

AGING RESPONSE OF BEEF MUSCLES FROM DIFFERENT QUALITY GRADES BEFORE AND AFTER FREEZING

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Story in Brief

Postmortem aging is widely known to improve tenderness of beef. This study was designed to determine the aging response and tenderness of six different beef muscles before and after freezing. The infraspinatus, supraspinatus, longissimus dorsi, psoas major, semimembranosus, and semitendinosus were cut into 1 inch steaks from right and left sides of 19 beef carcasses within the quality grades of low Choice, high Select, and low Select. Two steaks/muscle/side were assigned to aging periods of 2, 5, 7, 14, or 21 days. The first steak of each aging period was aged prior to being frozen and the second steak was frozen prior to aging. Although steaks frozen prior to aging indicated a higher loss of moisture during the aging period and cooking, there were no differences between the two treatments for Warner-Bratzler shear values. Muscles showed no improvement in shear values beyond 14 days of aging and the psoas major and semimembranosus muscles were unresponsive to aging over 21 days. This study indicates that freezing will not affect the overall aging response and enzyme activities of muscles.

(Key Words: Beef, Aging, Freezing, Tenderness.)

Introduction

Tenderness is a major palatability trait affecting consumer acceptance of beef. Tenderness differences occur between carcasses, between muscles within the same carcass, and between parts of the same muscle, thus indicating that the location of muscles along with postmortem aging is related to meat tenderness. It is well documented that different muscles react differently to postmortem storage. Olson et al. (1977) found a progressive decrease in shear force values (an objective measurement of tenderness) in the longissimus dorsi (ribeye) and semitendinosus (eye of round) muscles; however the psoas major (tenderloin) was unaffected by postmortem storage. The activity of calcium-dependent proteases (CDP-I and II) follow the same general pattern as the aging response of muscles and are unaffected by frozen storage. Calpastatin, an inhibitor to CDP's, has been found to be unstable during frozen storage (Koochmaraie et al., 1988). Since freezing of meat is common for warehouses and overseas shipment, we questioned if freezing would effect the rate of aging

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in different muscles. Therefore, the objective of this study was to examine the aging of six different beef muscles before and after freezing.

Materials and Methods

Right and left sides of 19 beef carcasses within the USDA quality grades of low Choice, high Select, and low Select were fabricated into six individual muscles at 48 hr postmortem. The muscles used included the infraspinatus (IF) and supraspinatus (SS) from the chuck; longissimus dorsi (LD) and psoas major (PM) from the loin; and semimembranosus (SM) and semitendinosus (ST) from the round. Two 1 inch steaks/muscle/side were assigned to treatments: the first steak was aged before frozen (T-1) and the second steak was frozen prior to aging (T-2). All steaks were frozen once and were stored for one month. Each steak was aged for 2, 5, 7, 14, or 21 days; however, because some muscles (primarily the SS and ST) could not yield the number of steaks to achieve all aging periods, the 5 day aging period was excluded for those steaks. Each steak was weighed and vacuum packaged prior to treatment.

The experimental design was established so that steaks from both treatments (T-1,T-2) from the same muscle and aging period were cooked on the same day to reduce variability. Aging periods were scheduled so cooking of all steaks could be accomplished on a predetermined day, ie: steaks assigned to the 21 d aging period were removed from the freezer 21 d prior to cooking. Steaks having been frozen after aging were thawed 18 h at 20°F prior to cooking. Individual weights of the steaks were obtained after the assigned storage period to determine purge/thaw loss and cook loss.

Steaks were cooked at 350°F to an internal temperature of 160°F using a forced air oven. After cooling for 2 h at room temperature (68°F), six 1/2" cores were removed from each steak parallel to the muscle fibers. Each core was sheared using a Warner-Bratzler shearing device attached to an Instron Universal Testing Machine. The Instron was fitted with a 1 kN load cell moving at a crosshead speed of 200 mm/min. Peak force was analyzed as an indication of tenderness.

