D30

MAINTENANCE OF PRERIGOR FUNCTIONALITY IN MANUFACTURING BEEF

Tyre C. Lanier and Penny Amato-Harwell
Department of Food Science, North Carolina State University, Raleigh, NC

KEY WORDS: cryoprotection, glucose, prerigor, gelation

BACKGROUND

A broad objective of our laboratory has been to determine a means to maximize the functionality of frozen meats. Since salted prerigor meat is recognized as having superior fat/water binding and gelling (texture forming) properties, typically called "bind properties", we first concentrated on cryoprotecting salted prerigor meat (Park et al., 1987). This work revealed that while cryoprotectants improved the frozen storage stability of both prerigor and postrigor beef, the presence of the salt (acting as a protein denaturant) acted to negate their effect. The result was that salted prerigor meat with cryoprotectants had about the same bind properties as fresh postrigor meat.

We next tried cryoprotecting unsalted prerigor meat (Park et al., 1994). In this work, Polydextrose® effectively improved the gel forming ability of both prerigor and postrigor beef and maintained their functionality during frozen storage better than the prerigor and postrigor controls. Control samples were made without Polydextrose® in the formulations, so initial values for Polydextrose®-containing samples were higher than controls, causing a biased result toward cryoprotected treatments. Evidence of improved functionality from Polydextrose®/phosphate mixtures used for cryoprotection were complicated by apparent phosphatase activity degrading the phosphate during frozen storage. Phosphate added to "control" meats after 5 months frozen storage induced a significant increase in gel forming ability and decrease in cook loss that we wanted to further investigate.

OBJECTIVE

The study we are reporting concentrated first on developing an understanding of the causes of the loss in functionality which occurs upon development of rigor mortis, with the intent of discovering a means of arresting or reversing this loss. Secondly, we wanted to determine an optimum procedure for producing a highly functional frozen meat material based upon the information gained from our previous work.

METHODS

Our first experiment investigated the natural decrease in functionality as meat goes through rigor mortis. We tested beef at various time intervals as the pH dropped due to postmortem glycolysis, then later (postrigor) adjusted the pH of the meat back to corresponding prerigor pH levels with sodium hydroxide (NaOH). We measured pH, gel forming ability (torsional stress and strain), protein extractability, and cooked yield at each interval.

Our next experiment used additives or processes to increase functionality of the meat by either increasing pH or protein solubility. Additives used to alter the pH of the meat were sodium chloride (NaCl) and glucose (Young et al., 1988) added prerigor to prevent pH drop and NaOH added to postrigor meat to restore prerigor pH. Phosphate addition and "preblending" the meat with salt for a 24 hour holding period were used to alter protein solubility. Again we measured the same functional properties.

Our third experiment added glucose (to inhibit pH drop in prerigor meat) in conjunction with sucrose (as a cryoprotectant) to maintain functionality in frozen ground prerigor and postrigor beef. Meats were tested initially (unfrozen) and after 2 and 7 months of frozen storage. Indicators of stability were the same functionality measurements used in the previous two experiments.

RESULTS AND DISCUSSION

From the first experiment, designed to determine if the superior gelling characteristics of prerigor beef deteriorate during rigor mortis primarily due to pH decline, we found that although some functionality was restored by adjusting the pH of postrigor meat upwards, the level of functionality expressed by the prerigor meat could not be restored. The greatest recovery was in gel strain (Fig. 1) and cooked yield (not shown), which returned to 83% and 97%, respectively of the prerigor value at pH 6.5 (calculated from the regression equations). With pH adjustment, gel stress recovered slightly (as much as 58%) in a curvilinear manner; however, extractable protein did not recover at all.

In the second experiment, which was designed to suggest the best means of maintaining or restoring prerigor functionality, we found that by the addition of phosphate to postrigor meat it is possible to recover all functionality lost due to rigor mortis; indeed, gels from postrigor meat treated with phosphate had even higher stress (Fig. 2) and strain (not shown) values than gels from prerigor meat. There seemed to be benefits in adding glucose to the meat prerigor to inhibit postmortem pH drop: this treatment, with or without phosphate addition, was near the best in all functionality testing. These results are for unfrozen meats. Since glucose is also an excellent cryoprotectant, its addition to prerigor meat prior to freezing might then be expected to have a double benefit. We found no beneficial effect of preblending.

From the first two experiments, it seemed likely that cryoprotection of meat prior to frozen storage, followed by addition of phosphate at the time of use, should result in functional properties near, or possibly exceeding, that of fresh prerigor (or fresh, salted prerigor) meat, so a frozen storage study with cryoprotectants (sucrose or a sucrose/glucose mixture) added to the meat before freezing was conducted. Results from this study showed that both cryoprotectant treatments stabilized postrigor meat during frozen storage and particularly its phosphate reactivity. Cryoprotected, postrigor samples equalled or surpassed the functionality of fresh prerigor samples (Fig. 3). Neither cryoprotectant treatment improved the stability of frozen prerigor beef, thus, prerigor processing is not required to achieve prerigor functionality in frozen beef.

