Auswirkungen des Gefriergrades und des Verpackungs-materials auf die Qualität gefroren gelagerter Beef Steaks.

J. Buckley and L. Kearney,
Department of Dairy and Food Technology,
University College,
Cork, Ireland.

Es wurden drei verschiedene Gefriermethoden mit unterschiedlichen Gefriergraden und zwei verschiedene Verpackungsmaterialien auf ihre Auswirkungen auf Beef Steaks untersucht, die 40 Wochen lang gefroren gelagert wurden.

Es ergaben sich signifikante Unterschiede im prozentualen Gewichtsverlust während der Lazerzeit und im prozentualen Kochverlust nach der Lazerzeit.
Unabhängig von der Gerfriermethode ergab sich während der Lagerung ein signifikanter Zuwachs im Peroxyd-Wert, im Thiobarbituratsäure-Wert und im Prozentwert der Metmyoglobinbildung. Auch ergab sich ein Einfluss der Gefriermethode auf die bakterielle flora der Steaks.

Effets de la vitesse de congélation et des moyens d'emballage sur la qualité des steaks de boeuf congelé.

J. Buckley et L. Kearney,
Department of Dairy and Food Technology,
University College,
Cork, Ireland.

On s'est serir de trois procédés de congélation, ayant trois vitesses différentes et deux formes d'emballage, pour déterminer leur effect sur des steaks de boeuf congelé, stockés pendant une péroide de 40 semaines.

Les procédés de congélation ont fini par avoir des différences significatives dans les % pertes de poids de la viande pendant la période de congélation, dans la cuisine de la viande congelée et aussi pendant la péroide de stockage. Dans tous les procédés utilisés on avait noté pendant le stockage des augmentations marquées dans la valeur de péroxyde, dans l'indice thiobarbiturique et dans le % de la formation metmyoglobine. Les procédés de congélation avaient aussi affecté la flore bactérienne des steaks.

Effect of Freezing Rate and Packaging Material on the Quality of Frozen Stored Beef Steaks

J. Buckley and L. Kearney,
Department of Dairy and Food Technology,
University College,
Cork, Ireland.

Three different freezing methods, having differing freezing rates and two different packaging materials, were used to determine their effect on frozen stored beef steaks over a 40 week period.

Freezing methods resulted in significant differences in percent weight loss during freezing and percent cooking loss after freezing and during frozen storage. Irrespective of freezing method, significant increases in peroxide value, thiobarbituric acid number and percent metmyoglobin formation were observed during frozen storage. The bacterial flora of the steaks were also affected by freezing methods.

Дейстие размера замораживания и материала для упакования на качество мороженого хранящегось бифштекса

J. Buckley and L. Kearney,
Department of Dairy and Food Technology,
University College,
Cork, Ireland.

Три разных метода замораживания. имеющих разные размеры замораживания, и два разных материала для упакования употребляись для определения их деиствия на мороженый запасенный бифштекс в течение 40 недель.

Методы замораживания имели результатом знаменательные разности процентной потери веса в течение замораживания и процентной кухонной потери после замораживания и в течение мороженого хранения. Несмотря на метод замораживания, замечались в течение мороженого хранения знаменательные увеличения цены перекиси и числа тиобарбитурического кисга и процентного образования миоглобина. На бактериалные флоры бифштекса тоже воздействовали методы замораживания.

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by

J. Buckley and L. Kearney,
Department of Dairy and Food Technology,
University College, Cork, Ireland.

Introduction

Freezing rate and packaging material are two of the more important factors to be considered in the freezing and frozen storage of meat. Freezing rate has a definite influence on the colour of meat. Packaging material can influence quality by - reducing moisture losses and retarding oxidation during storage.

The colour of frozen lean beef becomes progressively lighter as the rate of freezing is increased. Guenther and Hendrickson (1962) reported that temperatures of -35 to -40°C resulted in the most acceptable frozen meat colour while Lentz (1971) reported that air blast freezing at -29°C produced colour similar to that of the unfrozen product. Metmyoglobin formation has been reported as being the primary cause of colour deterioration during frozen storage (Ramsbottom and Koonz, 1941). This is particularly so when frozen meat packaged in transparent wrapper is exposed to light (Townsend and Bratzler, 1958).

Evaporation during freezing is reduced by increasing freezing rates (Cutting, 1973), and can be prevented during frozen storage by vacuum packaging. However, freezer burn, as a result of evaporation loss, has been shown to develop more rapidly in fast frozen meat than in slowly frozen meat. (Kaess and Weidemann, 1961).

Considerable reductions in microbial population occur during freezing and frozen storage and a variety of factors are known to influence the rate and extent of destruction (Geer et al. 1933). For example, slower freezing rates are reported as being more bactericidal than fast freezing rates.

