Relationship between glycolytic potential and technological quality of meat and dry-cured Parma ham in the Italian heavy pig

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SUMMARY - The glycolytic potential (GP) was determined at 1 hour *post mortem* on *Biceps femoris* (BF) muscle collected from the carcasses of 158 commercial hybrid pigs and 349 Duroc x (Landrace x Large White) crossbreeds. The pH and pH_u values were measured in the *Biceps femoris* (BF), *semimembranosus* (SM), and *Longissimus thoracis* (LT) muscles. Drip and cooking losses were evaluated on the LT muscle. The technological losses during the first salting phase and at the end of curing were calculated in hams processed as dry-cured Parma ham. The glycolytic potential averaged 128.6 µmol/g in commercial hybrid pigs and 138.9 µmol/g in crossbreeds. The percentage of carcasses with a GP value exceeding 180 µmol/g, considered as threshold value for identifying carriers of the RN^- allele of the RN gene, were 1.9% and 9.8%, respectively. The correlation coefficients between pH_u and GP were between -0.22 and -0.44 (P<0.01) while the coefficients between the GP and the losses due to first salting and curing varied between +0.22 and +0.39 (P<0.01). On the whole, the results obtained point to the need to check the meat glycolytic potential in Italian heavy pig since an increase could have a negative influence on the production of Parma ham due to increase in weight loss during the curing process.

Key words: Heavy pig, glycolytic potential, technological quality, dry-cured ham.

RESUME - *"Relations entre le potentiel glycolytique et la qualité technologique de la viande et du jambon sec de Parme chez le porc lourd Italien". Le potentiel glycolytique (PG) dans le muscle Biceps femoris à 1 h* post mortem *a été déterminé sur les carcasses de 158 hybrides commerciaux et 349 métis Duroc x (Landrace x Large White). Les valeurs de pH_1 et pH_u ont été mesurées sur les muscles* Biceps femoris*,* semimembranosus *et* Longissimus thoracis*. En outre nous avons évalué les pertes d'exsudat et de cuisson sur le muscle* Longissimus thoracis*. Les mesures de la perte de poids technologique ont été faites durant le premier salage et à la fin du séchage. Le potentiel glycolytique observé est en moyenne égal à 128,6 mol/g chez les porcs hybrides et 138,9 mol/g chez les porcs métis. Le pourcentage de carcasse avec une valeur de PG supérieure à 180 mol/g, considéré comme seuil de localisation des sujets porteurs de l'allèle RN^- du gène Rendiment Napole, s'est avéré respectivement égal à 1,9% et à 9,8%. Les coefficients de corrélation entre le pH_u et le PG observés sont compris entre -0,22 et -0,44 (*P*<0,01) tandis qu'entre ce dernier et les pertes de premier salage et de séchage les coefficients observés varient de +0,22 à +0,39 (*P*<0,01). Dans l'ensemble les résultats obtenus indiquent la nécessité de contrôler le potentiel glycolytique de la viande de porc lourd italien puisque son augmentation pourrait influencer d'une manière négative la production du jambon de Parme en augmentant les pertes de poids au cours de la fabrication.*

Mots-clés : *Porc lourd, potentiel glycolytique, qualité technologique, jambon sec.*

Introduction

The Glycolytic Potential (GP) of the meat is defined as the quantity of glucide compounds susceptible to conversion into lactic acid during the *post mortem* phase (Monin and Sellier, 1985). The GP strongly influences the ultimate pH which, in turn, conditions other quality traits such as water holding capacity and colour. The GP is found to be very high in pigs which are carriers of the dominant RN^- allele of the RN (Rendiment Napole) gene whose effect is to increase the content of muscular glycogen *in vivo*. Fresh meat from RN^- carriers has lower ultimate pH, lower water holding capacity and lower processing yield, especially in cooked ham (Sellier and Monin, 1994). Despite the importance of GP in determining the quality of meat as well as for RN gene monitoring in the pig population, no research has been conducted on muscle's GP in Italy. The aim of this study was to examine the *post mortem* GP in Italian heavy pigs evaluating its influence on the technological characteristics of fresh meat and dry-cured Parma ham.

Materials and methods

A total of 507 heavy pigs were examined. One hundred fifty-eight were commercial hybrids, with a dominance of Large White blood, while 349 were Duroc x (Landrace x Large White) crossbreeds subjected to the same pre-slaughtering conditions. All the pigs were examined in 14 consignments and slaughtered at the same plant.

