

Glycolytic enzymes and metabolites in relation to meat quality in porcine longissimus dorsi muscle

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Abstract

The objective of this study was to determine the relationships between glycolytic enzyme activities and metabolite contents measured at 45 min postmortem in porcine *longissimus dorsi* muscle, and also investigated the influence of the glycolytic traits on meat quality. The activities of lactate dehydrogenase (LDH) and pyruvate kinase (PK) were correlated with ATP content, and LDH activity was positively correlated with lactate content and glycolytic potential. The metabolites influenced the glycolytic rate and also affected meat quality traits such as lightness and drip loss. On the other hand, the glycolytic enzymes had limited effects on the meat quality traits, although both LDH and PK activity were correlated with muscle pH measured at 45 min postmortem.

Introduction

The activities of glycolytic enzymes, including lactate dehydrogenase (LDH) and pyruvate kinase (PK), are useful indicators for examining variations in metabolic traits during the early postmortem period (Gil *et al.*, 2003). However, there is still no clear understanding of how glycolytic enzyme activity, muscle fiber characteristics, glycolytic rate, and meat quality traits are related (Allison *et al.*, 2003; Larzul *et al.*, 1997). Therefore, the aim of this study was to increase our knowledge on the relationships between postmortem glycolytic traits, including glycolytic enzyme activities and metabolite contents, and meat quality measurements.

Materials and methods

A total of 96 crossbred (Landrace × Yorkshire × Duroc) pigs were used in this study. The treatment conditions for the animals were the same both before and after slaughter. At 45 min postmortem, muscle samples were collected from the *longissimus dorsi* muscles at the 8th *thoracic vertebra*, and were analyzed for glycolytic enzymes, metabolite contents, and glycolytic rate. The LDH and PK activities of the samples were determined via procedures described by Gil *et al.* (2003) and Scope (1977), respectively. Metabolite content, ATP, glucose, glucose-6-phosphate (G6P), lactate, and glycolytic potential (GP) were determined according to previously reported methods (Choi *et al.*, 2007). The glycolytic rates of the samples, including muscle pH and *R-value*, were evaluated at 45 min postmortem. After 24 h of chilling, the pork loins were collected to evaluate meat quality traits, including lightness, drip loss, filter-paper fluid uptake, cooking loss, and Warner-Bratzler Shear force (WBS) (Choi *et al.*, 2007). Finally, Pearson partial correlation coefficients (SAS Institute, 2001) were evaluated to determine the relationships existing between the glycolytic traits and the meat quality measurements.

Results and discussion

Table 1 shows the correlation coefficients between the glycolytic enzymes and metabolites at the early postmortem period. LDH activity was positively correlated with PK activity ($r = .29$), lactate content ($r = .38$), and GP ($r = .28$), and was negatively correlated with ATP content ($r = -.24$). While PK activity was negatively correlated with ATP ($r = -.24$) and G6P ($r = -.40$) contents.

The activities of LDH and PK were significantly correlated with muscle pH ($r = -.33$ and $-.23$, respectively) at 45 min postmortem (Table 2). The metabolite contents, especially ATP and lactate, were significantly correlated with the glycolytic rate during the early postmortem period. ATP content showed a positive correlation with muscle pH_{45 min} ($r = .57$) and a negative correlation with the *R-value* ($r = -.79$); however, lactate content and GP showed opposite tendencies. G6P content was negatively correlated with

lightness ($r = -.29$), and lactate content and GP were positively correlated with drip loss ($r = .31$ and $.29$, respectively).

Table 1. Correlation coefficients (R) between glycolytic enzymes activities and metabolite contents at early postmortem in porcine *longissimus dorsi* muscle

	PK	ATP	G6P	Glycogen	Lactate	GP
LDH	.29**	-.24*	-.21	-.16	.38***	.28*
PK		-.24*	-.40***	-.15	.20	.17
ATP			.20	.54***	-.54***	-.50***
G6P				.02	.02	.03
Glycogen					-.40***	-.32**
Lactate						.90***

Abbreviations: LDH, lactate dehydrogenase; PK, pyruvate kinase; G6P, glucose-6-phosphate; GP, glycolytic potential. Levels of significance: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 2 Correlation coefficients (R) between glycolytic traits and meat quality measurements in porcine *longissimus dorsi* muscle.

	LDH	PK	ATP	G6P	Glycogen	Lactate	GP
<i>Glycolytic rate</i>							
pH _{45 min}	-.33**	-.23*	.57***	-.05	.33**	-.52***	-.51***
<i>R-value</i>	.06	.07	-.79***	.03	-.52***	.61***	.57***
<i>Meat quality traits</i>							
Lightness	-.15	.22*	.16	.05	-.40***	-.06	-.03
Drip loss	-.14	-.13	.05	.10	.10	.31**	.29**
FFU	.15	-.09	.14	.06	.13	.04	.07
Cooking loss	.11	.11	.10	.02	.05	.08	.02
WBS	.30**	.03	.13	.01	-.04	.04	.04

Abbreviations: LDH, lactate dehydrogenase; PK, pyruvate kinase; G6P, glucose-6-phosphate; GP, glycolytic potential; FFU, filter-paper fluid uptake; WBS, Warner-Bratzler Shear Force. Levels of significance: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Conclusions

The results from this study appear to indicate that both LDH and PK activity potentially serve as determinants of certain early postmortem glycolytic traits in porcine *longissimus dorsi* muscle. However, the effects of the glycolytic enzymes on meat quality traits were somewhat limited.

References

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