Data were analyzed by the General Linear Models procedure of the Statistical Analysis System (SAS, 1986). The model included the effects of age, treatment, grade, and all interactions. Means were separated by Fischer's least significant difference and contrasts. Regression analysis was performed to predict Warner-Bratzler shear values over aging periods. Significance was reported when $P < .05$.

Results and Discussion

An age by treatment by muscle interaction was observed for total moisture loss. The percent of total moisture loss is a combination of the muscles losing

moisture during purge or thawing and during cooking. Primarily, muscles lose the greatest percentage of moisture during cooking. Figure 1 shows the aged to frozen treatment (T-1) in the top graph and the frozen to aged treatment (T-2) in the bottom graph. The SS and ST muscles showed a quadratic effect in T-1 having a decrease in moisture loss from 14 to 21 days of aging. For T-2, the SS continued to show a quadratic effect with a decrease in moisture from 14 to 21 days; however, the ST showed a 6-7% increase in moisture loss from 14 to 21 days. The reason for this increase is not completely clear but may be due to the differences in the aging process for the ST thus causing a greater moisture loss during cooking. In general, muscles frozen prior to aging (T-2) tended to have a greater total moisture loss than T-1.

Table 1 indicates thaw and cook losses of muscles as affected by quality grade. Muscles within the low Choice grade had lower ($P < .05$) thaw loss and, except for the SM and PM, muscles within the Select grades were not different ($P > .05$). For cook loss, the SS, ST, and SM within the low Choice grade were lower ($P < .05$) than the Select grades. The LD and PM showed no difference ($P > .05$) between quality grades, whereas the IF indicated a decrease ($P < .05$) in cook loss as the quality grade increased.

Regression lines for average shear values over aging time were developed for each muscle (Figure 2). Freezing muscles prior to aging (T-2) were not different ($P > .05$) from T-1 for shear values. Aging showed a decrease ($P < .05$) in shear values for the IF, LD, SS, and ST muscles. The PM and SM were unaffected ($P > .05$) by aging time for shear values. According to Shackelford et al. (1990), the window of acceptability requires shear values to be below 4.5 kg for consumers to identify beef as a tender piece of meat. In this study, the IF and PM did not require aging to get below 4.5 kg. The LD, SS, and ST required 4, 6, and 11 days of aging, respectively, to reach 4.5 kg. The SM did not reach 4.5 kg in this study.

Table 2 shows how muscles are affected by quality grade for shear values. The LD, PM, and SM indicated no difference ($P > .05$) in shear values between the low Choice and high Select grades; however, shear values were highest ($P < .05$) for low Select in these muscles. IF was the only muscle unaffected ($P > .05$) by quality grade for shear values; whereas the SS and ST had a higher ($P < .05$) shear value within the high Select grade.

Calcium-dependent proteases (CDP-I and CDP-II) and cathepsins have been identified as having activity during the aging process. CDP's establish initial tenderness up to day 2 (Calkins, 1988) while cathepsins B and H influence the tenderization of beef over a long period of time (Koochmarai, 1990). Koochmarai et al. (1988) has also shown that calpastatin or the calcium-dependent inhibitor is unstable in frozen storage, thus suggesting that meat will be able to tenderize more fully after frozen storage. The data presented shows no differences ($P > .05$) between the two methods of storage. Since aging times began after 48 h, the CDP's should have established initial

