefficients (R_C^2) were from 0.48 for y_1 set (pH_1 and pH_{24}) to 0.56 for y_6 set (pH_1 pH_{24} EC_2 EC_{24} L*) while for (Landrace x Yorkshire)x Hampshire were from 0.64 to 0.81 respectively.

Studies by [17] and [4] demonstrate that glycolytic potential variation accounts for only about 40% of the difference in pHu of pork loin while [15] shown that glycogen account for 60%, lactate for 80%, IMP for 71% and pH to 24 h *post mortem* for 85% variation in drip loss.

The ours earlier findings [10] and results of this work create the necessity to search for quick and cheap methods of estimation of glycogen content and utilization it in on-line monitoring of meat quality.

IV. CONCLUSIONS

The preliminary results indicate that R_1, glycogen & lactate content measurements may be useful to early *post mortem* diagnosis and classification of meat quality.

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Tab.1 Values of canonical correlations and respective squared canonical correlation revealing relationship between independent sets (x_1 - x_5) containing glycogen, lactate, pH_1 and R_1 value and dependent variables sets (y_1 – y_6) determining meat quality of (LxY)xH fatteners.

Dependent variables (y)		Independent variables (x)				
		$x_1 = R_1$, glycogen	$x_2 = R_1$, lactate	$x_3 = pH_1, R_1$,	$x_4 = R_1$, glycogen lactate	$x_5 = pH_1, R_1$, glycogen
y1 = pH_1 pH_{24}	C_R R_C^2	0.69** 0.48	0.76** 0.58	-	0.80** 0.64	-
y2 = pH_{24} EC_2	C_R R_C^2	0,72** 0.52	0.79** 0.62	0.72** 0.52	0.80** 0.64	0.74** 0.55
y3 = EC_2 EC_{24}	C_R R_C^2	0.71** 0.50	0.79** 0.62	0.75** 0.56	0.79** 0.62	0.75** 0.56
y4 = pH_1 pH_{24} EC_2	C_R R_C^2	0.70** 0.49	0.84** 0.70	-	0.84** 0.70	-
y5 = pH_1 pH_{24} EC_2 EC_{24}	C_R R_C^2	0.72** 0.52	0.85** 0.72	-	0.86** 0.74	-
y6 = pH_1 pH_{24} EC_2 EC_{24} L*	C_R R_C^2	0.68** 0.46	0.89** 0.79	-	0.90** 0.81	-

** - significant statistically at $p \leq 0.01$

Tab.2 Values of canonical correlations and respective squared canonical correlation revealing relationship between independent sets (x_1 - x_5) containing glycogen, lactate, pH_1 and R_1 value and dependent variables sets (y_1 – y_6) determining meat quality of (LxY)xD fatteners.

Dependent variables (y)		Independent variables (x)				
		$x_1 = R_1$, glycogen	$x_2 = R_1$, lactate	$x_3 = pH_1, R_1$,	$x_4 = R_1$, glycogen lactate	$x_5 = pH_1, R_1$, glycogen
y1 = pH_1 pH_{24}	C_R R_C^2	0.66** 0.44	0.66** 0.44	-	0.69** 0.48	-
y2 = pH_{24} EC_2	C_R R_C^2	0.55** 0.30	0.36NS	0.35NS	0.69** 0.48	0.56** 0.31
y3 = EC_2 EC_{24}	C_R R_C^2	0.37NS	0.39NS	0.40NS	0.41NS	0.45NS
y4 = pH_1 pH_{24} EC_2	C_R R_C^2	0.67** 0.45	0.67** 0.45	-	0.69** 0.48	-
y5 = pH_1 pH_{24} EC_2 EC_{24}	C_R R_C^2	0.73** 0.53	0.67** 0.45	-	0.74** 0.55	-
y6 = pH_1 pH_{24} EC_2 EC_{24} L*	C_R R_C^2	0.74** 0.55	0.67** 0.45	-	0.75** 0.56	-

** - significant statistically at $p \leq 0.01$, NS – not statistically significant