ANALYSIS OF QUALITY OF VARIOUS SOURCES OF GROUND BEEF

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Abstract – Traditional grind sources (T) were compared with non-traditional grind sources (N). All grinds were then packaged in overwrapped foam trays (OW), clear chubs (CH), or overwrapped foam trays in a low oxygen modified atmosphere bag (MAP). Retail display was conducted to simulate industry practices for each respective packaging treatment. Starting on the day packages were placed on display (d0), 3 packages from each grind/package treatment were removed for further analysis and 5 packages from each package/grind treatment were selected at random for daily color evaluation. After completion of the retail display period, oxidative rancidity evaluation was conducted. Between grinds, as fat percentage increased, L* tended to increase and a* tended to decrease. Between packaging, all treatments were different for L*, a* and b* (*P*<0.05). For days of display, all L* values were not different (*P*>0.05) until d3 of retail display. For days on display, a* and b* values were different (*P*<0.0001, *P*<0.05, respectively) except d2 and d3 (*P*=0.06). Two of the highest percentage fat grinds had the greatest thiobarbituric acid reactive substances (TBARS) values. Days 4 and 5 had the greatest values for TBARS. Day 3 was not different than d5 (*P*=0.33), and d0 to d3 were not different (*P*> 0.05).

Key Words – Beef grind source material, Non-traditional ground beef, Traditional ground beef

- INTRODUCTION

Historically, ground beef has been marketed by fat content, but now branded beef programs have become a very popular way to add value to beef. Over 75 of these branded programs now exist, with the oldest being Certified Angus Beef which was initially released in 1978 [1]. Some of these programs are associated with USDA Quality Grades as well as other qualifications, while others insinuate a production system in which the cattle were raised. Extensive research has been done on the effect of marbling (one of the key qualifications in USDA Quality Grading) on palatability in whole muscle cuts, yet little has been done to suggest that quality grade neither impacts nor if any of these branded programs truly represent differences in ground beef palatability.

Marbling is a good indication of overall palatability in loin cuts [2]. Additionally, Marbling is one of the major factors involved in the determination of USDA Quality Grade [3]; therefore branding programs with a quality grade requirement should be at least equal in quality to their associated quality grade.

The 2011 National Beef Quality Audit [4] indicated that consumers are confused by terminology in regards to quality. Research has shown consumers that self-identify as having low familiarity to the product they are purchasing show a 0.75 correlation between branding of the product to expected eating quality [5]. Branding, in this case, could both be seen as certification programs, in-store brands, or possibly USDA Quality Grades if they are shown on the package as was the brand created in the Bredahl [5] study. This indicates that consumers rely heavily on cues from branding when determining quality of beef they intend to purchase. As stated previously, these brands or quality grades are good indicators of quality in whole muscle cuts, but little research has been done to evaluate ground beef from these brands and how they differ from traditional ground beef.

The objective of this study is to examine ground beef from traditional and non-traditional (branded) grind materials to determine if differences exist that differ from what is expected based on fat percentage. It is hypothesized that differences in sensory characteristics, shelf life and color stability between these grind materials should follow a similar pattern as seen in previous studies of fat percentage in ground beef.

- MATERIALS AND METHODS

Ground Beef Materials

Ground beef from ten different grind sources were shipped to Cargill Meat Solutions' Research and Development Center (Wichita, KS) for evaluation. Three of the grinds were from traditional beef grind materials and the remaining seven were from non-traditional or branded grind materials. All grinds were finely ground prior to arrival.

Packaging

The ground beef was stored overnight and processed into retail packaging the next day. Each grind was packaged in to three packaging treatments: 0.45 kg loaves on traditional 2S Styrofoam trays (Cryovac, Duncan, SC) with absorbent diapers and overwrapped with oxygen-permeable polyvinyl chloride film (O_2 transmission = 23,250 mL/m^2/24 h, 72 gauge), 0.45 kg loaves on traditional overwrapped 2S Styrofoam trays in a modified atmosphere shipping bag, and 0.45 kg of meat stuffed into clear chubs.

After packaging, half of the overwrapped foam trays were placed into storage bags along with Multisorb CR20 Oxygen Scavenger (Multisorb Technologies, Buffalo, NY). Using a Fresh Vac Modified Atmosphere Machine (CVP System, Inc., Downers Grove, IL), air was then vacuumed out and flushed with an industry standard low oxygen gas mix, (approximately 0.4%CO, 30% CO_2, 60% N_2).

