EVALUATION OF GYLCOL CHILLING OF CHUB PACKAGED GROUND BEEF

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SUMMARY

Commercially prepared chub packs of coarse ground beef formulated to have 27 or 19% fat were chilled either by blending the meat with CO₂, snow before packaging or by immersion of the chub packages in 24, 18 or 6°F propylene glycol for 30 min. At the end of storage periods of 10, 14, 18, 22 and 26 days, the ground beef was evaluated for microbial quality and for storage and retail display characteristics. In general, the ground beef chilled with glycol was comparable in storage and retail characteristics to that chilled by adding CO₂ before packaging. Chilling in 6°F glycol tended to retard microbial growth through 18 days of storage. There were no significant differences in microbial quality due to different fat levels either during storage or retail display evaluation. Surface discoloration in the 6°F glycol chilled chub packages was higher at the end of storage than for any of the other chilling treatments, but this had no effect on the retail display characteristics. This discoloration was thought to be related to integrity of the seam of the chub casing. The surface freezing (crust) in the glycol chilled chubs had no effect on purge loss during storage.

INTRODUCTION

Marketing of beef has been changing from distribution of whole carcases to boxed beef produced at centralized processing plants. Along with this change, ground beef production has shifted from the retail store level to the centralized processing facilities. The shelf-life of ground beef produced at these plants must extend through the distribution system as well as time at the retail level. Traditionally, the shelf-life of ground beef has been more of a problem than shelf-life of muscle cuts because of increased handling and exposure to equipment, increased surface area upon grinding and elevated temperatures attained during processing.

Temperature control is a difficult but critical aspect of ground beef production. Increased temperature occurs during the accumulation of trimmings for mixing and fat adjustment (usually in the processing area that is at 40-45 °F or higher) and from heating caused by friction during grinding and mixing. The need for temperature control is further heightened for large volume producers who box the chub packs of ground beef because the boxes insulate the meat and slows chilling of the product.
At present, the most common method for temperature control is the addition of dry ice (CO₂) or liquid nitrogen to the meat during processing. However, the increasing cost of these materials, occasional worker safety problems and possible overmixing to assure even distribution are concerns of the industry.

Recently introduced chub chilling systems could eliminate some of the problems associated with chub-packed ground beef. These systems involve immersion of the chub packages into a chilled liquid such as propylene glycol. The chilling rate is controlled by the temperature of the liquid and the dwell time. For rapid chilling, these systems would freeze the surface (crust freezing) of the chub, then the temperature would equilibrate throughout the chub after boxing.

While these immersion systems offer some distinct advantages to the high volume ground beef producer, questions about product quality and shelf-life have not been investigated. The effect of crust freezing on purge loss, color stability and shelf-life, as well as operational parameters of temperature, dwell times and equilibration times need to be established.

OBJECTIVE

Determine the effects of chilling chubs of coarse ground beef by immersion in chilled propylene glycol on the quality of ground beef stored up to 26 days and to evaluate these products after fine grinding and packaging for retail display.

PROCEDURE

Four 6000 lb batches of coarse ground beef formulated at two fat levels, 73% lean and 27% fat (regular) and 81% lean and 19% fat (extra lean), were produced and packaged at a commercial plant. After the fat level had been adjusted, a portion of the batches were chilled by the addition of CO₂ snow to reduce the temperature to below 37 F, reground through a half-inch plate and stuffed into 15 lb chub packs. This was designated as the control and was boxed and stored in the chill cooler until shipping. The remaining meat was reground and stuffed into chub packs and randomly assigned to 30 min chilling in glycol at 24, 18 or 6 F. Preliminary tests using these temperature resulted in no surface (crust) freezing with 24 F glycol, crust freezing one-fourth inch deep with 18 F, and one-half inch crust when 6 F flycol was used. Following chilling, the chubs were boxed and placed in the chill cooler until shipping. Thermocouples were placed in the center of a portion of the chubs from each treatment group to monitor temperature changes for approximately 12 hr.

