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CHEMICAL, SHELF-LIFE AND SENSORY PROPERTIES OF VACUUM-PACKAGED PRECOOKED PORK FROM HOGS FED SUPPLEMENTAL VITAMIN E

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Key Words: Pork, Vitamin E, Shelf-life

INTRODUCTION

A problem associated with precooked/stored/reheated meat is warmed-over flavor (WOF), which is caused by oxidation of the lipids in meat (Tims and Watts, 1958). Lipid oxidation in cooked meat greatly reduces its consumer acceptability because of the associated rancid flavor (Cross et al., 1987).

Dietary vitamin E (alpha-tocopherol) may be useful as an antioxidant for meat that is to be precooked. Vitamin E inactivates free radicals in cell membranes, thus inhibiting phospholipid oxidation, the primary source of WOF (Coehlo, 1991). Previous studies have shown that lipid oxidation is inhibited in cooked and stored poultry (Lin et al., 1989) and pork (Monahan et al., 1990a,b, 1992b) if the meat is from animals supplemented with vitamin E. Successful inhibition of WOF by feeding of supplemental vitamin E would allow the opportunity for the production of precooked meat products with acceptable shelf-life and sensory characteristics.

The objective of this study was to determine the influence of supplemental vitamin E, fed to pigs for 84 d prior to slaughter, on lipid oxidation, shelf-life and sensory characteristics of pork precooked using cook-in-bag technology.

MATERIALS AND METHODS

Feeding regimen

Thirty crossbred pigs were assigned to five pen blocks based on weight. Within each block, pigs were randomly allotted to one of two treatment groups: 1) a control diet containing no supplementary vitamin E (CON) and 2) a diet formulated to contain 100 mg/kg of feed of supplementary vitamin E (VITE). After an 84 d feeding period, pigs were slaughtered using commercial procedures.

Precooked chop study

Loin from the right side of the carcasses were removed, deboned and trimmed to not have more than 0.31 cm of external fat. Loins were sliced into 2.54 cm chops and were randomly assigned to five storage times -- 0, 7, 14, 28 or 56 d. Chops were vacuum packaged (-0.8 bar) in cook-in-bags, steamed-cooked in a commercial oven (Alkar Model 450, Alkar, Lodi, WI) to an internal temperature of 60°C, showered (21°C) for 10 min and then stored at 2°C for the specified storage period. Lipid oxidation, total plate count (TPC), sensory analysis, cooking/storage losses and reheating losses were evaluated at each storage time.

Lipid oxidation was determined using thiobarbituric acid (TBA) analysis procedures of Salih et al. (1987), with the modification of 5% (w/v) aqueous trichloroacetic acid as the extraction solvent. Results were expressed as TBA values (mg of malonaldehyde per kilogram of wet tissue). Samples (10 g) for microbial evaluation were aseptically placed into bags containing 90 ml of a sterile 0.1% peptone water solution and homogenized. Appropriate serial dilutions were made in sterile peptone water and 0.1 ml of each diluent were spread onto total plate count (TPC) agar plates. Plates were incubated at 25°C for 48 hr and bacteria colonies were counted.

Chops used for sensory evaluation were reheated on open-hearth grills (Farberware Model 155N, Walter Kidde, Inc., Bronx, NY) to an internal temperature of 70°C. Cubed portions from each chop were served to a 6-member trained sensory panel for evaluations of tenderness, juiciness, pork flavor intensity, off-flavor intensity and overall palatability. Panelists used a 15 cm line scale with anchors and a midpoint (0 cm = extremely unacceptable and 15 cm = extremely acceptable). Proximate analysis was conducted on *longissimus* muscle from the chops used for the zero-day evaluation.

Precooked roast study

Closely trimmed *semimembranosus/adductor* muscles were removed from both fresh hams (n=60) of each carcass and were used to represent a product which would be prepared as a roast. Roasts were vacuum packaged (-0.8 bar) in cook-in-bags, steam-cooked to an internal temperature of 60°C and showered (21°C) for 10 min. Roasts were randomly assigned, by treatment, to five storage times (0, 7, 14, 28 or 56 d) and were held at 2°C for the specified storage period. Sensory evaluation, TBA analysis, TPC, storage losses and reheating losses were determined at the end of each storage period. Roast slices were reheated in a Hobart Model DN 97-19 convection oven (Hobart Corporation, Troy, OH) at 149°C to an internal temperature of 70°C. Sensory evaluation was conducted employing the procedures used for the precooked chops. Moisture and lipid contents as well as TBA and TPC analysis were determined.

