

**AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
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TITLE: The Potential for Hazelnut Livestock Feed to Improve Meat Quality, Shelf-Life and Nutrition.

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SUMMARY: The current study seeks to investigate the suitability of hazelnut culls as a component in livestock rations and determine potential changes in the nutritional composition and shelf-life of pork from hogs fed cull hazelnut meal at 15 (H15) or 30% (H30) of their diet with a commercial ration as the base diet and sole feed for control hogs (H0). Current results have shown that color of pork chops in retail display is not affected by inclusion of hazelnut meal but lipid oxidation after 4 or 6 days of display is suppressed in H15 and H30 compared to H0. Vitamin E and nutritionally beneficial monounsaturated fatty acids, especially oleic acid (18:1), are found in greater levels when hazelnuts are included in the animals' diets. Supplementation of hog diets with meal from cull hazelnuts was beneficial for fatty acid composition from a human health standpoint and demonstrated potential benefits for the shelf-life of products in retail display in this study.

OBJECTIVES:

1. Determine nutritional composition of cull hazelnuts used as livestock feed.
2. Assess the effects of supplemental feeding of hazelnuts on pork quality, with respect to color, tenderness, oxidative potential and fatty acid composition.

PROCEDURES:

Hazelnut composition and meat quality effects

Fifteen Berkshire cross mixed sex (7 barrows, 8 gilts) hogs weighing 210 ± 17.4 lbs were assigned to 3 treatments: 1) basal diet (control), 2) basal diet w/ 15% hazelnut meal (H15) or 3) basal diet w/ 30% hazelnut meal (H30). Animals were housed indoors in individual pens with free access to water.

The basal diet was a pelleted dry ration formulated by a national feed company. For the H15 and H30 treatments, the basal diet was altered to include 15 or 30% hazelnuts by weight, respectively. Cull hazelnuts, including kernels and shells (~95%/5%), were obtained from a local processor; this product is representative of what would be offered as a typical component for livestock rations. The hazelnuts were ground by a hammer mill to a diameter of <1 mm. The ground hazelnut was analyzed for fat, crude protein, moisture, metabolizable energy and amino acid composition by a commercial lab.

Hogs were fed twice per day in amounts to allow ad libitum intake. All animals were weighed weekly. After 42 d on feed, the hogs were transported to a local abattoir and humanely slaughtered under USDA inspection. Three days after slaughter, the loin was exposed by cutting between ribs 10 and 11. After 30 minutes exposure, color was taken instrumentally (Hunter Lab Miniscan EZ 45/0 portable spectrophotometer) and subjectively using guidelines from the National Pork Board (1 – 6 scoring system). Marbling in the loin was also subjectively scored following National Pork Board guidelines (1 – 10 scoring system). A portable pH meter (Hanna Instruments) was used to record loin pH. Back-fat was recorded over the last rib.

After recording carcass characteristics, the loin (IMPS 412B) and belly (IMPS 408) were excised from the left side of each carcass (IMPS 412B), vacuum packaged and stored at 2 °C for 4 d. On the fourth day, the loins were removed from their packaging, trimmed of excess fat and connective tissue and sliced to 1 inch thick chops. The chops were weighed, then placed in black polystyrene trays (8 ¼" x 5 ¾" x ¾") with soaker pads and overwrapped with clear stretch film (RMF 61-HY). The overwrap film had an O₂ transmission rate of 217 cm³/1 m² per 24 hr at 23 °C. Samples of muscle and adipose tissue were taken during trimming, pulverized by blender after freezing in liquid N₂ and stored at -20 °C for further analyses (pH, fatty acid composition, phenols, Vitamin E content, fat, moisture).

Overwrapped chops from each loin were designated for either lipid oxidation, cook loss and tenderness or color. Chops were stored at 3 °C in a simulated retail display with continuous fluorescent lighting (1600 – 2200 lux; 3500 K color temperature). At days 2, 4 and 6, designated samples were removed from the display and re-weighed to determine purge losses. Subsequently, chops destined for cook loss and tenderness measurement were vacuum packaged and frozen (-28 °C) until analysis could be performed. For lipid oxidation analysis, a two mm slice of the chop face was taken, vacuum packaged and frozen (-28 °C) for later analysis. Day 0 chops were treated in the same manner as above without being placed in the retail display. Color steaks were monitored every 24 ± 1 hr for 10 days with a portable spectrophotometer. On day 10, a 2 mm slice of the chop face from the color samples was taken for lipid oxidation analysis as above.

