

FINAL REPORT
for
THE NATIONAL PORK PRODUCERS COUNCIL
December 26, 1999

TITLE: Improved Storage Stability of Fresh Ground Pork by Utilization of Modified Atmosphere Packaging [#97-1800]

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Abstract

Modified atmosphere packaging (MAP) is being utilized extensively for preservation of fresh meat products. This contributes to less in-store fresh meat processing, replacing the effort with case-ready meat shipped from a central processing facility. High levels of carbon dioxide were more effective in inhibiting microbial growth than gas mixtures of 80:20 CO₂:O₂. During extended storage (8 days in 100% CO₂, inhibition of growth resulted in a 2 log reduction in aerobic plate counts. During lighted storage, pork packaged in CO₂ was at least 1 log lower in aerobic plate counts than when packaged with 80/20 mixtures of CO₂:O₂. Increases storage times prior to retail display resulted in higher plate counts.

Introduction

Case ready products that are attractive, convenient, and easy to prepare and are in demand by consumers at the supermarket meat case. Ground pork is a product that has not been widely accepted at the retail supermarket display case. Quality ground pork products could offer consumers an attractive alternative to ground beef served at home and in restaurant franchises. Ground pork with consistent quality, particularly color, has great potential for the consumer as a viable product with improved shelf-life and color as high priorities. Centralized distribution systems required of retail supermarket franchises demand technologies which will improve shelf-life of case-ready products. The amount of time a product remains in transit from point of manufacture to point of sale is variable depending on distance and shipping schedules. Estimates are given that this time is anywhere from 2 to 6 days. Retail stores require 2-3 days of lighted storage in the retail case followed by 1-2 days of fresh storage by the consumer prior to use. Central processing has many advantages over in-store preparation but requires extended color stability and eye appeal.

Current limitations on shelf-life of ground pork center around color stability, lipid oxidation and food safety. Further research into ground pork and packaging alternatives such as Modified Atmosphere Packaging (MAP) is needed to provide the necessary shelf-life required for centralized distribution systems to provide the consumer product with high quality and safety they have come

to know and expect.

Objectives

1. **Determine the effects of meat source and final product storage conditions on the shelf-life and quality of ground pork in modified atmosphere packaging.**
2. **Evaluate MAP packaged pork quality with microbial analyses, lipid oxidation, and physical evaluation of retail displayed ground pork after 2 day and 8 day unlighted storage, followed by 0, 2 and 4 days retail display.**

Materials and Methods

Ground pork (15% fat) was manufactured from lean sources (pork shoulders, pork knuckles, sirloin trim, and loin fat trim.) and lean trimmings to achieve a product fat level of 15%. The product will be packaged in an 80/20 oxygen/carbon dioxide MAP atmosphere and placed in unlighted storage for 2 or 8 days. Following unlighted storage, product will be placed under lighted retail storage conditions (0, 2, and 4 days) and shelf-life determined on the basis of lipid oxidation, microbial analyses, and physical evaluation during retail display.

The design is a randomized complete block design. The treatment design is a 2x2 factorial with meat source (2) by storage condition (2). The treatments will include:

Meat Source:

Muscle Type I (ham cushion, pork knuckles, blade meat, shoulder meat etc.)

Muscle Type II (85/15 pork trim)

Storage Conditions:

Unlighted storage [distribution time] will be measured at 2 or 8 days followed by lighted storage to the end of product shelf-life. Lighted storage [retail display] will be 0, 2 or 4 days under typical retail display conditions [43°C/39°F; 1076 lux Warm White Fluorescent Light].

Analyses:

The following variables will be tested at each time:

- Residual oxygen and carbon dioxide
- Color, L*, a*, b*
- Rancidity - TBA analyses
- Microbial analyses
- Purge, pH

Results and Discussion

The refrigerated shelf-life of fresh red meat packaged without atmosphere modification is 2-3 days and that of fresh sausage is 4-5 days (Forcinio, 1997). Modified atmosphere packaging can increase shelf-life to 6-10 days (high O₂ environment) and 21 days (low O₂ environment). Shelf-life has been defined as (a) color shelf-life - when surface metmyoglobin levels exceed 40% (Greene et.al., 1971) or 50% (Chan et.al., 1996) (b) microbial shelf-life - when microbial loads are about 10⁷ CFU/g (colony forming units/gram)(Kraft, 1986; or (c) oxidative shelf-life - when TBARS (Thiobarbituric Reactive Substances) reach a detection level of 1 mg malonaldehyde/kg meat for fresh ground pork (Tarladgis et.al., 1960).