Boxes of the ground meat were loaded onto the center of a refrigerated truck and shipped to the University of Florida Meat Products Lab where they were stored at 28-30 F until evaluated after 10, 14, 18, 22 or 26 days of storage. At the end of each storage period, five randomly selected chubs from each treatment group and fat level were subjectively evaluated for amount of surface discoloration and purge. Two of the five chubs were
aseptically opened and sampled for total plate count microbial analysis. The ground beef was then removed from the chub casings, broken apart by hand and allowed to bloom for 20 min before being evaluated for muscle color, surface discoloration and odor.

Samples were prepared for retail display evaluated by grinding the meat through a one-eighth inch plate, placing the meat on styrofoam retail trays and wrapping with polyvinylchloride film. Microbiology samples were aseptically obtained at each step. Retail packages were placed in a retail case maintained at 32-34 F and evaluated for two days.

Data were analyzed using a factorial design (four chilling treatments: CO₂, 24, 18 and 6 F; and five storage times: 10, 14, 18, 22 and 26 days). The two fat levels were analyzed separately since they were produced from different raw materials and on different days.

RESULTS AND DISCUSSION

Temperature decline in the center of regular ground beef (73/27) chub packs after packaging is shown in Figure 1. Similar trends were observed in the extra lean (81/19) ground beef. Since the meat for flyocol chilling treatments had not been previously chilled with CO₂, the initial temperature of the product was approximately 43 F. This internal temperature changed little during the glycol chilling; however, during the first few hours of equilibration there was a gradual temperature decline in chubs chilled in 24 F glycol and a rapid drop in temperature, from 41-42 F to 32 F, in the chubs chilled in either 18 or 6 F glycol. The equilibration time for the regular (73/27) ground beef was about 1 hr longer than for the extra lean (81/19) product probably due to differences in fat levels in these formulations. The similar rapid drop in temperature of the 18 F as compared to the 6 F glycol chilled meat suggested that use of a very low glycol temperature did not necessarily increase the chilling rate at the center of the chub. Excessive crust freezing at very low temperatures may slow heat transfer and temperature equilibration.

Since meat from the control (CO₂ chilled) and experimental treatments (glycol chilled) groups came from the same batches, they had similar initial microbial levels. The initial microbial aerobic plate counts (APC) were relatively low (log 4 or 10,000 organisms/g), reflecting good product quality. As expected, the APC increased as the storage time increased.

For both the regular (73/27) and extra lean (81/19) ground beef, the chilling treatments reacted differently at each storage time for microbial counts. This resulted in a significant interaction (Figure 2). There was little bacteria growth during the first 10 days of storage. This was a result of the normal shift of the bacteria population from those which grow well at warm temperatures to those which grow best at refrigerator temperatures. From days 10 to 14, the 18 F and 24 F groups had an increase in bacteria counts but there was little change in the 6 F and CO₂ chilled products. At day 18 only the 6 F chilled meat had remained unchanged. This suggested that other factors in addition to temperature affected microbial growth since the temperature decline for the 18 and 6 F treatments was
Figure 1. TEMPERATURE DECLINE IN REGULAR GROUND BEEF (75/27) CHUB PACKS

- 6°F glycol
- 13°F glycol
- 24°F glycol
- Control

Temperature, °F

Time, minutes
Figure 2. Interaction of chilling treatments and days of chubs storage on bacteria counts.
similar (Fig. 1). Perhaps the deeper crust freezing in the 6 F treatment affected bacteria growth. The 6 F treatment had delayed bacteria growth until after day 18, then it rapidly increased to the same level as the other treatments. It should be noted that the bacteria counts for all treatment groups and both fat levels reflect a high quality product even after 18 days of storage. No differences in bacteria counts due to the chilling treatment were observed among the products after grinding and at the end of retail display.

