THE IMPACT OF BEEF CHUCK MUSCLE ISOLATION ON OXIDATION RATE AND ODOR PROFILE

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Abstract – This experiment evaluated whether isolating certain muscles from the chuck for retail sale and excluding them from ground beef would cause a change in the number of days that ground beef is acceptable to consumers. Ground chuck was made including traditional muscles and excluding muscles that have been identified for individual retail sale (innovative). Raw patties were analyzed for thiobarbituric acid reactive substances (TBARS) and by a trained sensory panel for odor, and flavor volatiles were analyzed on cooked patties. No differences ($P > 0.05$) were observed in TBARS between traditional and innovative patties. Average TBARS concentrations were higher ($P < 0.05$) on day 6 than day 2, with values of 0.100 and 0.086 mg TBARS/kg meat, respectively. No differences ($P > 0.05$) were observed in trained sensory panel between innovative and traditional patties on any days. Average 'fruity' and 'putrid' notes were higher ($P < 0.05$) on day 7 and 'sour' notes increased ($P < 0.05$) from day 1 to 7. No differences ($P > 0.05$) in 2,3 Octanedione concentration were observed between treatments. This study shows that the exclusion of certain muscles from ground chuck does not appear to have an impact on oxidation rate and odor profile.

Key Word – Ground beef, Lipid oxidation, Odor, Shelf life

• INTRODUCTION

The success of the Beef Muscle Profiling Project led processors to isolate muscles from the chuck for individual sale and gain an approximate US $50 to $70/head in market value [1]. One of the consequences of this practice is the decrease in ground chuck available for premium grinds. In addition, previous research has shown differences in functional characteristics, such as color, heme-iron content and pH, between the most popular chuck muscles being utilized as steaks [1]. Other research has shown that using muscles with different color stabilities in ground beef can dramatically affect its shelf life as determined by discoloration and oxidation [2]. Neither of the aforementioned studies looked at using chuck muscles in different combinations. Our hypothesis is that isolating certain muscles from the chuck for retail sale and excluding them from ground beef will cause a change in the number of days that the ground beef has a viable appearance to consumers. The objective of this study was to determine the impact of removing high value muscles from ground chuck on the overall odor and flavor stability of ground chuck at four different retail storage time periods.

• MATERIALS AND METHODS

Ground Beef Manufacture:

Twenty-four beef steers were slaughtered at the University of Missouri-Columbia in groups of six. Right chucks were assigned to a traditional method and left chucks to an innovative method. Traditional included trim from the neck and shank, half of the clod (IMPS 114) and half of the chuck roll (IMPS 116A). Innovative included trim from the neck and shank, half

of the clod heart (IMPS 114E), half of the chuck eye roll (IMPS 116D), and excluded the infraspinatus (IMPS 114D), supraspinatus (IMPS 116B), teres major (IMPS 114F) and serratus ventralis (IMPS 116G). Resulting ground beef patties were placed on Styrofoam trays, overwrapped with polyvinyl chloride (PVC) and displayed under florescent lights at approximately 4°C for up to 7 days following fabrication to determine oxidative stability.
Fat Determination: Fat percentage determination, using the CEM procedure (CEM SMART Trac system, Matthews, NC, USA), described in Dow *et al.* [3] was conducted in triplicate. Briefly, 3.75 – 4.5 g of sample was dried in between two pads, wrapped in TRAC paper, and packed into the bottom of the CEM TRAC tube. Fat percentage was determined on a dry weight basis using nuclear magnetic resonance and converted to a wet weight basis.

Determination of Lipid Oxidation:

Patties were pulled on days 2 and 6 after fabrication to determine lipid oxidation using the thiobarbituric acid reactive substances (TBARS) extraction method, described by Pegg [4]. Briefly, 5 g of ground meat, 2.5 mL antioxidant solution, 50 mL TCA reagent and 50 mL distilled water was homogenized. The slurry was filtered, and a 5 mL aliquot was pipetted into a 50 mL centrifuge tube. 5 mL thiobarbituric acid (TBA) reagent (0.02M TBA in distilled water) was added to the solution and the tube was capped and vortexed for 3 sec. The tubes were placed in a boiling water bath for 35 min, removed, and placed promptly in ice for 5 min. The sample was transferred into a cuvette and absorbance was read at 532 nm using a spectrophotometer. A standard curve and malonaldehyde recovery were conducted to determine mg TBARS/kg meat.

