THE BEST TIME POSTRIGOR TO USE CHILLED BEEF FOR GELLED PRODUCTS

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Background

Fabricated foods can be made from many sources. The ability of meat proteins to gel on heating offers opportunities to develop a gelled multi-component fabricated foodstuff (Tolstoguzov and Braudo, 1983). Previous studies have shown that the gelling ability of meat proteins tends to diminish with frozen-storage time and many theories have been proposed to explain the phenomenon. Regardless of what causes muscle proteins to lose their gelling ability during storage, it is important that protein in its most optimum gelling state should be used to fabricate a gelled foodstuff. We know that meat stored frozen for 2-3 months significantly loses its gelling ability, yet we have some evidence that the gelling ability of meat frozen for a month is higher than that of fresh meat just after rigor (Farouk et al., 2001). There is a possibility that similar increases in gelling ability occur in chilled meat before deterioration on extended storage.

Objective

This study was designed to determine whether the increase in the gelling ability of post-rigor meat during storage is linear with time up to the first 1 month of storage, with the ultimate aim of obtaining the best raw material for fabricated gelled foodstuffs.

Methods

Four heifers were captive bolt stunned and processed, with no electrical immobilisation or stimulation, at a commercial meat plant. The *semimembranosus* from each heifer (n = 8) was removed within 45 min of slaughter and held at 15°C until rigor. Each muscle was divided into five equal portions to correspond to five storage times (0, 1, 2, 3, and 4 weeks). A randomised block design was used to allocate samples to the storage periods, taking account of any positional effect. Samples were placed individually in vacuum bags and these were evacuated and sealed. Vacuum packed samples were placed in cartoons and stored at -1°C until analysed. Sausage batter, physical and chemical properties and protein solubility were determined as described in Farouk and Swan (1997, 1998a). Malondialdehyde (MDA) was determined and SDS-PAGE was conducted according to Bergamo et al. (1998) and Laemmli (1970) respectively.

Results and discussion

The ability of muscle protein to gel and to form a stable fat-water-protein matrix in a cooked batter is an important property that should be exploited in the development of fabricated foodstuffs. This stabilisation can be measured by torsion shear stress and strain, cook yield and emulsion stability of the cooked batter. Shear stress is a measure of gel strength and is sensitive to protein concentration, whereas strain is a measure of gel deformability and is influenced by protein quality rather than concentration (Hamann and Lanier, 1987; Hamann, 1988).

Total protein and myofibrillar protein solubilities increased with time between week 1 and 3, and then started to decline ($P < 0.001$) (Figure 1a & b). Sarcoplasmic protein solubility decreased with time throughout the storage period ($P < 0.001$) (Figure 1c). This laboratory previously observed similar changes in protein solubilities for meat stored frozen for 1 month (Farouk and Swan, 1998a) and attributed the increase in solubilities to the proteolysis of muscle proteins and the resultant release of free amino acids and shorter protein peptides. The increases in pH with time ($P < 0.001$) (Figure 1d) observed in this study suggest an increase in free amino acids and dipeptides – particularly carnosine (Farouk and Swan, 1998b). SDS-PAGE of the myofibrillar proteins of the samples from the present study (data not shown) revealed the appearance of bands around 30 KD and other bands of lower molecular weights in samples stored 1 week, and the intensities of those bands increased with storage time. The appearance of these bands indicates increased proteolysis of muscle proteins, supporting the explanation we provided for the increased protein solubilities within the first three weeks. The higher protein solubilities with time are also reflected in the higher cooked batter gel stress, strain, cook yield and emulsion stability observed in the present study (Figure 1e-h).

Malondialdehyde (MDA) content of the samples increased with time for 3 weeks and then declined on the fourth ($P < 0.001$) (Figure 1i). MDA is formed mainly from the oxidative degradation of fatty acids. The decrease in MDA after the third week is attributed to the reaction of MDA with free amino acids and muscle proteins resulting in MDA-amino acid complexes, perhaps when the two products reach certain critical concentrations. The formation of complexes is the likely reason for the decreased protein solubility and gelling ability after 3 weeks of storage (Esterbauer et al., 1991).

Our data have shown that the gelling ability of beef muscle proteins tends to increase with time in the first month of storage and then to decrease thereafter. We explain this behaviour as follows: 1) In fresh meat less protein is soluble compared to meat stored for 3 weeks because the cumulative effect of proteolytic activity results in more free amino acids and peptides, which consequently increase protein solubility. 2) With longer storage times, proteolysis will further increase their concentration in the meat. Fat oxidation products will also accumulate; when the products reach a critical level they react with the free amino groups on the proteins, peptides and amino acids, so reducing protein solubility and gelling ability. 3) These changes will occur faster under chilled storage than frozen. However; actual differences in the magnitude of the change may be minimised due to other factors associated with frozen storage that are detrimental to protein functionality.

