Title: Improvement of Retail Case Life of Pork – **NPB# 98-105**

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Abstract

A 3 temperature (30, 34, 38°F or -1.1, 1.1, and 3.3°C) x 2 case type (single-level, multi-level) x 2 defrost cycle (2 cycles/24 h, or 4 cycles/24h) factorial arrangement of treatments was used to assess the quality of retail pork. Baseline information was conducted for 2-wk prior to data collection. Cases functioned for 2-wk at the treatment combination. Upon treatment changes, a 1-wk "warm-up" period was allowed before the next 2-wk treatment period began. Product temperature (using and infrared thermometer), L* a* b* values (Minolta 2002), and visual color was recorded for center loin chops in the case. Pork products pulled from the case the morning of data collection were also evaluated for the same information. Data collection began 1-h before defrost and lasted through 1-h after defrost, with readings taken every 15 min. The temperature treatment of 38°F was discontinued 3 d into the treatment period by the retailer because it resulted in an unacceptably high number of pork products being pulled from the case for poor color development. Therefore, no retail case should be set so that the airflow temperature surrounding pork packages is at 38°F. A single-level case at 30°F allowed for less product temperature gain, than did setting at 34°F, but in the multi-level case, the opposite was true. Because pork products were removed from the retail case for poor color reasons (turning gray or green), a setting which decreased the L* value would be desired such as a single-level at 30°F and 2 defrost cycles or a multi-level at 30°F and 2 defrost cycles. A single-level, 2 cycle setting caused no significant change in a* value, but the 4 cycle and the multi-level at either cycle increased the a* value. A 2-cycle defrost case set at 30°F caused little change in the b* readings of the products, however, the 2-cycle at 34°F, 4-cycle at 30° and 34°F all increased the b* value ($P < .05$), but were not different from each other. For the single-level cases with 2 defrost cycles, set at 30°F or 34°F, and for 4 defrost cycles set at 30°F, no products were pulled from the retail case for rework or disposal. For cases set at 4 defrost cycles and at 34°F, one case samples had no pulls, while the other had 2 packages removed because of poor color. For multi-level cases with 2 defrost cycles set at 30°F, no products were pulled. For cases with 2 defrost cycles set at 34°F, one case had no pulls, while the other had 2 packages removed because of poor color. As

for cases set at 4 defrost cycles, both the 30°F case had 3 products removed, and the 34°F cases had 3 products and 6 products removed for poor color reasons. A single-level case averages 385 BTU/ft^3. A multi-level averages of 177 BTU/ft^3. The cost/benefit would need to be assessed by each retail store, as energy costs and incoming product costs differ across the country.

Introduction

In the Pork Chain Quality Audit, packers reported a 10% incidence of pale, soft, and exudative (PSE) pork and a 4% incidence of dark, firm, and dry (DFD) pork while purveyors response was near 13% for PSE and slightly over 4% for DFD. These two color variations were estimated to cost the pork industry $0.35 per head or over $30 million a year (Meeker and Sonka, 1994). Research has offered many suggestions to reduce the incidence of these two quality problems from genetic control (Boles et al., 1991), resting time (Hamman, 1995), and chilling method (Milligan et al., 1998) to vitamin supplementation (Kerth et al., 1998). Although many of these practices are used in production and processing facilities, color and other quality problems remain a concern to retailers. Pork retailers compiled a "Top Ten List" of quality concerns. Topping this list was excessive color variation, followed by excess purge, short shelf life and lack of uniformity/consistency. To delay the onset of graying, browning, or greening of pork loin chops provides the retailer with a product that maintains consumer appeal longer. However, no data exist indicating how well pork loin chops is, what color develops when a chop is unacceptable, or even what variety of processing techniques (percentage injection with salt solutions) are reaching the consumer. This study was designed in two phases. The first phase was to asses these problems by surveying color of pork product pulls and temperature of retail cases, service cases, cutting rooms and holding coolers in supermarkets across the United States. Phase I clearly showed that a high percentage of pork sold at retail is subjected to much higher than optimum temperatures. The reslult of this are an elevated percentage of discolored pork in retail cases, high economic loss on pork because of premature discoloration and spoilage and increased consumer food safety risks. Other research conducted at NPPC has shown that the current average retail economic shrink on pork is 13%. It is known that reducing temperature abuse will reduce retail loss and allow pork to be more ideal colored. However, only a few (as demonstrated in Phase I) retailers have addressed this issue.