CONCLUSIONS

Very functional manufacturing beef can be made and stored frozen for many months by cryoprotecting postrigor beef prior to freezing. Using this manufacturing meat in combination with polyphosphate will produce excellent comminuted meat products equivalent to use of fresh prerigor meat. This process will allow manufacturers of processed meats to use frozen meats, which are more convenient and can be more cost efficient, with equal or better results than fresh prerigor meat.

REFERENCES

Park, J. W., Lanier, T. C., and Pilkington, D. H. 1993. J. Food Sci. 58(3):467-472.

Park, J. W., Lanier, T. C., Keeton, J. T., and Hamann, D. D. 1987. J. Food Sci. 52(3):537-542.

Young, O. A., Humphrey, S. M., and Wild, D. J. C. 1988. Proc. 34th Int'l Cong. of Meat Sci. and Technol. Brisbane, Australia. pp. 339-341

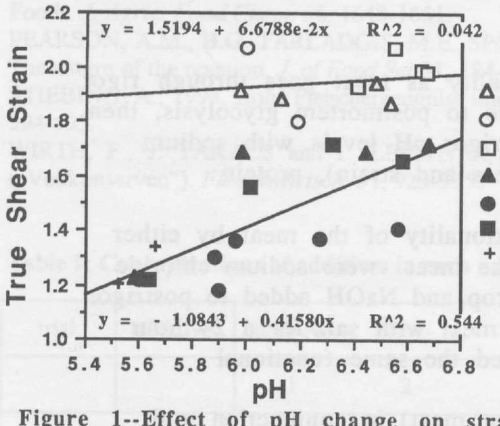

Figure 1--Effect of pH change on strain of postrigor and prerigor beef gels.

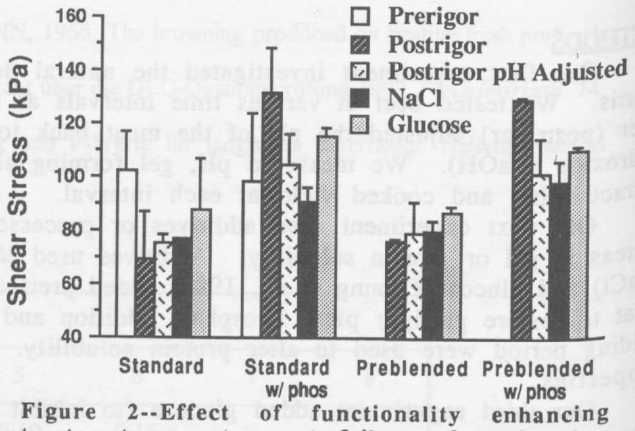

Figure 2--Effect of functionality enhancing treatments on stress at failure of beef gels.

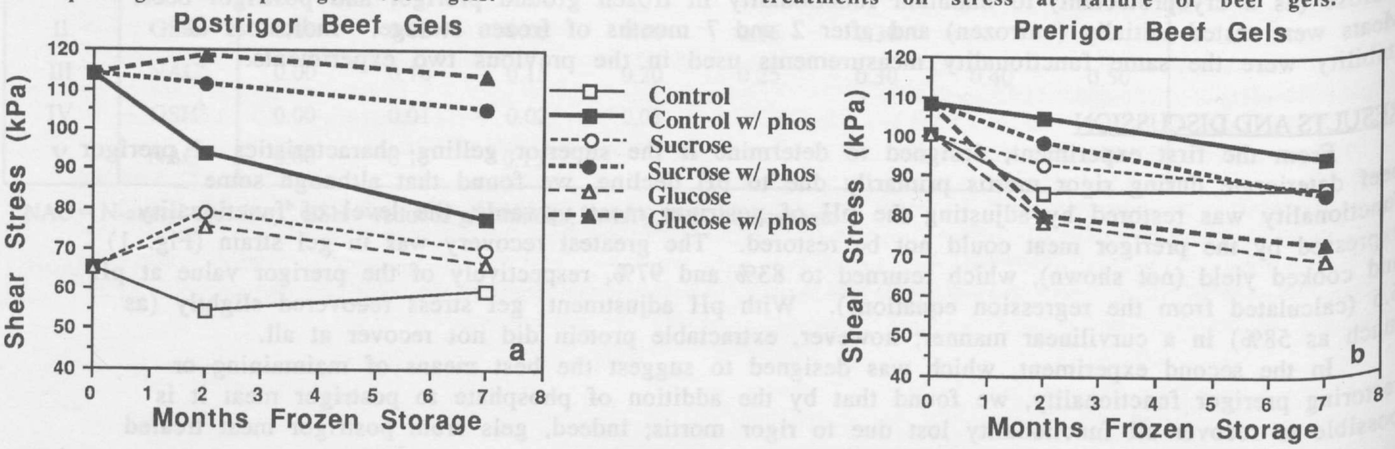

Figure 3--Effect of cryoprotectants on frozen storage stability of (a) postrigor and (b) prerigor beef.