PACKAGING FRESH AND CURED MEAT

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EXTENDING THE PACKAGE LIFE OF FRESH BEEF THROUGH SANITATION AND FORMULATED GASEOUS ATMOSPHERES

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This study focuses attention upon the effects of reduced microbial populations upon the stability of prepackaged fresh beef. Refrigerated beef short loins were treated with a dilute food grade acid solution prior to processing into steaks. Subsequently, the steaks were packaged with an overwrap of polyvinyl chloride and stored in atmospheres containing varying amounts of oxygen and carbon dioxide.

The dilute acid treatment reduced the numbers of viable microorganisms on the surface of the beef short loin and on the surface steaks subsequently removed from the short loin. Elevated carbon dioxide atmospheres inhibited microbial proliferation and elevated oxygen atmospheres facilitated maintenance of pigment in the oxygenated form.

CONSERVATION DE VIANDES FRAICHES EMBALLEES EN REGARD DES REGLES SANITAIRES ET DES CONSIDERATIONS GAZEUSES FORMULEES

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Cette etude decrit les effets de populations microbiennes réduites sur la stabilite de viande fraiche preemballee. De l'aloyau de boeuf refrigeré fut traité par une solutions diluee acide, avant la decoupe en steaks. Par la suite, les steaks furent empaquetés dans un emballage de polyvinyl chloride, le contenant gazeux de chaque paquet etait de proportion variable in oxygene et en dioxide de carbone.

Le traitment acide dilué a reduit le nombre de microorganismes vivants autant sur la surface de l'aloyau que sur les steaks ainsi debites de cet aloyau. L'augmentations du volume de dioxide de carbone aempeché la prolifération microbienne et l'augmentation du volume d'oxygen afacilité la maintenance du pigment dans sa forme oxygenisee.

VERLÄNGERUNG DER FRISCHHALTEZEIT VON VERPACKTEM FRISCHEM RINDFLEISCH DURCH SANITÄRE BEHANDLUNG UND FESTGELEGTE GASATMOSPHÄREN

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Diese Arbeit befaßt sich mit den Wirkungen von reduzierten Mikrobenkolonien auf die Haltbarkeit von fertigverpacktem frischem Rindfleisch. Gekühlte Roastbeefstücke (short loins) wurden mit einer verdünnten Säure der Nahrungsmittelklasse behandelt, bevor sie zu Steaks verarbeitet wurden. Danach wurden die Steaks mit einer Hülle aus Polyvinylchlorid verpackt und in Atmosphären mit unterschiedlichem Gehalt von Sauerstoff und Kohlendioxyd aufbewahrt.

Die Behandlung mit verdünnter Säure reduzierte die Zahl von lebensfähigen Mikroorganismen an der Oberfläche der Roastbeefstücke und auf den Oberflächensteaks,die anschließend von dem Roastbeefstück abgeschnitten wurden. Erhöhte Kohlendioxydatmosphären hemmten die Mikrobenvermehrung und erhöhte Sauerstoffatmosphären machten die Erhaltung des Pigments in der oxygenierten Form möglich.

ПРОТЯГИВАНИЕ СРОКА РАСФАСОВКИ СВЕЖЕГО МЯСА СПОСОБОМ САНАЦИИ И И ФОРМУЛИРОВАННЫХ ГАЗООБРАЗНЫХ АТМОСФЕР

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Это исследование сосредоточивает внимание на благотворное влияние уменьшенной микробной популяции на стабильность расфасованного свежего мяса. Замороженное мясо обработали раствором разбавленной продовольственной кислоты до обработки в бифштекс (котлеты). Потом, расфасовали бифштекс хлористым поливинилом и запасали их в атмосферах содержащих переменные количества кислорода и углекислоты.

Обработка разбавленной кислотой уменьшила число жизнеспособных микроорганизмов и на поверхности короткой филейной части и на поверхности котлет, позже отрезанных от короткой филейной части. Концентрированными атмосферами углекислоты ингибировалась микробная пролиферация и концентрированными атмосферами кислорода облегчалось сохранение оксимиаглобина в окисленной форме.

PACKAGING FRESH AND CURED MEAT

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Introduction

Loss from microbial spoilage exists at all levels of meat handling. Contamination starts at the abattoir, continues through the distribution channels and becomes most evident at the retail store level. Consumers will not accept meat that does not appear to be wholesome and appetizing. Most meat sold at retail in the U.S. is prepackaged in the store. However, in-store processing and packaging is inefficient and does not afford the economic opportunities that are attendant to centralized processing and packaging. A major impediment to wide-spread adoption of centralized processing and packaging is the limited shelf life of prepackaged fresh meats. Developments in sanitation and refrigeration in recent years have improved the prospects for successful centralized packaging (Ramsbottom, 1971). However, these developments have not been adequately utilized, modified and supplemented with advanced packaging technology to make central processing a wide-spread reality at this time.