Conclusions

The result of this study demonstrates the changes in the gelling ability of meat proteins within the first month of chilled storage. Within the parameters of the present study, meat stored chilled for 2 to 3 weeks had the best gelling ability and thus potentially could provide the best raw material for a gelled fabricated foodstuff.

References

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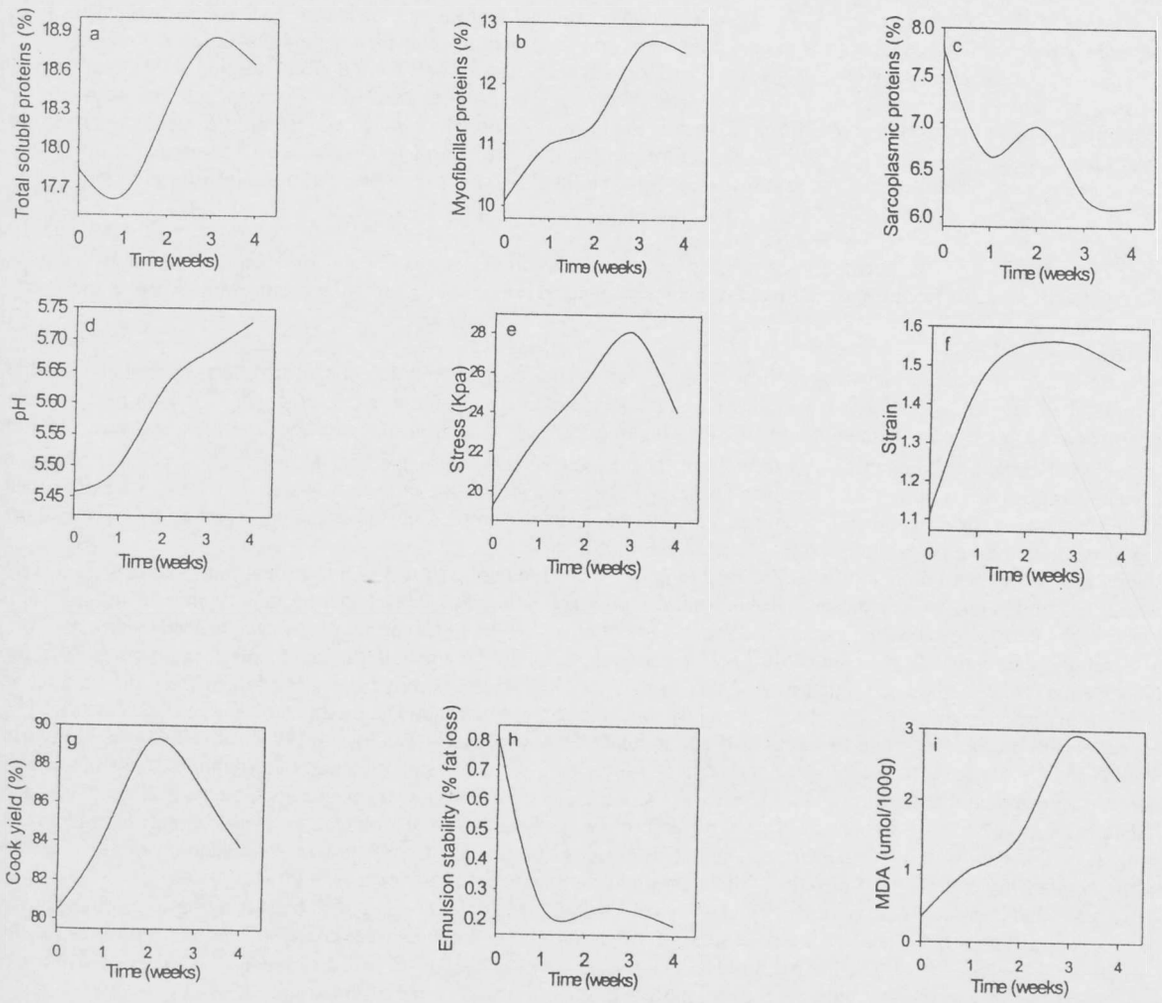

Figure 1 (a-i). Changes in the functional properties of beef stored chilled (-1°C) for one month. Protein solubilities are percentages of total meat proteins.