

Article

Innovative Technologies, Nanoprivates and Methods of Application of Probiotics in Veterinary Pharmaceuticals

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Abstract: This article presents information on modern innovative technologies in veterinary pharmacy, in particular nanopreparations and probiotics. The role of nanotechnology in drug delivery systems, the importance of probiotics in improving animal health and productivity are scientifically analyzed. The article reviews the effectiveness and prospects of innovative drugs used for various animals (cattle, poultry, pigs, fish).

Keywords: Veterinary medicine, pharmaceuticals, nanotechnology, nanopreparations, probiotics, agents, animal, health

Introduction

Modern veterinary pharmaceuticals are developing rapidly and are radically changing the methods of maintaining and treating animal health through the introduction of new innovative technologies. Among the most promising areas in this area, nanotechnology and probiotics occupy a special place. In developed countries, a lot of research is being conducted in this area. For example, in Japan and Germany, nanoparticles that enhance the immune system are being developed, which are used to a small extent and achieve high efficiency. In South Korea and Britain, early detection of diseases using biosensors is being carried out, for example; (brucellosis, tuberculosis). Nanotechnology (working with particles in the 1-100 nanometer range) is playing an important role in veterinary practice in improving the effectiveness of drugs, creating targeted delivery systems, and enhancing vaccine immunogenicity. Probiotics are widely used as an alternative to antibiotics to maintain the balance of the microbiome in the intestines of animals, strengthen immunity, and increase productivity.

Nanotechnology in veterinary pharmaceuticals. Nanoparticles and their properties. Nanoparticles (NPs) are materials with a diameter of 1-100 nanometers, which are widely used in

veterinary medicine due to their unique physicochemical properties. The main advantages of nanoparticles are as follows. High surface area - this property increases the bioavailability of drug substances. Targeted delivery - minimal impact on undamaged tissue. Controlled release - long-term supply of drug substances. The ability to pass through the cell membrane - high penetration. Drug delivery systems. Nanotechnology-based drug delivery systems (DDS) are divided into the following types:

Liposomes are vesicles (25 nm - 1 µm) composed of phospholipid bilayers, capable of transporting hydrophilic and hydrophobic drug substances. They have shown high efficiency in tumor-targeted drug delivery in veterinary oncology.

Polymer nanoparticles - Nanoparticles made from chitosan, polylactide-co-glycolide (PLGA), and other biodegradable polymers provide stability to drug substances and allow for controlled release.

Nanogels - Nanogels are three-dimensional polymer networks with high water holding capacity. They offer promising solutions for adjuvant delivery and controlled drug release in veterinary medicine.

Nanotechnology in vaccination - Nanotechnology significantly increases the immunogenicity of vaccines. The table below shows the effectiveness of vaccines based on various nanomaterials.

Nanomaterial - Chitosan-encapsulated Infectious Bronchitis Virus Poultry Strong antibody and cellular immunity. Selenium Nanoparticles (SeNZ) H5N1 Chickens Increases vaccine efficacy. Calcium phosphate NZ Newcastle disease virus Chickens Effective drug delivery. Also Silver nanoparticles (AgNZ) Foot-and-mouth disease antigen Mice 100% recovery within 12 hours Application of nanoparticles in various animals Ruminants (cattle, sheep, goats) Zinc oxide nanoparticles (ZnO-NZ).

Increases the level of digestion of food. Increases the formation of volatile fatty acids (VFA) and reduces methane emissions. Selenium nanoparticles (Se-NZ). Improves sperm quality, strengthens antioxidant status. Copper oxide nanoparticles (CuO-NZ) promote weight gain. Increases hepatic copper concentration even in the presence of dietary antagonists

Poultry - The use of nanoparticles in poultry farming has led to the following results. Nanoparticle Type Dose Results Copper NZ (CuNZ) 15 mg/kg Body weight, feed intake and immunity improved, Zinc Oxide NZ Standard Growth accelerated, pathogens (E. coli, Salmonella) decreased, Selenium NZ Optimal Small intestinal microarchitecture improved.

