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R.A. Mancini

Melvin C. Hunt

Donald H. Kropf

See next page for additional authors

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Maximizing desirable ground beef color with cold storage and display temperatures

Abstract

This study evaluated the combined effects of storage temperature, storage time, display temperature, display time, and fat level on ground beef color. Storage at 32°F minimized discoloration during display compared to storage at 40° and 48°F. Storage up to 12 days at 32°F did not affect ground beef color stability, whereas prolonged storage at 40° and 48°F increased discoloration dramatically. When storage was at 32°F, sales loss was 0.4%, compared to 62% at 48°F. Fat level did not influence discoloration. The use of 32°F during storage and display is essential for maximizing ground beef color life.

Keywords

Cattlemen's Day, 2002; Kansas Agricultural Experiment Station contribution; no. 02-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 890; Beef; Ground beef color; Cold chain management; Discoloration

Authors

R.A. Mancini, Melvin C. Hunt, Donald H. Kropf, K.A. Hachmeister, D.E. Johnson, and John A. Fox

MAXIMIZING DESIRABLE GROUND BEEF COLOR WITH COLD STORAGE AND DISPLAY TEMPERATURES

R. A. Mancini, M. C. Hunt, D. H. Kropf, K. A. Hachmeister, D. E. Johnson[1], S. Fox[2]

Summary

This study evaluated the combined effects of storage temperature, storage time, display temperature, display time, and fat level on ground beef color. Storage at 32°F minimized discoloration during display compared to storage at 40° and 48°F. Storage up to 12 days at 32°F did not affect ground beef color stability, whereas prolonged storage at 40° and 48°F increased discoloration dramatically. When storage was at 32°F, sales loss was 0.4%, compared to 62% at 48°F. Fat level did not influence discoloration. The use of 32°F during storage and display is essential for maximizing ground beef color life.

(Key Words: Ground Beef Color, Cold Chain Management, Discoloration.)

Introduction

Discoloration, defined as a change in ground beef color from bright-red to brown, results in consumer rejection, reduced shelf life, and decreased profit. Even though discoloration is inevitable, it is slowed by cold storage and display temperatures. A recent national retail survey found that the average display case temperature was 40°F. Our objectives were to evaluate the combined effects of storage temperature, storage time, display temperature, display time, and fat level on ground beef color.

Experimental Procedures

Coarse ground beef chubs (10 lb each) of 3 fat/lean blends (7/93, 19/81, and 27/73%) were shipped to the Kansas State University Meat Lab at 32°F. All chubs were stored for 6 days at 32°F before randomly assigning one chub per lean level per replication, to each of 12 storage temperature (32°, 40°, or 48°F) and storage time (0, 4, 8, and 12 days) combinations for each of 3 replications.

Following storage, each chub was mixed by hand and ground once through a 1/8 inch plate. After grinding, approximately one pound of ground beef was placed on a Styrofoam tray with a Dri-Loc pad and packaged with polyvinyl chloride (PVC) film. One package per chub per fat level per replication was displayed continuously for 48 hours at either 32°, 40°, or 48°F in one of three open-top display cases under 150 foot candles of Philips Ultralume 30 fluorescent light. The 32ºF case had two defrost cycles/day, the 40ºF case had one, and the 48ºF case had no defrost cycles.

Ground beef surface color was evaluated at 0, 24, and 48 hours of display by seven trained panelists. Initial color (0 hour) was evaluated 30 minutes after the meat was ground and packaged. Evaluation was on a five-point color scale (1=very bright cherry red, 2=bright cherry red, 3 = slightly dark red to tannish red, 4 = moderately grayish/tan to brown, and 5 = tan to brown) in increments

[1]Department of Statistics
[2]Department of Agricultural Economics

of 0.5. Borderline color acceptability was considered to be a score of 3.5.

The statistical design consisted of 5 main effects: fat level (n=3), storage temperature (n=3), storage time (n=4), display temperature (n=3), and display time (n=3), and their interactions. Data were analyzed over 3 replications using the Mixed procedure of the Statistical Analysis System (SAS, 2000). Least square means for significant interactions were separated ($P<0.05$).

Results and Discussion

Storage and/or display at 40º and 48ºF accelerated ground beef discoloration (Figure 1). Storage at 32ºF resulted in brighter-red initial bloomed color than storage at either 40º or 48ºF. Storage at 32ºF also maintained this more desirable color during display, whereas longer storage times had more adverse effects at warmer temperatures. Failing to use cold display temperatures accelerated discoloration dramatically (Table 1).

When 32ºF storage was coupled with 32ºF display, display time effects were so minimal that at no point during the 48-hour display did color become unacceptable. However, utilizing only cold storage temperatures and allowing warmer display temperatures negated the benefits of 32ºF storage. In general, as storage temperature and display temperature increased, discoloration during display was accelerated. Changes in discoloration due to lean level were relatively small.