This study investigated the potential of a four percent acetic acid spray sanitation treatment of beef short loins to reduce the microbial count on the external surface of the short loin and on the surface of steaks subsequently cut from the short loin. Superimposed on the sanitation treatment was a study of the effect gaseous atmospheres containing differing amounts of oxygen and carbon dioxide on the microbial populations and color characteristics of prepackaged steaks in storage and display for varying time periods.

Materials and Methods

General. The ten pairs of beef short loins (lumbar portion of carcass) used in this study were seven days post mortem and were refrigerated to an internal temperature of 0 to -1.1°C. The short loins were subjected to the sanitation treatment before processing into steaks. The short loins were processed into steaks in a -1.1°C room which had been sanitized thoroughly with a hot detergent-sanitizer solution. All equipment used in processing the short loins into steaks also were cleaned with a detergent-sanitizer solution before use. Each short loin was cut into 17 steaks (34 steaks per pair), 19mm. thick. All were placed in serially numbered polyurethane meat trays. The trayed steaks were packaged in a shrinkable polyvinly chloride film and conveyed through a 163°C tunnel for sealing and shrinking the film. One short loin of each pair was spray sanitized for one minute with a 57°C solution of four percent acetic acid. The sanitizing was accomplished by suspending the short loin in a 68 x 45 x 30 cm. cabinet with six nozzles fitted in the side of the cabinet to accomplish uniform distribution of the spray on the loin surface during a 360° rotation in the one minute spraying. The pressure system was a small twin pump (Hypro 5300) that generated 80 pound pressure per square inch at the nozzle and pumped 3,500 ml per minute. The control short loin of each pair was sprayed with tap water.

Gaseous Atmospheres. Three-fourths of the packaged steaks were placed into pouches containing approximately one liter of a gas mixture. These were: air, 15 percent carbon dioxide and 85 percent air, and 15 percent carbon dioxide and 85 percent oxygen. The packaged steaks were placed in 18 x 30 cm. polythylene-mylar laminated pouches and evacuated in 18 inches of Hg before the gas mixture was introduced and the pouch heat sealed. The remaining one-fourth of the packaged steaks received no further treatment and are referred to as the ambient air treatment.

Storage and Display. Steaks were stored and displayed in a -1.1°C temperature environment. Storage was in an unlighted chamber. All steaks were displayed for two days under 120 foot candles of fluorescent (warm white) illumination at the surface of the steaks. The temperature during storage and display was monitored at the top surface (beneath the packaging film) of the steaks. At the termination of the storage periods, the packaged steaks were removed from the pouches and displayed in the original polyvinyl chloride film.

Visual Appraisal. The steaks were scored for the extent of discoloration and for the desirability of color of the lean by a six member panel at the end of the storage and display period. A freshly cut and packaged reference steak was provided for the panel to use as a standard. The reference steak was cut and packaged one hour prior to panel evaluation. A freshly cut reference steak was provided for each evaluation session. All samples were illuminated with 200 foot candles of incandescent light during visual appraisal.

Microbiological Evaluation. Four core samples (25 mm in diameter) of the subcautaneous fat were taken before the spray sanitation and after a 16 hour drying period in a -1.1°C chamber. The steaks were sampled for microbiological evaluation immediately following visual appraisal. A core was asceptically removed from the center, upper surface of the L.dorsi. Standard plate count determinations were conducted on both the fat and L.dorsi core samples.

Statistical Treatment. A random order of sampling was used to determine the allocation of packaged steaks to treatments. The same order of treatment was used for steaks from both sanitized and control short loins from each pair. Data were subject to analyses of variance and means were separated by using the least significant difference procedure (Snedecor and Cochran, 1971).

Results and Discussion

The presence of surface contamination on beef carcasses and carcass parts upon arrival at the beef processing plant or butcher shop in the order of log 5 or more organism per cm^2 occurs frequently in the U.S.A. Most often the meat has been shipped several hundred miles, has been handled several times during distribution, and has not always been maintained in an ideal refrigerated environment. The microorganism population on the beef short loins in this study was reduced significantly from a mean of over log 5 per cm^2 to less than log 2 per cm^2 due to the use of a four percent acetic acid solution as a spray sanitizer (Table 1). The effect of this sanitation treatment of the short loin had a significant, though not so dramatic, effect in reducing the contamination on steaks derived from these short loins within twenty-four hours following the sanitizing treatment. These results concerning the efficacy of acetic acid as a sanitizer are in general agreement with previous research in this laboratory (Bali (1970) and Gonzales (1971)) and with the more recent results of Carpenter (1972).

The storage of prepackaged steaks in an atomsphere enriched with carbon dioxide as a minor constituent had a significant inhibitory effect upon the proliferation of microorganisms. The microbial count of prepackaged steaks stored in 15 percent carbon dioxide was lower after a storage period of 14 days followed by two days of display than untreated steaks held only half as long (Table 2). The decline in microbial count after 7 and 14 days in both carbon dioxide treatments suggests strongly that the treatment not only was inhibitory but may have had a certain degree of sanitizing accomplished before apparent growth began. The prepackaged steaks were in semi-permeable pouches during the storage phase of this study so that the carbon dioxide concentration may have been modified through differential gas transmission through the polyethylene-mylar laminated film. The limited data in this study suggest that the microorganisms in the carbon dioxide treatments begin normal logarithmic growth after two weeks of storage and display.

