# RESEARCH SUMMARY: Effects of Meat Packaging Technology

## About the Study
Texas Tech University has completed a two-part study evaluating the safety and spoilage characteristics of ground beef contained in modified atmosphere packaging (MAP) systems. The controlled study, funded by The Beef Checkoff, used simulated retail display conditions to compare five packaging systems.

This study is timely given recent petitions to the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA), which are requesting re-evaluation of carbon monoxide gas as an approved packaging component.

## Government Standing
The use of carbon monoxide as a component of a MAP system for storing meat was thoroughly and favorably reviewed by FDA in February 2002. Since then, it has been reviewed two additional times with FDA reaching the same conclusion. In addition, USDA’s Food Safety and Inspection Service (FSIS) reviewed the use of carbon monoxide as a component of MAP and concluded it was effective in performing its intended purpose of use. FSIS also concluded the use of carbon monoxide would not result in a product that misleads consumers.

## Controlled Research Study
Texas Tech University’s MAP study was a controlled study. All product was generated and packaged on the same day to control initial variation. A uniform holding environment simulating retail display conditions (continuous fluorescent lighting and a temperature average of 34°F) was maintained throughout the study.

Ground beef patties were packaged using five treatments:
1. Control (foam tray with film over-wrap)
2. High-oxygen (80 percent \(O_2\), 20 percent \(CO_2\)) MAP
3. High-oxygen MAP with rosemary extract
4. Low-oxygen carbon monoxide (0.4 percent \(CO\), 30 percent \(CO_2\), 69.6 percent \(N_2\)) MAP
5. Low-oxygen carbon monoxide MAP with rosemary extract

Rosemary extract was used in some packages because of its oxidation-inhibiting properties. It was added to the coarse ground beef and mixed prior to a final grind. The five packaging treatments were examined at 0, 1, 3, 5, 7, 14 and 21 days.

## Part 1: Safety Characteristics of MAP ground beef
In order to determine the safety of the five packaging processes, concentrated cultures of *Salmonella* and *E. coli* O157:H7 were added to the ground beef during the initial grinding. The growth and survival of the pathogenic bacteria were monitored over time.

After 14 and 21 days of storage, both the *Salmonella* and *E. coli* O157:H7 populations increased in product subjected to traditional over-wrap packaging. For all MAP treatments — high-oxygen and low-oxygen carbon monoxide, both with and without rosemary extract — the total population of *Salmonella* and *E. coli* O157:H7 present decreased over time. Therefore, the study illustrates that modified atmosphere packaging may inhibit foodborne pathogens, providing added safety to ground beef products.
Spoilage characteristics — color, odor and microbial loads — were determined for each of the five types of packaging. To determine color and odor characteristics, two groups of panelists evaluated the ground beef patties. One group was trained by university meat science faculty in multiple sessions using representative samples prior to the start of the project. A second group of consumer panelists was recruited from the surrounding community and received no training. When evaluating odor, panelists observed the ground beef patties under red lighting to eliminate visual bias. All panelists reported on color and odor, while microbe counts were tested using standardized methods.

- **Color:** The low-oxygen carbon monoxide packaging had a stabilizing effect on meat color after the formation of carboxymyoglobin (a compound that gives meat its bright red color). This packaging method also prevented the development of surface discoloration during the display period. Consumer-panel scores followed the same pattern as trained-panel scores for meat color.

- **Odor:** The traditional and high-oxygen packaged samples developed off-odors earlier in the display period than packages containing carbon monoxide. According to the consumer panel, ground beef packaged with low-oxygen carbon monoxide was more likely than the others to smell fresh at 7, 14 and 21 days. However, consumer panelists also said they would probably not consume the ground beef after 14 days based on the odor. Similarly, 83 percent of trained panelists observed an off-odor in the low-oxygen carbon monoxide packages after 14 days of display.

- **Microbial loads:** Microbial loads were determined at each time interval for the five packaging methods. Researchers found low-oxygen carbon monoxide packages do not support bacterial growth. In fact, when compared to traditional retail packages, MAP suppresses the growth of the aerobic (oxygen-requiring) bacteria that grow at cold temperatures. These bacteria typically cause spoilage.

  Importantly, the microbial loads determined in the second part of the study are spoilage bacteria, whereas *Salmonella* and *E. coli* O157:H7 are foodborne, pathogenic bacteria.

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**Important Study Implications**

This study highlighted the fact that spoilage should not be determined from one trait alone. When choosing packaged beef at retail, several factors should be taken into consideration, including color, odor, texture and packaging date. Additionally, consumers should always refer to the "use-by-date" on the package.