Meat Quality Indicators and their Correlation in Two Crosses of Pigs

Goran KUŠEC[1]
Gordana KRALIK[1]
Antun PETRIČEVIĆ[1]
Hrvoje GUTZMIRTL[2]
Dražen GRGURIĆ[2]

SUMMARY

The study was performed on 53 carcasses of three way crossed castrated pigs divided into two groups regarding the breed of the terminal sire (1st group; Pietrain, n=25 and 2nd group; Large White, n=28). After the slaughter at approximately 100 kg, following measurements were taken from MLD samples: pH_{45}, pH_{24}, water holding capacity (w.h.c.), consistency and Minolta L*a*b* values. Significant differences between the groups were found for pH_{45} ($p<0.01$) values and Minolta L* ($p<0.01$), a* ($p<0.05$) and b* ($p<0.01$) values, while no significant differences were found for pH_{24}, w.h.c. and consistency. The classification of meat from both groups according to quality (PSE, suspicious, "normal") by different criteria (pH_{45}, pH_{24}, Minolta L*) showed obvious discrepancies which may have occurred due to recently determined additional quality classes such as RSE, RFN and PFN which points out the need of further investigations in that direction. In the 1st group pH_{45} was not correlated with any other meat qulity traits, while in 2nd group significant correlations for this trait were found with pH_{24} ($r=0.43$) and w.h.c. ($r=-0.51$). Ultimate pH values measured on the pig carcasses of the 1st group were correlated with w.h.c ($r=-0.46$) and Minolta L* value ($r=-0.43$), while in 2nd group this trait was significantly correlated with all other indicators of meat quality ($p<0.01$). In the 1st group of samples minolta L* values were significantly correlated also with w.h.c. ($r=0.40$), while in the 2nd group this indicator was in significant correlation with all other idnicators with exception of pH_{45}.

KEY WORDS

breed, correlation, pork quality

[1] J.J. Strossmayer University in Osijek
Faculty of Agriculture, Department of Zootechnique
Trg Sv. Trojstva 3, HR-31000 Osijek, Croatia
[2] Center of Livestock Production Improvement
Vinkovačka 63, HR-31000 Osijek, Croatia
E-mail: gkusec@pfos.hr

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INTRODUCTION

The production of high quality pork has been a constant objective of pig industry during past decades. The main goal is to obtain pigs with high lean percentage and good meat quality traits at the same time. However, this goal turned to be difficult to achieve. The producers of pork were always confronted with variation in the properties of muscle tissue of various pig breeds. For this reason a range of attempts were made in order to accurately identify pig carcasses because in this manner quality variations could be minimized or even eliminated. There are three important parameter by which is quality of pork usually defined: surface exudate expressed as water holding capacity or drip loss, ultimate pH (pH_{24}) and color (Lee et al., 2000). Various meat quality predictors are used to achieve this goal such as early pH values (pH_{45}), measurements of electrical conductivity etc. By this predictors, meat can be classified into quality categories such as PSE (pale, soft, exudative), "normal" or RFN (red, firm, non-exudative) and DFD (dark, firm, dry) meat. Beside these traditional categories, Kaufman et al. (1992) suggested two additional: RSE (reddish-pink, soft, exudative) and PFN (pale, firm, non-exudative).

In Croatia, meat quality is most often described by early and ultimate pH values (pH_{45} and pH_{24}), Minolta color, water holding capacity (w.h.c.) and consistency. With exception of w.h.c. and consistency these indicators of meat quality are easily measured at the slaughter line and in cooling rooms at the abattoir. Since occurrence of new quality categories of meat mentioned earlier the prediction of meat quality of pigs might be to some extent reduced. The objective of this paper is to give an overview of meat quality of pigs slaughtered in eastern Croatia, investigate their relation and to stress some of the difficulties that may occur when traditional classification of pork into quality categories is applied.