Storage and Retail Display

Traditional overwrapped foam trays were immediately placed on retail display in a Hussman retail display case (Hussman, Bridgton, MO). Chubs were held for three days in dark storage to simulate shipping then placed on retail display. Overwrapped foam trays in the modified atmosphere storage bags were placed in individual plastic trays to prevent crushing of the bags. These trays were placed in dark storage for three days then moved to normal storage for an additional seven days to simulate average shipping and storage of retail ground beef. After storage, packages were placed on retail display for five days. Every day, starting on d0, three packages were removed from display and frozen for later analysis. Additionally, 5 packages were selected at random and scanned with a Hunter Miniscan XE Plus (Hunter Lab, Reston, VA) starting on d0 and rescanned every 24 hours.

Processing

Once thawed, each sample was removed from its retail package and placed in a 20.3×38.1 cm 3mil High Barrier Nylon/Ethylene Vinyl Alcohol/Polyethylene Vacuum pouch (Cryovac, Duncan, SC) and mixed thoroughly by hand. From these bags approximately 50g were removed and placed in a 50mL plastic conical tube (VWR, Radnor, PA) for analysis in the laboratory.

Thiobarbituric Acid Reactive Substances

A modified Buege and Aust [6] procedure for thiobarbituric acid reactive substances (TBARS) was used to measure the levels of malondialdehyde in each kg of meat.

Statistical Analysis

Statistical analysis was performed with the mixed procedure of SAS (SAS Inst. Inc., Cary, NC). Type-3 tests of fixed effects were performed for all variables. Grind product, packaging treatment and day of storage were fixed effects. Least squares means for protected F-tests ($P < 0.05$) were separated by using least significant differences (LSD, $P < 0.05$).

- RESULTS AND DISCUSSION

Color

In this study, grind materials were compared by fat percentage. Table 1 lists the means of the colorimetric values L*, a*, and b* for each grind. It was hypothesized that greater fat percentages would equal greater L* values as the increasing amount of fat would create a lighter color than smaller amounts of fat. The traditional grinds followed this trend closely. While the 6.2% and 8.1% fat non-traditional grind materials did have the smallest L* values, the remaining non-traditional grind materials varied in L* values in a manner that did not follow this trend.

Redness or a* values did not follow the hypothesized trend that as fat percentage increased, a* values would decrease because of the lesser amount of lean red tissue in those materials. Neither the traditional nor the non-traditional grind materials fit this idea.

Overall, color values did not trend with the fat content in each grind as hypothesized. Differences in these color measurements could be associated with differences in the fiber type, quality grade, production practice, or other factors in each grind material beyond fat percentage.

Table 1 LSMEANS of colorimetric values and SEM for traditional and non-traditional grinds

Fat %	L*	a*	b*
Traditional			
9.6	44.55 ± 0.13^{e}	16.98 ± 0.21^{b}	18.83 ± 0.09^{bc}
11.4	49.47 ± 0.13^{b}	13.75 ± 0.21^{ef}	18.48 ± 0.09^{d}
16.3	50.19 ± 0.13^{a}	14.70 ± 0.21^{d}	18.72 ± 0.09^{cd}
Non-traditional			
6.2	39.61 ± 0.13^{g}	14.18 ± 0.21^{de}	17.17 ± 0.09^{g}
8.1	39.94 ± 0.13^{g}	19.21 ± 0.21^{a}	18.90 ± 0.09^{bc}
10.5	41.11 ± 0.13^{f}	18.76 ± 0.21^{a}	19.03 ± 0.09^{b}
19.3	49.41 ± 0.13^{b}	15.79 ± 0.21^{c}	19.27 ± 0.09^{a}
21.3	48.25 ± 0.13^{c}	10.95 ± 0.21^{g}	17.68 ± 0.09^{f}
28.4	47.52 ± 0.18^{d}	13.36 ± 0.28^{f}	18.03 ± 0.11^{e}
29.0	49.73 ± 0.13^{b}	11.10 ± 0.21^{g}	17.95 ± 0.09^{e}

^{abcdefg}Means within the common superscripts in the same column are not different (P>0.05).