Muscle tissue, adipose tissue, premixed diets and hazelnut raw materials were analyzed for Vitamin E, total phenols, fatty acid composition. Vitamin E was measured as α-tocopherol by HPLC after saponification and extraction of samples. Resulting values were compared to a standard curve from an α-tocopherol standard and quantified. Total phenols in hazelnuts, diets, muscle and adipose tissue were measured by the Folin-Ciocalteu colorimetric method after extraction in methanol. Fatty acid composition was determined by gas chromatograph after chloroform/methanol extraction and BF₃ methylation to yield fatty acid methyl esters (FAME). Fat, moisture and pH were determined on muscle samples only by solvent extraction, drying and dilution measurement with a table top pH meter, respectively.

SIGNIFICANT ACCOMPLISHMENTS:

Hazelnut composition and meat quality effects

It is common for hog diets in the United States to contain lipid sources high in polyunsaturated fatty acids, especially linoleic acid (18:2). This can result in greater deposits of linoleic acid in pork fat depots, contributing to increased lipid oxidation potential, high n-6/n-3 fatty acid ratio and increased fat softness. These factors to lead to detrimental effects on shelf life, nutritional impact on humans and decreased yields, respectively. The hazelnut is a crop rich in nutritionally beneficial oleic acid (18:1) and α-tocopherol. A cull segment of this crop comes from hazelnuts considered to be unmarketable to humans represents a relatively low-cost potential feedstuff for livestock. Altering the fatty acid profile of pork to reduce proportions of linoleic acid and increase oleic acid could allow for improved shelf life and a beneficial nutritional profile. To this end, we sought to explore the effects of adding cull hazelnuts as a lipid source to hog diets on pork shelf-life and fatty acid composition.

Cull hazelnuts (95% kernel/5% shell) were ground and used to replace a commercial pork finishing ration at 0, 15 or 30% (H0, H15 or H30, respectively) of the diet. Hogs (5/diet, avg. 97 Kg) were fed *ad libitum* individually for 42 d, then slaughtered. Loins were removed 72 hr postmortem and held at 3 °C in vacuum packaging for 4 d, then sliced into 2.54 cm thick chops. Chops were overwrapped with O₂ permeable film and placed into a simulated retail display with continuous fluorescent lighting (3500K CCT, 1600-2200 lux) and held at 3 °C. Color was monitored daily with a portable spectrophotometer and

samples were pulled at days 0, 2, 4 and 6 for determination of lipid oxidation by thiobarbituric acid reactive substances (TBARS). Additional samples were taken to determine fatty acid composition, α -tocopherol content and total phenols. Data were analyzed as a completely randomized design with individual hog serving as the experimental unit. Diet treatment was the main effect with analysis day serving as a repeated effect in the case of shelf-life analyses.

Redness (CIE a^*) declined over storage time for all treatments, but rate of decline was not different between treatments. Lipid oxidation (TBARS) was suppressed ($P < 0.05$) by 44-59% at d 4 and 6 by both H15 and H30 compared to H0. Total phenols were not different ($P > 0.05$ between diet treatments but α -tocopherol levels were 83 and 132% higher ($P < 0.05$) in H15 and H30, respectively, than H0. Levels of palmitic acid (16:0) were reduced ($P < 0.05$) in H30 pork while oleic acid (18:1) was increased ($P < 0.05$) from 43.7% to 48.2% and 50.4% in H15 and H30, respectively. No significant changes ($P > 0.05$) in linoleic acid (18:2) or n-6/n-3 ratio were detected.

Overall, pork fatty acid composition was improved nutritionally through increases in oleic acid (18:1) by hazelnut feeding. The suppression of TBARS was likely due to increased α -tocopherol levels in muscle but was not sufficient to produce noticeable effects on shelf life when measured by color change alone.

BENEFITS & IMPACT:

Hazelnut culls were investigated for their effects on pork shelf-life and nutritional compositions when used as a component in hog rations. In this study, when hogs were fed diets containing 15 or 30% hazelnut meal from cull hazelnuts, lipid oxidation in pork chops was suppressed through 6 days of retail storage although color change (loss of red color) was not affected. Vitamin E (α -tocopherol), an antioxidant compound, was detected in 82-131% greater concentrations in muscle when hazelnut meal was fed, which may explain the suppression of lipid oxidation. The n-6/n-3 ratio was positively impacted by hazelnut supplementation, as it was reduced from 12.2 to a low of 5.7 which is beneficial for human health. Supplementation of hog diets with meal from cull hazelnuts was beneficial for fatty acid composition from a human health standpoint and demonstrated potential benefits for the shelf-life of products in retail display in this study.

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