THE EFFECTS OF AN EDIBLE CALCIUM PECTINATE FILM ON BEEF CARCASS SHRINKAGE AND SURFACE MICROBIAL GROWTH

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INTRODUCTION

Minimizing carcass shrinkage while simultaneously maintaining low microbial populations is one of the continuing concerns of the meat packing industry. The greatest rate of carcass shrinkage occurs while the carcass temperature drops from 40°C to 27°C, and the greatest potential for bacterial growth occurs in the temperature range 10-40°C (Price et al., 1976). Fleming and Earle (1968) found that lamb carcass shrinkage could be controlled by maintaining low temperatures, high humidity and minimal air circulation. In a comparison of various packaging systems with wholesale pork loins, Smith et al. (1974) found that vacuum packaging reduced shrinkage and microbial growth, compared to wrapping with a polyvinyl chloride film. Application of a chlorine spray (10-200 ppm chlorine) every 30 minutes during the first 8 hours postmortem has also been found to reduce both shrinkage and microbial growth. This procedure has been found to reduce shrinkage in beef and pork carcasses by about 0.5% (Heitter, 1973), and reduce pork carcass bacterial count by 97.5% (Heitter, 1975). Allen et al. (1963) first reported attempts to protect meat surfaces by application of calcium alginate or calcium alginate-cornstarch coatings. Lazarus et al. (1976) evaluated a calcium alginate coating (formed by gelling a malto-dextran sodium alginate coating with a calcium chloride-carboxymethylcellulose solution). They reported that coated lamb carcasses were significantly lower in 24-hour shrinkage loss and total surface microbial counts, compared to untreated controls. However, Williams et al. (1978) reported that the same coating did not significantly reduce total bacterial counts or coliforms on individually coated beef cuts.

In this study, we investigated the effects of a calcium pectinate gel coating with regard to control of beef carcass shrinkage and control of bacterial growth on individual beef plates (i.e., wholesale lower ribs).

MATERIALS AND METHODS

Experiment 1. Beef Carcass Shrinkage.
Beef carcass shrinkage evalutions were conducted in the Industrializadora del Cerado, S.A. packing plant located at Robinson, Chihuahua, Mexico. Eight beef carcasses were randomly removed from production. The first 5 carcasses were split and one side was pectin-coated while the other side was used as an untreated control. The following 3 carcasses were split and both halves were pectin-coated. Thus, 5 sides were untreated and 11 sides were pectin coated. One of the pectin coated sides was sprayed with 1 liter of water every 30 minutes for 2.5 hours, then once each 24 hours for an additional 7 days. Ten additional sides were shrouded for comparison. All sides were weighed initially. Pectin-coated sides were weighed again after application of the pectin coating. The shrouds were removed from the shrouded sides at 24 hours, and the sides were weighed and released. All other sides were weighed each 24 hours for 3 days, and again at day 7.

To prepare the pectin coating, low methoxyl pectin (LM-3477, Sunkist Growers, Corona, CA) was mixed in a Waring lab blender with tap water on a 3% (w/v) basis. The mixture was blended for 1 minute. The gelling solution consisted of 3% (w/v) calcium chloride in tap water. The viscous pectin solution was applied at a rate of 1.4 L/min. with a Wagner ST 1000 Super airless sprayer (Spray Tech Corp., Minneapolis, MN) equipped with a #1810 orifice. After thorough application of the side with pectin solution, a light mist of calcium chloride gelling solution was applied for about 1 minute with a pressurized yard and garden sprayer.

Experiment 2. Bacterial Growth on Beef Plates.
To prepare the innoculating solution, 10 day old carcasses were swabbed. The swabs were innoculated into 1 liter of tryptic soy broth (Difco, Detroit, MI) and incubated 24 hours at 21°C. Total microbial counts were then diluted to 10^6 cells/ml.

Six plates were dipped into the innoculating solution briefly and allowed to drip for 30 seconds. Two plates were then pectin coated, 2 were coated with an acidified pectin, and 2 were untreated controls. The pectin solution was applied by dipping. The gelling solution was again applied by a hand pump sprayer, misting for 30 seconds. The acidified pectin solution was prepared by addition of glacial acetic acid (14 ml/L) to tap water prior to the addition of pectin and blending.