Aquaculture (fish farming) - Nanotechnology is being used in the following areas in fish farming. Selenium NZ (1-2 mg/kg): increases growth, immunity and stress resistance. Zinc NZ (40 mg/kg): improves growth performance and hematological parameters. Chitosan NZ + vitamins C and E: reduces mortality, increases disease resistance. Nanoparticles in neutralizing mycotoxins. Nanoparticles are highly effective in binding and neutralizing mycotoxins in feed,

NZ type Purpose Efficiency. Magnetic chitosan NZ ~70% reduction of aflatoxin M1 in milk, Silver NZ Complete inhibition of A. flavus in soil at <8 µg/ml. Zinc oxide NZ Inhibition of Fusarium graminearum DON synthesis, Cinnamon oil NZ 68% reduction of aflatoxins in beef, Nanomedicines in practice Some nanomedicines used in veterinary practice. Disease Nanomedicine Animal type Main effect. Mastitis Colostrum-Containing Extracellular Vesicles Cattle Anti-Inflammatory through Modulation of NF-κB. Salmonellosis Silver NZ Sheep/Goat Effective against multidrug-resistant strains. Dry eye syndrome Gelatin-EGCG NZ Rabbits Reduces eye inflammation

Probiotics in veterinary pharmacy - Concept and classification of probiotics Probiotics are living microorganisms that, when consumed in sufficient quantities, have a beneficial effect on the host organism. The most commonly used probiotic strains in veterinary practice. Lactobacilli, yeasts Mechanisms of action of probiotics, Probiotics improve animal health through several mechanisms. Direct antagonism Competition for nutrients and adhesion sites - probiotics suppress pathogens. Production of antimicrobial compounds, bacteriocins (plantaricin, reuterin, enterocin), organic acids (lactic, acetic, propionic acids).

Regulates anti-inflammatory cytokines. Use of probiotics in animals Probiotics in poultry, Meat protein consumption is expected to increase by 14% by 2030, further increasing the importance of probiotics in poultry farming.

Probiotic Dosage Results:

- *L. acidophilus*, *L. casei* 1%, $>5 \times 10^9$ CFU/g Improved immunity, growth rate, and antioxidant levels
- *L. plantarum* LTC-113 1×10^9 CFU Protection against Salmonella. *Pediococcus acidilactici* Standard Increased egg production and intestinal health
- *Limosilactobacillus ingluviei* Optimally inhibits *Campylobacter* colonization. Probiotics in ruminants

Probiotic Animal Effect - Cattle Increases milk production and protein concentration, stabilizes cattle pH *Megasphaera elsdenii* Prevents Cattle Rumen Acidosis.

B. subtilis, *B. amyloliquefaciens* Cattle Intestinal development via GH/IGF-1 pathway *Lactobacillus* spp. Sheep, goat Growth, immune modulation. *Faecalibacterium prausnitzii* Cattle Diarrhea reduction, weight gain.

Probiotics in pigs - *Bacillus subtilis* growth performance, nutrient absorption, intestinal integrity *Enterococcus faecium*: modulation of intestinal microbiota, immunity *Lactobacillus* spp. Pathogen incubation, prevention of diarrhea The European Union banned the use of antibiotics as growth promoters from January 1, 2006 (Regulation (EC) No. 1831/2003). This situation has dramatically increased interest in probiotics.

Conclusion

Nanotechnology and probiotics are emerging as important innovative technologies in veterinary pharmaceuticals. Nanoparticles are opening up new opportunities in targeted drug delivery, vaccine efficacy, and diagnostics, Probiotics, as a safe alternative to antibiotics, are playing an important role in maintaining animal health and increasing productivity. Further scientific research, safety assessment, and regulatory systems are needed for the widespread implementation of these technologies, The integration of nanotechnology and probiotics is expected to offer more effective and safe solutions for the future of veterinary pharmaceuticals.

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