factsheet
Pork Information Gateway

Impact of Paylean™ on Pork Quality

Author
Scott N. Carr & Dr. Floyd K. McKeith, University of Illinois

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Reviewer
David Gerrard, Purdue University

Introduction

Ractopamine hydrochloride (RAC or Paylean™) is a phenethanolamine with beta-adrenergic agonist properties. The FDA approved the use of Ractopamine, up to 18g/T for finishing swine weighing up to 240 pounds (109 kilograms). The recommended usage today is at a level of 4.5 to 9g/T for the last four weeks of the finishing period. The effects of RAC on carcass composition and pork quality have been characterized in the literature. The majority of the research in the literature was conducted prior to 1990. There have been numerous production changes in the last decade. Those changes include genetics and management practices. The emphasis on quality and the techniques used to evaluate quality have also changed drastically during this time period. The importance of pork quality is major issue to the industry. Pork quality is not clearly defined and may describe a wide range of characteristics. For the purpose of this review, it will be defined as the visual characteristics (color, water-holding capacity and marbling) and eating quality (tenderness, juiciness and flavor). The objective of this paper is to provide a broad overview of pork quality measurements, examine past research addressing the impact of Paylean™ on fresh pork quality and the current status of knowledge relating to the impact of Paylean™ on pork quality.

Fresh Pork Color

Pork color is an important characteristic that impacts the consumer's perception of fresh pork (Brewer & McKeith, 1999). It is typically characterized objectively using colorimeters, described using the L*, a* and b* described by AMSA (1991) and subjectively using a set of pork color standards such as NPPC 1991, NPPC 1999 or the Japanese color standards.

Fresh pork color from Paylean™ fed pigs has been evaluated both objectively and subjectively. In an early study, Uttaro et al. (1993) objectively compared pork from pigs fed 18g/T of Paylean™ to controls and did not observe any differences in fresh loin L* values. However, differences ($P<0.05$) were found in a* values and b* values with the pork from the controls being more red and yellow in color compared to the pigs fed 18 g/T Paylean™. Furthermore, Uttaro et al.

Variable	Paylean Treatment (g/ton)			
	0	9	18	SEM
pH 45 min[1]	6.12	6.09	6.26	0.042
pH 1.5 h[2]	5.88	5.79	5.96	0.080
pH 3.0 h[2]	5.65	5.72	5.82	0.066
pH 4.5 h[2]	5.70	5.65	5.92	0.076
pH 8.0 h[2]	5.51	5.57	5.59	0.034
pH 24 h[1]	5.52	5.55	5.55	0.011
Loin chop pH[3]	5.46[a]	5.53[b]	5.53[b]	0.015

Table 1. Post-mortem pH measurements on pork carcasses. Treatment means within a row with different superscripts are different ($P<0.05$) [1]Measured on the loin of 180 carcasses. [2]Measured on the loin of 30 carcasses [3]Measured on the loin chop of 180 carcasses at approximately 30h post mortem.

	grams/Ton	pH-45m	pH-24h	L* Loin	a* Loin	b* Loin	L* Cured Ham	a* Cured Ham	b* Cured Ham	C	F	M	Shear value (kg)	Drip%	Tend	Juice	Flavor
Zimmerman et al. 1989	0										3.0						
	18										2.8						
Aalhaus et al. 1990	0	6.23[a]	5.49										5.86[a]	3.76			
	9	6.10[b]	5.52										6.32[b]	3.84			
	18	6.15[ab]	5.51										6.41[b]	3.87			
Watkins et al. 19902	0											2.1					
	4.5											2.1					
	9											2.2					
	18											2.3					
Watkins et al. 19903	0											1.8[a]					
	4.5											2.1[b]					
	9											2.2[b]					
	18											2.2[b]					
Stites et al. 1991	0										2.8	2.9					
	4.5										2.7	3.0					
	9										2.9	3.0					
	18										3.0	3.0					
Dunshea et al. 1993 (gilts)	0		5.43											6.59			
	18		5.38											7.43			
Dunshea et al. 1993 (barrows)	0		5.41											5.83			
	18		5.44											5.92			
Uttaro et al. 1993	0			46.32	7.59[a]	3.14[a]	62.40[a]	11.00	8.51				4.23[a]	6.45			
	18			45.84	6.48[b]	2.42[b]	60.92[b]	10.72	8.96				4.72[b]	4.31			
Stites et al. 1994	0		5.41							2.85			2.84		5.72	4.82	6.42
	4.5		5.44							2.82			3.15		5.44	4.93	6.26
	9		5.44							2.76			3.76		5.61	5.03	6.34
	18		5.48							2.75			2.78		5.69	5.13	6.18

Table 2. Summary of Paylean™ affects on pork quality. Treatment means within column per experiment with different superscripts are different (P<0.05). [2]Study 1. [3]Study 2.