Objectives

The objective of the second phase was to assess the quality of fresh and stored products at various temperature ranges (ranges found in phase I) on shelf life of pork loin chops and to conduct a cost-benefit analysis to determine the most cost effective display storage.

Procedures

The methods and results of Phase I can be found in the Pork Quality & Safety Summit, 1998. The study was designed as a 3 (temperature) x 2 (case type) x 2 (defrost cycle) factorial, with repeated measures (repeated once for each retail chain; see Table 1). Baseline information was conducted for 2-wk prior to data collection. Cases functioned for 2-wk at the treatment combination. Upon treatment changes, a 1-wk "warm-up" period was allowed before the next 2-wk treatment period began. Three temperature settings (30, 34, 38°F or -1.1, 1.1, and 3.3°C) were utilized. Retail cases (single-level, multi-level) set at one of two defrost treatments (2 cycles/24 h, or 4 cycles/24h) were adjusted so that the airflow temperature at the product level in the center of the case was equal to one of the three temperature treatments (Table 1). After the "warm-up" period, product temperature (using and infrared thermometer), L* a* b* values (Minolta 2002), and visual color was recorded for center loin chops in the case. Ambient temperature was also recorded. Pork products pulled from the case the morning of data collection were also evaluated for the same information. Data collection began 1-h before defrost and lasted through 1-h after defrost, with readings taken every 15 min.

Results

Temperature – The temperature treatment of 38°F was discontinued 3 d into the treatment period by the retailer. This treatment resulted in an unacceptably high number of pork products being pulled from the case for poor color development. Therefore, no retail case should be set so that the airflow temperature surrounding pork packages is at 38°F.

The simple effects of case type, defrost cycle setting, and case temperature on net product temperature change, before, during and after defrost are shown in Table 2. Product in single-level cases had a net temperature increased of 2.76°F, as compared to 4.12°F net increase for products in a multi-level case from 1 h before defrost, until 1 h after the defrost cycle was complete ($P < .05$). A 2-cycle defrost provided a net product temperature increase an average of 4.51°F compared to only 2.37°F net increase ($P < .05$). The case temperature setting of 30 or 34°F had no significant increase in product temperature during the sampling period. Figure 1 shows the case type*defrost cycle setting interaction for net product temperature change. In both the single and the multi-level case, a 4-cycle (4 defrost times/24 h) case caused less net temperature gain by the product than the 2-cycle (2 defrost times/24 h) defrost. This could be explained by the shorter time the case is actually in defrost in a 4-cycle as compared to a 2-cycle. Figure 2 indicates the case type*case temperature setting interaction on the net product temperature change. A single-level case at 30°F allowed for less temperature gain by product, than did setting at 34°F, but in the multi-level case, the opposite was true.

Net L Change* - Table 3 includes the same effects on the net L* change, before, during and after defrost. Case type, defrost cycle and case temperature all indicate differences by individual treatment (-1.20 vs. –1.10, -1.27 vs. –.95, and –1.87 vs. -.58, respectively). Figure 3 indicates the case type*case temperature interaction for the net L* change of the product. For a single-level case, a case setting of 34°F produced little change in the product's L* value over the 3 h sampling period before, during and after defrost. However, setting at 30°F caused an average L* decrease of –1.8 points ($P < .05$). A multi-level case set at 30°F had a similar L* decrease as the corresponding single-level case, compared to the -.60 point decrease if set at 34°F ($P < .05$). The defrost cycle setting*case temperature interaction for L* can be seen in Figure 4. A 2-cycle case set at 30°F caused a –1.67 point change in L* over the 3 h sampling period. However, the 34°F setting caused a decrease of -.70 L* points. For the 4-cycle case, the 30°F setting caused the largest decrease of –1.90 L* points ($P < .05$), but the 34°F setting was not different from the 2-cycle 34°F setting. Because pork products were removed from the retail case for poor color reasons (turning gray or green), a setting which decreased the L* value would be desired such as a single-level at 30°F and 2 defrost cycles or a multi-level at 30°F and 2 defrost cycles.