Sensory Panel:

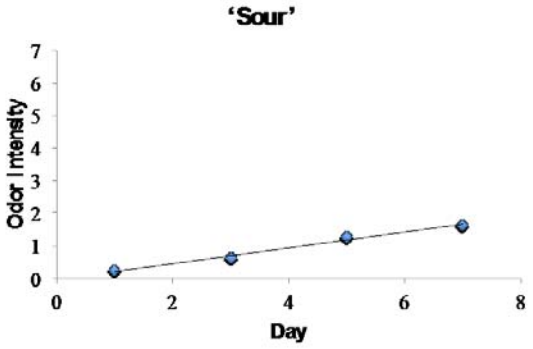
A team of eight, trained sensory panelists evaluated objective odors of patties on days 1, 3, 5 and 7 using the methods described by Rhee *et al.* [5]. Patties were placed in 15.24 cm diameter, glass petri dishes thirty minutes before sensory evaluation. Plastic watch glasses were placed on each glass dish to trap the odor volatiles. Two min was timed between panelists to allow for the re-accumulation of volatiles. Panelists briefly lifted the watch glasses to sniff the patties and immediately recorded the off odors detected. Off odor descriptors included 'putrid', 'sour' and 'fruity', and each descriptor had an 8-point intensity scale (0 = no off odor, 7 = extreme off odor). Panelists assigned odor intensity for each descriptor to each patty. References for each off odor were available to panelists throughout the sensory evaluation [5]. Strawberry yogurt was defined to give an intensity of 6 on the fruity scale and buttermilk had an intensity of 4 on the sour scale. Additionally, intensity markers were available to panelists at each evaluation, with 8 vials of increasing concentration of vanilla to water (0 – 100% water, 0% vanilla and 7 – 0% water, 100% vanilla).

Flavor Volatile Analysis:

Flavor volatile analysis was conducted on cooked patties on days 1, 3 and 7 as described by Fernando *et al.* [6] with some revisions. Patties were cooked in an impingement oven (Blodgett Combi Oven, Model 00S8E/AA; Burlington, VT, USA) at 204°C for 7 min. Cooked patties were mashed and 5 g sample was weighed into 10 mL auto-SPME sample vials (Supelco, Bellefonte, PA, USA) and 100 µL internal standard (2-methyl pentonal in distilled water) was added. Sample order was randomized before each analysis and duplicates were run in the same sequence following sample. Aluminum vial caps containing Teflon-lined septa (Supelco) were crimped. The vials were heated on a hotplate to 70°C for 30 min and then allowed to return to room temperature. A Varian 3400CX gas chromatograph (Varian Associates, Walnut Creek, CA, USA), equipped with a Varian 8200 auto sampler in the SPME mode containing a 50/30 µm DVB/CAR/PDMS stableflex SPME fiber (Supelco)

was used to analyze the flavor volatile content in the headspace. An absorption time of 20 min and desorption time of 3 min in the splitless mode was used for this purpose. The gas chromatographic column used was a DB-5 column. Column flow (He) and split flow were 1 and 100 mL/min, respectively, at 10 psi column head pressure. Injector and detector (FID) temperatures were maintained at 250°C and 275°C, respectively. The column temperature was maintained at 35°C for 3 min and raised to 220°C at 5°C/min, then to 250°C at 10°C/min and held at 250°C for 2 min. The data were processed using a Varian Star (Varian Associates) chromatographic workstation. Quantitative estimation of flavor volatile concentration was achieved using an internal standard method. A Varian GC 3400CX (Varian Associates), equipped with a 1078 programmable injector connected to a Varian Saturn 2000 Mass spectrometer with an ion trap detector was used for GS-MS analysis. Volatiles were separated using a DB-5 fused silica capillary column. Helium carrier gas glow rate was 1mL/min and injector, transfer line and ion trap temperatures were 250, 250, 150°C, respectively. Desorption time of SPME fiber at the injection port was 4 min in the splitless mode and the post desorption split flow was 100 mL/min. Identification of 2, 3 Octanedione was established using mass spectra comparison with the NIST 1992 and Wiley 5 libraries, retention indices of standards and literature values.

Statistical Analysis:



Statistical analysis was performed using the MIXED procedure of SAS (version 9.2, SAS Inst., Cary, NC USA) with fat percentage as a covariate. $P < 0.05$ was used to determine significance.

- RESULTS AND DISCUSSION

The mean fat percentage for traditional patties was 17.7% and for innovative patties was 17.3% and they did not differ. However, because of the effect fat percentage has on lipid oxidation, fat percentage was used as a covariate in all statistical analyses.