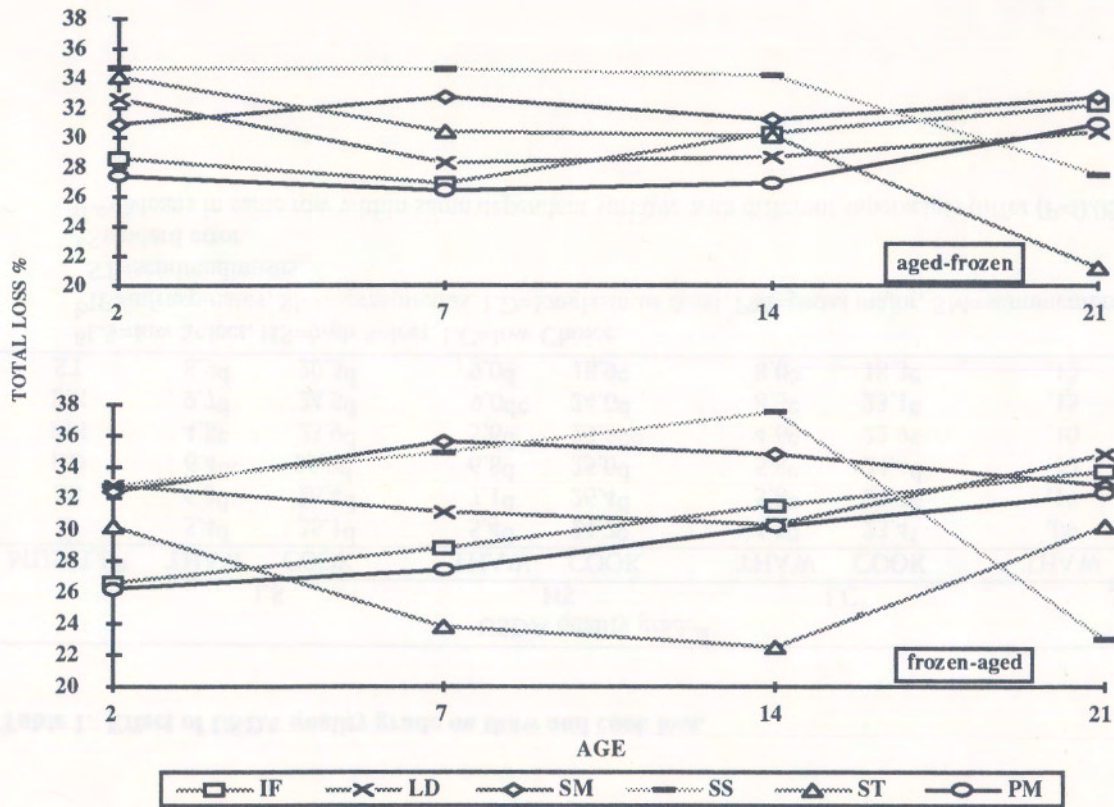


Figure 1. Effect of aging period and storage treatment on total moisture loss of muscles.

Table 1. Effect of USDA quality grade on thaw and cook loss.

MUSCLE ^b	USDA quality grade ^a						SE ^c	
	LS		HS		LC		THAW	COOK
	THAW	COOK	THAW	COOK	THAW	COOK		
IF	5.4 ^d	26.1 ^d	5.4 ^d	24.7 ^e	4.5 ^e	23.4 ^f	.09	.20
SS	6.8 ^d	26.4 ^d	7.1 ^d	26.4 ^d	5.8 ^e	24.7 ^e	.17	.24
LD	6.4 ^{de}	25.0 ^d	6.8 ^d	25.0 ^d	5.8 ^e	24.4 ^d	.12	.19
PM	4.8 ^e	23.9 ^d	5.6 ^d	23.5 ^{de}	4.6 ^e	22.9 ^e	.10	.19
SM	9.7 ^d	24.5 ^d	9.0 ^{de}	24.0 ^d	8.3 ^e	23.1 ^e	.15	.18
ST	8.9 ^d	20.3 ^d	9.0 ^d	18.9 ^e	8.0 ^e	18.3 ^e	.12	.19

^aLS=low Select, HS=high Select, LC=low Choice.

^bIF=infraspinatus, SS=supraspinatus, LD=longissimus dorsi, PM=psoas major, SM=semimembranosus, ST=semitendinosus.

