MICROBIAL SHELF LIFE OF CHUB-PACKAGED GROUND BEEF FROM FOUR LARGE U.S. PROCESSING PLANTS

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Summary

Ten pound chubs of coarsely ground beef of two different lean:fat specifications (73:27 and 81:19) were stored at three temperatures (34, 38 or 45°F) to monitor the effects of storage temperature on microbial condition of the product. Ground beef from four U.S. plants was tested (2 trials each), and microbial analyses were conducted on storage days 0, 6, 10, 14, and 18 using seven different media to estimate counts of total aerobic and anaerobic, lactic acid bacteria (LAB), and Gram-negative bacteria. Bacterial counts for a given culture medium were similar among plants and meat types. At day 10, total microbial counts from chubs stored at 38 or 45°F were approximately 8 $\log_{10}$ CFU/g, whereas total counts from chubs stored at 34°F were approximately 4.5 $\log_{10}$ CFU/g (4 log=10,000, CFU is colony forming units). Regardless of storage temperature and meat type, LAB predominated. Growth of gram-negative enteric bacteria was delayed in chubs stored at 34°F throughout the 18 day study, whereas counts increased in chubs stored at 38 or 45°F.

(Key Words: Ground Beef, Shelf Life, Meat Spoilage, Microbiology.)

Introduction

In 1994, the average American consumed 64 pounds of ground beef. Therefore, the quality of ground beef becomes an important issue. The nutrients in meat that are essential for humans also are essential for microorganisms, resulting in an extremely perishable product.

Increased bacterial growth reduces shelf life by initiating spoilage characteristics such as off odor, off color, and gas formation in vacuum bags. Contamination during processing limits shelf life of the already fragile ground beef product.

Groups of microorganisms interact to inhibit each other, depending especially on storage temperature. A small number of initial carcass microflora are psychrotropic (grow best in the cold). They increase as the initial predominant mesophilic organisms (grow best at body temperature) decrease under cold conditions.

Organisms associated with meat spoilage include *Pseudomonas, Acinetobacter, Moraxella, Serratia, Altermonas, Brochrothrix, Lactobacillus,* and *Hafnia*. Packaging can enhance populations of lactic acid bacteria(LAB). *Pseudomonas* spp. are most prevalent in aerobically packaged fresh beef, whereas *Hafnia alvei* has been implicated in

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the spoilage (gassy packages, hydrogen sulfide odor) of vacuum-packaged strip loin steaks. Because the initial microflora on meat is primarily mesophilic, shelf life is prolonged by the combined use of refrigeration and vacuum packaging. A greater increase in microbial counts in chub-packed ground beef during storage was reported at 45°F than at 36°F. Total aerobic plate counts have been reported to increase during storage, as well as the proportion of gram negative to gram positive organisms. Severe or even slight temperature abuse contributes to premature product deterioration, resulting in financial loss and negative response from consumers.

This study was conducted to determine the changes in microflora of three formulations of chub packaged ground beef over an 18 day storage at three temperatures using total aerobic and anaerobic plate counts in conjunction with selective and differential agars. Four individual meat packing facilities in four separate locations throughout the United States were sources of beef.

Experimental Procedures

Ten pound ground beef chubs were sampled from four U.S. meat processing facilities. Samples were collected twice from each facility between August, 1996 and January, 1997. Three product types with different fat and lean concentrations were examined from each facility [73/27 (73%) ground beef, 81/19 (81%) ground beef, and 81/19 (GC) ground chuck]. All ground beef samples were coarsely ground. During product collection from each facility, chubs from each product type were collected randomly and boxed. All chubs used for one trial at one plant were produced on the same day during the same shift. The chubs used for day 0 sampling were transported on ice to either Kansas State University (KSU) Manhattan, KS or the Food Research Institute (FRI) Madison, WI for microbiological analysis. The chubs to be sampled on days 6, 10, 14, and 18 were transported to corresponding laboratories by commercial refrigerated truck.

Kansas State University stored ground beef from two plants at 38 and 45°F, and the FRI stored product from two other plants at 34 and 45°F. Immediately upon arrival at the laboratories, chubs were separated randomly into two equal groups and stored at the two different temperatures.

Microbial analyses were performed on two chubs from each temperature on days 0, 6, 10, 14, and 18. A 50 g sample of ground beef was removed aseptically from the chub and placed into a stomacher bag along with 150 ml of 0.1% peptone (Difco), resulting in an initial 1:4 dilution. Serial 1:10 dilutions (0.1% peptone) were spiral-(KSU), spread-(FRI), or pour- (KSU, FRI) plated onto seven different commercially available agars and incubated at 68°F for 5 days.

Tryptic Soy Agar (Difco, Detroit, MI) with 5% defibrinated sheep blood added was used to determine both the total aerobic and anaerobic plate counts. Anaerobic incubation conditions were achieved using an anaerobe jar in conjunction with a BBL GasPak Plus anaerobic atmosphere generators (4 to 10% carbon dioxide). APT Agar (APT) was used by KSU, whereas the FRI used MRS Agar (MRS) to enumerate LAB. *Pseudomonas* Isolation Agar (PIA) was used to determine the presence of *Pseudomonas* spp., especially *P. aeruginosa*. Violet Red Bile Agar (VRBA) was used in the pour plate method to determine coliform and gram negative counts. Desoxycholate Lactose Agar (DL)

was used to enumerate gram negative enteric bacilli. All plates were incubated at 68°F.

Results and Discussion

Because the bacterial plate counts were similar for all three meat types, data are presented only for 73% lean ground beef. Initial total aerobic plate counts were approximately 4 to 5 $\log_{10}$ CFU/g for samples from all four plants. Within 10 days, total aerobic and anaerobic counts from chubs stored at 45°F had reached 8 $\log_{10}$ (100 million) CFU/g and were similar for all four plants. Product stored at 38°F (two plants, FRI) had counts similar to those of product stored at 45°F; 7.5 $\log_{10}$ at day 10 and increasing to 8 $\log_{10}$ CFU/g at day 14. In contrast, plate counts from products stored at 34°F (two other plants, KSU) increased approximately 1 $\log_{10}$ CFU/g by day 10 and reached 7 $\log_{10}$ CFU/g by day 18.

After 18 days at 34°F, LAB reached about 7 $\log_{10}$ CFU/g; at 38 or 45°F counts reached 7 to 8 $\log_{10}$ CFU/g. Because counts of 8 $\log_{10}$ CFU/g also were recovered on Blood Agar (total aerobic and anaerobic-microbial load), LAB were presumed to predominate.

Initial gram negative enteric bacteria were present at about 2 to 3.5 $\log_{10}$ CFU/g in samples from all plants and increased to approximately 5.0 and 5.5 $\log_{10}$ CFU/g during the 18 days of storage.

Because the initial bacterial load of ground beef in general is relatively high, low refrigeration temperature (ca. 34°F or less) is important for delaying microbial growth and inhibiting the proliferation of spoilage organisms. Temperature control is critical, because only a 4°F increase in storage temperature resulted in more rapid microbial growth and faster product spoilage.