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**Abstract**
Commercially produced vacuum packaged, fully cooked, microwaveable beef roasts from four producers were purchased from local retail markets. Salt concentration, pH, water activity (aw), and percent moisture, fat and protein were determined. Samples of both package juice and homogenized beef plus juice were analyzed for the presence of aerobic, anaerobic and lactic acid bacteria and clostridia-type organisms. The cooked beef products had pH values from 5.82 to 6.19, water activity of 0.992 to 0.997, and contained 0.34 to 1.07% salt, 61.89 to 72.39% moisture, 4.29 to 18.21% fat and 15.92 to 20.62% protein. No growth was detected in juice for aerobic, anaerobic or lactic acid bacteria or clostridia-type organisms. Combined beef and juice had less than 2 CFU/g for aerobic, anaerobic or lactic acid bacteria or clostridia-type organisms. Cooking and chilling schedules used in the manufacture of the four products we evaluated in this study limited survival and outgrowth of microorganisms.

**Keywords**
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# MICROBIAL FLORA OF COMMERCIALLY PRODUCED VACUUM PACKAGED, COOKED BEEF ROAST

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## Summary

Commercially produced vacuum packaged, fully cooked, microwaveable beef roasts from four producers were purchased from local retail markets. Salt concentration, pH, water activity ($a_w$), and percent moisture, fat and protein were determined. Samples of both package juice and homogenized beef plus juice were analyzed for the presence of aerobic, anaerobic and lactic acid bacteria and clostridia-type organisms. The cooked beef products had pH values from 5.82 to 6.19, water activity of 0.992 to 0.997, and contained 0.34 to 1.07% salt, 61.89 to 72.39% moisture, 4.29 to 18.21% fat and 15.92 to 20.62% protein. No growth was detected in juice for aerobic, anaerobic or lactic acid bacteria or clostridia-type organisms. Combined beef and juice had less than 2 CFU/g for aerobic, anaerobic or lactic acid bacteria or clostridia-type organisms. Cooking and chilling schedules used in the manufacture of the four products we evaluated in this study limited survival and outgrowth of microorganisms.

(Key Words: Microbial Flora, Vacuum Packaged, Cooked Beef.)

## Introduction

Demand for beef in the United States is on the rise. Contributing to this increased demand is the development of heat-and-serve beef entrees. These vacuum packaged, cooked, then chilled in the package beef products are meeting consumer demand for convenience and high quality, with minimal preparation time. Use of microwaveable beef entrees reduces meal preparation time to less than 10 minutes. In 2000, sales of heat-and-serve beef products, such as beef pot roast, reached $84 million.

Beef roasts that are vacuum packaged, cooked, then chilled in the package have the advantage of extended shelf life since cooked product is not re-exposed to spoilage organisms. During heat treatment of extended shelf life, refrigerated foods, vegetative cells are destroyed but spores can survive. Little or no preservative is used in the manufacture of these products and refrigeration is required to ensure product safety. Temperature abuse occurs in the food distribution chain, as well as by consumers. Potential temperature abuse, along with vacuum packaging that creates an anaerobic environment, makes these types of foods a potential risk from spore forming bacteria such as *Clostridium botulinum* and *C. perfringens*.

Microwaveable beef roast (pot roast) is the most common retail heat and serve product. Our objective was to determine the microbial flora and compare pH, salt concentration, water activity, moisture, fat and protein content of different commercially available beef roast heat and serve products.

## Experimental Procedures

Commercially produced retail beef roast heat-and-serve products from four manufacturers were purchased locally. Each manufacturer was assigned a code: A, B, C, or D. For each manufacturer's product, three sets of duplicate packages, each set bearing a different code date, were selected with one exception. Only packages bearing the same lot number were available for supplier A. Product was transported from the retail store to the lab in an insulated cooler, and stored at $40^{o}$ F for not more than two weeks, at which time all testing was completed.

Product samples were analyzed for the presence of aerobic, anaerobic and lactic acid bacteria and clostridia-type organisms. Salt concentration, pH, water activity and moisture, fat and protein content were determined. Data were analyzed using proc GLM, and mean separation was done with Fisher's least significant difference (LSD) test (SAS, 1999). Significance level was $P<0.05$.