Means for storage characteristics for the chilling treatments and days of storage are shown in Table 1. Although there were significant differences among the chilling treatment groups in the amount of purge (fluid accumulation) in the chub package at the end of the storage periods, this was not a large difference since all treatment groups only had slight amount. The amount of purge in the 6 F chilling treatment was highest in the extra lean product and lowest for the regular ground beef. This illustrates the effect of the amount of fat on purge loss in the ground beef formulation. The 6 F chilling treatment had more surface discoloration for both extra lean and regular formulations than the other treatment groups. This could have been due to the deeper crust freezing during chilling, but the discoloration was noted to occur primarily along the seam of the package. This finding suggested that the package did not maintain its integrity at this temperature.

After the packages had been opened and allowed to bloom, the muscle color scores ranged from cherry red to slightly light cherry red, with the control (CO₂ chilled) product having the brightest color for either formulation. Other differences in storage characteristics were seen; however, these differences were too small to be of practical importance.

The effect of length of storage on characteristics of ground beef (Table 1) indicated a typical increase in the amount of purge as storage time increased. There was also a concurrent increase in the amount of surface discoloration from less than 5% to 10-25% of the surface discolored. Nevertheless, the evaluation scores indicated that the products were still very acceptable even after 18 and 22 days of storage. There were no off-odors detected for either fat level in any of the chilling treatments or at any of the storage times.

Few significant differences in retail evaluations (not presented in tabular form) for chilling treatment groups and storage times for the regular ground beef and extra lean ground beef were noted. Although significant, many of these differences were so small there appears to be little practical importance. In general, consumer desirability scores indicate a very acceptable product on the first day of simulated retail store conditions with the product from the 6 F and CO₂ chilled groups being slightly more desirable than that from 18 or 24 F chilled chubs. Muscle color was slightly light cherry red and was brighter for the CO₂ chilled product. As expected, muscle color became darker the longer the ground beef was displayed and surface discoloration increased. Consumer desirability scores were in the acceptable range after one day of display which is a slightly longer time than ground beef should be in the meat counter at most retail stores, but by the second day of retail display the products
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*a, b, c, d.* Means on a row within a group bearing different superscripts are different (P<.05).

*Chub packs were chilled for 30 min using a glycol chiller set at 6, 18 or 24h and controls were chilled with CO2 snow added.

*Evaluated on the opened chub pack at the end of the storage period using a 12 point scale wherein 1 = no purge; 5 = slight amount; 8 = moderate amount; 12 = excessive amount of purge.

*Evaluated on the opened chub pack using an 8 point scale wherein 8 = no surface discoloration; 5 = 30-50% discoloration; and 1 = 90-100% discoloration.

*Evaluated on the total chub contents after a 20 min bloom using an 8 point muscle color scale wherein 8 = very light cherry red; 5 = cherry red; and 3 = moderately dark red.

*Evaluated on the total chub contents after a 20 min bloom using the above discoloration scale.

*Evaluated after a 20 min bloom period using a 4 point odor scale wherein 1 = no detectable odor; and 4 = extremely objectional odor.
were undesirable. After 2 days of display, the extra lean ground beef chilled in 6°F flycol had lower off-odor scores than the other chilling treatment groups, most likely due to lower microbial counts.

It was concluded from these data that ground beef chilled using propylene glycol was comparable in storage and retail display characteristics to that chilled using CO₂. The 6°F glycol temperature tended to retard microbial growth through 18 days of storage. The surface discoloration around the chub package seam appeared to have little effect on the final retail product. Further research using chilling temperatures between 6° and 18°F may result in overcoming the problem of the casing seam integrity (that is, reduce surface discoloration) while giving a product with low microbial growth and acceptable shelf-life. Other parameters that need further study are using the same temperature for simultaneously chilling chubs of different sizes, appropriate chilling times, how to handle and box the chubs when they lose their flexibility upon crust freezing, and cost studies to determine how much increased volume and reduced operating expenses offset the capital expenditures for glycol chilling equipment.