Net a Change* - As seen in Table 4, case type and defrost cycle did effect a* change of the products, but the case temperature setting did not (.16 vs. 2.11, .19 vs. 2.08, and 1.12 vs. 1.14, respectively; $P < .05$). Figure 5 displays the case type*defrost cycle setting interaction for the average net a* change over the sampling period. This effect is opposite of the effect the treatment had on net product temperature change. The single case, 2-cycle provided little change in the a* values, where the 4-cycle increased the a* readings by an average of .82 ($P < .05$). The same effect was seen in the multi-level case, however, the 4-cycle single-level and the 2-cycle multi-level were not different. The same effect of case type*case temperature was also seen for the net a* change as was seen for the L* readings (Figure 6). The same can be said also for the defrost cycle setting*case temperature interaction for a* and L* values (Figure 7).

Net b Change* - Table 5 includes the effects for b* change over the sampling period. Case type, defrost cycle and case temperature all effect b* changes (2.03 vs. 7.18, 3.32 vs. 5.89, and 3.73 vs. 5.48 respectively; $P < .05$). Figure 8 displays the case type*defrost cycle setting interaction for net b* change over the 3 h sampling period. With in the single-level cases, 4-cycle showed to increase the net b* value significantly more than the 2-cycle (2.76 vs. 1.3, respectively). The same was true for the multi-level cases. Figure 9 shows the case type*case temperature interaction for the net b* change. Within the single-level cases, neither the 30 nor 34^{o}F settings significantly changed the b* readings over the sampling period. In the multi-level cases, the 30^{o}F setting and the 34^{o}setting increased the b* change (4.85 and 9.51; $P < .05$). In Figure 10, the defrost cycle setting*case temperature interaction is shown. A 2-cycle defrost case set at 30^{o}F caused little change in the b* readings of the products, however, the 2-cycle at 34^{o}F, 4-cycle at 30^{o} and 34^{o}F all increased the b* value ($P < .05$), but were not different from each other.

Product Pulls – As previously stated, pork products were pulled from the retail case for poor color more often than for any other reason. This color, as described by the meat managers and as assessed by visual color evaluation, was a gray or gray-green. For the single-level cases with 2 defrost cycles, set at 30^{o}F or 34^{o}F, and for 4 defrost cycles set at 30^{o}F, no products were pulled from the retail case for rework or disposal. For cases set at 4 defrost cycles and at 34^{o}F, one case samples had no pulls, while the other had 2 packages removed because of poor color. For multi-level cases with 2 defrost cycles set at 30^{o}F, no products were pulled. For cases with 2 defrost cycles set at 34^{o}F, one case had no pulls, while the other had 2 packages removed because of poor color. As for cases set at 4 defrost cycles, both the 30^{o}F case had 3 products removed, and the 34^{o}F cases had 3 products and 6 products removed for poor color reasons.

Cost/Benefit – Manufacture data indicates that an 8 ft single-level case has a capacity of 10.8ft^3 and utilizes 4160 BTU, where a 12 ft case has a capacity of 16.2 ft^3 and utilizes 6240 BTU for an average of 385 BTU/ft^3. An 8 ft multi-level case has a capacity of 63.3 ft^3 and uses 11,200 BTU where a 12 ft case has a capacity of 95.0 ft^3 uses 16,800 BTU for an average of 177 BTU/ft^3. The cost/benefit would need to be assessed by each retail store, as energy costs and incoming product costs differ across the country.

References

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Table 1. Retail case type, temperature, energy use and defrost cycle treatments for Phase II.

Case Type	Temperature, ^{o}F	Defrost, cycles/24 h	Watts/hr	BTU's/hr
Single-level	30	2	3,161	34,471
Single-level	34	2	2,732	30,554
Single-level	38	2		
Single-level	30	4		
Single-level	34	4		
Single-level	38	4		
Multi-level	30	2	5,438	59,008
Multi-level	34	2	4,678	53,420
Multi-level	38	2		
Multi-level	30	4		
Multi-level	34	4		
Multi-level	38	4		

Table 2. Simple effects of case type, defrost cycle setting, and case temperature on net product temperature change, before, during and after defrost.

Treatment	LSMean
Case	
Single-level	2.76[a]
Multi-level	4.12[b]
Defrost Cycle	
2	4.51[a]
4	2.37[b]
Case Temperature	
30	3.46[a]
34	3.42[a]

[a,b]LSMeans with different superscripts differ ($P < .05$).

Table 3. Simple effects of case type, defrost cycle setting, and case temperature on net L* change, before, during and after defrost.

