# TENDERNESS OF MEAT COOKED FROM FRESH, FROZEN AND THAWED STATES

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## INTRODUCTION

In the eyes of the consumer meat tenderness is one of the key elements of meat quality. Inconsistency in meat tenderness is a major problem of the red meat industries (Morgan *et al.* 1991). While palatability has several components including tenderness, juiciness and flavour, Koohmaraie *et al.* (1995) state that there is twice as much variation in tenderness as in juiciness and flavour and it is well known that tenderness of meat is one of the most important components of eating satisfaction. Hence tenderness is one aspect of meat quality that has potential to be improved, leading to increased consumer satisfaction when eating red meats. Objective measurement of tenderness is an important means for benchmarking the quality of meat reaching consumers.

To measure tenderness, various direct quantitative methods, usually based on the force required to shear samples of cooked meat, have been developed. Methods vary, based on type of cut used, weight of meat cooked and cooking method (Anon 1995, Chrystall and Devine 1991, Bouton and Harris 1972). Quality assurance for tenderness can improve marketing prospects for red meats however shear force procedures for measuring meat tenderness need to be standardised to achieve meaningful results. Boneless cuts are increasing in popularity amongst consumers and lend themselves to a process that can be standardised.

This work aimed to examine the impact of storage and cooking method on the tenderness of muscle samples from lambs measured mechanically by a Warner Bratzler shear blade.

## MATERIALS AND METHODS

### Samples

*Longissimus thoracis et lumborum* were collected from lambs slaughtered and processed at commercial domestic works.

**Experiment 1**: Loins were collected from 30 carcasses ranging in weight from 17.9 to 23.5 kg (mean 20.5 ± 1.8) with a pH range of 5.42 to 5.82 (mean 5.62 ± 0.04) After having the subcutaneous fat and endomysium (silver skin) removed, 80g samples of loins were cooked fresh (Treatment 1), or after being frozen then thawed and cooked for testing (Treatment 2). Samples were placed in perforated plastic bags and cooked in a water-bath at 80°C to an internal temperature of 76°C.

**Experiment 2**: Loins were collected from 22 carcasses ranging in weight from 15.8 to 22.2 kg (mean 19.2 ± 1.6), with a pH range of 5.53 to 5.71 (mean 5.64 ± 0.05). Muscle samples were stored at -22°C for up to 6 months prior to testing. Frozen denuded loin muscle samples were thawed at 5°C for 24h (Treatment 3). After thawing , the muscles were trimmed and cooked as in Experiment 1. An alternative treatment was cooking 110 g samples of 22 loins from the frozen state (Treatment 4). These samples were taken from the opposite loin at the posterior end, were not trimmed of fat and endomysium, and cooked as above. From the anterior end of the loin used for Treatment 4 , 100 g samples with fat and endomysium still present, were thawed for 24h at 5°C (Treatment 5) and cooked, as described above.

After cooking, samples were cooled under running cold water, blotted dry and weighed to estimate cooking loss in all treatments. Samples were stored at 5°C overnight before being tested. Blocks of one $cm^2$ square cross section with muscle fibres lying longitudinally were cut from the cooked and chilled samples. Mechanical measurement of tenderness was made with a Warner-Bratzler shear device fitted to an Instron Materials Testing Machine (Model 4301).

Data was analysed by the analysis of variance.

## RESULTS AND DISCUSSION

Internal muscle temperature for samples from Treatments 1, 2, 3, 4 and 5 after 1h of cooking was 76°C, indicating that state and presence of fat and membrane prior to cooking did not affect the degree of cooking.

The results for cooking loss (CL%) and Warner-Bratzler (WB) shear force ($kg/cm^2$) are given in Table 1.