The combination of oxygen with the carbon dioxide was to provide the presence of sufficient oxygen partial pressure to maintain a desirable color. Color characteristics of the steaks were monitored with a sensory panel. Steaks in pouches containing 85 percent oxygen were maintained longer without apparent discoloration and maintained a desirable appearance longer than other treatments (Tables 3 and 4). At the end of the study (20 days) steaks in the high oxygen treatment were scored moderately desirable after two days of lighted display. The high oxygen treatment resulted in a significantly superior appearance during the longer storage and display times.

These results demonstrate the efficacy of controlled atmospheres during storage at desirable refrigeration temperatures to extend the packaged life of beef steaks. However, it is unclear why the microbial growth resumed on the steaks after approximately two weeks. This may have been due to: an adaptation of the microorganisms to the carbon dioxide enriched atmosphere, the survival and ultimate normal growth characteristics of tolerant organisms after the death of susceptible organisms, or the depletion of carbon dioxide by leakage of the semi-permeable pouch. Further, it is unclear as to how much oxygen pressure is needed to sustain desirable color for extended periods of time at -1.1°C. Studies are currently under way at this laboratory to elucidate these phenomena.

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Table 1

EFFECT OF SANITATION TREATMENT ON THE MICROBIAL COUNT OF BEEF SHORT LOINS AND DERIVED STEAKS

Sanitation Treatment	Mean microbial count[1] (log number per cm^2)	
	Short Loin[1]	Steaks[2]
Sanitized[3]	1.90	1.09
Unsanitized (control)	5.29	2.57

[1] t value (P <.05) = 2.30

[2] t value (P <.05) = 0.66

[3] Short loins were sprayed for 60 seconds with 4 percent acetic acid solution at 55-60° C.

Table 2

EFFECTS OF GASEOUS ATMOSPHERES AND TIME ON MICROBIAL COUNT OF PREPACKAGED BEEF STEAKS

Gaseous Atmospheres	Mean microbial count[1] (Log number per cm^2) Time (Days)				
	0	7	13	15	20
Ambient air	1.83^{ab}	2.57^{bc}	4.35^{d}	5.48^{e}	7.00^{f}
Air (in pouch)	1.83^{ab}	2.27^{b}	3.74^{cd}	4.45^{d}	5.89^{e}
15 percent carbon dioxide and 85 percent air (in pouch)	1.83^{ab}	1.69^{ab}	1.56^{a}	2.49^{b}	3.27^{c}
15 percent carbon dioxide and 85 percent oxygen (in pouch)	1.83^{ab}	1.50^{a}	1.62^{a}	2.14^{ab}	2.99^{bc}

[1] LSD (P <.05) = 0.64.

[a-f] Any two means that have a common superscript letter are non-significant at P <.05.

Table 3

EFFECTS OF GASEOUS ATMOSPHERES AND TIME ON THE DISCOLORATION OF PREPACKAGED BEEF STEAKS

Gaseous Atmospheres	Mean discoloration score[1,2] Time (Days)				
	0	7	13	15	20
Ambient air	1.14^{a}	1.33^{a}	3.02^{b}	4.51^{c}	5.87^{d}
Air (in pouch)	1.14^{a}	1.11^{a}	2.51^{b}	4.37^{c}	6.49^{d}
15 percent carbon dioxide and 85 percent air (in pouch)	1.14^{a}	1.17^{a}	1.63^{ab}	2.79^{b}	4.65^{c}
15 percent carbon dioxide and 85 percent oxygen (in pouch)	1.14^{a}	1.03^{a}	1.09^{a}	1.35^{a}	2.64^{b}

[1] LSD (P <.05) = 0.96.

[2] No discoloration = 1, 25% discoloration = 3, ...completely discolored = 9.

[a-d] Any two means that have a common superscript letter are non-significant at P <.05.

Table 4

EFFECT OF GASEOUS ATOMOSPHERES AND TIME ON DESIRABILITY SCORE OF PREPACKAGED BEEF STEAKS

Gaseous Atmospheres	Mean desirability score[1,2] Time (Days)				
	0	7	13	15	20
Ambient air	8.25^{ab}	7.74^{b}	5.72^{d}	4.29^{e}	2.72^{f}
Air (in pouch)	8.25^{ab}	8.31^{ab}	5.38^{d}	4.10^{e}	2.65^{f}
15 percent carbon dioxide plus 85 percent air (in pouch)	8.25^{ab}	7.95^{ab}	7.07^{bc}	6.03^{cd}	4.13^{e}
15 percent carbon dioxide plus 85 percent oxygen (in pouch)	8.25^{ab}	8.76^{a}	8.33^{ab}	8.11^{ab}	6.71^{c}

[1] LSD (P <.05) = 1.00.

[2] Extremely desirable = 9, Desirable = 8, ...Extremely undesirable = 1.

[a-f] Any two means that have a common superscript are non-significant at P <.05.