3 - 5 INFLUENCE OF AGEING, FREEZING RATE AND LENGTH OF STORAGE ON QUALITY OF BEEF

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INTRODUCTION

Frozen meat is becoming gradually a more common sight in stores and supermarkets. There is however some resistance by a large portion of consumers in buying frozen meat mainly due to the belief that is inferior in quality. One of the problems associated with frozen meat is that of drip on thawing. This loss in moisture that can be detected to a lesser extent in chilled meat is caused by the decrease in pH during the process of Rigor Mortis, that brings the major muscle proteins close to their iso-electric point, Howard (1956) and Lawrie (1974) and to the formation of the irreversible actomyosin. Both factors bring about a decrease in the water holding capacity of the muscle proteins. Denaturation of myofibrillar proteins can also occur in frozen meat due to a combination of low pH and salt precipitation, Bendall (1971) and Voyle (1974) contributing therefore to an increase in the amount of drip. Earlier workers have postulated that fast freezing promotes the formation of small ice crystals within the fiber and by thawing the moisture can be readily absorbed. Slow rate of freezing, on the other hand, would cause formation of large extra-fiber ice crystals that would draw moisture from within the cell and on thawing, a larger proportion of fluid would be available for dripping, Ramsbotton and Koons (1941) and Callow (1952). Pearson and Miller (1950) however, failed to detect any influence of rate of freezing on drip, but as length of storage was increased from 0 to 120 days, there was a significant increase on it. More recently, Bendall (1971) pointed out that extra cellular ice formation is extensive at higher freezing temperature (about - 5 C) but become much less as the frozen temperature is reduced to - 20 C. Some tenderizing effect of the freezing process has been reported by Hiner et al. (1945) whilst Pearson and Miller (1950) indicated that tenderness was not affected by rate of freezing but length of storage had a negative effect on it.

Ageing of beef has been demonstrated by several workers to have a benefitial effect on texture, Herring et al. (1967) and Bouton et al. (1973). Less is known however on the effect of conditioning on the quality of beef that has been posteriorly frozen. The purpose of this study was to verify the effect of conditioning, freezing rate and length of storage on the losses and texture of beef.

MATERIAL AND METHODS

Both Semitendinosus muscles of 6 Hereford x Friezan steers about 18-20 months old were removed from the carcasses after 24 hs. chill. Samples measuring 5 x 7 x 2.5, cut across the fiber, that after bits for sarcomere length and pH determination had been removed, were reduced, to 4 x 6 x 2.5 and weighing about 70 g, were obtained from the right side muscle. The samples were weighed, vacuum sealed in plastic bags and the unfrozen/unaged samples were immediately cooked for posterior texture determination. The other samples were placed in a freezing room at - 10 C or - 20 C for a period of 2 or 4 months storage. The corresponding muscle from the left side was aged for 10 days at 1 C, before being utilized to obtain the samples following the same procedure as used for the unaged ones.

Treatments were randomized within muscle to overcome possible variations between distal and proximal ends. Five samples were obtained from each muscle and 10 per animal giving a total of 60 samples.

Samples were thawed in the bags overnight (18 hs) at a temperature of about 7 C. They were then removed from the bags, dried with tissue paper and weighed. After that they were vacuum sealed again and cooked in a water bath at 80 C for 30 minutes. After that, they were cooled in the bags in cold running water, the juices discarded, the samples wipped off moisture surface, weighed and then stored in a chill cabinet for posterior texture determination. Six sub-samples measuring 1 x 1 cm were obtained from each sample. They were then compressed in a plane at right angles to the direction of the fibers, between blunt jaws mounted in a Instron Universal Testing Machine, Rhodes et al. (1972). Only the force at first yield was recorded. Measurements in triplicates were taken in each sample for sarcomere length determination by optical difraction, Voyle (1971).

RESULTS AND DISCUSSION

The different treatments affected significantly the amount of drip with a lesser effect in cooking loss, table 1.

TABLE 1

EFFECT OF AGEING, FREEZING RATE AND LENGTH OF STORAGE ON LOSSES OF BEEF

		Dripping loss		Cooking loss	
Unaged		Mean	SD	Mean	SD
Unfrozen		-	-	35.90^{d}	1.29
Frozen	- 10/2 months	9.11^{b}	1.82	34.02^{ab}	.65
	- 10/4 months	12.12^{c}	2.56	34.14^{ab}	.88
	- 20/2 months	10.76^{bc}	2.20	34.06^{ab}	1.10
	- 20/4 months	13.13^{c}	3.10	33.58^{a}	1.32
Aged					
Unfrozen		-	-	35.35^{bc}	1.34
Frozen	- 10/2 months	6.51^{a}	1.64	34.15^{ab}	1.83
	- 10/4 months	7.99^{a}	1.30	35.41^{bc}	1.73
	- 20/2 months	7.83^{a}	2.05	35.38^{bc}	.82
	- 20/4 months	8.62^{ab}	1.43	34.75^{abc}	.63

^{abc} Means on a column with no common superscripts are different (P .05)

An increase in the water-holding capacity through conditioning has been reported by Arnold et al. (1956) and Hamm (1960). As can be seen by the present results, this is maintained even during frozen storage resulting in less drip on thawing.