MATERIAL AND METHODS

Present study was performed on 53 carcasses of three way crossed castrated pigs divided into two groups regarding the breed of the terminal sire. The dams were crossbred of Swedish Landrace x Large White, while Pietrain and Large White boars were used as terminal sire. The first group (Pietrain) had 25 and second (Large White) group included 28 pigs. The pigs were slaughtered at approximately 100 kg live weight in "Sotin" slaughter plant VUPIK, Vukovar. After 45 minutes post mortem, pH_{45} values were measured, while after 24 hours of cooling following measures were taken: pH_{24} values, water holding capacity (w.h.c.), consistency and color of m. longissimus dorsi were taken. The measurements of pH_{45} and pH_{24} were carried out by digital pH-meter "Mettler MP 120-B". Water holding capacity (w.h.c.) was determined using compression method by Grau and Hamm (1952); while consistency was expressed as the area of compressed muscle tissue (cm^2) obtained during w.h.c. measurement. The colour of the meat was measured in triplicate with "Minolta CR-300" device, viewing angle 2°, illuminant D65 at m. longissimus dorsi cut and presented as minolta L* (degree of lightness), minolta a* (degree of redness) and minolta b* (degree of yellowness). Statistical analysis was performed using STATISTICA (5.0) for Windows program; graphs were drawn using Microsoft Excel (Office XP) program.

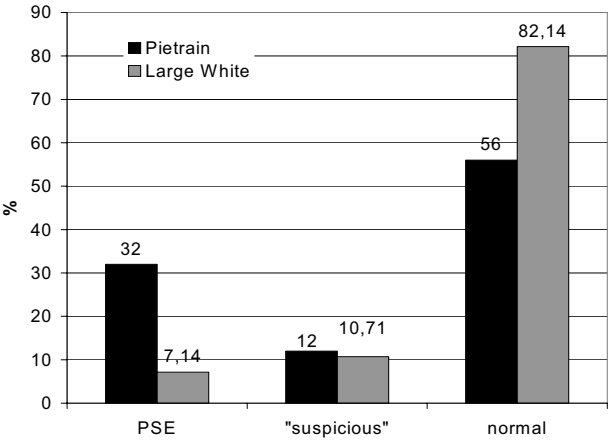
RESULTS AND DISCUSSION

Meat quality indicators of the pigs from two groups are presented in table 1. From the results presented here, it is obvious that the mean pH_{45} measured in MLD muscle of the first group is significantly lower than in second group. Moreover, in the first group it is very close to the border value for PSE meat. The value of pH measured 45 minutes post mortem is a predictor of pork quality often used to classify the meat for further processing at the slaughter line. Hofmann (1994) suggested classification according to which is meat with pH_{45} value of 5.8 or less considered as PSE meat; values between 5.8 and 6.0 are considered suspicious and above 6.0 is called "normal" meat. Dark, firm and dry meat (DFD) cannot be detected 45 minutes p.m. and it is determined by ultimate pH values. According to ultimate pH value, both groups showed normal mean values with no significant differences detected between them.

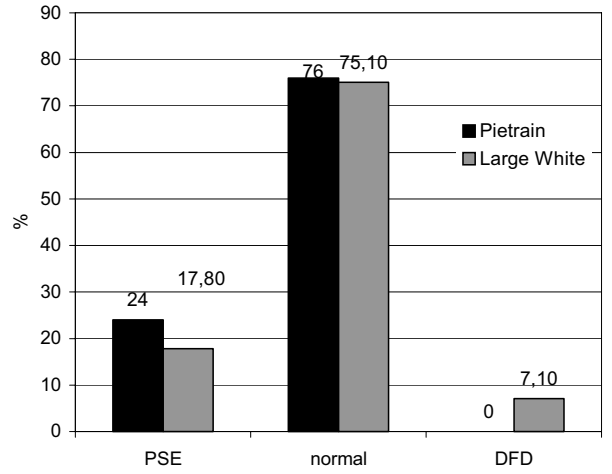
However, when the samples were classified according to pH_{45} values as presented in graph 1, it became obvious that 32% of the samples from the 1st

Table 1. The differences between indicators of meat quality traits of the carcasses from investigated groups of pigs

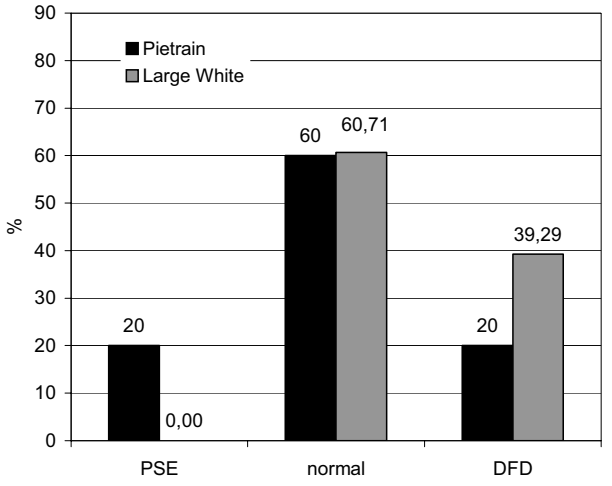
Indicators	1st group	2nd group	Level of significance
pH_{45}	6.04	6.28	$p<0.01$
pH_{24}	5.66	5.73	n.s.
WHC	10.23	9.87	n.s.
Consistency	3.25	3.23	n.s.
Minolta L*	54.58	51.99	$p<0.01$
Minolta a*	7.70	6.56	$p<0.05$
Minolta b*	7.25	5.67	$p<0.01$