Colorimetric values for the packaging treatments are shown in Table 2. The MAP packaging displayed the greatest L*, a* and b* values. This was followed by the OW packaging and the CH packaging. These results were expected. Carbon monoxide in the MAP packaging binds to myoglobin in the meat, reducing the rate of oxidation due to the lack of oxygen while maintaining the fresh meat color. The chub had an anaerobic atmosphere, so lesser colorimetric values were expected over the MAP and OW. This anaerobic environment removes the oxygen needed to bind to myoglobin to create oxymyoglobin. In this state, deoxymyoglobin is produced showing a more purple color.

Additionally, a day of display effect was measured and the colorimetric values are displayed in Table 3. These results were expected. As oxidation of both lipids and myoglobin occurs overtime, color is impacted negatively.

Table 2 LSMEANS of colorimetric values and SEM for traditional and non-traditional grind products in three different packaging treatments

Package	L*	a*	b*
Modified Atmosphere	47.27±0.08[a]	17.81±0.12[a]	19.68±0.05[a]
Overwrap	45.53±0.08[b]	15.29±0.12[b]	18.62±0.05[b]
Chub	45.13±0.08[c]	11.53±0.12[c]	16.91±0.05[c]

[abc]Means within the common superscripts in the same column are not different (P>0.05).

Table 3 LSMEANS of colorimetric values and SEM for traditional and non-traditional grind products over days of storage in retail display

Day	L*	a*	b*
0	45.55±0.10[c]	21.30±0.17[a]	20.49±0.69[a]
1	45.53±0.10[c]	17.62±0.17[b]	19.53±0.69[b]
2	45.76±0.10[c]	15.35±0.17[c]	18.61±0.69[c]
3	46.02±0.10[bc]	13.69±0.16[d]	18.34±0.69[d]
4	46.18±0.10[b]	11.51±0.17[e]	16.94±0.69[e]
5	46.70±0.10[a]	9.78±0.17[f]	16.52±0.69[f]

[abcdef]Means within the common superscripts in the same column are not different (P>0.05).

Thiobarbituric Acid Reactive Substances

Thiobarbituric acid reactive substances (TBARS) are an indication of the lipid oxidation of a sample. As the level of lipid oxidation increases in a sample, the TBARS value increase. The greatest TBARS value was detected in the 21.3% and 29.0% fat non-traditional grind materials. The least TBARS value was in the 19.3% fat non-traditional grind material. It was hypothesized that as fat percentage increased, so would the amount of lipid oxidation and, in turn, TBARS values. This did not hold true. Also, the grind materials with the greatest TBARS values were frozen prior to arrival at the research facility, possibly altering the ultimate lipid oxidation which occurred.

The MAP had the greatest TBARS values, followed by OW and then CH for packaging treatment averaged over the grind products and days of display (Table 4). MAP packaged materials were much older than both OW and CH, leading to increased oxidation once removed from the modified atmosphere. The anaerobic environment presented in the CH packaging method

Table 4 LSMEANS of Thiobarbituric Acid Reactive Substances values and SEM for traditional and non-traditional grind products in three different packaging treatments

Package	MDA mg/kg
Modified Atmosphere	1.73±0.08[a]
Overwrap	1.28±0.08[b]
Chub	0.90±0.08[c]

[abc]Means within the common superscripts in the same column are not different (P>0.05).

There was also a days of display effect. D0, 1, 2 and 3 lesser TBARS values and were not different (P>0.05) and d 4 and 5 had greater TBARS values and were not different (P>0.05) form one another or from d 3 (Table 5).

Table 5 LSMEANS of TBARS values and SEM for traditional and non-traditional grind products over days of storage in retail display

Day	MDA mg/kg
0	1.17±0.11[a]
1	1.13±0.11[a]

2	1.06±0.11[a]
3	1.36±0.11[ab]
4	1.59±0.11[b]
5	1.52±0.11[b]

[ab]Means within the common superscripts in the same column are not different (P>0.05).

- CONCLUSION

Some factors appear to play a large role in shelf life and color stability other than fat content. Additional research should be conducted to identify these factors. The 19.3% fat non-traditional grind material appeared to be superior in many respects, even to grinds of similar fat content. Factors such as genetics of cattle, cattle sex and age, feeding programs, production systems, quality grade, and others should be evaluated in ground beef at the different levels of these factors at the same fat percentage or different fat percentages within one level of the factor with all other factors being equalized could help identify the relationship of each to fat content.

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