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The effect of corn distiller's dried grains with solubles, ractopamine, and conjugated linoleic acid on the carcass performance, meat quality, and shelf-life characteristics of fresh pork following three different storage methods

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ABSTRACT

The objective of this study was to evaluate dietary corn distiller's dried grains with solubles (DDGS), ractopamine hydrochloride (RAC), and conjugated linoleic acid (CLA) on growth performance, carcass and fat quality, and shelf-life of fresh pork from finishing pigs. Barrows (n = 72) were fed one of eight treatments consisting of two diet sources (corn–soy and corn–soy + 20% DDGS), two levels of RAC (0 and 7.4 ppm), and two levels of CLA (0 and 0.6%) for 28 days. Loins were portioned (n = 3) into one of three storage conditions (fresh, cold, frozen); each followed with seven days of retail display. Feeding RAC improved ADG and G:F ($P<0.05$), whereas DDGS decreased belly fat firmness ($P<0.05$). Dietary DDGS increased total polyunsaturated fatty acids in jowl and belly samples and increased Iodine Value (IV) ($P<0.05$), but addition of CLA decreased IV. Dietary DDGS, RAC, or CLA had minimal impact on pork quality following varied storage methods.

1. Introduction

Pork quality is increasingly important in certain foreign markets where consumers desire higher quality fresh pork that is more uniform in color, with greater degrees of marbling, and with greater percentages of fat than is typically desired in the domestic market (Dransfield, 2008; Martinez & Zering, 2004). Therefore, it is important that the pork industry find a balance between nutrition and meat quality, while at the same time utilizing production methods that are cost effective.

Large-scale ethanol production has resulted in large supplies of distillers dried grains with solubles (DDGS). Including DDGS in swine diets is possible with minimal effects on growth performance and pork quality when fed at levels below 20–30% (Apple, 2002; Stein & Shurson, 2009). However, there is a limited amount of information available presenting the effect of DDGS on the shelf-life of pork and pork products (Leick et al., 2010). Typically, DDGS contain 8–12% oil, a high proportion being unsaturated fatty acids (White et al., 2009; Xu et al., 2010). It has been documented that the fatty acid profile of pork carcasses reflects the composition of fat sources consumed in the diets of swine and that diets high in unsaturated fats may result in soft fat on pork carcasses (Apple, 2002; Larsen, Wiegand, Parrish, Swan, & Sparks, 2009; Warnants, Van Oeckel, & Boucque, 1999; Wood et al., 2003). Problems arising from soft fat include decreased belly sliceability, altered appearance in retail packaging, and decreased oxidative stability (Apple, 2002; Xu et al., 2010).

Various feed ingredients have been shown to alter fat deposition in pigs and the fatty acid profile of pork. The addition of DDGS has been shown to decrease pork fat quality (White et al., 2009; Whitney, Shurson, Johnston, Wulf, & Shanks, 2006) which may have detrimental effects on the shelf-life of fresh pork products in storage. Ractopamine hydrochloride (RAC; Paylean, Elanco Animal Health, Greenfield, IN, USA) is a beta adrenergic agonist that has been shown to decrease fat and increase lean deposition (Leick et al., 2010; Weber et al., 2006). Conjugated linoleic acid (CLA) refers to a group of geometric and positional isomers of linoleic acid (Blankson et al., 2000; Peterson, Kelsey, & Bauman, 2002). The addition of CLA to swine diets has been shown to improve pork fat quality (Pettigrew & Esnaola, 2001).

Therefore, the objective of this study was to evaluate the effect of RAC and CLA on the meat quality and shelf-life stability following storage of fresh pork from pigs fed 20% DDGS.

2. Materials and methods

All animals were subject to a University of Missouri Animal Care and Use Committee Approved Protocol.

2.1. Experimental design

Barrows, PIC 337 (PIC C29 maternal line PIC 337 terminal line), (n = 72) weighing 100.68 kg ± 4.93 kg were obtained from a

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commercial grow-finish unit and placed on a corn–soy acclimation diet for 7 d. Following the acclimation period pigs were weighed, blocked by weight and randomly assigned to a 2×2×2 factorial arrangement with 9 replications per treatment. Experimental diets were formulated to meet or exceed NRC requirements (NRC, 1998) and to include DDGS (0 or 20%), CLA (Luta-60, BASF Corporation, Florham Park, NJ, USA) (0 or 0.6%), and RAC (Paylean®, Elanco Animal Health, Greenfield, IN, USA) (0 or 7.4 mg/kg) (Table 1) (AOAC Official Methods 946.06, 960.03B(a)(1) & 978.01 A to H, 980.02, 982.30 E(a,b,c), ch. 45.3.05, 990.03, 2006). Inclusion rates of CLA and RAC were determined per manufacturer instructions and according to U.S. Food and Drug Administration regulations. Pigs were individually penned and had ad libitum access to water and feed for 28 d prior to slaughter. Pig was the experimental unit. On the last day of the feeding period feed was removed and pigs were weighed. Growth performance measures of average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (kg gained per kg feed consumed) (G:F) were measured for the total experimental period. Approximately 12 h following feed withdrawal pigs were transported 5 Km to the University of Missouri Red Meats Abattoir and Meat Processing Facility. Barrows (136 kg ± 8) were humanely slaughtered and carcasses fabricated under USDA-FSIS inspection (United States Department of Agriculture, Food Safety and Inspection Service, Federal Register. Washington, D.C., USA).

