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REDUCTION OF MICROBIAL POPULATIONS IN HIGH AND LOW FAT BEEF TRIM IN RESPONSE TO SURFACE FLAMING. T.R. VOSEN, W.B. MIKEL, S. DALE, D.E. CONNER, J.S. KOTROLA, W.R. JONES AND W.H. GREGORY. AUBURN UNIVERSITY, DEPARTMENT OF ANIMAL AND DAIRY SCIENCES, AUBURN UNIVERSITY, AL 36849. Key words: Beef patties, Microbiological, Heat resistance.

BACKGROUND

Increasing consumer demands upon the meat industry for a more wholesome ground beef product has led to a reevaluation of production techniques and possible intervention methods. Since microbial populations have been found to be related to product fat level (Vanderzant et al., 1986), possible methods of microbial reduction on products with various levels of fat should be investigated. Final cooking temperature has proven effective in eliminating microorganisms in muscle foods, therefore it appears logical that short-time high-temperature heating on raw materials may be a viable intervention step in the reduction of inherent microbial populations.

OBJECTIVES

Objectives were to determine the effects of surface flaming of low and high fat beef trim on microbial populations and quality aspects of ground beef patties destined for retail marketing.

Materials and Methods

Processing Procedure:

Semitendinosus muscles from cull cows were obtained from the Lambert Meat Science Laboratory (Auburn University, AL), vacuum sealed and frozen at -20°C until used. Muscles were tempered at 0°C for 48 h with one-half trimmed of all visible fat and the remainder retaining all external fat. Muscles were sliced into 1.27 cm^2 strips, with the length of the strips determined by the width of the muscle. Low fat (1.60%) and high fat (20.25%) beef strips were placed in covered pans and tempered at 4.4°C for an additional 12 h and divided into four 2.95 kg treatments. Beef strips were weighed and placed on a sterile stainless steel mesh belt for flaming both dorsally and ventrally, simultaneously for either 0 and 10 seconds of surface contact time. Treatments were: LF0 = low fat, no heat; HF0 = high fat, no heat; LF10 = low fat, flame 10 seconds; HF10 = high fat, flame 10 seconds. After flaming, beef strips were weighed, ground twice through a 4.5 mm grinding plate using a Kitchen Aid Model #KSM90WH Mixer/Grinder (St. Joseph, MO), formed into 113.5 g patties, placed onto styrofoam meat trays and overwrapped with an oxygen permeable film. Patties from each treatment were stored for one of five storage periods (0, 1, 2, 4, and 8 days) of cooler storage at 1.7°C.

Microbial, Chemical and Physical Analysis:

Populations of aerobic, anaerobic, and psychrotrophic bacteria were enumerated at each storage period. All microbial data was expressed in log cfu's/g of sample. Determination of metmyoglobin concentration (Chen and Trout, 1991) was performed at each storage period. Samples (5 g) were added to 50 ml of 0.04M phosphate buffer (pH 6.8), homogenized for 30 seconds and the homogenate was centrifuged for 30 minutes at 5°C (50,000 x G). The supernatant was filtered through Whatman No. 1 filter paper and analyzed spectrophotometrically at 525, 572, and 730nm. The measurement of metmyoglobin was expressed as a percent. Product pH was determined using 100ml of deionized distilled H_2O and 10g of product mixed for 30 seconds with pH recorded with an Extech Instruments Corporation pH Meter. Objective product color measurements were obtained for patties at each storage period using a Hunter Labs D25 DP9000 (Reston, VA) Color Difference Meter. The unit was standardized using a white (C2-36852) standard plate with values expressed as Hunter Color "L", "a" and "b" values. Water-holding-capacity was determined at 0 and 8 days of cooler storage according to the procedures of Hamm (1960). The amount of free water was calculated as follows: mg free water = (area in cm^2/0.0498) + 8.0. Analysis of 2-thiobarbituric acid reactive substances (TBARS) were determined according to the procedures of Ke et al. (1984). Sarcomere lengths were determined according to the procedures of Elgasim et al. (1981) at 0 and 8 days of cooler storage. Sarcomeres were counted using a Olympus BH2 Microscope utilizing a 10^2 power oil emersion lens. Lengths of sarcomeres were reported in uM. Post-treatment temperatures were obtained from freshly ground meat at five randomly selected sites using a Koch Supplies Incorporated AT-500 Digital Thermometer (Kansas City, MO). Moisture, fat and protein analysis were performed in triplicate according to AOAC (1984) methods on a randomly selected sample taken from lean beef strips immediately prior to treatment. Pattie surface discoloration was evaluated at each storage period by a four member experienced panel. Each panelist viewed patties in a retail display case to determine percent pattie surface discoloration and percent surface fat smearing immediately after processing. This experiment was conducted as a 2X2 factorial in a split-plot over time with two replications (Steele and Torrie, 1980). When differences (P<0.05) were determined, means were separated by Student-Newman-Kuels Test (SAS, 1988).