**Table 1. Shear force (WB) and cooking loss (CL) (means ± standard errors) for treatments 1, 2, 3, 4 and 5.**

| | Experiment 1 | | Experiment 2 | | |
|---|---|---|---|---|---|
| | Treatment 1<br>Trim/fresh | Treatment 2<br>Trim/frozen/thawed | Treatment 3<br>Trim/frozen/thawed | Treatment 4<br>No trim/frozen/thawed | Treatment 5<br>No trim/frozen |
| WB ($kg/cm^2$) | $4.25 \pm 0.24^A$ | $3.14 \pm 0.16^B$ | $3.70 \pm 0.25^a$ | $4.16 \pm 0.27^a$ | $4.05 \pm 0.27^a$ |
| CL (%) | $32.2 \pm 0.34$ | $32.4 \pm 0.21$ | $37.2 \pm 0.26^a$ | $23.9 \pm 0.52^b$ | $23.5 \pm 0.48^b$ |

$^{A, B}$ Experiment 1 figures with different superscripts in rows are significantly different, P<0.001
$^{a, b}$ Experiment 2 figures with different superscripts in rows are significantly different, P<0.001

Samples cooked from the fresh state (Treatment 1) had significantly ($P<0.001$) higher WB shear force values than samples that had been thawed (Treatment 2). There was no significant difference in WB shear force values when samples were cooked from the frozen (Treatment 5) or thawed states (Treatments 3 and 4). Cooking from the frozen state with the presence of fat and membranes, significantly ($P < 0.001$) reduced cooking loss, but had no significant effect on WB shear force values.

The current study showed lower variation in samples that had been frozen and then thawed (Treatment 2) compared to samples tested fresh (Treatment 1). In addition, freezing and thawing led to an underestimate of tenderness compared to fresh samples. Samples that had been thawed following freezing (Treatments 3 and 4) did not have less variation than samples cooked from the frozen state (Treatment 5) indicating that `freezing processes' may have a greater effect on meat samples rather than the `thawing processes'. This would have to be investigated through further studies. Notwithstanding, cooking from the frozen state offers practical advantages for assessing tenderness by eliminating the time required for thawing. pH and colour parameters however would have to be obtained either prior to frozen storage or from a thawed section of the frozen sample.

Our results support the suggestion (Anon. 1995) that meat samples should be evaluated fresh to avoid effects or bias due to differences in rates of freezing and thawing and length of storage. If, for logistical reasons, samples have to be stored frozen before testing, they can be conveniently cooked from the frozen state as suggested by Chrystall and Devine (1991) without significant effect when compared to samples that have been thawed.

## CONCLUSIONS

1. Samples that had been previously frozen, then thawed prior to cooking gave significantly lower WB shear force values than samples cooked and tested fresh. In contrast, there was no significant difference in WB values for samples cooked after being thawed versus those cooked from the frozen state

2. Boneless samples can be cooked with subcutaneous fat on without significantly affecting WB shear force values.

3. Cooking samples with fat on significantly affects cooking loss. This effect will have to be considered when data sets based on results from this type of approach are being compared to data from samples that have been denuded. Given that cooking loss is a good measure of juiciness when the pH ranges from 5.4 to 5.8 (Bouton *et al.*, 1971), this relationship may be affected by the presence of fat.

4. For WB measures, a standard method should be based on the use of a denuded cut that has been cooked from the frozen state when tenderness is the only characteristic being tested. This will avoid confusion with the estimate of cooking loss from the lean portion that is significantly affected in the presence of subcutaneous fat.

5. Compared to fresh samples that are tested, freezing significantly lowers the average WB shear force measure of samples. An alternative practical method may be to cook the samples immediately after collection and prior to dispatch for WB assessment. It is suggested that whenever possible, samples should be tested from fresh to give as an accurate a picture of what is happening at the consumer level, and to avoid the introduction of bias due to storage practises.

## REFERENCES


Anon. (1995) Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. American Meat Science Association and the National Live Stock and Meat Board.

Bouton, P.E and Harris, P.V. (1972) *J. Food Sci.* **37**:218.

Bouton, P.E, Harris, P.V. and Shorthose, W.R. (1971) *J. Food Sci.* **36**:435.

Chrystall, B.B. and Devine, C.E. (1991) Quality assurance for tenderness. Technical Report. MIRINZ, Hamilton, NZ.

Koohmaraie, M., Wheeler, T.L. and Shackleford, S.D. (1995) Beef Tenderness: Regulation and prediction. US Meat Animal Research Center, Clay Center, NE.

Morgan, J.B., Savell, J.W., Hale, D.S., Miller, R.K., Griffin, D.B., Cross, H.R. and Shackleford, S.D. (1991) *J. Anim. Sci.* **69**: 3247.