(1993) also evaluated cured ham color and demonstrated that Paylean™ treated pigs had lower (P<0.05) L* values than controls, while no differences were observed in a* and b* color values. Stites et al. (1994) observed no differences (P>0.05) in subjective lean color scores for pigs fed 0, 4.5, 9 and 18g/T of Paylean™.

In more recent studies, Ivers et al. (2000), Stoller et al. (2002) and Ivers et al. (2002) reported no differences (P>0.05) in L* Minolta values or subjective color scores of the cut fresh loin. There were differences (P<0.01) in a* and b* values as the controls yielded higher values compared to the Paylean™ treated pigs. Herr et al. (2000) reported no differences (P>0.05) in Hunter Miniscan L, a or b color measures of the cut fresh loin.

Marbling

Marbling or intramuscular fat (IMF) has long been associated with eating quality of meat. Marbling or IMF can be measured visually and objectively. Visually using a one (1) to five (5) scale (NPPC, 1991) or the recent standards (NPPC, 1999) are on a continuous scale, which actually represents the amount of chemically determined lipid in the muscle. Objective measurements are based on chemical analysis of muscle tissue.

Stites et al. (1991) and Crome et al. (1996) reported no differences (P<0.05) in subjective marbling scores between control pigs and pigs that were fed Paylean™. Watkins et al. (1990) reported the results of two

studies. In study 1 with 888 pigs, no differences (P>0.05) were observed. In study 2 with 360 pigs, Paylean™ fed pigs had higher (P<0.05) subjective levels of marbling compared to control pigs. Whereas, Stites et al. (1994) observed no differences (P>0.05) in extractable lipid content between control and Paylean™ fed pigs. More recent studies have reported no differences in subjective marbling scores between control and Paylean™ fed pigs (Ivers et al., 2000; Herr et al., 2000; Stoller et al., 2002 and Ivers et al., 2002). Stoller et al. (2002) reported a breed by diet interaction for chemically separated loin lipid content as Berkshire pigs fed Paylean™ had lower (P<0.05) lipid values than control pigs while Duroc pigs were unaffected. Ivers et al. (2002) reported pigs fed 9g/T PayleanTM have lower chemically separated loin lipid content compared to pigs fed 18g/T PayleanTM.

Firmness

Firmness and wetness are two variables of pork quality that have often been evaluated together. This is conducted by visually appraising the cut loin surface and comparing it to a three- (NPPC, 1999) or a five- (NPPC, 1991) point scale. An evaluator is trained from these reference scales before beginning these subjective measures.

Stites et al. (1991) compared control pigs to pigs fed 4.5, 9 and 18g/T Paylean™ and reported no differences (P>0.05) in firmness between any of the treatments. Zimmerman et al. (1989) compared 0 and 18g/T Paylean™ and also observed no differences (P>0.05) in firmness.

Herr et al. (2000), Stoller et al. (2002) and Ivers et al. (2002) all reported no differences (P>0.05) in firmness between control and Paylean™ fed animals.

pH

pH is a measure to determine the level of acidity or the alkaline level in any given substance and is correlated with meat quality traits. As a result, it is one of the most commonly used measurements in the industry today to help determine the quality of meat. Meat color, firmness and water holding capacity are affected by the pH of the muscle. An optimum ultimate pH for fresh pork would be in the range of 5.7-5.9.

Aalhus et al. (1990) and Dunshea et al. (1993) reported no differences (P>0.05) in ultimate pH values for pigs fed Paylean™ compared to controls. However, Aalhaus et al. (1990) showed a numerically higher ultimate pH values for Paylean™ fed pigs. In addition, Dushea et al. (1993) reported numerically higher ultimate pH values for barrows but numerically lower pH values for gilts at the 18g/T level of Paylean™. Stites et al. (1994) observed no statistical differences (P>0.05) in pH values for loin chops from pigs fed diets containing with 4.5, 9 and 18g/T Paylean™ compared to the control pigs.

Ivers et al. (2002) found no differences (P>0.05) in 45 min, 1.5, 3.0, 4.5, 8.0 & 24hr post-mortem pH measurements between control pigs and Paylean™ fed pigs (table 1). However, pigs fed the 18g/T level have numerically higher muscle pH values at all six post-mortem measurements. In addition, Ivers et al. (2000) reported greater (P<0.05) ultimate loin chop pH values for pigs fed Paylean™ compared to the control pigs. Herr et al. (2000) reported no differences (P>0.05) in 45-min post-mortem pH values between control and Paylean™ fed pigs. Stoller et al. (2002) observed no differences (P>0.05) in 24 and 48-hr post-mortem ultimate pH between Paylean™ fed and control pigs.