Results and Discussion

Microbial, physical and chemical attribute date are shown in Table 1. Total-plate-counts (TPC) were different (P<0.01) between treatments, days of cooler storage and product fat levels. The HF0 patties had higher (P<0.01) log cfu's/g than other products, which were similar (P>0.05) for TPC. Pattie TPC increased as cooler storage lengthened with Day 0, 1, and 2 patties displaying similar (P>0.05) but lower TPC (P<0.01) than Day 4 or 8 patties. Additionally, Day 4 patties had lower (P<0.01) total aerobic counts than Day 8 patties. Higher fat products had greater TPC (P<0.01) than lower fat products. Psychrotrophic-plate-counts (PPC) were different (P<0.01) among treatments, days of cooler storage and fat levels. Products LF0 and LF10 had lower (P<0.01) PPC than HF0 and HF10 products, with HF0 patties having higher (P<0.01) counts than HF10 patties. Psychrotrophic colonies increased over time (P<0.01) at each storage period. Higher fat products had greater (P<0.01) counts than products with less fat.

Pseudomonad counts (PSU) of products were different (P<0.01) among treatments, days of cooler storage and fat levels. Treatment HF0 patties exhibited higher (P<0.01) counts than all other products. In addition, while being similar (P>0.05) to LF10 patties, LF0 had lower (P<0.01) PSU than HF10 patties. Over storage time, PSU counts were similar (P>0.05) for Days 0 and 1, but were lower (P<0.01) than Days 2, 4 and 8 which increased (P<0.01) chronologically. Higher fat products had greater (P<0.01) PSU counts than lower fat products.

Lactobacillus counts (LPC) were not different (P>0.05) between fat types. However, a significant (P<0.01) interaction was detected for storage time * treatment for log LPC. In general, LPC were similar on Days 0-4 with HF10 patties having lower (P<0.05) counts at Day 8 versus other patties. High fat patties contained higher microbial levels than low fat patties, however, flaming of high fat beef trim on microbial populations appeared positive.

Lipid oxidation, TBARS, exhibited no significant differences (P>0.05) among treatments or fat types indicating no lipid breakdown due to heat application. Over storage time, TBARS values were different (P<0.01) with Day 8 patties having higher (P<0.01) values than Day 1, 2 or 4 patties.

Product pH was different (P<0.01) among treatments, over storage times and between fat types. Treatment LF0 patties displayed higher (P<0.01) pH values than all other patties. In addition, LF10 patties had higher (P<0.01) pH values than HF0 patties, which were greater (P<0.01) than HF10 patties. Day 0 and 1 patties had similar (P>0.05) pH's which were (P<0.01) higher than Days 2, 4 and 8 which were similar (P>0.05). Lower fat patties possessed higher (P<0.01) final product pH's than the higher fat products. Water-holding-capacity (WHC) was not different (P>0.05) among treatments or fat types. Day 0 patties had higher (P<0.01) WHC than patties stored for 8 days.

Significant (P<0.01) interactions occurred between storage time * treatment and storage time * fat level for metmyoglobin content. These two interactions are related, in that both reveal slight numerical increases as storage time lengthened. However, between Days 4 and 8 of storage the higher fat patties showed greater increases in metmyoglobin content indicating a greater sensitivity to the exposure to flame.

Visual evaluation of product surface discoloration revealed significant (P<0.01) interactions for storage time * treatment and storage time * fat type. In general, values for patties increased over time. However, as with the significant interaction of storage time * treatment in the analysis of metmyoglobin, HF0 patties displayed a marked increase in product discoloration between Days 4 and 8 of storage with the HF10 patties having a lower conversion. Increases were noted for low and high fat patties over storage, with the high fat patties initially displaying higher

values. However, between Days 0 and 1 of storage, low fat patties had greater increases in discoloration while over the remainder of storage, magnitudes of differences between low and high fat products were extremely variable. In general, discoloration values increased over storage times for all products with flamed products displaying slightly higher numerical values than control products. However, between Day 4 and 8 of storage, control patties increased sharply and were higher in visual surface discoloration than flamed patties indicating that surface flaming had little negative effect on product discoloration during short term retail storage.

Hunter color "L" values (lightness) were different ($P<0.01$) among treatments, over storage periods and over fat types. High fat products displayed similar ($P>0.05$) "L" values but were higher ($P<0.01$) than either low fat products. Furthermore, LF10 displayed a lighter ($P<0.01$) colored pattie than did LF0. No differences ($P>0.05$) were revealed for product "L" values over 0, 1, 2, and 4 days of storage, however, each of these patties had higher ($P<0.01$) "L" values than Day 8 patties. Product "L" values among fat types indicated higher fat patties displayed a lighter ($P<0.01$) color than low fat patties with this difference due in part to increased fat content.