All plates were sampled before, immediately after and 48 hours after pectin treatment using a 4.1 cm^2 coring tool to remove a core of about 0.5 cm in depth. Twelve cores, evenly distributed over the surface of the plate, were removed at each sample time. After pectin treatment and removal of the appropriate core samples, the plates were loosely covered with plastic film and incubated 48 hours at 21°C. Final core samples were then removed.

Core samples were blended with phosphate diluent in a Stomacher Lab Blender (Cook Laboratory Products, Alexandria, VA) and plated onto Standard Methods Agar with a Spiral Systems Plater (Spiral Systems, Inc., Cincinnati, OH). Petri plates were incubated 4 days at 21°C. The aerobic plate count (APC) data are presented as the difference in log counts before and after pectin treatment, calculated as follows: Difference = $\log_{10}$ (APC after treatment) - $\log_{10}$ (APC before treatment).

Data from both experiments were subjected to analysis of variance using the Statistical Program Package (Hurst, 1974). Significant differences among treatments were determined by the Least Significance Difference test (Ott, 1977).

RESULTS:

Experiment 1. Beef Carcass Shrinkage.
The mean percent shrinkage for all treatments is presented in Table 1. At 24 hours the pectin treated sides were significantly ($P<0.01$) lower in shrink loss than either shrouded sides or untreated controls. The shrouded sides were significantly ($P<0.05$) lower in shrink loss than the untreated control sides. The pectin coated sides continued to be significantly ($P<0.01$) lower in shrink than the uncoated controls at 2, 3 and 7 days in the cooler, although the absolute differences were progressively less. The coolers were maintained at 2.5 $\pm$ 1°C and 85 $\pm$ 5 percent relative humidity during the test period. The mean added weight of pectin coating was 1.8 $\pm$ 0.2 Kg, resulting in a final residual weight of about 0.06 Kg of pectin film per side.

The smooth exterior appearance of the shrouded sides was generally judged to be superior to the somewhat rough exterior appearance of the pectin coated sides. However, the internal cavity and exposed lean portions of the pectin coated carcasses appeared moist and bright red, compared to the dry dark appearance of exposed lean of control sides. The pectin coating itself dried to a thin colorless film by day 7, and was not noticable except on close inspection.

Experiment 2. Bacterial Growth on Beef Plates.
Application of either a pectin or an acidified pectin coating reduced the aerobic plate counts on beef plates (Table 2). The microbial load remained lower than the initial innoculated levels for pectin coated plates after 48 hours of incubation at 21°C (Table 2). Beef plates coated with acidified pectin had the lowest ($P<0.01$) aerobic plate counts. The plates coated with unacidified pectin were also significantly ($P<0.01$) lower in aerobic plate counts than the controls.

CONCLUSIONS

The pectin coating procedure described herein may be of practical value in reducing cooler shrinkage of beef carcasses and in controlling surface bacterial growth. Since the pectin coating is prepared from food-grade ingredients, the coating is edible. However, this particular use of pectin is not currently permitted on food products in the United States. The pectin coated, water sprayed side had the lowest shrinkage loss in this test. Further studies may show this procedure to be of value in the reduction of cooler shrink loss from beef carcasses.

Table 1. Mean values[a] for postmortem shrinkage of beef carcasses

Treatment	Sample Size	Postmortem Percent Shrinkage Loss			
		Day 1	Day 2	Day 3	Day 7
Uncoated control	5	2.07 $\pm$ 0.25[a]	2.55 $\pm$ 0.18[a]	2.69 $\pm$ 0.24[a]	3.98 $\pm$ 0.32[a]
Shrouded control[c]	10	1.64 $\pm$ 0.35[a]	released	---	---
Pectin coated	10	0.44 $\pm$ 0.38[b]	1.47 $\pm$ 0.28[b]	1.76 $\pm$ 0.21[b]	3.31 $\pm$ 0.22[b]
Pectin coated, water sprayed	1	0.0 --	0.56 --	0.56 --	0.85 --

[a,b]Means in the same column bearing different letters differ significantly ($P<0.01$).

[c]At 1 day postmortem, the uncoated controls had a significantly higher ($P<0.05$) percent shrink loss than the shrouded controls.

Table 2. Difference values[a] in the log (Aerobic Plate Count) on beef plates

Treatment	Sampled immediately after coating	Sampled 48 hours after coating
Pectin coated	-0.56[a]	-1.31[a]
Acidified pectin coated	-2.73[b]	-2.17[b]
Control	+0.64[c]	+3.37[c]

[a,b]Values in the same column bearing different letters differ significantly ($P<0.01$).

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