2.2. Carcass measurements

Hot carcass weight (HCW) was obtained directly following slaughter and at 1 h postmortem pH was measured in the longissimus dorsi between the 10th and 11th ribs using a portable spear-type pH meter (Meat Probes, Inc., Topeka, KS, USA). Following a 24 h chilling period carcasses were ribbed, allowed to bloom for 30 min, and the following measurements taken on ribbed carcasses: loin eye area (LEA), and fat thickness at the 1st, 10th, and last rib. Additional meat quality measurements taken 24 h postmortem included pH of the loin (at the 10th and 11th rib interface) and ham (along the aitch bone in the semimembranosus). Instrument color values (L*, a*, b*) were taken on exposed loins at the 10th and 11th rib interface using a Minolta Chroma Meter CR-410 (Konica Minolta, Sensing, Inc., Japan). Subjective quality measures of color, firmness, and marbling were taken by trained personnel on ribbed carcasses (AMSA, 2001).

2.3. Carcass fabrication and loin storage

The right side of each carcass was fabricated to obtain center-cut bone-in loins (IMPS #412; NAMP, 2007), boneless center-cut loins (IMPS #412B; NAMP, 2007), and bellies (IMPS #408; NAMP, 2007). Bone-in loins were skinned and Minolta color values (L* a* b*) for fat color measured on skinned loins. Center-cut boneless loins were divided into three sections, based on weight, and each section randomly assigned to a storage method. Storage methods included fresh storage, cold storage, and frozen storage using the following methodology: fresh storage loin sections were obtained immediately following carcass fabrication by way of the following: loin sections were weighed, tagged, packaged, and placed on display approximately 24 h postmortem in order to provide a treatment that was fresh and never placed into storage. Cold storage loin sections were weighed, tagged, placed into vacuum bags, shielded from light, and placed into cold storage for 30 d under refrigeration at 4 °C. Frozen storage loin sections were weighed, tagged, placed into vacuum bags, shielded from light, and placed into frozen storage for 60 d at −20 °C. Following the respective storage methods, loin sections (IMPS #412B; NAMP, 2007) were removed from packaging and fabricated into 2.54 cm boneless pork loin chops. One chop from each loin section was weighed, placed on a

Table 1
Diet composition for pigs fed 20% DDGS with or without conjugated linoleic acid or ractopamine hydrochloride.

	Corn–soybean meal				20% DDGS[a]			
Ractopamine	−	−	+	+	−	−	+	+
Conjugated linoleic acid	−	+	−	+	−	+	−	+
Corn	82.67	79.80	73.20	70.32	67.03	64.13	55.72	52.87
SBM 48%	13.00	15.30	22.25	24.55	8.75	11.05	20.00	22.30
DDGS	0.00	0.00	0.00	0.00	20.00	20.00	20.00	20.00
Fat, choice white grease	2.00	1.40	2.00	1.40	2.00	1.40	2.00	1.40
Monocal	0.60	0.55	0.65	0.60	0.20	0.20	0.25	0.15
Limestone	0.90	0.93	0.80	0.83	1.13	1.13	1.00	1.05
Salt	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
L-lysine	0.17	0.17	0.25	0.25	0.25	0.25	0.26	0.26
MHA[b]	0.00	0.00	0.05	0.05	0.00	0.00	0.01	0.01
L-threonine	0.01	0.01	0.12	0.12	0.00	0.00	0.07	0.07
Paylean®[c]	0.00	0.00	0.04	0.04	0.00	0.00	0.04	0.04
Conjugated linoleic acid	0.00	1.20	0.00	1.20	0.00	1.20	0.00	1.20
Vitamin premix[d]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix[e]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
NRC ME (Mcal/kg)	3.340	3.353	3.428	3.353	3.395	3.317	3.392	3.315
Crude protein (%)	13.20	13.33	16.96	17.09	15.31	15.44	19.78	19.91
TID lysine (%)	0.65	0.66	0.95	0.96	0.65	0.66	0.95	0.96
TID methionine + cysteine:lysine	65.29	65.19	57.99	57.97	66.75	66.63	58.09	58.07
TID threonine:Lysine	64.23	64.19	68.19	68.14	64.51	64.46	68.12	68.07
TID tryptophan:lysine	18.08	18.39	17.58	17.76	17.50	17.76	18.36	18.54
Total phosphorus (%)	0.45	0.45	0.50	0.50	0.45	0.46	0.50	0.50
Available phosphorus (%)	0.18	0.18	0.20	0.20	0.22	0.23	0.25	0.24
Ca (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Na (%)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

[a] Corn dried distiller's grains with solubles.
[b] L-Met precursor HMTBA, an 88% aqueous solution of 2-hydroxy-4-(methylthio) butanoic acid, Novus International Inc., St. Louis, MO.
[c] Provided per kilogram of final diet: vitamin A, 6,614 IU; vitamin D3, 661 IU; vitamin E, 13.2 IU; riboflavin, 4.96 mg; vitamin B12, 0.02 mg; Menadione, 2.4 mg; D-pantothenic acid, 16.9 mg; niacin, 19.8 mg.
[d] Elanco Animal Health, Greenfield, IN.
[e] Provided per kilogram of final diet: iron, 110 mg; zinc, 110 mg; manganese, 22 mg; copper, 11 mg; iodine, 0.2 mg; selenium 0.198 mg.