Initial data on raw materials and final meat products are listed in Table 1. Pork knuckles and loin fat trim (pork sirloin) were blended to a final fat content approximately equal to the fat content of ground pork shoulder. Initial microbial levels were below 10⁴ CFU/g for aerobic plate count (APC) and psychrotropic plate counts (PSY) were below 100 CFU/g for Coliforms (COL).

Atmosphere composition was monitored throughout the storage study. In the 100% CO₂ atmosphere, oxygen content decreased from 3 mm Hg (0.6%) to less than 1 mm Hg (0.2%) during lighted storage, while CO₂ content ranged from 76-79%. The remaining gas was assumed to be nitrogen { N₂ } gas since both oxygen and carbon dioxide levels were measured independently. In 80:20% oxygen:carbon dioxide (O₂:CO₂) atmosphere, O₂ levels ranged from 70-74% during lighted display and CO₂ levels ranged from 16-21%.

APC counts for ground pork (80:20 CO₂) (Table 2) were described by highly significant 3-way interactions [meat source x atmosphere x day]. In the 80:20 O₂:CO₂ atmosphere, no significant differences in APC were observed between ground pork (2DAY), displayed under lights for 6 days(8

day total) and ground pork held 8 days under unlighted storage. In a similar manner, ground pork (2DAY), displayed under lights for 8 days (total 10 days) was not significantly different from ground pork (8DAY) displayed under lights for 2 days (total 10 days). Therefore, the effect of total storage time (unlighted plus lighted) is of greater importance than the amount of time the product is displayed under lights. This trend was present for both ground sirloin and for ground shoulder.

The use of a 100% CO₂ atmosphere was successful in controlling lipid oxidation through 16 days. TBA values for ground pork 80/20 atmosphere reached 1.0 mg malonaldehyde/kg meat after 4 days. Metmyoglobin reducing ability of ground pork significantly higher in CO₂ lighted display, indicating that color shelf-life in this atmosphere may extend beyond that of products held in high O₂ environments.

The move toward centralized production, packaging and distribution has resulted in greater product uniformity and safety, with the additional benefit of reduced labor and capitol equipment costs to the retail merchandiser. With this benefit is a necessity for intervention strategies which result in greater shelf-life than can be achieved by traditional in-store overwrap packaging. Significant differences were found in shelf-life of ground pork due to meat source. APC and PPC plate counts were lower for ground sirloin in either atmosphere or under either storage treatment. The effect of storage time on aerobic reducing ability was greater for ground shoulder than ground sirloin. As storage time increased, more metmyoglobin was formed during low O₂ storage of ground shoulder. In both meat sources, a* values declined as storage time increased (less red color). The data from this study indicate that ground sirloin packaged in 100% CO₂ atmosphere would provide the maximum increase in shelf-life over traditional in-store overwrap packaging.

References

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Table 1. Proximate analyses, microbiological data, pH and TBARS^a of fresh ground pork raw materials and finished product.

Proximate Analyses

	Protein	SEM*	Moisture	SEM*	Fat	SEM*	Ash	SEM*
Pork Knuckles**	18.5	0.3	74.8	0.3	3.5	0.4	4.8	1.7
Pork Shoulder**	14.2	0.5	63.6	2.0	18.4	3.1	5.0	1.0
Loin Fat Trim**	9.2	0.1	41.5	0.1	46.7	0.1	5.0	0.5
Pork Sirloin***	16.3	0.5	64.7	1.2	18.2	1.7	2.8	0.6
Pork Shoulder***	15.8	0.5	64.5	1.6	18.8	2.1	2.6	0.2
	Aerobic Plate Counts (logCFU/g)	Psychrotrophs (logCFU/g)	Coliforms (logCFU/g)	pH	TBARS			
Pork Knuckles**	2.8	2.6	58.0	6.2	0.5			
Pork Shoulder**	3.4	3.2	<10	6.3	0.4			
Loin Fat Trim**	3.1	2.5	<10	6.2	0.5			
Pork Sirloin***	3.1	2.5	11.0	6.1	0.2			
Pork Shoulder***	3.4	2.9	11.4	6.3	0.2			

* SEM = Standard Error Measurement

** Raw Materials

*** Finished Products

TBARS = Thiobarbituric Acid Reactive Substances (mg malonaldehyde/kg meat)