Graph 1. The distribution of the meat samples from investigated groups of pigs into meat quality categories according to pH_{45} values



Graph 2. The distribution of the meat samples from investigated groups of pigs into meat quality categories according to pH_{24} values



Graph 3. The distribution of the meat samples from investigated groups of pigs into meat quality categories according to Minolta L* values

group showed PSE condition; while in 2nd group this percentage was lower (7.1%). The percentages of «suspicious» meat were 12 and 10.7% of the 1st and 2nd group respectively. This resulted in much higher percentage of so called normal meat in the 2nd group (82.1%) than in the 1st group of carcasses (56%). Many authors reported lower meat quality characteristics in the cross s with Pietrain on the side of the sire independently of the MHS status (Howard & Smith, 1977; Oliver et al., 1993; Hamilton et al., 2001), although this traits are also influenced by other factors such as handling of the animals, transport, rest before slaughter etc.

Although pH_{45} measurements can provide a reasonable prediction of final pork quality, Kauffman et al. (1993) showed that recent inclusion of new meat quality classes such as RSE (reddish-pink, soft, exudative) and PFN (pale, firm, non-exudative) meat made the prediction of meat quality prior to the onset of rigor mortis more difficult if not impossible. For that reason ultimate pH values remains the most valuable indicator of meat quality of pigs at the slaughter plants. Forrest (1998) reported that ultimate pH value of 5.5 or less indicates PSE condition of the meat, while pH_{24} values of 6.2 and above determine DFD meat.

Graph 2 shows the classification of the meat from two different groups of pig carcasses into PSE, "normal" and DFD (dark, firm, dry) according to ultimate pH values. As obvious, the situation regarding the meat quality looks different, especially regarding the proportion of so called normal meat which is quite similar in both groups, contrary to the classification by pH_{45} values. The percentage of PSE meat was still higher in the 1st group than in 2nd but in the 1st group it was to some extent decreased and increased in the 2nd when compared to classification by pH_{45} values. It seems that all "suspicious" meat from 2nd group identified by pH_{45} values turned into PSE meat after 24 hours of chilling. Additionally, the occurrence of 7.1% DFD meat was observed in 2nd group, while in the 1st group it was not the case.

According to Petričević et al. (2003), water holding capacity measured by the compression method between 4 and 8 cm^2 is characteristic for "normal" meat. Higher values, outside this area indicate unfavourable meat quality. Mean values calculated for both groups, presented in table 1 indicate non satisfactory meat quality of investigated pigs. Significant differences between the groups of pigs for water holding capacity and consistency were not found.

Graph 3 presents the classification of the examined pig meat into three quality classes according to Minolta L* values. Van Laack (2000) reported that PSE meat is characterized by L* values of 58 and above, whilst values less than 52 indicate DFD condition. For this meat quality trait significant difference

Table 2. Correlation coefficients between the investigated meat quality traits from the investigated groups of pigs

		pH_1	pH_2	W.h.c.	Cons.	L	a
1st group	pH_1	1					
	pH_2	0.253	1				
	W.h.c.	–0.291	–0.456*	1			
	Consistency	0.121	0.317	–0.335	1		
	L	–0.195	–0.429*	0.402*	–0.327	1	
	a	–0.244	–0.281	0.007	0.033	0.030	1
	b	–0.192	–0.557	0.304	–0.251	0.503*	0.774**
2nd group	pH_1	1					
	pH_2	0.429*	1				
	W.h.c.	–0.514**	–0.643**	1			
	Consistency	0.372	0.594**	–0.447*	1		
	L	–0.293	–0.542**	0.403*	–0.547**	1	
	a	–0.253	–0.439*	0.356	–0.439*	0.233	1
	b	–0.305	–0.639**	0.517**	–0.545**	0.666**	0.798**

between the groups was found ($p<0.01$). Both mean values calculated for Minolta L* value were below 58 indicating favourable brightness of the meat samples, but their distribution into PSE, "normal" and DFD meat revealed that 20% of the pork originated from Pietrain sires exhibited PSE and DFD condition. The meat from 2nd group had no PSE condition at all, but 39.29% of the samples were DFD meat, leaving 60.71% of the meat samples in the category of normal quality traits.

