Weight Losses and Eating Quality in Frozen Beef as Affected by the Blast Freezing of Hot Quarters.

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In Australia, it is normal ~~slaughter~~house practice to cool beef at -0.5°C to 1.5°C for 2 to 3 days before placing it in the commercial freezing chambers. Rigor mortis is complete before freezing commences. Working on small pieces of muscle in 1929, Moran had shewn that if freezing were rapid enough to arrest the onset of rigor mortis then, on thawing, drip was much higher than usual. The term, 'drip', refers to the characteristic reddish fluid which exudes from meat on thawing: it represents perhaps the most obvious drawback of frozen beef.

Since there has been a recent tendency in commercial practice to speed up the freezing of meat, the possibility of prengor freezing and of the excessive drip associated with it, were of obvious interest. As part of the programme of cooperative meet investigations jointly undertaken in Brisbane during 1953-56 by personnel of the C.S.I.R.O. of Australia, and the D.S.I.R. of the United Kingdom, a study was therefore made of the effect on drip and eating quality of blast freezing beef quarters without a prior period of chilling.

There were two series of experiments on this topic. In the first of these (Howard and Lawrie, 1956), 6 beef cattle from each of the Queensland grades, first and second quality export and canner, constituted the experimental material i.e. 18 carcases in all. One side of each carcase was placed in the commercial chillers for 2 to 3 days and was then transferred to commercial freezing chambers at -12°C to -18°C for 3 to 5 days. Such sides were then stored for 20 weeks at -10°C. The other side of each carcase entered a blast tunnel within 90 minutes of slaughter.

The blast operated at 250 ft/min and -35°C and was permitted to run until recorders indicated that the deep butt was frozen. 48 hours after entering the tunnel the blast-frozen sides were transferred to frozen storage at -10°C(for 20 weeks).

Under these conditions it proved impossible to cool the beef carcases at a sufficiently high rate to freeze them before the onset of rigor mortis, the deep butt taking about 24 hours to freeze. There was thus no excessive drip on thawing. The blast freezing process was advantageous however in that the overall percentage loss of weight from before freezing until after 20 weeks storage at -10°C was considerably less than in the case of the normally chilled and frozen beef quarters (Table 1).

Table 1 Percentage Weight Losses from Beef Quarters during Freezing and Storage.

	Blast Frozen at -35°C without prior chilling.	Normal chilling and freezing.
Weight loss during:- Chilling	-	1.5 ¥
Freezing	0.60	1.33
20 weekly storage at -10°C	0.74	0.36
Total (% hot weight)	1.34	3.22

¥ Estimated

Incidentally, both during freezing and storage, and on thawing, canner carcases lost more weight than those of the two better grades studied. In comparison with the beef chilled and frozen by normal commercial practice, the eating quality of the beef which had been blast frozen without prior chilling was significantly less. Its general acceptibility was lower, principally on account of a darker appearance and lower tenderness.

In the second series of experiments beef carcases from 10 Queensland first quality export steers were used. An equal number of sides were allocated to each of 4 treatments. Blast freezing without prior chilling (but after preslaughter injections of relaxant doses of magnesium sulphate), normal chilling and freezing after such injections and corresponding non-injected controls for both methods of freezing. In this

second series (Howard and Lawrie, 1957) a blast tunnel operating ab - 40°C and 1000 ft/min was employed: the beef was kept at -10°C for 14 weeks only. Recording thermometers indicated that the deep butt had been frozen in 18-20 hours; but there was again no evidence for increased drip which would have been indicative of prerigor freezing. On the contrary, the blast freezing treatment significantly lowered drip on thawing the beef as butcher's joints. The effect was more marked in the case of the blast frozen sides from steers injected preslaughter with magnesium sulphate. Again, by elimination of the chilling period, the blast-frozen sides lost much less weight during freezing than those frozen in the normal commercial manner.

A particularly interesting additional finding, however, which was contrary to the effects with the less powerful blast, was that the eating quality of roasts and grills from the blast frozen beef was fully as high as that from the normally chilled and frozen controls, although the colour of the blast frozen meat was again darker.

The loss of eating quality in comparison with controls of the beef blast frozen at the slower rate (250 ft/min and -35°C) was attributed to the absence of the chilling period, during which an increase of tenderness would have been expected. Since the absence of the chilling period would also operate against tenderness in the work with the more powerful blast, however, it must be presumed that this factor was more than offset bymicro-structural changes effected by the greater rate of freezing. At the moment it is not possible to specify what these changes may be, for although freezing has been shewn to make beef more tender (Hiner, Madsen and Hankins, 1945: Hiner, 1951), the rate necessary appears to be of the order of that required to cause intrafibrillar ice formation. Such rates are virtually impossible with beef quarters.

Beneficial microstructural changes other than intrafibrillarice formation may well be implicated also in accounting for the decrease in drip associated with the faster rate of blast freezing. Microphotographs published by Cook, Love, Vickery and Young (1926) and Moran (1932) indicate that the degree of disruption and distortion of histological elements caused by ice crystal formation diminishes as freezing times decrease from 20 to 3 hours.

With the faster rate of blast freezing much of the beef carcases was frozen in 5 to 9 hours and some would have been frozen in less than 5 hours.

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