Aspects of Gene Therapy in Bovine Mastitis Management

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Abstract

Bovine mastitis is a major disease problem in dairy animals and development of resistant bacteria is major public health problem. Gene therapy is a good alternative for treatment but it is in infant stage of development. It is a good alternative for treatment of mastitis cause by antibiotic resistant bacteria. Insertion of gene coding lysozyme and lysostaphine are good for prevention and cure of clinical as well as subclinical bovine mastitis.

Key words: Bovine mastitis, Gene therapy, Antibiotic, Lysozyme, Lysostaphine.

1. Introduction

Bovine mastitis is a multi factorial and most prevalent disease of dairy cattle (Forsman et al., 1997). It causes significant economic loss by reduction in milk production through rejected milk, treatment costs and most difficult to control. Among bacteria, Staphylococcus aureus and E. coli followed by Streptococcus agalactie, are most frequently isolated from mastitic milk (Krishnaveni et al., 2014; Karabasanavar and Singh, 2013). In most of countries, present strategy to combat mastitis involves irresponsible use of antibiotics but, its frequent and unwise use creates crisis like increasing prevalence of antibiotic resistant bacteria with high risk of human transmission as well as presence of antibiotic residue in milk (Nkang et al., 2010). Hence, considerable international pressure applied to limit the use of antibiotics and way out advance strategies to combat mastitis like Cytokine immunotherapy (Sordillo et al., 1997), Recombinant mucolytic protein therapy (Gruet et al., 2001), Breeding of genetic resistant animals (Wall et al., 2005) and Gene therapy (Fan et al., 2002).

2. Gene Therapy

Gene therapy typically involves insertion of functioning genes into cells to correct a cellular dysfunction or provide new cellular function (Culver, 1994). First time gene therapy was applied on four year old Sri Lankan girl in US national institute of Health in 1990 to treat rare genetic disease severe combined immunodeficiency (SCID). Genes can be inserted into body or cell by two methods.

- Germ line gene therapy in which germ cells are modified by integrated genes, so that change is heritable and passes in to subsequent generations.
- Somatic gene therapy includes transferred therapeutic genes in to somatic cells of patient and effects will be restricted to individual patients only.

Gene delivery can be access by vectors which are none other than carrier molecules carry genes to the host cells. Vectors are of two types:

- Viral vectors: Desired DNA is inserted into virus and via replication desired DNA is placed inside host genome. But limitations with viral vectors include possible generation of immunologic reaction. Examples of viral vectors are Retro virus, Adeno virus, Adeno associated virus etc.
- Non Viral vectors: (i) Direct injection of naked DNA in tissues (ii) Gene gun in which plasmid DNA was coated into 1-3 µm gold or tungsten particles fired at the tissue via electrical of gas pulse acceleration (iii) Cationic liposomes, an artificial lipid sphere with aqueous core carries the therapeutic DNA and capable to passing the DNA through target cell membrane.
3. Aspects of Gene Therapy in Bovine Mastitis

Antibiotic therapy of lactating animals is not much effective, so now goal of scientists is detoured towards enable mammary cells to produce novel antibacterial proteins (Fan et al., 2002). This is only possible with the help of gene therapy and success of gene therapy in some human cases promises its use in the veterinary field also. Therefore, gene therapy should be considered as an option for treating mastitis causing by resistant bacteria (Kerr, 2001).

Antimicrobial peptides like Lysozyme isolated from many different organisms can be effectively used as a tool of gene therapy against bovine mastitis (Zasloff, 2002). Anti-microbial proteins are able to kill microorganisms either by inhibition of macromolecule biosynthesis or by interacting with specific vital components inside the organism (Ulvante, 2004). Some important antimicrobials proteins are:

- rhlYZ (Recombinant Human Lysozyme) is a well-known muramidase with potent antibacterial activities against a variety of microorganisms. The lytic mechanisms for bacterial killing by LYZ include enzymatic peptidoglycan hydrolysis of bacterial wall and induction of autolysins that can cause bacterial autolysis. The non-lytic mechanisms include induction of membrane perturbation of its targets through binding of a certain domain to and interaction with bacterial surface.

- Lysostaphin (Schindler and Schuhradt, 1964) is a 27 kDa protein produced by Staphylococcus simulans and acts on cell wall of Staphylococcus aureus causing its lysis.

- Bovine Lactoferricin (Belamy et al., 1992) releases from bovine lactoferrin upon cleavage by gastric pepsin causing unavailability of iron for bacteria by chelating it.

4. Conclusion

Bovine mastitis is most prevalent disease of dairy cattle causing heavy economic loss to dairy industry. Overwhelming use of antibiotics against causative bacteria of bovine mastitis causes high rise in antibiotic resistant bacterial population in recent decade. Such situation must be overcome by alternative therapeutic regimens e.g. Gene therapy. Though use of gene therapy in bovine mastitis is in infant stage but tremendous scope is present for gene therapy to treat bovine mastitis.

References