## Results and Discussion

No aerobic or anaerobic microorganisms, lactic acid bacteria or clostridia-type organisms were detected in juice from the beef roast packages (Table 1). Similarly, less than two (estimated) colony forming units/g (CFU/g) of these organisms were detected when combined cooked beef and juice were sampled, regardless of manufacturer. Meat is an ideal growth medium for microbes because it is high in moisture and nitrogen, supplies ample amounts of minerals and growth factors, and has a favorable pH of 5.6 or higher. Intrinsic properties (Table 2) indicated some differences ($P<0.05$) among manufacturers, but each product would provide a good substrate for growth if bacteria were present. Thorough cooking must have been used by the four manufacturers to significantly reduce or eliminate micro-organisms, and subsequent chilling, distribution and refrigerated retail display was adequate to prevent outgrowth of spores that may have been present.

Because the seasoned beef roast products were vacuum packed and cooked, all the natural juices were retained in the packages, leading to the high moisture and water activity results (Table 2). Salt content was 0.34%, 0.43% and 0.54% in three of the products and 1.07% in the fourth. Considering the high moisture content of these products, the ability of the low salt content to serve as an antimicrobial was limited. Even salt levels of 2-3% in products with moisture contents above 60% do not provide a significant preservative effect. The ingredient statements for these products indicated that no acidulants were added to the products (Table 3). The beef roasts had a pH range of 5.82 to 6.19. Three products had similar fat contents ($P>0.05$) but sample A contained three times more fat, at 18.21%. That was the product that was not available after the first set of samples had been purchased and only one sample was available for chemical analysis. It was a whole muscle product and may have contained seam fat not found in other samples. It may also not be truly representative of the manufacturer's normal product because, based on the nutritional panel on this sample, the fat content should have been 10.7 % $\pm$ 2.1%.

Manufacturing, chilling, distribution and retail display for the cooked beef roast products from all four manufactures resulted in less than 2 CFU/g of aerobic, anaerobic and lactic acid bacteria and clostridia-type organisms. This indicates that the cooking and chilling protocols used limited survival and outgrowth of the microorganisms we measured. Our results are consistent with the good safety record for products of this type.

**Table 1. Microbial Counts (CFU/g) for Commercially Available Vacuum Packaged, Cooked Beef Roasts from 4 Manufacturers**

| Product | Manufacturer | Aerobic Plate Count | Anaerobic Plate Count | Clostridia-type Organisms | Lactic Acid Bacteria |
|---|---|---|---|---|---|
| Juice | A | NG[1] | NG | NG | NG |
| | B | NG | NG | NG | NG |
| | C | NG | NG | NG | NG |
| | D | NG | NG | NG | NG |
| Beef and Juice | A | <2 est.[2] | <2 est. | <2 est. | <2 est. |
| | B | <2 est. | <2 est. | <2 est. | <2 est. |
| | C | <2 est. | <2 est. | <2 est. | <2 est. |
| | D | <2 est. | <2 est. | <2 est. | <2 est. |

[1]NG=no growth.
[2]est.=estimate.

**Table 2. pH, Salt Concentration, $a_w$, and Proximate Analysis of Commercially Available Vacuum Packaged, Cooked Beef Roast from 4 Manufacturers**

| Company | pH | % Salt | % Fat | $a_w$ [1] | % Moisture | % Protein |
|---|---|---|---|---|---|---|
| A | 6.19[a] | 0.34[c] | 18.21[a] | 0.994[a] | 61.89[a] | 18.56[c] |
| B | 6.00[b] | 1.07[a] | 4.29[b] | 0.997[a] | 72.39[b] | 15.92[d] |
| C | 5.82[c] | 0.54[b] | 5.38[b] | 0.996[a] | 70.81[b] | 20.62[a] |
| D | 6.04[b] | 0.43[c] | 6.30[b] | 0.992[a] | 71.00[b] | 19.63[b] |

[a,b,c,d]Means in the same column with a different superscript letter differ ($P<0.05$).
[1]Water activity.

**Table 3. Combined Ingredient List for 4 Commercially Prepared Beef Roast Products and Number Who Used Each**

| Ingredient | Number of Products Containing Ingredients | Ingredient | Number of Products Containing Ingredients |
|---|---|---|---|
| Salt | 4 | Caramel Color | 4 |
| Sweeteners | 4 | Disodium inosinate | 2 |
| Hydrolyzed protein | 3 | Disodium guanylate | 2 |
| Garlic | 2 | Beef tallow | 2 |
| Onion | 3 | Starch | 2 |
| Sodium lactate | 1 | Sodium phosphate | 2 |
| Monosodium glutamate | 1 | Gums | 1 |
| Flavoring | 2 | Spices or extracts | 3 |