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## 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  $\mu\text{mol/g}$  in commercial hybrid pigs and 138.9  $\mu\text{mol/g}$  in crossbreeds. The percentage of carcasses with a GP value exceeding 180  $\mu\text{mol/g}$ , 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  $pH_i$  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  $\mu\text{mol/g}$  chez les porcs hybrides et 138,9  $\mu\text{mol/g}$  chez les porcs métis. Le pourcentage de carcasse avec une valeur de PG supérieure à 180  $\mu\text{mol/g}$ , 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.

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### 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 waterholding 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  $\geq 180$  mol/g, this value being considered the limit for identifying carriers of the RN<sup>-</sup> 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 ( $\pm$  S.D.) was  $128.62 \pm 25.17$  mol/g for hybrid pigs and  $138.93 \pm 30.11$  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<sup>-</sup> 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  $\geq 180$  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<sup>-</sup> 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<sup>-</sup> 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.

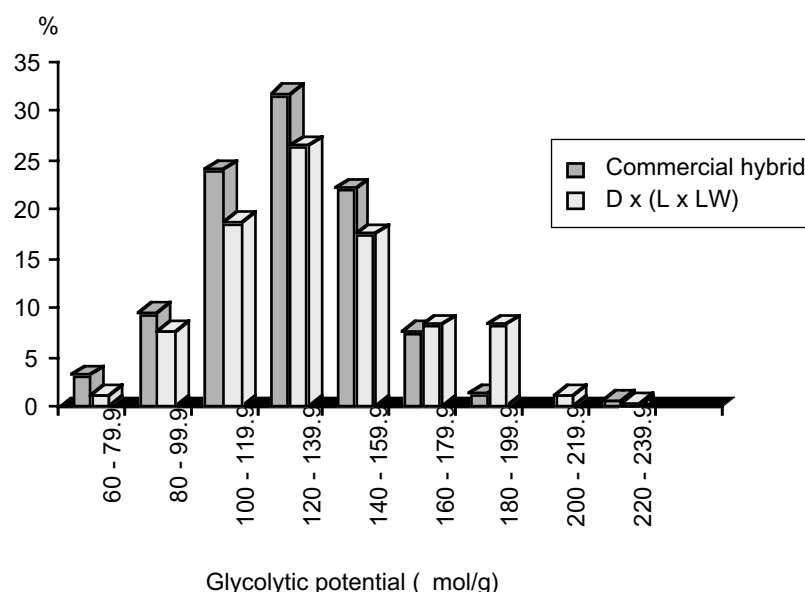


Fig. 1. Glycolytic potential distribution on genetic types examined.

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

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

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

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

	Commercial hybrid	D x (L x LW)
	r	r
pH <sub>1</sub> BF	+ 0.08	- 0.05
pH <sub>1</sub> SM	+ 0.10	+ 0.07
pH <sub>1</sub> LT	- 0.01	- 0.12
pH <sub>u</sub> BF	- 0.37**	- 0.44**
pH <sub>u</sub> SM	- 0.25**	- 0.42**
pH <sub>u</sub> LT	- 0.22**	- 0.36**
Drip loss LT	+ 0.15	- 0.01
Cooking loss LT	+ 0.21**	+ 0.10
Ham:		
1 <sup>st</sup> 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<sup>-</sup> 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.

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## References

- Bergmeyer, H.U. (1974). *Methods of Enzymatic Analysis*. Academic Press, NY.
- Enfält, A.C., Lundström, K., Hansson, I., Lundeheim, N. and Nystrom, P.E. (1997). Effects of outdoor rearing and sire breed (Duroc or Yorkshire) on carcass composition and sensory and technological meat quality. *Meat Sci.*, 45: 1-15.
- Honikel, K.O. (1987). How to measure the water-holding capacity of meat? Recommendation of standardized methods. In: *Evaluation and Control of Meat Quality in Pigs*, Tarrant, P.V., Eikelenboom, G. and Monin, G. (eds). Martinus Nijhoff Publisher, Dordrecht, The Netherlands, pp. 129-142.
- Larzul, C., Le Roy, P., Monin, G. and Sellier, P. (1998). Variabilité génétique du potentiel glycolytique du muscle chez le porc. *INRA Prod. Anim.*, 11: 183-197.
- Lundström, K., Andersson, A. and Hansson, I. (1996). Effect of RN gene on technological and sensory meat quality in crossbreed pigs with Hampshire as terminal sire. *Meat Sci.*, 42: 145-153.

- Monin, G. and Sellier, P. (1985). Pork of low technological quality with a normal rate of muscle pH fall in the immediate post-mortem period: the case of the Hampshire breed. *Meat Sci.*, 13: 49-63.
- Russo, V., Nanni Costa, L., Lo Fiego, D.P. and De Grossi, A. (1991). Early estimation of seasoning loss in Parma ham production. In: *Proc. 37<sup>th</sup> Int. Congr. Meat. Sci. Technol.*, Kulmbach, Germany, pp. 926-929.
- Sellier, P. and Monin, G. (1994). Genetics of pig meat quality: a review. *J. Muscle Foods*, 5: 187-219.
- Talmant, A., Fernandez, X., Sellier, P. and Monin, G. (1989). Glycolytic potential in *Longissimus dorsi* muscle of Large White pigs, as measured after *in vivo* sampling. In: *Proc. 35<sup>th</sup> Int. Congr. Meat. Sci. Technol.*, Copenhagen, Denmark, pp. 1129-1132.
- Terlouw, C., Rybarczyk, P., Fernandez, X., Blinet, P. and Talmant, A. (1997). Comparaison de la réactivité au stress des porcs de races Large White et Duroc. Conséquences sur des indicateurs de qualités des viandes. *Journées Rech. Porcine en France*, 29: 383-390.