Frozen meat is susceptible to lipid oxidation which can be accelerated by fluctuating temperatures and inadequate protection from the atmosphere during frozen storage (Love and Pearson, 1971).

Contradictory reports have been given as to the effect of freezing rate on drip loss. It is probable that differences in pH values of the meat and differing freezing rates could explain these contradictions. In general, it is felt that freezing rate has no significant effect on drip loss (Bailey, 1972).Pearson and Miller (1950) stated that the rate of freezing did not affect cooking losses in beef, however, frozen storage increased it greatly. Cooking losses are reported to be increased in frozen meats and that rapid freezing results in a less juicy product (Lind et al. 1971).

Tenderness, which is one of the most important palatability factors in consumer acceptance of beef, has had many contradictory reports as to the effect of freezing and frozen storage. This is probably due to the many factors which affect tenderness measurements such as the degree of doneness (Cover and Hostetler, 1960), measurement techniques (Bratzler and Smith, 1963), location within a muscle (Taylor et al. 1961) and position within that location (Hedrick et al. 1968).

This report has attempted to look at these factors and parameters, among others, and how freezing rate and frozen storage affects them.

Methods and Materials

Freezing and Packaging

The longissimus dorsi (l.d.) muscles, from both sides of two carcases, cut at the 6th lumbar vertebra to the 11th rib were used. Carcases had been aged for 8 days at 38°F. Steaks 1.5 cm thick were cut and numbered from 1 to 30 from the 6th lumbar vertebra. Bones were removed prior to freezing. Steaks from the l.d. of one side were compared with those of the opposite side as follows:

Carcase No. 1 — Liquid Nitrogen frozen (L.N.) v Plate frozen (Pl) (4 cm/hr) (20 cm/hr)

Carcase No. 2 — Deep freeze (D.F.) v Plate frozen (Pd) (0.2 cm/hr)

Freezing rates were obtained and all steaks were frozen to final interval temperatures of approximately -13°F (-25°C). All even numbered steaks were vacuum packed and the odd numbered steaks were wrapped in an oxygen permeable P.V.C. film (normal). Steaks were stored in a deep freeze at -6°F (-21°C) and analysed after 10, 24 and 40 weeks of storage.

Analysis

Two steaks from each l.d. were used for fresh analysis. Four steaks from each l.d. were used for analysis immediately after freezing. Four vacuum packed and four normal wrapped steaks were used for analysis at the end of each storage period.

Weight loss: Determined by weighing individual steaks immediately after freezing and at the end of storage.

Colour: Cores, 2.8 cm in diameter were removed from the centre of steaks and immediately measured over a range of 700 to 400 nm using a Beckman DK-2A spectrophotometer. Reference meat samples were prepared according to Snyder (1965). Percent myoglobin, oxymyoglobin and metmyoglobin were calculated using Table 11 of Hood (1973). Visual observations of the steaks were also made to determine the degree of freezer burn and darkness or lightness of the steak colour.

Microbiology: Cores, 2.8 cm in diameter(approximately 10g), were aseptically removed, placed in sterile plastic bags containing 90 ml of 1/4 strength Ringers solution, macerated in a Colworth stomacher and all subsequent dilutions made to 1 in 10. The following determinations were made with media or method in parenthesis: total counts (tryptone soya agar), Fl. pseudomonads (medium B of King et al. 1954), coliforms (violet red bile agar) microbacteria (Gardners' medium, Gardner, 1966) and lactobacilli (MRS medium of Rogosa and Sharpe, 1960).

Oxidation: The thiobarbituric acid number (TBA) was used as a measure of rancidity in the lean portion of steaks using the method of Tarladgis et al. (1960). Peroxide value (P.V.) and free fatty acid (FFA) were measured on the outside fat layer, using a common chloroform extract (Pearson and Muslemuddin, 1969). FFA were expressed as percent oleic acid and P.V. as mequiv/kg of fat.

Drip and cooking loss: Steaks were thawed on wire trays at 16°C for 4 hours, covered with normal wrap to prevent condensation. Loss in weight was expressed as percent drip loss. Cooking was carried out in a convection oven, preheated to 350°F (177°C) and cooked to an internal temperature of 171°F (77°C). Loss in weight was expressed as percent cooking loss.

Tenderness: Cores, 1.27 cm in diamter, were taken in parallel orientation with muscle fibres afer cooking and storing at 50°F (10°C) overnight. A Warner-Bratzler meat shear fixture fitted to an Instron table model IIII was used to measure shearing forces (kg).

Statistical analysis: The t-test was used to test whether the means of the different sets of data differed significantly.