The discrepancy in classification of meat according to quality (PSE, suspicious, "normal") by different criteria (pH_{45}, pH_{25}, Minolta L*) could have happen due to the occurrence of additional quality classes such as RSE, RFN and PFN described by Kaufman et al. (1992). RSE pork should be stressed as the main problem since it has the color of normal meat, exceptionally high drip loss (van Laack et al., 1994, Warner et al., 1997) and cannot be detected by early or ultimate pH values (von Lengerken et al., 2002). Since Cassens et al. (1992) found more than 50% of the m. gluteus medius to be RSE and only 15% was "normal" (RFN) in the survey of 14 pork processing plants in USA, it is clear that closer attention should be given to this problem in Croatia too. Classification of the meat into PSE, RSE, RFN and DFD on the basis of L* values, drip loss and pH_{24} is described in the work of Kaufmann et al. (1992) and Warner (1994).

Poor meat quality of certain crossbred pigs manifested through low pH_{45} and pH_{24} values, high drip loss or pale color is often explained by the presence of MHS-gene in genome, although number of authors reported unsatisfactory meat quality traits in progeny of Pietrain sires regardless of this gene (Howard & Smith, 1977; Oliver et al., 1993; Hamilton, 2001). Since boars used in this study were not tested on MHS-genotype, results presented here point at the need for such tests.

The correlation coefficients calculated for both groups of pigs are presented on table 2. From the presented results it can be seen that pH_{45} showed no significant correlations with any other meat quality trait measured in present study. This indicates that it is a weak predictor of final meat quality of pigs with Pietrain as a terminal boar which is in agreement with the results of Hambrecht et al. (2003) who reported no significant correlations of any pH value with other meat quality traits in the population of Hypor pigs. On the other hand, in 2nd group of pigs with Large White as a terminal sire pH_{45} was significantly correlated with ultimate pH_{24} ($p<0.05$) and water holding capacity ($p<0.01$) which make it more useful in prediction of meat quality for this group. This result is in agreement with the results of van der Wal et al. (1995) who found pH_{45} to be in rather consistent correlation with water holding capacity in all investigated breeding populations of Large White.

Ultimate pH values were significantly correlated with w.h.c. and Minolta L* values in the first group (Pietrain sire); while in 2nd group this measurement was significantly correlated with all other meat quality traits measured in present study. This confirms the findings of other authors arguing that pH_{24} is the most accurate determinant of meat quality (Eikelenboom et al., 1995; Petersen et al., 1996; Forrest, 1998; van Laack, 2000).

Significant correlations were found between Minolta L* values and pH_{24} and w.h.c. ($p<0.05$) in the 1st group of pigs, while with pH_{45} this correlation was insignificant ($p>0.05$). In 2nd group L* values were significantly correlated with all other meat quality traits with exception of pH_{45} which is rather normal because the development of color has not reached the ultimate stage and it is simply too early for color measurement.

CONCLUSION

On the basis of results from present study following can be concluded:

- Significant differences between the groups were found for pH_{45} ($p<0.01$) values and Minolta L* ($p<0.01$), a* ($p<0.05$) and b* ($p<0.01$) values, while no significant differences were found for pH24, w.h.c. and consistency. It should be stressed that mean pH45 of the pork from 1st group was close to the border values for PSE, while mean w.h.c. determined in both groups was unfavourable (PSE).
- The classification of meat from both groups according to quality (PSE, suspicious, "normal") by different criteria (pH_{45}, pH_{24}, Minolta L*) showed obvious discrepancies which may have occurred due to recently determined additional quality classes such as RSE, RFN and PFN which points out the need of further investigations in that direction.
- In the 1st group pH_{45} was not correlated with any other meat qulity traits, wile in 2nd group significant correlations for this trait were found with pH24 ($r=0.43$) and w.h.c. ($r=-0.51$). Ultimate pH values measured on the pig carcasses of the 1st group were correlated with w.h.c ($r=-0.46$) and Minolta L* value ($r=-0.43$), while in 2nd group this trait was significantly correlated with all other indicators of meat quality ($p<0.01$). In the 1st group of samples minolta L* values were significantly correlated also with w.h.c. ($r=0.40$), while in the 2nd group this indicator was in significant correlation with all other indicators with exception of pH_{45}.

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