^cStandard error

^{d,e,f}Means in same row within same dependent variable with different superscripts differ ($P < 0.05$).

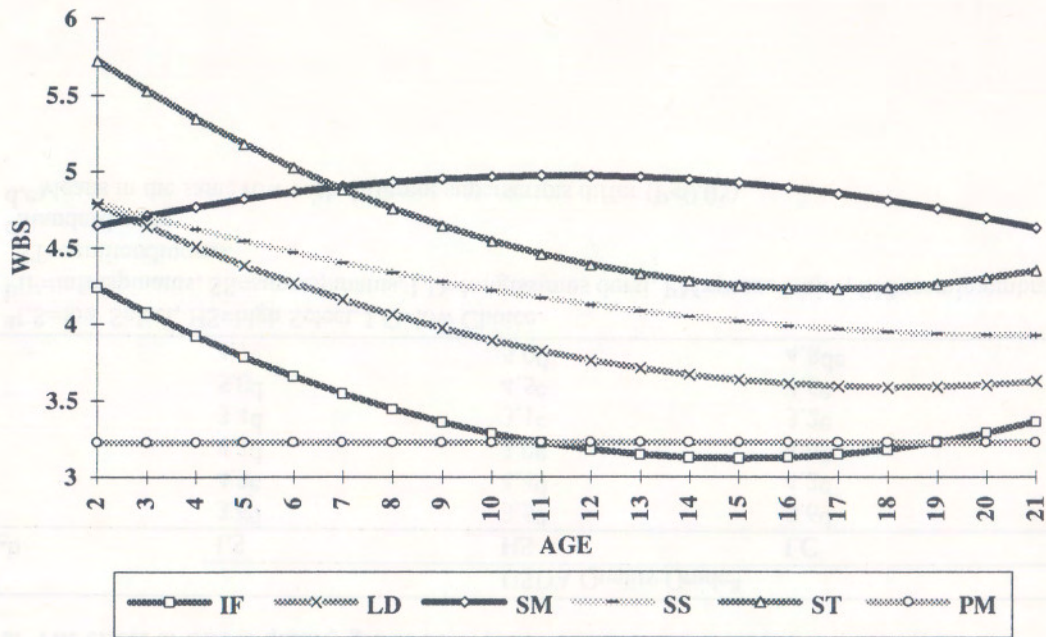


Figure 2. Regression lines showing Warner-Bratzler shear values of muscles as affected by aging period.

Table 2. The effect of USDA quality grade on Warner-Bratzler shear values within muscle.

Muscle ^b	USDA Quality Grade ^a			SE ^c
	LS	HS	LC	
IF	3.6 ^d	3.5 ^d	3.6 ^d	.04
SS	4.3 ^e	4.4 ^d	4.2 ^e	.03
LD	4.3 ^d	3.9 ^e	4.0 ^e	.04
PM	3.4 ^d	3.1 ^e	3.2 ^e	.03
SM	5.0 ^d	4.5 ^e	4.6 ^e	.05
ST	4.7 ^e	5.0 ^d	4.8 ^{de}	.04

^aLS=low Select, HS=high Select, LC=low Choice.

^bIF=infraspinatus, SS=supraspinatus, LD=longissimus dorsi, PM=psoas major, SM=semimembranosus, ST=semitendinosus.

^cStandard error

^{d,e}Means in the same row with different superscripts differ (P<0.05).

differences and the aging process of muscles is not affected by freezer storage if frozen after 48 h postmortem.

This study suggests that freezing muscles prior to aging tended to result in greater total moisture lost during aging and cooking; however, there was no significant effect on the aging response of muscles as indicated by Warner-Bratzler shear. Muscles showed no improvement in shear values beyond 14 days of aging and the PM and SM indicated no response to aging over 21 days. This study indicates that freezing will not effect the overall aging response of muscles, thus giving more flexibility for storage.

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