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Effects of dietary potato by-product and rumen-protected histidine on growth, carcass characteristics and quality attributes of beef☆

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ABSTRACT

We hypothesized that variable composition in finishing rations, more specifically; the proportion of potato-by-product (PBP) and rumen protected histidine (His) supplementation may influence growth and meat quality attributes. Two different diets were fed (1) finishing ration with corn and barley as grains (CB, n = 20) and (2) substitution of 10% corn, DM basis, with PBP (PBP, n = 20). Additionally, half of each dietary treatment received 50 g/hd/d rumen protected His (HS, n = 20) while the other half received no supplement (NS, n = 20). Inclusion of 10% PBP or HS did not affect growth or carcass traits. Color stability was analyzed using Hunter color values as well as AMSA visual appraisal in both *longissimus thoracis* (LT) and *gluteus medius* (GM) muscles. The LT, but not the GM, of CB steers was more color stable over a 9 d simulated retail display compared to those fed a PB diet. Steers receiving HS produced significantly ($P < 0.05$) more color stable LT and GM steaks.

1. Introduction

Rising feed costs along with competition for available commodities continues to drive consideration of alternate feedstuff in diets. In 2008 processing of frozen potato products produced approximately 4.3 million t (as-is basis) of potato by-product in the United States and Canada (Nelson, 2010). This potato by-product (PBP) can be fed to livestock. However, it is imperative for maintaining sustainability and consumer satisfaction that there are no negative impacts on growth, carcass traits or meat quality. Currently, there are conflicting reports regarding feedlot performance when PBP is included in beef rations. Potato by-product was reported to have no effect on ADG, feed efficiency or carcass characteristics until the inclusion of PBP exceeded 51.9% of DM in barley-based diets (Hanks, Heinemann, & Young, 1978). Further, inclusion of 10% ensiled potato pieces in corn-based finishing diets increased DMI, ADG and marbling (Nelson, Busboom, Cronrath, Falen, & Blankenbaker, 2000). However, Radunz et al. (2003) found that inclusion of PBP at 10, 20, 30 or 40% of DM decreased feedlot performance but had little effect on carcass or meat quality. This study was implemented to determine effects of including PBP in feedlot diets and further test performance of finishing beef cattle provided with up to 10% PBP in the ration.

Histidine (His) is known to be a limiting AA for growing cattle (Chalupa, Chandler, & Brown, 1973; Greenwood & Titgemeyer, 2000). Several studies have shown that provision of His to lactating dairy cows increases milk and milk protein yield (Huhtanen, Vanhatalo, & Varvikko, 2002; Little, 1975; Vanhatalo, Huhtanen, Toivonen, & Varvikko, 1999). Additionally, His and its metabolites; carnosine and anserine, have been shown to have antioxidant properties (Boldyrev, Dupin, Pindel, & Severin, 1988; Wade & Tucker, 1998). However, we are not aware of any studies that have reported the effects of providing supplemental His to feedlot steers on growth, carcass and meat quality characteristics. We hypothesize that in rapidly growing finishing cattle, dietary histidine availability may be limiting rates of lean body gain and further that increased histidine availability will increase color stability of meat in association with enhanced storage of the anti-oxidant histidine metabolites distributed in muscle.

Objectives of this study are; (1) evaluate differences in growth, carcass traits and meat quality in feedlot steers fed either a diet with corn and barley as grains or a diet with 10% of the corn substituted for PBP and (2) evaluate the effects of providing rumen protected His to feedlot steers on growth, carcass traits and beef quality.

2. Materials and methods

2.1. Animal care

All animal procedures were reviewed and approved by the Institutional Animal Care and Use Committee (IACUC) as required by federal law and University of Idaho policy.

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2.2. Animals & diets

Forty steers were obtained from the University of Idaho's Steer-A-Year program. Steers came from producers across Idaho and were received at the University of Idaho. Steers utilized in the trial had Angus, Charolais, Hereford and Simmental breeding, typical of cattle raised in this area, and were approximately 7–9 mo of age upon being received. Steers were received over a two month period and were fed the same back-grounding ration upon arrival until commencement of the trial. Treatment groups included steers finished on a conventional ration within the US with the grains being corn and barley (CB, n = 20) or a diet with 10% potato by-product substituted for corn (PB, n = 20); diet composition and nutrient analysis can be seen in Table 1. This study utilized hopper waste as the potato by-product, specific nutrient composition of the hopper waste utilized in this study can be seen in Table 2. Further, half of the animals in each of the diet treatments were supplemented with 50 g/hd/d of rumen protected His (no His supplementation, NHS, n = 20 or receiving histidine supplementation, HS, n = 20). The His product (Balchem Corporation, New Hampton, NY) contained 40% His and has been shown to be highly rumen protected and bioavailable in the ruminant (Little, 1975; Patton & Parys, 2012). Further, it was estimated that 25 g/d of His on the CB diet and 24 g/d of His in the PB diet were flowing to the small intestine as predicted by Model II of the Beef NRC (NRC, 1996). Steers were initially weighed and placed into one of 4 different treatment groups (10 steers per treatment) at random. Animals from different treatment groups were randomly allocated to 1 of 8 different pens with 5 steers per pen. Pens had a concrete floor and steers were bedded with sawdust. All animals were branded, dewormed and vaccinated with Pyramid5® (Boehringer Ingelheim, Ridgefield, CT) and Caliber7® (Boehringer Ingelheim). Subsequently, animals were implanted with Revalor S® (Merck Animal Health, Summit, NJ) and moved into pens 5 mo prior to harvest. Steers were trained to use Calan gates (American Calan, Northwood, NH) over a 2 week period and the feed trial commenced approximately 5 mo prior to expected harvest date. Steers were fed ad libitum twice daily at 0700 and 1600. His was individually pre-measured and top dressed on the ration each morning. Animals were weighed bi-weekly prior to the morning feeding during the trial. The finishing period lasted for 129 d. Animals were then transported to Washington Beef in Toppenish, WA in a single load and harvested the following morning.