The normal level of sales loss (i.e. price discounts and profit loss due to discoloration) was assumed to be 6% at 40ºF. Reducing the storage and display temperatures from 40° to 32°F reduced the sales loss to 0.4% (Figure 2). Increasing the storage and display temperatures to 48°F was estimated to increase sales loss to 31%. Increasing the storage time to 12 days at 48°C resulted in estimated sales losses of 62%. However, sales losses for 8 and 12 days of storage at 48°F may be underestimated because those chubs had high microbial counts, extreme surface discoloration, off odors, and/or gas pockets; rendering them unsuitable for grinding and display.

Use of 32°F was far superior to storage and display at 40° and/or 48°F. Thus, to maximize color life and profit, 32°F during storage and display is strongly recommended. Failure to select and maintain 32°F will accelerate discoloration dramatically and increase sales losses. Except at 32°F, increasing storage time was detrimental to color. Thus chub storage should be as brief as possible. Ground beef fat level had minor effects on discoloration.

These results overwhelmingly suggest that the use of cold temperatures (32°F) during both storage and display of ground beef maximizes shelf life and profit.

Table 1. Relative Rates of Color Loss for Ground Beef Displayed for 48 Hours Compared to Those Stored at 32°F for 0 Days Prior to Display at 32°F. Rates Larger than 1.0 Indicate Increased Discoloration Compared to Optimum Conditions

	Storage Temperature (°F)					
	32			48		
Storage	Display Temperature (°F)					
Time (d)	32	40	48	32	40	48
0	1.0	1.9	2.7	1.0	1.9	2.7
4	1.1	1.7	2.7	1.3	1.4	2.1
8	1.4	1.9	2.9	2.4	2.9	3.2
12	1.3	1.8	2.8	3.8	6.4	7.2

