Volume : 2 | Issue : 9 | Sept 2013 • ISSN No 2277 - 8160

Research Paper

Food Science

Effects of Freezing Temperature and Ageing on Weight Loss From Pork Longissimus Dorsi During Frozen Storage

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ABSTRACT

The effects of ageing (meat not aged versus meat aged 3 days), freezing and storage temperature (-18°C versus -60°C) on changes in weight loss were investigated during 1 month of frozen storage on pork Longissimus dorsi. Temperature of freezing and rate of ageing was found to have a significant effect ($p < 0.05$) on weight loss during frozen storage

KEYWORDS : freezing, frozen storage, ageing, pork

1.Introduction

In the past few years, frozen meat was the main raw material used in the meat industry, while frozen storage was often applied to prolong the storage life of meat. Most physical and chemical changes occuring in meat during freezing and storage of frozen meat are caused by moisture migration and ice recrystallisation (Fennema, O.R. 1996). Several studies have concluded that the size and location of crystals formed during freezing and storage are responsible for decreased quality in meats after freezing. Hence, Anon and Calvelo (1980), as well as Grujic et al., (1993), showed the influence of the freezing rate on the formation of ice crystals that underlies the mechanisms of damage during the freezing of meat tissue and the difference between fast freezing and slow freezing rates. Furthermore, Petrovic et al. (1993) found that slowly frozen meat – 0.22 and 0.39 cm/ h – lost more weight during freezing than meat frozen at 3.95–5.66 cm/ h. However, Rahelic et al. (1985) reported that the location of ice crystals is not always directly related to the freezing temperature, while Ngapo et al., (1999) demonstrated that the freezing rate used before storage did not influence drip loss. Yu et al., (2009) showed a link between the optimum time post-mortem to freeze meat and freezing loss. Thus, freezing meat at 45 min post-mortem significantly reduced freezing loss when compared with meat frozen at 4 and 24 h post-mortem.

However, there are/is little data in the literature to suggest that the temperature of freezing and the rate of ageing prior to freezing have any substantial influence on weight loss of meat during frozen storage. Weight loss occuring during freezing and storage of meat represents a considerable economic loss to the meat industry. Since weight loss during freezing and frozen storage have economic consequences, it is important for the meat processing industry to control and optimize these processes. Therefore, it is important to know whether temperature of freezing and rate of ageing before freezing will lead to changing weight loss of pork meat during one month of frozen storage. The main goal of this study was to determine the optimum temperature and rate of ageing before freezing meat in order to minimize the detrimental effects of frozen storage on weight loss of pork.

2.Material and methods

The experiment was carried out at the pilot station located at "Dunarea de Jos" University of Galati, Romania. Longissimus dorsi muscle from ten carcasses with the same weight (24 h post-mortem) was cut into four samples of similar size, shape and weight (100g). Each sample was wrapped with polyethylene film.The experimental design comprised two factors: ageing (meat not aged versus meat aged 3 days) and temperature during frozen storage (-18°C versus -60°C). Frozen samples were stored at -18°C and -60°C for one month. The four samples were divided as follows: S1-24h at 0°C followed by freezing at -18°C and 1 month storage at -18°C (control); S2-24h at 0°C followed by 3d ageing at 2°C , freezing at -18°C and 1 month storage at-18°C; S3-24h at 0°C followed by freezing at -60°C and 1 month storage at -60°C; S4-24h at 0°C followed by 3d ageing at 2°C , freezing at -60°C and 1 month storage at -60°C. Forty samples were used for conducting this research.

The analysis of variance (Anova Single Factor) was used to analize weight loss. The analysis of variance was made to determine the significance of the main effects. The results are displayed as average values together with standard deviations.

3.Results and discussions

Table 1 shows the values of weight loss for two temperatures of freezing and storage (-18°C and -60°C) and two rates of ageing (meat not aged and meat aged 3 days). The samples frozen and stored at -18°C had higher values ($p < 0.05$) than the samples frozen and stored at -60°C. Meat aged before freezing and storage had lower weight loss values ($p < 0.05$) than meat not aged.

On the one hand, in terms of temperature, freezing and storage at -60°C gave 34% lower weight loss values for meat not aged, compared with meat frozen and stored at -18°C (S1 compared with S3), whereas meat aged 3 days had 22% lower weight loss values compared with meat with the same ageing time (S2 compared with S4). Consequently, we noticed that a lower temperature of freezing and storage led to lower weight losses, regardless of the rate of aging (either meat not aged or meat aged 3 days).

On the other hand, in terms of rate of ageing, freezing and storage at -18°C gave 20% lower weight loss values for meat aged 3 days before freezing followed by storage compared with meat not aged (S1 compared with S2), whereas meat aged 3 days before freezing followed by storage at -60°C had 10% lower weight loss values compared with meat not aged (S3 compared with S4). Consequently, the rate of ageing led to lower weight losses, regardless of the freezing temperature (either -18°C or -60°C).

Anon and Calvelo (1980) had previously observed a reduction in the amount of exudate on unfrozen meat by increasing aging time. Also, Sakata et al., (1995) reported that no correlation between freezing temperature (-20°C and -80°C) and drip loss was found and no significant difference was noted.

However, the results of previous studies bear no comparison to ours, since there were no similar conditions in terms of temperature of freezing and storage on the one hand and rate of ageing on the other hand. Freezing and storage at -60°C led to lower weight loss values in both meat not aged and meat aged 3 days.

Taking into account the interaction between rate of ageing and temperature of frozen storage, it seems that a lower freezing temperature affected weight loss values of aged pork during one-month storage, producing a decrease in this parameter (weight loss) in aged pork.

To sum up, weight loss values were significantly affected ($p<0.05$) by the freezing temperature and rate of aging. These results indicate that aging before freezing and storage at low freezing temperature may reduce weight loss during frozen storage.

4.Conclusions

Our results indicate that freezing and storage at -60°C of aged pork muscle (3 days) reduce weight loss values as compared to meat not aged and freezing and storage at -18°C. Freezing and storage at -60°C after 3 days ageing have the potential of producing significant savings for the meat industry due to low weight losses. Further on, more studies are necessary to show the influence of freezing and storage at -60°C on meat quality attributes such as thawing loss, cooking loss, color and tenderness.

Table 1. Weight loss (%) according to freezing temperature and rate of ageing

Samples	Weight loss (%)	Standard deviation
S1 frozen at -18°C (not aged)	0.59	0.11
S2 frozen at -18°C (3days aged)	0.49	0.15
S3 frozen at -60°C (not aged)	0.44	0.08
S4 frozen at -60°C (3days aged)	0.4	0.18

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