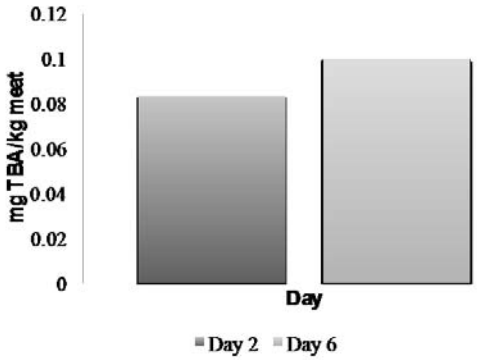
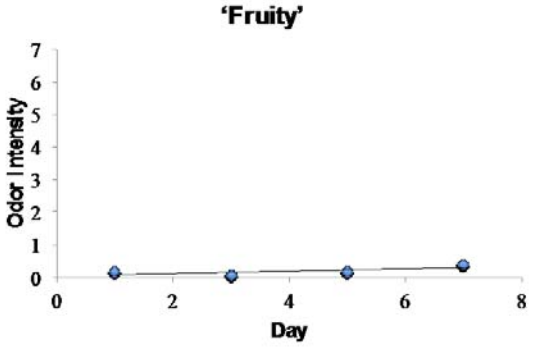
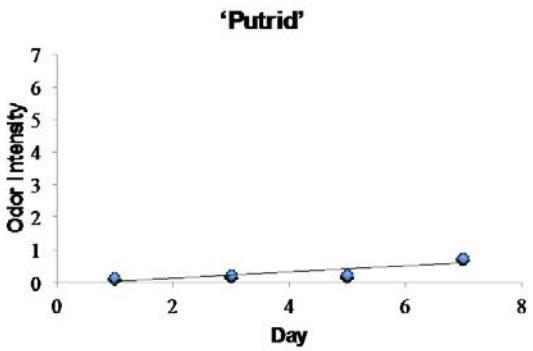


Figure 1. Effect of days of storage on thiobarbituric acid reactive substances (TBARS).

Lipid Oxidation: No differences ($P = 0.295$) in TBARS were observed between traditional and innovative patties, with average values of 0.095 and 0.088, respectively. TBARS increased ($P < 0.05$) between days 2 and 6, with average values of 0.083 and 0.100, respectively (Fig. 1). These values are much lower than those reported by other researchers with similar shelf-life studies [2, 5] which may be due to different packaging and storage conditions. Trim from this study was sourced at 3 d carcass aging and was never subject to temperature abuse which may explain the differences in TBARS values between this study and previous studies.





[1]Odor intensity scale 0 = no off odor and 7 = extreme off odor

Figure 2. Effect of day of storage on trained sensory panel odor scores[1]

Sensory Panel:

No differences ($P > 0.05$) were found on any days for 'fruity,' 'putrid' or 'sour' notes between innovative and traditional patties in the sensory panel. 'Fruity' and 'putrid' notes were higher ($P < 0.05$) on day 7 compared to the other days of storage. Both of the 'fruity' and 'putrid' notes, which are more related to spoilage than oxidation, did not rise to a 1 on the scale indicating that spoilage had not occurred during the length of this study (Fig. 2). However, 'sour' notes ($P < 0.05$) increased with days of storage (Fig. 2) which parallels the TBARS findings, indicating that oxidation did occur in the latter stages of this study. Our results were similar to those reported by Rhee *et al.* [5] which showed no change in 'fruity' and 'putrid' odors from day 0 to 8 but an increase in 'sour' odors.

Flavor Volatiles:

2,3 Octanedione was chosen as a flavor volatile of interest because this compound is associated with warmed over flavor and lipid oxidation [7]. Concentration of 2,3 Octanedione was not different ($P = 0.697$) between innovative and traditional patties. Average concentrations of 2,3 Octanedione was higher on day 7 than days 1, 3, and 5 (Fig. 3). This indicates that oxidation occurred in cooked ground chuck after day 7 of shelf-life.

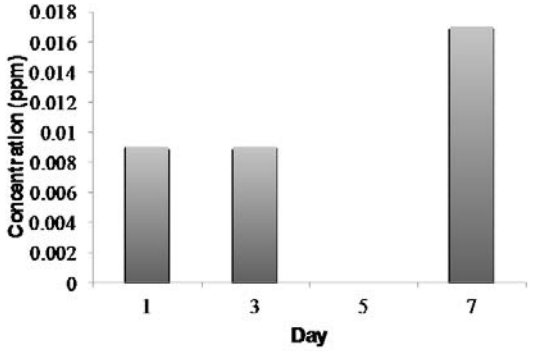


Figure 3. Effect of day on 2, 3 Octanedione concentration

- CONCLUSION

This study showed that the isolation and exclusion of certain muscles from the beef chuck has little if any impact on the oxidation rate and odor profile of the resulting ground beef. The sensory panel did not detect any differences ($P > 0.05$) in off odors and there were no differences ($P > 0.05$) in TBARS or 2,3 Octanedione concentration between treatments. Therefore, meat processors may continue the practice of excluding higher valued cuts from ground chuck without detrimental effects on oxidation rate or odor. Economic analysis, color analysis, and myoglobin information would paint a more complete picture to help meat processors make research-based decisions regarding ground chuck.

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