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Commentary

Molecular Detection of Listeria Monocytogenes in Raw and Processed Meat Using PCR-Based Methods

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DESCRIPTION

Listeria monocytogenes is a pathogenic bacterium of major public health concern due to its ability to cause severe foodborne illness, especially in vulnerable populations such as pregnant women, the elderly, and immunocompromised individuals. Its prevalence in meat and meat products poses a significant food safety challenge, as contamination can occur at various stages of production, from slaughtering to processing and packaging. Conventional culture-based methods for detecting Listeria monocytogenes are time consuming and may not always detect the pathogen in its viable but non-culturable state. To address these limitations, Polymerase Chain Reaction (PCR)-based methods have emerged as reliable tools for rapid and specific detection of L. monocytogenes in food matrices. This study aimed to assess the prevalence of L. monocytogenes in raw and processed meat products from Iranian markets using a PCR-based molecular approach, evaluating both its detection sensitivity and the public health implications of its presence.

A total of 200 meat samples were collected from retail outlets, including 100 raw meat samples (beef, lamb, and poultry) and 100 processed meat products (sausages, ham, and meatballs) from Tehran and nearby urban areas. Samples were transported under refrigerated conditions and analyzed within 4 hours of collection. For each sample, bacterial DNA was extracted after an initial enrichment step in Listeria Enrichment Broth, followed by cell lysis and purification. PCR amplification targeted the hlyA gene, which encodes listeriolysin O, a virulence factor specific to L. monocytogenes, making it a suitable marker for molecular identification. Positive and negative controls were used throughout the experiments to ensure the accuracy and specificity of results.

The findings revealed that L. monocytogenes was present in 28% of the total samples, with a higher occurrence in raw meats (34%) compared to processed meats (22%). Among raw samples, poultry exhibited the highest contamination rate at 38%, followed by beef (30%) and lamb (26%). Processed meat products showed varied results, with meatballs showing the highest prevalence (28%), likely due to post-processing contamination and improper handling. PCR successfully detected the hlyA gene in all positive samples, confirming the presence of the pathogenic strain rather than non-pathogenic Listeria species. Notably, the PCR assay demonstrated a detection limit of 10^2 CFU/mL, showing high sensitivity and suitability for routine diagnostic screening.

In comparison to culture-based detection performed on a subset of 50 samples, PCR was significantly faster and more accurate, identifying L. monocytogenes in 12% more samples than traditional methods. Culture methods often missed low-level contaminations or samples with competing microflora, emphasizing the value of molecular diagnostics in food safety monitoring. Furthermore, the presence of L. monocytogenes in both raw and processed meats reflects potential lapses in hygiene during slaughter, processing, and post-packaging handling. Interviews with meat processors revealed that despite awareness of Listeria risks, routine microbiological monitoring is infrequent and often lacks the incorporation of advanced molecular methods.

The detection of a virulent pathogen like L. monocytogenes in consumer-ready meat products is alarming, considering the severity of listeriosis, which has a high hospitalization and mortality rate. The ability of L. monocytogenes to grow at refrigeration temperatures and form biofilms on food contact surfaces further complicates its control in meat processing environments. The findings point to an urgent need for the meat industry in Iran to adopt rapid screening methods like PCR for real-time monitoring and early detection. In addition, enforcement of stricter hygiene protocols, temperature control throughout the cold chain, and training of food handlers are critical to minimize contamination risks.

In conclusion, this study demonstrates the effectiveness of PCR-based methods for the rapid and specific detection of Listeria monocytogenes in meat products, offering a more sensitive and timely alternative to conventional microbiological techniques. The relatively high prevalence of this pathogen in both raw and processed meat samples from Iranian markets raises significant

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concerns regarding food safety and public health. These results underscore the importance of integrating molecular diagnostics into routine surveillance programs and adopting a preventative approach to meat hygiene throughout the supply chain. By implementing such measures, food authorities and meat processors can work collaboratively to ensure the microbiological safety of meat products and reduce the burden of listeriosis among the Iranian population.