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III. Microbiological Profile of Raw Beef

A. General Microbiological Parameters Associated with Beef

Beef muscle is a nutrient-rich substrate that can support the growth of a wide range of microorganisms. It is generally assumed that the interior of intact muscle is free of microorganisms. However, localized presence of bacteria can occur in lymph nodes or the area adjacent to bone joints, particularly if they are inflamed. Microorganisms are introduced into the interior of meats as a result of the translocation of bacteria from the surface of the carcass. The initial microflora is diverse at the time of slaughter; however, subsequent refrigerated storage selects for a limited group of aerobic psychrotrophic species, particularly those of the Pseudomonas-Moraxella-Acinetobacter group (Johnston and Tompkin, 1992). The specific genera encountered is dependent on the storage temperature. oxygen availability, pH, and moisture content (von Holy and Holzapfel, 1988).

1. Temperature

Microbial growth in beef is strongly dependent on environmental temperature. As storage temperatures are lowered toward freezing there is a significant decrease in the rate of microbial growth as well as a reduction in the diversity of the microflora.

2. Moisture Content

Fresh meat has a water activity (a_w) of ≥ 0.99 which supports the growth of a wide variety of bacteria, yeast, and molds. At high a_w values $(a_w > 0.97)$, the rapid growth rates characteristic of bacteria allow them to predominate. However, as meat surfaces dry, the differential in growth rates becomes less important. Below a_w values of 0.94, fungal species play an increasingly important role as the dominant type of microorganism.

3. pH

The pH of fresh beef is dependent on a number of factors including feeding and handling practices at the time of slaughter, and range from 5.3–6.5. Under normal conditions, the pH of beef after slaughter and chilling is ≤5.8. Both the rate of microbial growth and the diversity of the microflora will be restricted at the lower end of the pH range (Grau, 1981).

4. Oxygen Availability

Unpackaged fresh beef actually represents two microbiological environments in relation to oxygen availability. The surface is aerobic; an environment that permits the rapid growth of aerobic psychrotrophs such as Pseudomonas. However, the poising capacity of meat tissue is high, and an anaerobic environment predominates within 2 mm of the surface. This selects for anaerobes, microaerophiles, and facultative anaerobes. Restricting oxygen availability through the use of physical barriers can substantially alter microbial growth at the surface of meats. Fresh beef is an actively respiring system and even a partial restriction of oxygen permeability across a plastic wrap results in a depletion of oxygen and an accompanying increase in carbon dioxide. This produces a shift from aerobic species (e.g., pseudomonads) to microaerophiles and facultative anaerobes such as Lactobacillus, Pediococcus, Leuconostoc, Streptococcus, Carnobacterium, and Brochothrix. Grinding raw beef increases the surface area exposed to oxygen, at the same time distributing any contamination present on the surface throughout the meat. However, the increased surface area also increases the amount of actively respiring muscle tissue, leading to rapid oxygen depletion within packaging material that restricts oxygen availability.

There has been speculation that vacuum packaging or modified atmosphere packaging (VP/MAP) could lead to a situation where if a product