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Microbial Blocking Agents: A New Approach to Meat Safety

The human gastrointestinal tract is nature's exquisite bioengineering marvel. It is a food processing system with precise management of critical control points, microbial hurdle mechanisms, food safety inspection service, and waste disposal.

This sequence of events occurs with impeccable automation. The antigen-processing cell cascade at the intestinal mucosa regularly conducts microbial surveillance to establish an immune-memory database. A foodborne illness or intoxication is a manifestation of this intestinal processing system, flushing out a particular microorganism and/or its cellular compounds via an acute-phase response resulting in diarrhea, vomiting, fever, etc.

Microbial blocking agent (MBA) is a new term to define a class of naturally occurring innate defense factors at the mucosa that block microbial adhesion–colonization and growth–multiplication and neutralize toxic proinflammatory compounds such as endotoxins, mitogens, etc. MBAs are present in exocrine secretions such as milk, saliva, tears, and gastric fluids that bathe mucosal wrappings around tissues to shield against invading pathogens. A live animal has active MBAs to protect its tissue. However, meat processing conditions either deplete or inactivate these blocking agents.

Could it be possible to replenish the muscle food with MBAs and thus shield it from pathogens? Is it possible for a dead tissue to release its endogenous intracellular pool of antimicrobial factors for self-defense? Research indicates that the answer is yes.

Emergence of enterohemorrhagic *Escherichia coli* O157:H7 as a foodborne pathogen has revamped the food safety rules of the beef industry. The symptoms of this microbial infection range from mild diarrhea to a deadly hemolytic uremic syndrome, depending on the extent of internal processing of the gastrointestinal tract. Populations with normal acute-phase reactivity could block and flush this pathogen from the system at the mucosal level. However, immunocompromised individuals with reduced or dysfunctional reactivity fail to block the invasion of this pathogen.

Clinical research to understand the regulation of virulence factors of enteric pathogens such as *E. coli*, *Salmonella*, *Shigella*, and *Campylobacter* has led to the identification of several MBAs at the mucosal surface. Similarly, a number of factors with MBA activity have also been identified in milk and gastric mucins of cow.

Integrating medical technology with meat microbiology is akin to reinventing the fascinating ancient Egyptian art of protecting the dead tissue! However, cosmetic embalming is out of the question, since thousands of carcasses are processed each day in a beef packing plant and the available window of opportunity to replenish the tissue with MBAs is only few seconds. Though this may sound like science fiction, such a tissue-protective barrier for meat safety can be accomplished with recent advances in antimicrobial delivery systems.

For decades, food microbiologists have developed various methods of food protection, incliuding procedures that prevent microbial entry into foods, methods that inactivate endogenous and contaminating microflora, and techniques to prevent or slow down growth of microbes should they gain access to and not be inactivated in foods. Most of these processes operate either by stasis or cidal antimicrobial mechanisms. Since microbial explosion or implosion that results from cidal activity leaves a substantial residue of proinflammatory cell debris and toxins from the pathogen, the treated target is not "pyrogen-free." Furthermore, the microbial response to stress leads to conditions such as resistance to heat shock, acid shock, and radiation shock. Since no antimicrobial system is perfect, a "hurdle concept" involving a combination of methods is recommended.

MBAs provide a unique microbial hurdle in a food-processing cascade. They inhibit the expression of specific colonization factors on the microbial surface that promote tissue attachment and compete for tissue-binding sites on the epithelial surface to block or detach microorganisms. Because of this two-fold effect, the microorganism is repelled from a biological surface. Since the blocking activity is a molecular phenomenon related to structure–function, the activation of functional sites and a specific target-delivery mechanism are critical for the efficacy of an MBA system.

Nature has developed the MBA mechanism as one of its many antimicrobial hurdles in the intestinal food processing system. These natural antimicrobials are time tested and effective. With the advent of emerging pathogens, food microbiology and medical technology have met at the crossroads. The MBA technology, an integrated path to enhance food safety, is near commercialization. Watch for it. ●

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