The freezing rate had no significant effect on drip losses being the average value for - 10 (8.93%) and for - 20 (10.08%). These results are in contrast with the findings of Callow (1952) but in agreement with the data reported by Pearson and Miller (1950). The length of storage, on the other hand, significantly increased dripping loss for the unaged samples at - 10 C and an increase was also noticiable at -20, although not significant. A non significant greater amount of drip due to storage length was also verified in the aged samples, but here the difference was smaller than in the unaged pieces. An increase in drip due to storage has also been noticed by Pearson and Miller (1950). As pointed out by Bendall (1971), this increase in drip during frozen storage, is a result of an increase in the size of extracellular ice crystals at the expense of the intracellular water resulting in an increase in salt concentration within the fiber. This fact together with the low pH, leads to protein denaturation, being the phenomenon more noticeable at higher storage temperatures.

Cooking loss was less affected by the several treatments. The average loss for the frozen/unaged samples was 33.95 and 34.92 % for the aged.

A great deal of variation was found with respect to losses between animals. Drip however, was the variable that presented the greatest variation as can be deduced by the magnitude of the standard deviations with cooking losses presenting values more concentrated around the mean. The effect of the different treatment on texture, pH and sarcomere length, can be seen on table 2.

Unaged/unfrozen samples presented a significantly higher shear force of 5,93 than the aged, 4.95. The same was true for the frozen meat being the average values for the unaged 4.89 and 3.96 for the aged. The beneficial effect of conditioning on texture, therefore, as has been reported by Davey and Gilbert (1967) and Herring et al. (1967) is maintained even after the meat has been frozen.

Texture was not affected by rate of freezing with the -10 C samples presenting an average value of 4.53 and -20, 4.32. These results are in agreement with those published by Pearson and Miller (1950). The freezing process however presented a tenderizing effect both in the unaged and aged samples, with the frozen samples presenting an average shear force of 4.43 against 5.44 for the unfrozen. A tenderizing effect of the freezing process has been cited by Hiner et al. (1945). Different results however were found by Howard and Lawrie (1956) where no significant differences in the shear forces for frozen or unfrozen samples could be detected.

A decrease in tenderness during frozen storage has been noticed by Pearson and Miller (1950) and Jakobsson and Bengtsson (1973). No clear indication that meat becomes tougher with prolonged storage could be inferred from the results of this study although the 4 months storage samples tended to be less tender and more variable than the 2 months treatment.

TABLE 2
EFFECT OF AGEING, FREEZING RATE AND LENGTH OF STORAGE ON QUALITY OF BEEF SAMPLES

	Texture		pH		Sarcomere length	
Unaged	Mean	SD	Mean	SD	Mean	SD
Unfrozen	5.93^{d}	.58	5.46^{ab}	.11	2.07	.11
Frozen - 10/2 months	4.93^{cb}	.30	5.42^{ab}	.05	1.99	.24
- 10/4 months	4.92^{cb}	.85	5.46^{ab}	.05	1.88	.16
- 20/2 months	4.84^{b}	.65	5.41^{a}	.04	1.93	.21
- 20/4 months	4.87^{b}	.80	5.47^{b}	.04	1.97	.11
Aged						
Unfrozen	4.95^{c}	.50	5.52^{b}	.06	1.94	.09
- 10/2 months	4.05^{a}	.42	5.43^{ab}	.05	2.08	.04
- 10/4 months	4.22^{ab}	.57	5.52^{b}	.05	1.93	.30
- 20/2 months	3.64^{a}	.28	5.42^{ab}	.08	2.12	.19
- 20/4 months	3.93^{a}	.57	5.53^{b}	.04	1.94	.24

^{abc} Means on a column with no common superscripts are different (P .05)

A non significant higher pH value of 5.48 was found for the aged samples in comparison with the unaged value of 5.44. Hamm (1960) stated that the pH may rise during ageing whilst Buchter and Zenthen (1971), stated that they could detect no difference in pH of unaged or aged (6 days) pork. A significant increase in pH however was found between the 2 and 4 month storage period being the average values 5.42 and 5.50 respectively. Although Ramsbotton and Koons (1941) reported that there was little change in pH of beef during the course of 1 year freezer storage, Van der Berg (1964 and 1966) stated that enzimatic activity is not eliminated by freezing and therefore some pH fluctuation is bound to occur during freezing storage.
In the present study, freezing rate had no effect on pH. The several treatments did not affect sarcomere length with the exception of length of storage although no significantly. The average value for 2 months was 2.03 and 1.93 for the 4 months period.

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