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FACTORS DISCRIMINATING BETWEEN DIFFERENT PORK QUALITY CONDITIONS

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SUMMARY

The present study was carried out on 119 randomly chosen carcasses of barrows, slaughtered at approximately 100 kg live weight in three abattoirs form east Croatia. Main meat quality traits were measured: pH_i, pH_u, CIE-L* and drip loss by compression and bag method. Among investigated drip loss predictors the highest significance was found for WHC and pH_u values ($p<0.05$). Values of pH_i and CIE-L* were not statistically significant. Accuracy of classification by discriminant analysis was 58.93% correct in the class with excessive drip loss and 65.08% in the class characterized as non-exudative. Overall discrimination was approximately 62% correct. More variables, value other than 5% as threshold for exudative meat and a larger sample are suggested for the improvement of model accuracy. Two classes of samples were formed by discriminant analysis (exudative and non-exudative). Between the classes significant differences were found for pH_u values and WHC ($p<0.05$). When pH_u and WHC class means for exudative group were individually used as criteria for subsequent differentiation into meat quality groups, around 60% and 61% of the samples, respectively, were accurately characterized as exudative or non-exudative.

Key-words: pork, meat quality traits, discrimination classes

INTRODUCTION

Unfavourable water holding capacity or drip loss causes major problems in pork industry due to its negative impact on the appearance of meat and the yield in further processing. Another undesirable characteristic of such meat is unnaturally pale colour, the first trait consumer use when judging the acceptability of meat. Since drip loss and colour are both affected by post mortal glycolysis in the muscle, initial and ultimate pH values are considered as meat quality indicators enabling fair predictions of drip loss and colour of the meat. Colour measurements are effective only after a period of time needed to cool (24 hours) and to develop a final hue on the cut surface (blooming time). Often applied methods for measuring water loss in pork are the compression method by Grau and Hamm (1953) and the bag method developed by Honikel (1987), the later being the most accepted internationally. However, the results of these methods are known relatively late.
For this reason, it is of special interest to differentiate the meat into different classes of drip loss on the basis of measurements which can be made as earlier as possible. In the literature, different criteria for sorting the pork in meat quality groups are proposed. Kauffman et al. (1992) and Warner et al. (1997) used drip loss >5% to differentiate watery from "normal" meat; Joo et al. (1999) set up threshold value for excessive drip loss to be 6%. Regarding the pH values, criteria are not clear either. Selier and Monin (1994) used initial pH less than 5.8 and ultimate pH less than 5.5 to predict pale, soft and exudative pork; Forrest (1998) reported that ultimate pH value of 5.5 or lower indicates PSE condition; while van Laack (2000) used ultimate pH value of 5.7 for the same purpose. Kušec *et al.* (2005) interpolated ultimate pH value of 5.69 as threshold value differentiating exudative from "normal" pork *longissimus dorsi* muscle.

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The objective of this paper was to investigate the significance of pork quality indicators used to predict final drip loss and to set up a model for discrimination of meat samples into classes of excessive (>5%) and favourable (<5%) drip loss.

MATERIAL AND METHODS

The present study was carried out on 119 randomly chosen carcasses of barrows, slaughtered at approximately 100 kg live weight in three abattoirs form east Croatia. At the slaughter line, 45 minutes after sticking, initial pH values (pH_i) together with temperature were taken at the *longissimus dorsi* muscle of primarily processed swine carcasses. After 24 hours of cooling, ultimate pH values (pH_u) and temperature were taken at the same place as for pH_i; colour of *m. longissimus dorsi* was measured too. Water holding capacity was measured by compression method (Grau and Hamm, 1952) and by bag method as described by Kauffman et al. (1992); former method being termed as WHC and later as "drip loss" in the present paper. The samples for WHC and drip loss were taken from *longissimus dorsi* muscle after 24 hours of cooling; the former were compressed on filter paper for planimetry while latter were weighed, placed in plastic bags and stored for 48 hours at 6 ^oC and than reweighed for the calculation of drip loss percentage. The colour of meat was measured by "Minolta CR-300" device at *m. longissimus dorsi* cut after 15 minutes of blooming and presented as CIE L* values. The measurements of pH_i and pH_u were carried out by digital pH-meter "Mettler MP 120-B". Collected data were statistically processed using STATISTICA (6.0) for Windows program. Statistical methods applied were descriptive statistics, GLM procedure and traditional discriminant analysis.

RESULTS AND DISCUSSION

The main parameters of meat quality are shown in Table 1. According to Hofmann *et al.* (1994) border value of initial pH indicating PSE condition of pork is 5.8; values of L* higher than 53 and drip loss lower than 5% point at the same meat quality condition as well. Regarding the ultimate pH values, different values for differentiation between "normal" and PSE meat were suggested: e.g. 5.5 by Forrest (1998) and 5.7 by van Laack (2000). Water holding capacity measured by compression method (WHC) higher than 9 cm^2 indicates PSE condition too (Blendl et al., 1991). The ability of meat to withhold water, measured by bag method was expressed as drip loss. Having in mind threshold values mentioned above, the meat quality traits of pigs from present study indicate desirable meat quality, with exception of drip loss measured by bag method which was too high according to Kauffman *et al.,* (1992) and Warner et al. (1997), but acceptable according to Joo et al (1999). Variations of measured parameters resemble those reported in literature (Ryu and Kim, 2005; Kusec et al., 2005).