Treatment	LSMean
Case	
Single-level	-1.20[a]
Multi-level	-1.10[b]
Defrost Cycle	
2	-1.27[a]
4	-0.95[b]
Case Temperature	
30	-1.87[a]
34	-0.58[b]

[a,b]LSMeans with different superscripts differ (P < .05).

Table 4. Simple effects of case type, defrost cycle setting, and case temperature on net a* change, before, during and after defrost.

Treatment	LSMean
Case	
Single-level	.16[a]
Multi-level	2.11[b]
Defrost Cycle	
2	.19[a]
4	2.08[b]
Case Temperature	
30	1.12[a]
34	1.14[a]

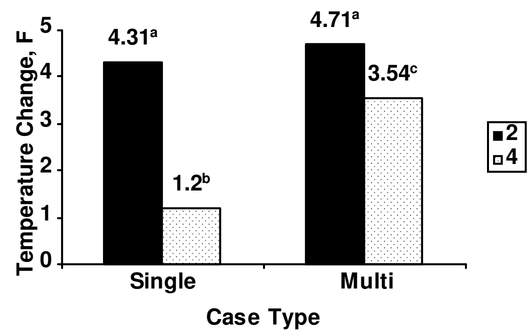
[a,b]LSMeans with different superscripts differ (P < .05).

Table 5. Simple effects of case type, defrost cycle setting, and case temperature on net b* change, before, during and after defrost.

Treatment	LSMean
Case	
Single-level	2.03[a]
Multi-level	7.18[b]
Defrost Cycle	
2	3.32[a]
4	5.89[b]
Case Temperature	
30	3.73[a]
34	5.48[b]

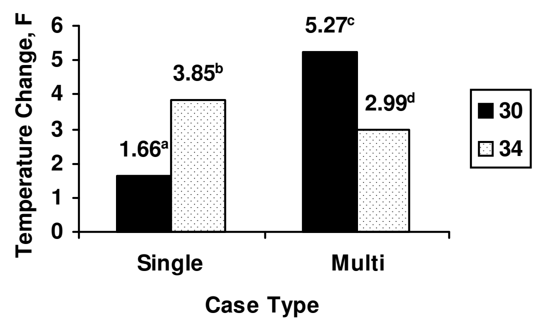
[a,b]LSMeans with different superscripts differ (P < .05).

Figure 1. Case type and defrost cycle setting interaction for net product temperature change.



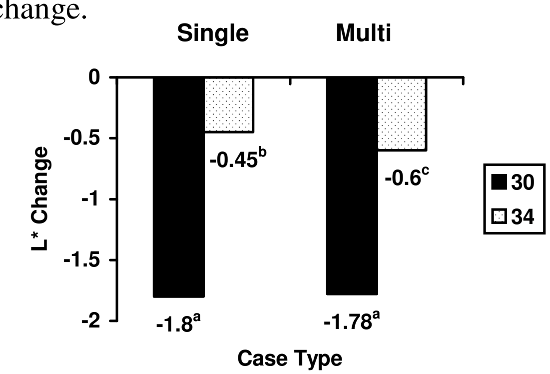
[a,b]LSMeans with different superscripts differ (P < .05).

Figure 2. Case type and case temperature interaction for net product temperature change.



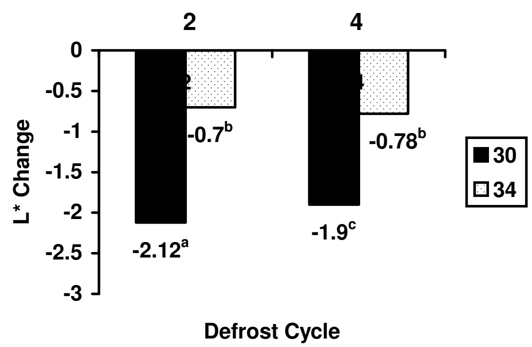
a,bLSMeans with different superscripts differ (P < .05).

Figure 3. Case type and case temperature interaction for net L* change.