The pH_1 and the pH_u were measured in the *Longissimus thoracis* (LT), *semimembranosus* (SM) and *biceps femoris* (BF) muscles on each left half-carcass, after 1 hour and 24 hours *post mortem* respectively. At the same time as pH_1 measurement, a 5 g sample was taken from the *biceps femoris* (BF), immediately placed in liquid nitrogen and then lyophilised. The glycogen, glucose, glucose-6-phosphate and lactic acid content were separately determined in the sample (Bergmeyer, 1974). The GP was calculated according to the Monin and Sellier (1985) and expressed as mol of lactic acid equivalent per g of fresh muscle, assuming a moisture content of 75% (Talmant *et al.*, 1989).

Drip and cooking losses (Honikel, 1987) were also determined in the LT muscle. The left thighs were delivered to a plant to be processed as Parma dry-cured ham. At the end of first salting, lasting 7 days, liquid loss, absorbed salt and the resulting weight loss were determined. Loss due to curing (Russo *et al.*, 1991) was determined after 14 months, at the end of processing.

The GP frequency distribution and averages of the meat quality traits were calculated for both genetic types in animals with GP < and ≥180 mol/g, this value being considered the limit for identifying carriers of the RN^- allele of the RN gene (Lundström *et al.*, 1996). These averages were corrected owing to the effect of the day of slaughter. A statistical comparison of groups with different GPs was not made for commercial hybrid pigs due to the low number of animals whose GP was higher than the limit value. The correlations between the GP and the technological characteristics of the meat and hams subjected to curing were also calculated for each genetic type.

Results and discussion

The distribution of GP in the two genetic type studied is illustrated in Fig. 1. The average value (± S.D.) was 128.62 ± 25.17 mol/g for hybrid pigs and 138.93 ± 30.11 mol/g for D x (L x LW) crossbreeds. The higher value found in the latter animals could be due to the presence of the Duroc breed as terminal boar. In this breed Terlouw *et al.* (1997) found a higher GP in the LT muscle compared with that in the Large White breed. However, a comparison between crossbreeds with Large White or Duroc terminal boars showed a slightly lower GP value in the latter (Enfält *et al.*, 1997). Animals with GP higher than the limit value were 1.9% for hybrid pigs and 9.8% for D x (L x LW) crossbreeds. This data would appear to indicate the presence of the RN^- allele in slaughter heavy pigs, although with a lower frequency. However, the need to carry out further studies in order to identify and quantify the presence of this allele in Italian heavy pigs would appear to be essential.

The technological quality traits of fresh meat and the ham weight loss due to curing in animals with GP < and ≥ 180 mol/g are presented in Table 1. In the two groups, the average GP values were 127.24 and 198.80 mol/g in commercial hybrid pigs and 133.23 and 191.51 mol/g in crossbreeds, respectively. In the latter genetic type, animals with GP higher than the limit value showed a higher glycogen content (P<0.01) and the pH_u values significantly lower. These results agree with those observed in pigs which were carriers of the RN^- allele (Larzul *et al.*, 1998). Hams from crossbreeds with GP higher than the limit values showed a curing loss that was higher by over one percentage point (P<0.05). This highlights the fact that the RN^- allele can have a negative effect on the yield of products subjected to curing.

Table 2 shows the correlation between the GP and the technological characteristics of the meat and cured ham, for each genetic type. The GP was found to be significantly and negatively correlated to the pH_u, and the coefficients observed, between 0.22 and 0.44, seem to be comparable to those observed by Lundström *et al.* (1996) and Larzul *et al.* (1998). A positive, significant correlation, with coefficients between 0.22 and 0.39, was observed between the GP and technological losses due to first salting and curing. This relationship, although not particularly close, indicates that the mechanisms responsible for lower cooking yields for meats with high GP (Sellier and Monin, 1994) are also probably capable of causing an increase in technological loss in the production of cured ham.

