S7P37.WP

CHARSACTERISTICS OF RESTRUCTURED STEAKS MANUFACTURED FROM PRE-RIGOR AND POST-RIGOER BEEF

H. WANG, N.G. MARRIOTT, J.R. CLAUS and P.P. GRAHAM

Department of Food Science and Technology, Virginia Polytechnic Institute and State University, Blacksburg, VA, United States

INTRODUCTION

During the past decade, consumers have expressed less interest in beef roasts. Steaks and chops have become the most preferred beef cut (Jeremiah, 1982). These cuts contribute to only 15-25% of a carcass and most of this product is processed into less expensive comminuted items (Secrist, 1987). Contemporary consumers are looking for low fat and tender products but at an affordable price. Lack of these products have made the beef industry less competitive. To increase the monetary return, efforts have been made to transform the less expensive carcass cuts into high value products through restructuring.

The high proportion of connective tissues are the major problems when utilizing the chuck and shank as raw materials for the manufacture of restructured products with collagen as the major factor that causes toughness. This research was designed to investigate an alternative method for the optimal utilization of the beef chuck by converting the less attractive muscles (high connective and fatty tissue) into restructured steaks to improve the value of this flavorful but challenging cut. Furthermore, the intent was to evaluate the effects of rigor state of raw materials and storage time on the acceptability of the restructured steaks.

MATERIALS AND METHODS

Sample Preparation

Muscles from the left shoulder and shank (except m.longissimus thoracis and Infraspinatus) of five ungraded (no roll) steer carcasses (300 to 360kg) were excised at 60 minutes post-mortem for manufacturing pre-rigor restructured steaks. The same muscles from the right side were removed at 24 hours post-mortem for conversion to post-rigor steaks. The shank muscles and the high connective tissue or fatty chuck muscles were comminuted to 3.0mm particle size with a Hobart grinder (Model 4532, The Hobart Manufacturing Company, Troy, Ohio). The other muscles were reduced to 9.9mm. The raw materials for the restructured steaks were composed of 60% large and 40% small particle portions. Adjuncts for the formulation included 1.0% salt and 0.25% sodium tripolyphosphate which were mixed for eight minutes in a Hobart mixer (Model A-200, The Hobart Manufacturing Company, Troy, Ohio), stuffed into 100mm fibrous casings (Viskase Corp., Chicago) and placed in -20°C storage for 12 hours. The samples were subsequently tempered to -5°C in a -2°C storage environment, shaped into logs with a Ross Superform press (Model T-20, Ross Industries, Midland, Va.), cut into 25.4mm steaks, wrapped in polyvinyl chloride (PVC) film, and stored at 2°C in a dark cooler for subsequent analysis.

Sensory Evaluation

Sensory evaluations of samples were conducted after storage for two and six days. The samples were cooked to an internal temperature of 70°C in a 165°C electric oven. Seven 12.7mm diameter cores were made from each sample. Tenderness, texture, and flavor of these cores were evaluated by seven trained (Rainey, 1979) panelists using an 8-point scale (1=very undesirable; 8=very desirable).

Texture Profile Measurement

Five 12.7mm diameter cores were made from each sample. Shear force and total work were measured with a computerized Instron (Model 1011) containing a Warner-Bratzler attachment. Fifty kilogram load cells were used, with a crosshead speed of 200mm/min and 10% load range.

Color Evaluation and Measurement

After two and six days of storage, the steaks were transferred into a display case (4°C). Color, texture, and overall appearance of these steaks were evaluated under 1076 lux of cool white fluorescent light using an 8-point scale (1=very undesirable; 8=very desirable).

The CIE values of steaks used for subjective evaluations were determined after two and six days of storage using a Minolta CR-200 Chroma Meter (Minolta Camera Co., Osaka, Japan). The Instrument was calibrated by a standard plate (CIE L^*= 97.91, a^*=-0.71, b^*=+2.44). Three areas on each steak were measured and the mean of these measurements was incorporated in the statistical analysis.

Oxidative Rancidity Determination

Oxidative rancidity development of steaks during storage was determined after 0, 2 and 6 days of storage by the thiobarbituric acid (TBA) test (Tarladgis *et al.*, 1960) with the modification according to Rhee (1978).

Standard Plate Count

The microbial stability of steaks during storage was determined at 0, 2, and 6 days by the Standard Plate Count (SPC) method. Eleven grams of a sample with 99ml of 0.1% peptone solution were homogenized for two minutes in a stomacher (Model S10-400, Techmar Co., Cincinnati) and the subsequent solution was used for SPC.