Water Holding Capacity

The ability of meat to bind water and retain moisture during storage can accurately define water capacity. Drip loss refers to the percentage of moisture that is lost during the storage period, usually 24 or 48hr, of a chop. Purge loss refers to the percentage of moisture that is lost during the storage period, usually 7 to 21d, of a section of loin.

Aalhaus et al. (1990) and Dunshea et al. (1993) reported no differences (P>0.05) in loin chop drip loss for pigs fed Paylean™ compared to control pigs.Ivers et al. (2002) reported pigs fed 18g/T Paylean™ level had less (P<0.05) loin chop drip loss than controls. Carr et al. (2002) also reported that pigs fed 18g/T Paylean™ tended to have less purge loss from unenhanced loins compared to the controls. However, pigs fed diets containing 18g/T Paylean™ tended to have higher purge loss values in enhanced loins than the control treatment. Herr et al. (2000) and Stoller et al. (2002) reported no differences in water holding capacity between any control and Paylean™ fed pigs.

Sensory Properties

Sensory properties of meat can include juiciness, tenderness and off-flavor/flavor intensity. Trained sensory panelists using a linear scale can measure these properties. Mechanical measurements of tenderness can also be applied. The most common mechanical device is the Warner-Bratzler shear force machine for the objective determination of muscle tenderness.

Stites et al. (1994) reported no differences (P>0.05) between control pigs and Paylean™ fed pigs for juiciness, tenderness and off-flavor. Carr et al. (2002) reported no differences (P>0.05) between control and Paylean™ fed pigs for enhanced chops. However, they observed that treated pigs (9 or 18g/T Paylean™) had lower (P<0.05) sensory tenderness scores than controls (7.91 vs. 7.96 vs. 9.06, respectively) for non-enhanced chops from the same pigs.

Aalhaus et al. (1990) observed higher (P<0.05) shear values indicating less tender pork, for Paylean™ fed pigs compared to controls. Uttaro et al. (1993) also reported higher (P<0.05) shear values for 18g/T Paylean™ fed pigs compared to the controls. However, Stites et al. (1994) observed no differences (P>0.05) in tenderness between control and Paylean™ fed pigs. Carr et al. (2002) reported no differences (P>0.05) in shear values of enhanced chops, but observed higher (P<0.05) shear values for Paylean™ treated non-enhanced loins compared to the non-enhanced control loins.

Implications

Recent and past research shows that feeding Paylean™ to late finishing swine does not have an adverse effect on pH, visual color or objective L color value. Furthermore, feeding Paylean™ does not impact water-holding capacity, Warner Bratzler shear force and has been associated with reduced tenderness when fed at a high level for prolonged time periods.

Literature Cited

Aalhus, J.L., S.D.M. Jones, A.L. Schaefer, A.K.W. Tong, W.M. Robertson, J.K. Merrill and A.C. Murray. 1990. The effect of ractopamine on performance, carcass composition and meat quality of finishing swine. *Can. J. Anim. Sci.* 70:943-952.

AMSA. 1991. Guilelines for meat color and evaluation. American Meat Science Association. Kansas City, MO and National Live Stock and Meat Board. Chicago, IL.

Brewer, M.S. and F.K. McKeith. 1999. Consumer-rated quality characteristics as related to purchase intent of fresh pork. *J. Food Sci.* 64(1) 171-174.

Carr, S.N., D.J. Ivers, D.B. Anderson, D.J. Jones, D.H. Mowrey, M.B. England and F.K. McKeith. The effect of ractopamine hydrochloride (Paylean™) on lean carcass yields and pork quality characteristics. *J. Anim. Sci.* (Submitted)

Crome, P.K., F.K. McKeith, T.R. Carr, D.J. Jones, D.H. Mowrey, and J.E. Cannon. 1996. Effect of ractopamine on growth performance, carcass composition, and cutting yields of pigs slaughtered at 107 and 125 kilograms. *J. Anim. Sci.* 74:709-716.

Dunshea, F.R., R.H. King, R.G. Campbell, R.D. Sainz and Y.S. Kim. 1993. Interrelationships between sex and ractopamine on protein and lipid deposition in rapidly growing pigs. *J. Anim. Sci.* 71:2919-2930.