Table 1
Composition and chemical analysis (DM basis) of the two different finishing diets.

Item	Potato-based[a]	Corn-based[b]
Ingredient, %		
Feeder alfalfa	9.20	9.20
Potato by-product	10.00	–
Apples	9.00	9.00
Dried distillers grains	14.00	14.00
Corn	22.20	32.20
Barley	30.80	30.80
Performix supplement	4.80	4.80
Chemical analysis		
DM, % as fed	60.69	68.24
CP, %	13.68	13.39
Crude fiber, %	11.46	10.85
Fat, %	4.40	3.69
Ash, %	6.12	5.16
NE_m Mcal/lb	0.87	0.90
NE_g Mcal/lb	0.55	0.58
TDN, %	76.49	78.58
Nitrogen free extract, %	64.34	67.36

[a] 10% potato-by product substituted for corn.
[b] Conventional finishing ration in the US with corn and barley as grains.

Table 2
Nutrient composition of potato by-product, hopper waste, used in finishing ration.

Item	Dry-basis, %	As received, %
Moisture	–	77.45
Dry matter	–	22.55
Protein, crude	8.83	1.99
Fat (EE)	0.74	0.17
Ash	11.66	2.63

2.3. Carcass data collection

Hot carcass weight was recorded by Washington Beef and carcass data were acquired by trained personnel from the University of Idaho. Rib eye area (REA), kidney, pelvic and heart fat (KPH), marbling score, quality grade and final yield grade (YG) were determined approximately 24 h after harvest. USDA Quality Grade was also determined for each carcass by Washington Beef via the VBG2000 Vision Camera.

2.4. Preparation of steaks for beef quality measurements

After processing, the vacuum packaged strip loin (IMPS/NAMP 180, 2010) from the left side from each carcass was obtained and transported on ice to the UI Moscow campus meat science laboratory for aging and post-harvest processing. These samples were used for analyses of color (Hunter MiniScan EZ, Restin, VA), Warner–Bratzler shear force (WBSF) (GR Manufacturing, Manhattan, KS) and HPLC metabolite analysis (Waters e2695 and a Waters 2998 photodiode array detector, Milford, MA, USA). On d-14 post-mortem, wholesale cuts were removed from the vacuum packages. The anterior end of the strip loin was prepared by removing a slice approximately 2 cm-thick, perpendicular to the long axis of the *longissimus* muscle. Subsequently, two 2.54 cm-thick steaks were removed from the anterior end for analysis of *longissimus thoracis* (LT) color and WBSF. A 2.54 cm-thick steak from the posterior end of the strip loin was used for analysis of *gluteus medius* (GM) color. Steaks from the LT and GM muscles were chosen for their known differences in color stability (Renerre, 1984). Steaks for WBSF were transported to the UI food science lab. Steaks for color analysis during retail display were packaged in white styrofoam trays with an oxygen permeable PVC overwrap (Koch Industries, Inc #7500-3815; Wichita, KS) and allowed to bloom for at least 20 min.

2.5. pH determination

Muscle pH was measured on d14 immediately after fabrication. A portable pH meter (Model 1140, Mettler-Toledo, Woburn, MA) equipped with a puncture-type electrode was used to measure pH of the LT from the anterior end of the strip loin and the GM from the posterior end of the strip loin. The pH meter was calibrated using standard pH 4.0 and 7.0 buffers chilled to 4 °C. Two pH measurements were recorded for each steak and an average of these two values was reported.

2.6. Warner–Bratzler shear force determination

Steaks from the anterior end of the strip loin were weighed and cooked on open-hearth broilers to an internal temperature of 40 °C, then turned and cooked to a final internal temperature of 71 °C. Steaks were re-weighed to determine cooking loss and allowed to cool to room temperature. Six cores (1.27 cm diam.) were mechanically removed parallel with the muscle fiber orientation using a drill press-mounted coring device, and shear force was determined by shearing each core perpendicular to the muscle fibers using a Warner–Bratzler shear machine. The average WBSF value of the six cores ± SEM is reported.