Collagen Solubility

The determination of hydroxyproline in the steaks was based on the procedure outlined by Hill (1966). Hydroxyproline content of the supernatant and residue were multiplied by 7.52 and the sum of collagen of the residue and supernatant was reported as total collagen content. The percentage of soluble collagen was calculated by dividing the collagen content of the supernatant by total collagen.

Statistical Analysis

Statistical analyses were conducted with the split-split-plot model for sensory and color panel evaluation and split-plot for the other measurements. The general Linear Model procedure of the SAS program (SAS, 1990) was used to determine the effects of rigor state of raw materials and storage time on the characteristics of restructured steaks.

RESULTS AND DISCUSSION

After two and six days of storage, those steaks made from pre-rigor beef had higher CIE a^* numerical values which indicated more color saturation than for post-rigor steaks, although this comparison was not significant ($P>0.05$). As expected, CIE a^* values of both pre-rigor and post-rigor steaks decreased ($P<0.05$) from two days to six days of storage (Table 1).

No significant differences ($P>0.05$) were found among panelists for color or overall appearance rating scores between pre-rigor and post-rigor restructured steaks (Table 1). The panelists detected a similar satisfaction of color for both pre-rigor and post-rigor steaks and did not sense the difference ($P<0.05$) characterized by CIE measurements. The rating scores for color and overall appearance decreased ($P<0.05$) with storage time. Visual texture scores of the post-rigor steaks were higher ($P<0.05$) than the pre-rigor steaks but this trait was not affected

(P>0.05) by storage time.

No significant differences (P>0.05) were found in microbial load (SPC) between pre-rigor and post-rigor steaks (Table 1). Storage time affected (P<0.05) microbial growth for both pre-rigor and post-rigor steaks. There was no difference (P>0.05) in SPC count between 0 days and two days for both pre-rigor and post-rigor steaks. But, the counts after six days of storage were higher (P<0.05) than for 0 and 2 days, with the highest number of 6.1 (log CFU/g) found among pre-rigor steaks.

The rigor state of raw materials affected (P<0.05) oxidative rancidity of restructured steaks as measured by TBA values (Table 1). There were no differences (P>0.05) in initial TBA values between the two types of steaks (0.16 vs 0.09). Yet, in each storage period, oxidation developed faster among the steaks manufactured from pre-rigor beef, resulting in higher (P<0.05) TBA values than those made from post-rigor beef (0.98 vs 0.4) after six days of storage.

Differences in oxidative rancidity, as measured by TBA values, between pre-rigor and post-rigor steaks were not sensed by panelists. The flavor scores (Table 2) ranged from 6.0 to 6.3 which indicated insignificant differences (P>0.05) in panel satisfaction between pre-rigor and post-rigor steaks for all storage periods. The panelists still expressed moderate satisfaction (6.0-6.3) when the TBA values reached 0.98mg/kg for the pre-rigor steaks. This observation suggests that the off-odor of restructured beef steaks formulated with salt and phosphate may be identified in a higher range of TBA values.

Collagen analyses (not shown) revealed that there was no significant difference (P>0.05) between pre-rigor and post-rigor steaks in total collagen (17.4mg/g vs 16.2mg/g) and percentage of soluble collagen (20.3% vs 19.2%). The Warner-Bratzler peak break force of the restructured steaks was below 1.7kg (Table 2) which suggested that the high level of connective tissue in the raw material from the chuck and shank did not cause toughness in the restructured steaks.

Steaks manufactured from post-rigor beef were rated higher (P<0.05) for tenderness than those made from pre-rigor beef (Table 2). However, there was no difference (P>0.05) between pre-rigor and post-rigor steaks in Warner-Bratzler peak break force. The work used to break the samples of the post-rigor steaks (11.4 and 13.4kg*mm) were numerically higher than the pre-rigor steaks (8.8 and 9.9kg*mm), although this difference is not significant (P>0.05).

Rigor state of raw materials had no effect (P>0.05) on the texture and flavor scores of restructured steaks during sensory evaluation (Table 2). Also, the tenderness, texture and flavor of these steaks were not affected (P>0.05) by two or six days storage time.

CONCLUSIONS

Results from this study suggested that:

Restructured steaks manufactured from pre-rigor chuck muscles were superior in color to post-rigor counterparts when measured with the Minolta Chroma Meter.