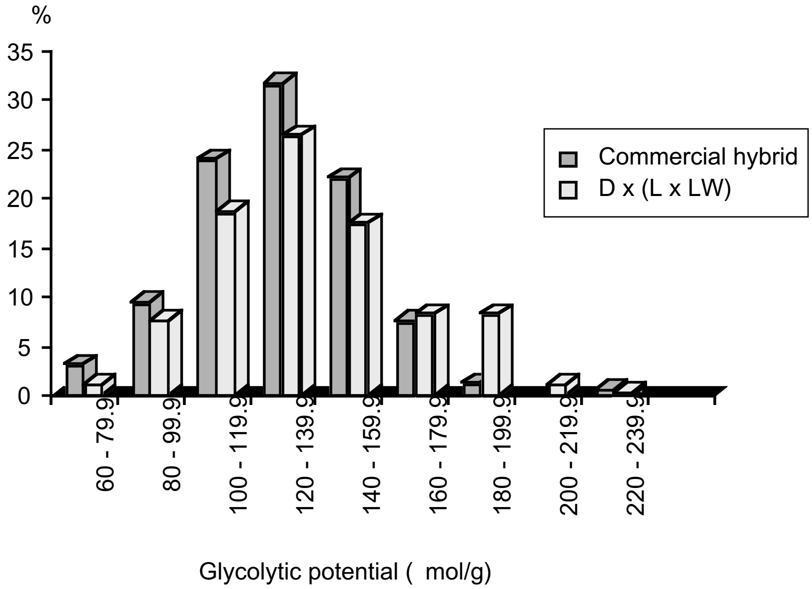

Fig. 1. Glycolytic potential distribution on genetic types examined.

Table 1. Technological meat quality and ham weight loss due to curing (least squares means ± s.e.) in animals with GP < and ≥180 mol/g

	Commercial hybrid		D x (L x LW)	
	<180 mol/g	≥180 mol/g	<180 mol/g	≥180 mol/g
No. pigs	155	3	314	34
1 h *post mortem*:				
pH_1 BF	6.41 ± 0.01	6.48 ± 0.11	6.46 ± 0.01	6.42 ± 0.04
pH_1 SM	6.33 ± 0.02	6.48 ± 0.13	6.41 ± 0.01	6.39 ± 0.04
pH_1 LT	6.29 ± 0.02	6.42 ± 0.14	6.37 ± 0.01	6.27 ± 0.04
Glycogen (mol/g) BF	44.20 ± 0.93	77.26 ± 6.93	50.62 ± 0.63^{A}	65.37 ± 2.14^{B}
Lactate (mol/g) BF	34.24 ± 0.86	28.60 ± 6.43	27.35 ± 0.65^{a}	32.76 ± 2.18^{b}
24 h *post mortem*:				
pH_u BF	5.57 ± 0.01	5.47 ± 0.04	5.54 ± 0.01^{A}	5.48 ± 0.02^{B}
pH_u SM	5.57 ± 0.01	5.49 ± 0.04	5.53 ± 0.01^{a}	5.49 ± 0.02^{b}
pH_u LT	5.49 ± 0.01	5.44 ± 0.04	5.49 ± 0.01^{A}	5.44 ± 0.02^{B}
Drip loss (%) LT	3.78 ± 0.08	3.98 ± 0.61	3.62 ± 0.07	4.06 ± 0.22
Cooking loss (%) LT	26.98 ± 0.20	30.27 ± 1.48	22.08 ± 0.15	22.97 ± 0.52
Ham processing loss (%)	27.42 ± 0.14	28.28 ± 1.01	27.32 ± 0.15^{a}	28.56 ± 0.50^{b}

a,b: $P<0.05$; A,B: $P<0.01$

Table 2. Correlation coefficients (r) between the Gliycolytic potential and the technological quality of meat and dry-cured ham

	Commercial hybrid	D x (L x LW)
	r	r
pH_1 BF	+ 0.08	- 0.05
pH_1 SM	+ 0.10	+ 0.07
pH_1 LT	- 0.01	- 0.12
pH_u BF	- 0.37**	- 0.44**
pH_u SM	- 0.25**	- 0.42**
pH_u LT	- 0.22**	- 0.36**
Drip loss LT	+ 0.15	- 0.01
Cooking loss LT	+ 0.21**	+ 0.10
Ham:		
1st salting:		
- liquid loss	+ 0.22**	+ 0.30**
- absorbed salt	+ 0.11	+ 0.05 NS
- weight loss	+ 0.25**	+ 0.39**
processing loss	+ 0.28**	+ 0.28**

*P<0.05; **P<0.01; NS: Non significant

Conclusion

In this first study on the GP in Italian heavy pig, it highlighted a positive relationship with the technological loss in Parma ham and there seems to be the possibility of an albeit limited presence of animals that are carriers of the RN⁻ allele of the RN gene. This points to the need to check the GP in genotypes used for the production of heavy pigs since its increase could represent a potential risk for the quality of meat produced for processing purposes.

Acknowledgements

This study was supported by MURST (ex 40%).

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