Hunter "a" values were not different ($P>0.05$) over fat types. A significant ($P<0.01$) interaction was detected between storage time * treatment. This interaction is probably closely related to those previously mentioned, in that over the first four days of storage treatment HF0 patties exhibited numerical values superior to other treatments. However, between Days 4 and 8 the rate of degradation was more rapid than that of other treatments.

Hunter "b" values (yellowness) were significant ($P<0.01$) among treatments, storage periods and fat types. Yellowness values were higher ($P<0.01$) for treatment HF0 patties than all other patties. Additionally, HF10 patties displayed higher ($P<0.01$) values than either low fat product. The highest ($P<0.01$) "b" values were displayed on Days 1 and 2 of storage while values recorded on Days 4 and 8 were similar ($P>0.05$). Day 0 patties had lower ($P<0.01$) "b" values than those of Day 4. Higher fat products displayed higher ($P<0.01$) "b" values than those of the low fat products with this difference probably due to differing fat levels.

Evaluation of surface fat smearing revealed differences ($P<0.05$) among treatments. Due to a combination of fat level and the use of flame, HF10 patties displayed greater ($P<0.05$) surface fat smearing than all other patties, which were found similar ($P>0.05$). Among fat types, the higher fat patties displayed higher ($P<0.01$) smearing values than low fat patties.

Post-treatment temperature means were different ($P<0.01$) among treatments. No differences ($P>0.05$) were noticed for post-treatment temperature in relation to fat type. Post-treatments temperatures of LF0 and HF0 while similar ($P>0.05$) were lower ($P<0.01$) than for flamed treatments, which were found similar ($P>0.05$). Post-treatment temperatures of treatments exposed to surface flaming were much higher ($P<0.01$) than those exposed to no heat.

CONCLUSIONS

Patties subjected to the use of flame, while displaying numerically lower microbial means than patties utilizing no heat were not significantly different in microbial populations in lean beef patties. However, the utilization of surface flaming in high fat products showed very positive effects for microbial growth. Additionally, the higher fat products were found to contain greater microbial growth than the lower fat patties. Moreover, no oxidative effects were noted by the utilization of flame on high or low fat products. However, surface flaming did produce patties with reduced redness as evaluated by Hunter "a" analysis. Results appear to conclude that the use of prolonged flaming (10 seconds) to reduce microbial proliferation in high fat beef trim to be a viable intervention method to reduce microbial populations, however, further investigation in this area is essential to determine the maximum efficacy of this method.

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Table 1. Effects of heat treatment and storage period on microbial, chemical and physical characteristics of low and high fat beef trim.

TRT[a]	TPC[b] log/g	PPC[c] log/g	PSU[d] log/g	TBARS[e] mg/kg	pH	L[f] VALUE	a[g] VALUE
LF0	2.51[k]	2.75[l]	2.28[l]	0.88[j]	5.72[j]	31.57[l]	8.98[m]
LF10	2.52[k]	2.69[l]	2.41[kl]	0.95[j]	5.67[k]	32.57[k]	9.35[l]
HF0	3.23[j]	3.48[j]	2.91[j]	0.90[j]	5.60[l]	37.12[j]	10.66[j]
HF10	2.70[k]	3.18[k]	2.59[k]	0.98[j]	5.56[m]	37.56[j]	10.23[k]
SEM[h]	0.08	0.06	0.08	0.04	0.01	0.23	0.10
Day 0	1.51[l]	1.52[n]	1.22[m]	0.99[jk]	5.68[j]	35.26[j]	9.12[l]
Day 1	1.64[l]	1.80[m]	1.21[m]	0.83[kl]	5.67[j]	34.69[j]	10.50[j]
Day 2	1.86[l]	2.30[l]	1.61[l]	0.90[kl]	5.62[k]	34.75[j]	10.37[j]
Day 4	3.02[k]	3.54[k]	3.15[k]	0.79[l]	5.61[k]	34.94[j]	9.63[k]
Day 8	5.66[j]	5.97[j]	5.55[j]	1.14[j]	5.62[k]	33.90[k]	9.39[kl]
SEM[h]	0.09	0.06	0.09	0.05	0.01	0.25	0.11

[a]LF0=low fat, no heating; LF10=low fat, 10 seconds flame; HF0=high fat, no heat; HF10=high fat, 10 seconds flame. [b]total-plate-counts. [c]psychrotrophic-plate-counts. [d]pseudomonad counts. [e]2-thiobarbituric acid reactive substances. [f]Hunter "L" value. [g]Hunter "a" value. [h]SEM=standard error of the mean. [j-n]Means within columns with common letters are similar ($P>0.05$).