Samples manufactured from pre-rigor chuck muscles were more acceptable in tenderness and visual texture as evaluated by trained panelists and developed less oxidative rancidity.

Discoloration and oxidative rancidity increased with additional storage time.

Rigor state had no significant effect on microbial load, Warner-Bratzler peak break force and rating scores for texture, color, overall appearance and flavor.

REFERENCES

HILL, F. 1966. The solubility of intramuscular collagen in meat animals of various ages. *J. Food Sci.* 31:161-166.

JEREMIAH, L.E. 1982. Review of factors influencing consumption, selection, and acceptability of meat purchases. *J. Cons. Stud. and Home Econ.* 6:137-154.

RAINEY, B.A. 1979. Selection and training of panelists for sensory testing. In: *Sensory Evaluation Methods 7-1 -7-9.* Institute of Food Technologists, Chicago.

RHEE, K.S. 1978. Minimization of further lipid peroxidation in the distillation 2- thiobarbituric acid test of fish and meat. *J. Food Sci.* 43: 1776-1778.

SAS. 1990. *SAS/STAT User's Guide, Version 6, 4 Ed.* Statistical Analysis Systems Institute, Inc., Cary, N.C.

SECRIST, J.L. 1987. Restructured meat - the past and present. In : PEARSON, A.M., and DUTSON, T.R. (eds). *Advances in Meat Research. Vol.3, Restructured Meat and Poultry Products.* Avi Publ. Co., Inc., New York. p.1-19.

TARLADGIS, B.G., WATTS, B.M., YOUNATHAN, M.T. and DUGAN, L.R., Jr. 1960. A distillation method for quantitative determination of malanaldehyde in rancid foods. *J. Am. Oil Chem. Soc.* 37: 44-48.

Table 1. Effect of rigor state on the appearance and stability traits of restructured steaks.

	Pre-rigor State 0 days Mean	SE	3 days Mean	SE	7 days Mean	SE
Colour panel						
Colour	--	--	5.5b	0.13	5.0c	0.13
Texture	--	--	5.6cd	0.09	5.5d	0.10
Overall appearance	--	--	5.4bc	0.11	5.2c	0.11
Minolta CIE `a'	--	--	22.3b	1.10	19.1bc	1.10
TBA (mg/kg)	--	--	0.61c	0.0.7	0.98b	0.07
SPC (lofCFU/g)	3.64c	0.45	4.02c	0.39	6.10b	0.39

	Post-rigor State 0 days Mean	SE	3 days Mean	SE	7 days Mean	SE
Colour panel						
Colour	--	--	5.5b	0.13	5.2bc	0.13
Texture	--	--	6.1b	0.10	5.8bc	0.09
Overall appearance	--	--	5.6b	0.11	5.4bc	0.11
Minolta CIE `a'	--	--	21.6b	1.10	16.9c	1.10
TBA (mg/kg)	0.09e	0.07	0.29de	0.07	0.40cd	0.07
SPC (lofCFU/g)	3.38c	0.46	4.49c	0.48	5.80b	0.48

[a] 1 = very undesirable; 8 = very desirable.
[b,c,d,e] Means in each row with the same superscript are not different ($P>0.05$).

Table 2. Effect of rigor state on the tenderness traits of reconstructed steaks.

	Pre-rigor State 3 days Mean	SE	7 days Mean	SE
Sensory panel				
Tenderness	6.2bc	0.16	6.0c	0.16
Texture	5.9b	0.14	6.1b	0.14
Flavour	6.0b	0.14	6.1b	0.14
Warner-Bratzler Peak Force				
Total Work (Kgf*mm)	8.8c	0.97	9.9c	0.97
Peak Force (Kg)	1.5b	0.20	1.3b	0.20
	Post-rigor State 3 days Mean	**SE**	**7 days Mean**	**SE**
Sensory panel				
Tenderness	6.5b	0.16	6.6b	0.16
Texture	5.9b	0.14	6.0b	0.14
Flavour	6.2b	0.14	6.3b	0.14
Warner-Bratzler Peak Force				
Total Work (Kgf*mm)	11.4bc	0.97	13.4b	0.97
Peak Force (Kg)	1.4b	0.20	1.7b	0.20

[a] 1 = very undesirable; 8 = very desirable.
[b,c] Means in each row with identical superscripts are are not different (P>0.05).