RESULTS AND DISCUSSION

Weight loss: Weight loss during freezing was significantly different between the slow and faster freezing rates, however, freezing rates of greater than 4 cm/min showed no significant advantage in reducing weight loss (Table 1).

Table 1: Effect of freezing methods on weight loss during freezing

Freezing method	% Weight Loss (means)		t-value
Liquid Nitrogen v Plate	0.84	0.73	N.S.
Plate v Deep freeze	0.65	2.22	13.47***

N.S. = Not significant

*** = ($P < 0.001$)

During frozen storage no weight loss was observed for vacuum packs but significant weight losses were noted at 10, 24 and 40 weeks of storage in the normal wraps (Table 2). There were no significant differences in weight loss between any of the freezing methods during storage.

Table 2: Effect of frozen storage on percent weight loss for different freezing methods in normal wrap

Freezing Method	Storage time (weeks)					
	10 v 24			24 v 40		
	means		t-value	means		t-value
Liquid nitrogen	0.3	1.02	5.4**	1.02	1.96	N.S.
Plate	0.57	0.96	3.94**	0.96	2.43	2.43**
Deep freeze	0.71	0.97	N.S.	0.97	2.37	2.67*

N.S. = Not significant

** = ($P < 0.01$)

* = ($P < 0.1$)

Colour: Visual observations indicated that the slow freezing rate of 0.2 cm/hr resulted in an undesirable dark red colour while the fast freezing rate of 20 cm/hr gave a pale red colour. The most acceptable meat colour resulted from the intermediate freezing rate of 4 cm/hr. During frozen storage colour deteriorated in all steaks particularly after 24 weeks. In the normal wrapped steaks freezer burn was observed after 10 weeks which became progressively more evident with storage, particularly in the liquid nitrogen or fast frozen steaks.

Percent metmyoglobin increased most signficantly during the first 10 weeks of storage for all freezing methods and packaging materials (Table 3).

Table 3: Effect of storage time and packaging material on percent metmyoglobin formation.

Storage time (weeks)	Packaging Material					
	Vacuum			Normal		
	means		t-value	means		t-value
0 v 10	13.6	35.4	16.77***	13.6	39.2	19.69***
10 v 24	35.4	41.1	2.15*	39.2	39.8	N.S.
24 v 48	41.1	48.2	5.46**	39.8	51.1	8.69***

*** = ($P < 0.001$)

** = ($P < 0.01$)

* = ($P < 0.1$)

There was no change in the amount of reduced myoglobin in the vacuum packed steaks during frozen storage, this is due to the inhibition of the enzymatic reducing systems.

Microbiology: Freezing methods did not result in decreases in total bacterial numbers immediately after freezing. During frozen storage some decrease in total numbers could be attributed to liquid nitrogen or fast freezing. Freezing methods showed widely differing effects on coliforms. Deep freezing resulted in a large decrease in coliform numbers whereas liquid nitrogen freezing resulted in increases in coliform numbers probably due to the breaking up of colonies by the liquid nitrogen spray. Figure 1 shows the effects of liquid nitrogen and plate freezing on certain bacteria and total counts at 10, 24 and 40 weeks of frozen storage. Liquid nitrogen shows a trend to reduce bacterial numbers in comparison to plate freezing. There was little difference between plate and deep freezing techniques on bacterial numbers.

Packaging material did not affect the microbiological quality of the steaks during storage.

Oxidation: Freezing method or packaging material had no significant effect on oxidative changes during storage. As expected the peroxide values (Table 4) and thiobarbituric acid number (Table 5) showed significant increases during storage.

Table 4: Effect of storage time and packaging material on peroxide value

Storage time (weeks)	Packaging Material					
	Vacuum			Normal		
	means		t-value	means		t-value
0 v 10	0.83	0.86	N.S.	0.87	0.9	N.S.
10 v 24	0.86	1.47	N.S.	0.9	1.67	N.S.
24 v 40	6.10	6.10	7.85***	1.67	4.98	4.94***

Table 5: Effect of storage time and packaging material on thiobarbuturic acid number

Storage time (weeks)	Packaging Material					
	Vacuum			Normal		
	means		t-value	means		t-value
0 v 10	.12	.21	N.S.	.16	.23	N.S.
10 v 24	.21	.56	4.72***	.23	.50	4.11***
24 v 40	.57	.66	3.88**	.50	.67	4.02**

N.S. = Not significant
*** = ($P < 0.001$)
** = ($P < 0.01$)

From these results it would seem that oxidation occurs first in the lean tissues and then in the adipose tissues. Ledward and MacFarlane (1971) reported that high TBA numbers generally corresponded with high metmyoglobin contents during frozen storage however, for lower concentrations they stated that TBA numbers are not directly related to pigment oxidation. Figure 2 shows how percent metmyoglobin and TBA number increased during frozen storage.