Herr, C.T., W. Yake, C. Robson, D.C. Kendall, A.P. Schinckel and B.T. Richert. 2000. Effect of nutritional level while feeding PayleanTM to late-finishing swine. Presented at Purdue University 2000 Swine Day Report.

Ivers, D.J., W.C. Weldon, J.D. Muegge, S.N. Carr, M.B. England, F.K. McKeith, and D.B. Anderson. 2000. The effect of PayleanTM on lean yields and pork quality characteristics. Page 131 in Proc. of the 53rd RMC., The Ohio State University.

Ivers, D.J. S.N. Carr, D.B. Anderson, D.J. Jones, D.H. Mowrey, M.B. England and F.K. McKeith. The effect of ractopamine hydrochloride (PayleanTM) on growth performance and carcass characteristics of late finishing swine. *J. Anim. Sci.* (Submitted)

NPPC. 1991. Procedures to Evaluate Market Hogs (3rd edition). Natl. Pork Prod. Counc., Des Moines, IA.

NPPC. 1999. Pork Quality Standards. Natl. Pork Prod. Counc., Des Moines, IA.

Stites, C.R., F.K. McKeith, S.D. Singh, P.J. Bechtel, D.J. Jones and D.H. Mowrey. 1994. Palatability and visual characteristics of hams and loin chops from swine treated with ractopamine hydrochloride. *J. Muscle Foods* 5:367-376.

Stites, C.R., F.K. McKeith, S.D Singh, P.J. Bechtel, D.H. Mowrey, and D.J. Jones. 1991. The effect of ractopamine hydrochloride on the carcass cutting yields of finishing swine. J. *Anim. Sci.* 69:3094-3101.

Stoller, G.M., H.N. Zerby, S.J. Moeller, T.J. Baas, C.D. Johnson, L.E. Watkins. 2002. The effect of feeding ractopamine (Paylean™) on loin quality and sensory characteristics in three genetic lines of swine. *J. Anim. Sci.* 88(Suppl. 2): 79.

Uttero, B.E., R.O. Ball, P. Dick, W. Rae, G. Vessie, and L.E. Jeremiah. 1993. Effect of ractopamine and sex on growth, carcass characteristics, processing

yield, and meat quality characteristics of crossbred swine. *J. Anim. Sci.* 71:2439-2449.

Watkins, L.E., D.J. Jones, D.H. Mowrey, D.B. Anderson and E.L. Veenhuizen. 1990. The effect of various levels of ractopamine hydrochloride on the performance and carcass characteristics of finishing swine. *J. Anim. Sci.* 68:3588-3595.

Zimmermann, D.R. 1989. Effects of ractopamine on performance and carcasses of finishing pigs fed diets with various protein and lysine concentrations. In: ISU Research Report 1989. pp 17-21, Iowa State University, Ames, Iowa 50011.

	Carr et al. 2002			Ivers et al. 2002			Herr et al. 2000			Ivers et al. 2000			Crome et al. 1996		
grams/Ton	18	9	0	18	9	0	Phase + Paylean™	18% CP + Paylean™	16% + Paylean™	16% CP	18	9	0	18	9	0
pH-45m							6.11	--	6.06	6.11						
L* Loin							50.23	--	51.94	51.01	48.93	48.11	48.73			
a* Loin							9.29	--	8.97	9.59	7.55[b]	7.96[b]	9.23[a]			
b* Loin							8.57	--	8.72	8.81	3.69[b]	3.85[b]	5.10[a]			
L* Cured Ham											49.05	49.40	48.71			
a* Cured Ham											8.12[b]	8.60[ab]	9.88[a]			
b* Cured Ham											3.22[b]	3.60[b]	4.51[a]			
C				2.73	2.77	2.76	2.8	2.8	2.5	2.7				2.27	2.25	2.25
F				2.65	2.58	2.62	1.6	1.7	1.7	1.5				2.27	2.25	2.17
M				1.60	1.63	1.50	3.0	3.0	2.8	2.7				2.10	2.21	2.00
IMF				2.29[b]	1.98[a]	2.07[ab]										
Shear value (kg)	4.42[b]	4.29[b]	3.76[a]													
Drip%	3.82[b]	4.04[ab]	4.79[a]													
Purge %	1.89[b]	2.10[ab]	2.68[a]													
Tend	7.96[b]	7.91[b]	9.06[a]													
Juice	7.98	7.76	8.17													
Flavor	14.32	14.51	14.61													

Table 3. Summary of Paylean affects on pork quality1 1Treatment means within column per experiment with different superscripts are different (P<0.05)

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