Table 1. Descriptive statistics of investigated meat quality traits

Variable	Mean	Std.dev	Minimum	Maximum
pH_i	6.09	0.276	5.43	6.62
pH_u	5.63	0.176	5.38	6.46
CIE-L*	46.79	4.898	35.65	59.40
WHC (cm^2)	8.31	1.432	4.30	12.50
Drip loss (%)	5.55	2.754	0.98	14.79

The significance of meat quality indicators predicting drip loss is presented in table 2. Among investigated indicators, highest significance was found for water holding capacity (WHC) obtained by compression method and ultimate pH values ($p<0.05$), whilst initial pH value was on the very border of statistical significance. WHC measured by compression was considered as indicator here because its results are known 48 hours earlier than the results of drip loss determined by bag method. Paleness of meat expressed by CIE-L* value was not statistically significant ($p>0.05$) as the predictor of drip loss. The importance of muscle ability to withhold water and its implications on meat quality was extensively discussed in literature (Kušec et al., 2005; Otto et al., 2004). Investigating the relations between meat quality indicators Kušec et al. (2005) and Kralik et al. (2002) found significant correlation between ultimate pH values, water holding capacity obtained by compression method and drip loss (bag method).

Table 2. Univariate tests of significance for drip loss prediction with meat quality indicators as independent variables

	SS	D.F.	MS	F	P
Intercept	52.6429	1	52.64288	7.964613	0.005630
pH_i	25.7736	1	25.77363	3.899425	0.050720
pH_u	27.7851	1	27.78514	4.203756	0.042628
CIE-L*	3.4150	1	3.41504	0.516679	0.473733
WHC (cm^2)	31.9173	1	31.91729	4.828932	0.030008
Error	753.4941	114	6.60960	-	-

Traditional discriminant analysis model was applied in order to classify samples into groups with high (>5% exudative) and favourable (<5%, non-exudative) drip loss on the basis of investigated meat quality predictors. From the table 3 it is obvious that classification functions for exudative and non-exudative classes had different accuracy; in the classes with excessive and “normal” drip loss 58.93% and 65.08% of the investigated loin samples, respectively, were accurately differentiated. Overall discrimination percentage was not high either (~62%), suggesting the need for inclusion of more significant meat quality traits into analysis and larger sample. Another possible way of improving the efficiency of discrimination is to use other criterion for drip loss differentiation or to use other trait as independent variable. In the paper value of 5% drip loss was used as suggested by majority of other authors (Kauffman et al., 1992; Warner et al., 1997).

Table 3. Classification matrix obtained by discriminant analysis

	Exudative (p=0.471)	Non-exudative (p=0.529)	Total	Correctly classified (%)
Exudative	33	23	56	58.93
Non-exudative	22	41	63	65.08
Total	55	64	119	62.18

Rows: Observed classifications; Columns: Predicted classifications (prior probabilities in brackets)

Two classes of samples were formed by discriminant analysis; their main meat quality traits are presented in Table 4. The class of exudative samples had significantly lower ultimate pH values, and higher water holding capacity ($p<0.05$), while initial pH and CIE-L* values were not significantly different ($p>0.05$).

Table 4. Class means and standard deviations (in brackets) for the indicators of meat quality from groups formed by discriminant analysis

	pH_i	pH_u	CIE-L^*	WHC (cm^2)
Exudative	6.06 (0.291)	5.59^a (0.140)	46.76 (4.219)	8.65^a (1.261)
Non-exudative	6.12 (0.261)	5.67^b (0.198)	46.82 (5.465)	8.01^b (1.515)

Means in columns with different superscripts are significantly different ($p<0.05$)

Taking into account results from Table 2, significant predictors (pH_u and WHC) of drip loss were used for the differentiation of samples. Hence, when pH_u and WHC class means calculated for exudative group was individually used as threshold values differentiating between the meat quality groups, around 60% and 61% of the samples, respectively, were accurately characterized as exudative or non-exudative. Other values, including those from the literature (Forrest, 1998; Joo et al., 1999; van Laack 2000), demonstrated lower classification efficiency when applied to the same data.

CONCLUSION

Based on the results of the study, conclusions can be drawn as follows:

- Among selected predictors of drip loss measured by the bag method, the highest significance was found for water holding capacity (WHC) obtained by compression method and ultimate pH values ($p<0.05$); initial pH value was on the very border of statistical significance. Paleness of meat expressed as CIE-L* value was not statistically significant ($p>0.05$).
- Accuracy of classification functions was higher in the class characterised as non-exudative (65.08% correct) than in the class with excessive drip loss (58.93%). Overall discrimination percentage was not high either (~62%). Inclusion of more significant meat quality traits into analysis, usage of threshold value other than 5% for division of samples into exudative and non-exudative group and a larger sample is recommended in order to improve the discrimination power.
- Two classes of samples were formed by discriminant analysis; the samples from exudative class had significantly lower ultimate pH values, and higher water holding capacity ($p<0.05$), while initial pH and CIE-L* values were not significantly different ($p>0.05$). When pH_u and WHC mean values of exudative class (5.59 and 8.65, resp.) were individually used as differentiation criteria, around 60% and 61% of the samples, respectively, were accurately characterized as exudative or non-exudative.

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