All data were analyzed using the General Linear Model procedures of SAS (1986). For the precooked chop study, TBA, TPC, pH, cooking/storage losses, reheating losses and taste panel data were analyzed using a repeated measures model that included the fixed effect of treatment and storage period as a repeated measure. Data for precooked roasts (TBA, TPC, pH, reheating losses, storage losses and taste panel evaluations) were analyzed using a completely randomized design. The model included the fixed effects of treatment and storage period, and the interaction between the two effects. Lipid and moisture data for both the chop study and roast study were analyzed using a complete randomized block design.

RESULTS AND DISCUSSION

Precooked chop study

Percentage moisture and percentage lipid were not different ($P > 0.05$) for precooked chops from pigs supplemented with vitamin E as compared to precooked chops from pigs fed the control diet. At 0 d, 14 d, 28 d and 56 d, TBA values were lower ($P < 0.05$) for VITE chops than for CON chops. The lower TBA values for cooked chops from pigs fed supplemental vitamin E agree with the results of Monahan et al. (1990a,b). The TBA values detected were below the threshold value (TBA) needed for detection of WOF (Boles and

Parrish, 1990). The relatively low extent of lipid oxidation can be attributed to the use of the cook-in-bag process, which removed oxygen by vacuum-packaging the product prior to cooking.

Sensory characteristics of precooked chops from control pigs and from pigs supplemented with vitamin E were not significantly different. The lack of differences in off-flavor intensity relate to the fact that the detectable level of lipid oxidation was below the threshold value needed to result in WOF. Cooking/storage losses were numerically lower, but not statistically significant, for VITE chops than for CON chops throughout the storage period.

No differences ($P > 0.05$) in TPC existed between treatments at any given storage time, but during the storage period, counts increased ($P < 0.05$) by approximately one log. According to Ayres (1955), typical spoilage occurs at bacterial levels between 10^7 and 10^8 CFU/g. The TPC values observed throughout the storage period in the present study were far below the level of 10^7 indicating that, by using the cook-in-bag processing, precooked *longissimus* chops can be stored for at least 56 days. Acceptable TBA values, sensory characteristics and microbial levels were maintained through the 56-day storage period.

Precooked roast study

Percentage moisture was lower ($P < 0.05$) in the muscles of VITE roasts than in the muscles of CON roasts while lipid levels were similar in the muscles of roasts from the two treatments. Although the difference in percentage moisture was significant, the magnitude of the difference (73.57% compared to 72.63%) was very small. At 0 d, 7 d and 14 d, TBA values were lower ($P < 0.05$) for VITE roasts than for CON roasts. The trends in lipid oxidation observed in the precooked roast study were similar to those in the precooked chop study. Only CON roasts stored for 14 d had TBA values above the threshold value for detection of WOF. These results indicate that precooking under vacuum and then storing under vacuum can minimize lipid oxidation over an extended period of time and that supplementation of vitamin E to the live animal can be used as added insurance to reduce lipid oxidation.

Sensory panel score for off-flavor intensity -- indicators of WOF -- were consistently lower ($P < 0.05$) for VITE roasts than for CON roasts. Values for overall palatability were higher ($P < 0.05$) for VITE roasts than for CON roasts and followed a pattern similar to that for off-flavor intensity for the duration of the storage period. At 0 d, 7 d and 14 d, VITE roasts had higher ($P < 0.05$) tenderness ratings than did CON roasts. No previous research on feeding supplemental vitamin E to pigs has resulted in differences in tenderness. These results indicate that precooked roasts, prepared and stored under the conditions of the present study, have acceptable sensory characteristics after storage for up to 56 d, and that adding supplemental vitamin E to the swine diet will help ensure minimal detection of off-flavors and can optimize sensory acceptability of such product.

Cooking/storage losses were consistently lower ($P = 0.05$) for VITE roasts than for CON roasts. This trend relates to that which was observed but was not significant for the precooked chops. Previous investigators have reported that vitamin E supplementation of swine diets significantly lowered storage drip-loss of fresh pork chops (Asghar et al., 1991a; Monahan et al., 1992a). Reheating losses were not different ($P > 0.05$) between the two treatment groups in the present study.

Total plate counts were higher for VITE roasts than for CON roasts at 0 d and 14 d of storage, but no consistent storage effects were detected and the maximum counts detected did not exceed 3.0 log CFU/g. As with the precooked chops, the TPC values for the precooked roasts were well below TPC levels at which products are considered to be spoiled.

CONCLUSIONS

Overall, these results suggested that cook-in-bag technology can be used to store precooked pork chops and roasts for at least 56 days. During storage for 50 d, lipid oxidation and microbial growth can be minimized and sensory characteristics can be maintained at acceptable levels by use of the cook-in-bag technology. Additionally, supplementation of vitamin E in the swine diet during the growing/finishing period can provide added protection against lipid oxidation when the pork is to be precooked.

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