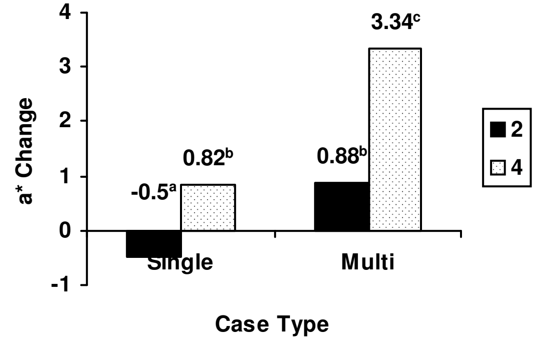
a,bLSMeans with different superscripts differ (P < .05).

Figure 4. Defrost cycle setting and case temperature interaction for net L* change.



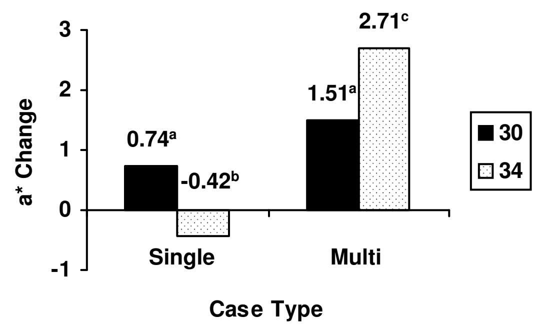
a,bLSMeans with different superscripts differ (P < .05).

Figure 5. Case type and defrost cycle setting interaction for net a* change.



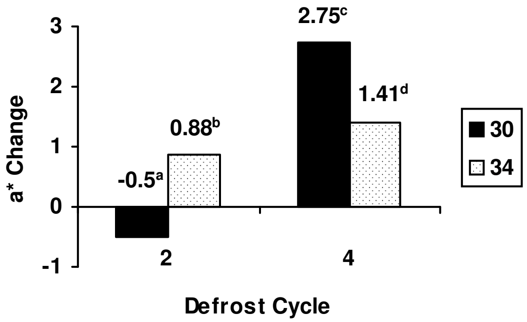
a,bLSMeans with different superscripts differ (P < .05).

Figure 6. Case type and case temperature interaction for net a* change.



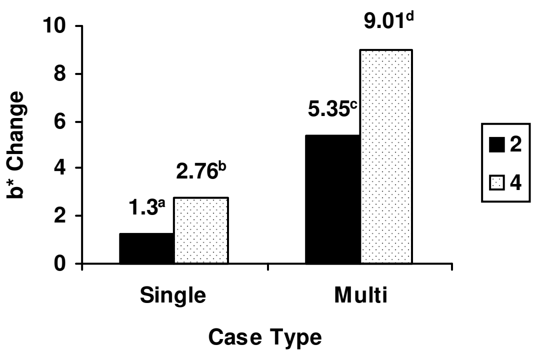
a,bLSMeans with different superscripts differ (P < .05).

Figure 7. Defrost cycle setting and case temperature interaction for net a* change.



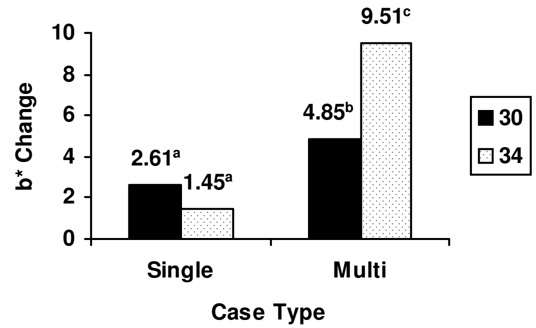
a,bLSMeans with different superscripts differ (P < .05).

Figure 8. Case type and defrost cycle setting interaction for net b* change.



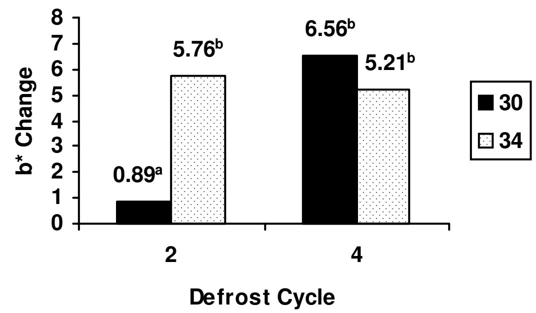
a,bLSMeans with different superscripts differ (P < .05).

Figure 9. Case type and case temperature interaction for net b* change.



a,bLSMeans with different superscripts differ (P < .05).

Figure 10. Defrost cycle setting and case temperature interaction for net b* change.



a,bLSMeans with different superscripts differ (P < .05).