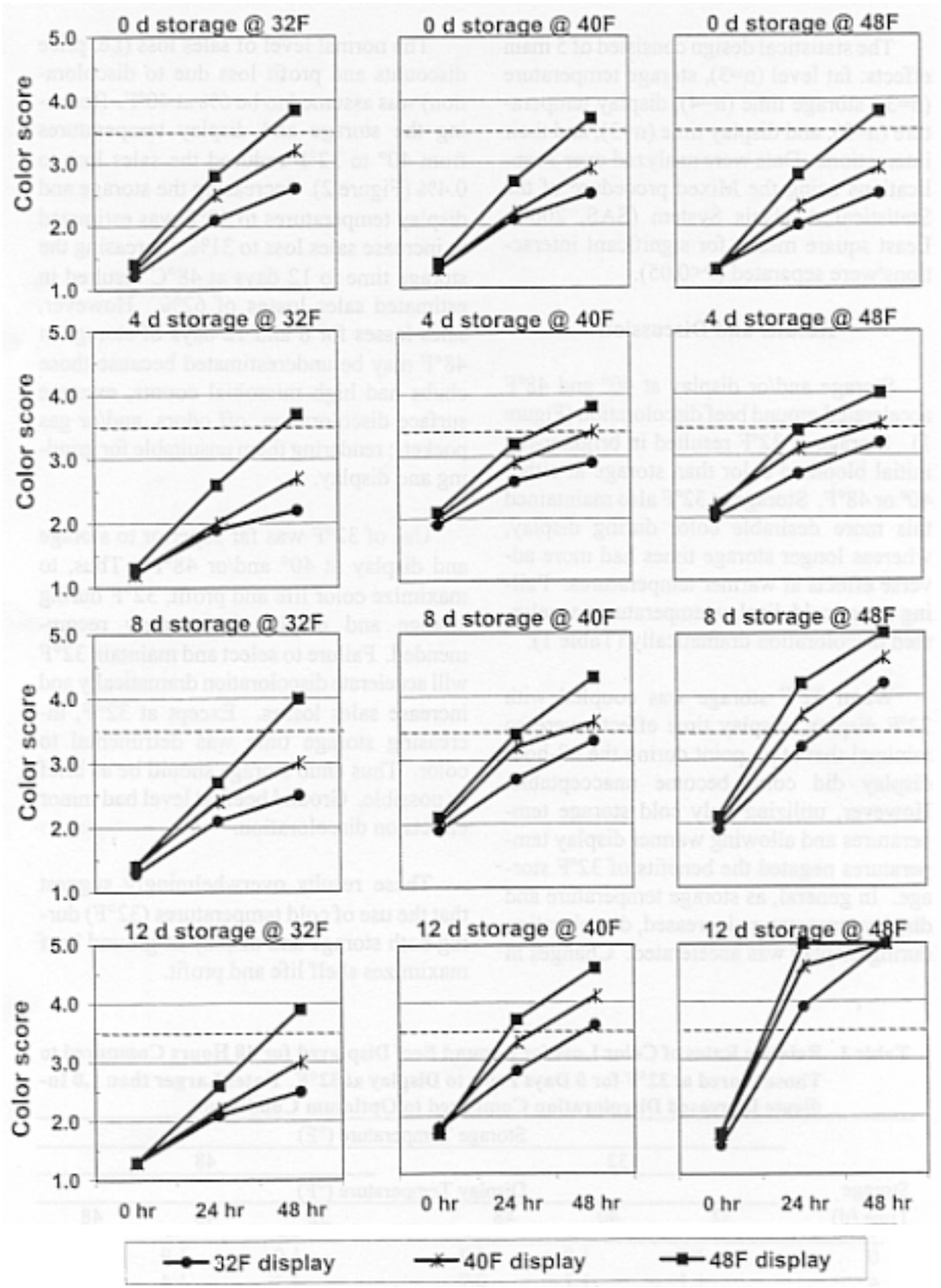

Figure 1. Effect of Temperature and Time of Storage and Display on Visual Color Score. Visual color scale: 1=very bright cherry red; 3.5=unacceptable slightly dark red; 5=brown.

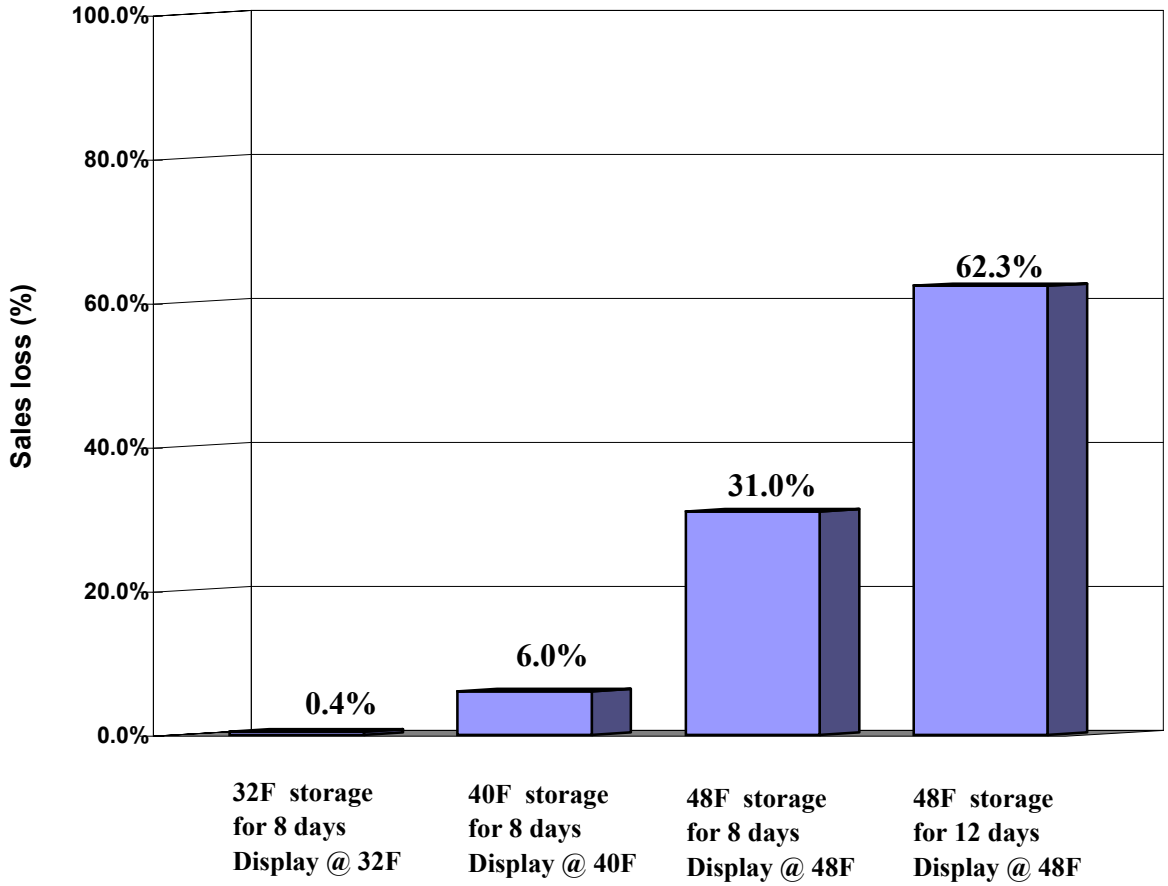

Figure 2. Effects of warm temperatures and prolonged storage times on sales loss of ground beef.