Free fatty acid values showed no significant difference between freezing methods, or packaging material during frozen storage.

Drip and cooking losses: Rate of freezing or packaging material showed no significant influence on drip loss. Liquid nitrogen freezing resulted in significantly greater cooking losses (Table 6) however, storage time or packaging material had little effect.

Table 6: Effect of freezing method on cooking loss after different storage times

Storage time (weeks)	Freezing Method		
	Liquid Nitrogen	V Plate	
	means		t-value
0	28.8	24.0	2.29*
10	27.1	23.1	2.76*
24	29.1	23.1	4.02***
40	25.3	22.3	2.2*

% Cooking loss in non frozen steaks = 18%

*** = ($P < .001$)

* = ($P < .1$)

Tenderness: Tenderness was not affected by either freezing rate or storage time.

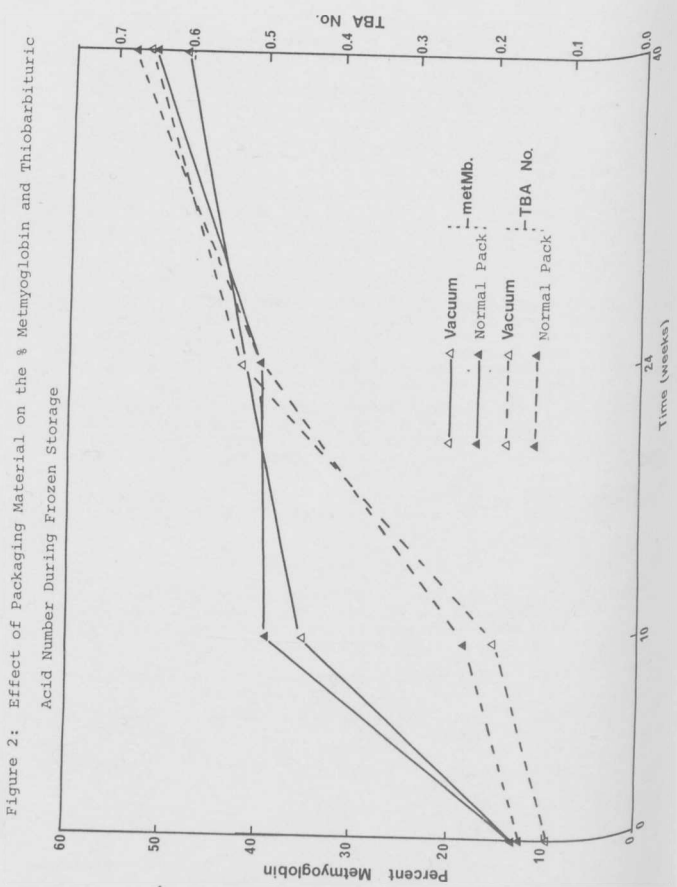

Figure 2: Effect of Packaging Material on the % Metmyoglobin and Thiobarbituric Acid Number During Frozen Storage

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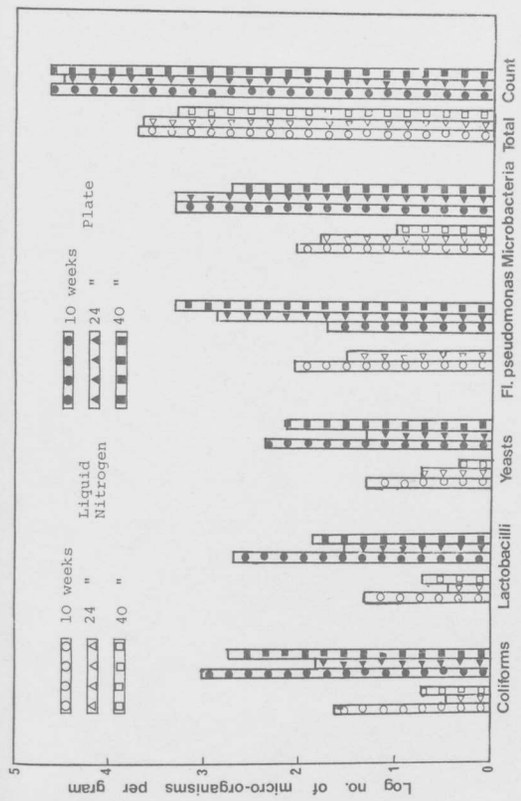

Figure 1: Effect of Liquid Nitrogen and Plate Freezing on Microbial Counts of Beef Steaks During Frozen Storage