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Project title:

Applications of Nanotechnology In veterinary Medicine

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By:

Mustafa Kazem Mohsen

Under Supervision of:

Assistant Professor Dr. Hassan Khalaf Al-Karagoly

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

فَتَعَٰلَى ٱللَّهُ ٱلْمَلِكُ ٱلْحَقُّ ۗ وَلَا تَعْجَلْ بِٱلْقُرْءَانِ مِن قَبْلِ أَن يُقْضَىٰٓ إِلَيْكَ وَحْيُهُۥ ۖ وَقُل رَّبِّ زِدْنِى عِلْمًا ﴿١١٤﴾

صَدَقَ اللهُ العَظِيمُ

من سورة طه

Certificate of Supervisor

I certify that the project entitled (**Applications of Nanotechnology In veterinary Medicine**) was prepared by **Mustafa Kazem Mohsen-** under my supervision at the College of Veterinary Medicine / the University of Al-Qadissiya.

Supervisor

Assistant Professor Dr. Hassan Khalaf Al-Karagoly

Dept. of **Internal Medicine**

Coll. Of Vet.Med./ Univ. of Al-Qadissiya.

16/ 05/ 2021

Certificate of Department

We certify that **Mustafa Kazem Mohsen** has finished his/her Graduation Project entitled (**Applications of Nanotechnology In veterinary Medicine)** and candidate it for debating.

Instructor

Dr. Saa'd Hashem

-- / -- / 2021

Head of Dept of Int. and Prev. Med.

Dr. Dr. Saa'd Hashem

-- / -- / 2021

Dedication

I dedicate my humble effort to my beautiful family, and all who supported me during my studies and made me proud of my profession.

Acknoldgements

Acknowledgment First and foremost, I would like to thank and praise Almighty God for enlightening my path and guiding me through every success I achieve or may attain. I would like to express my sincere gratitude to my supervisor Dr. Hassan Khalaf Ulaiwi Al-Karagoly for his continuous support. Bachelor's degree study and research for her patience, motivation, enthusiasm and tremendous knowledge. Helped me guide him all the time researching and writing this thesis. I could not have imagined a better supervisor and mentor for my bachelors degree studies. Thank you ..., Last but not least, thank you, my father, my mother and the rest of my family for giving me the strength to reach the stars and chase my dreams, which had it not been for their support and help, I would not have been able to complete my studies and research in the bachelor's degree.

Abstract:

The development of modern methods for manipulating materials at the nanoscale has influenced medical research in several ways. There are currently thousands of nanomaterials classified based on their structure, origin, or use. Nanotechnology offered fresh approaches to old issues. They are used in medical research for diagnostic and medicinal purposes. They can be used to make nano vaccines and nanoadjuvants, among other things. Their use of cancer research and gene therapy ushered in a modern age in medicine. Various nanotechnology applications have recently begun to make their way into the veterinary sector. They're making inroads into animal therapeutics, diagnostics, veterinary vaccine manufacturing, farm disinfectants, animal farming and reproduction, and even animal feeding. Their substitution of widely used antibiotics has a significant impact on public health. They reduce drug tolerance in both human and veterinary medicine and drug residues in milk and meat.

Furthermore, by reducing the volume of wasted milk and the quantity of culled calves in dairy herds, they have a significant economic effect. Nanotechnology has also been used to create pet care supplies and sanitary items. The advantages of utilizing nanomaterials over their equivalents, the different groups of nanoparticles, and the applications and importance of nanotechnology in veterinary medicine are discussed in this study.

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Chapter I

Introduction

1. Introduction:

Nanotechnology is an increasingly growing discipline established in 1974 to assemble novel materials with a size range of 1 to 100 nm. The term nano refers to a tiny scale (1nm equals 109 m) and is in origin derived from the nanus “ a Latin word,” which means "predominate"(Ochekpe et al., 2009, Pollution, 2008). Nanotechnology is another form of innovation with applications in several fields, including science and agriculture. Additionally, nanomaterials can influence biomedical applications and research conducted in vivo and in vitro (Cardoso et al., 2018, Kalpana and Devi Rajeswari, 2018).

Due to their massive surface-to-volume ratio, increased reactivity, durability, bioactivity, bioavailability, regulated particle size, managed drug release, site-specific targeting, and controlled arrival of drugs, nanoparticles exhibit novel physicochemical properties that are superior to those of bulk materials (Zaidi et al., 2017, Narayan et al., 2018). Additionally, nanotechnology has tremendous potential for drug delivery because it can infiltrate cells, tissues, and organs more efficiently than macroparticles, overcoming the poor bioavailability and toxicity of conventional pharmaceutics (Patra et al., 2018, Bhatia, 2016). Medications may be incorporated into or applied to the surface of nanoparticles. Additionally, nanomedicines are described as using various nanotechnology-based apparatuses to accelerate and expand responses to science problems or infection control

(Vahedifard and Chakravarthy, 2021, Hamdan et al., 2017). It is beneficial for addressing the obstacles inherent in conventional medicine and comprehending different physiological and obsessive strategies. The economies of the majority of countries are mainly reliant on livestock (Chau et al., 2007). Even though numerous illnesses are on the rise, modern predictive and beneficial innovations are constantly being built to diagnose and treat animal diseases with the ultimate goal of increasing protein availability for human nourishment (Swain et al., 2016).

Nanotechnology has immense potential for optimizing drug delivery in veterinary medicine (Num and Useh, 2013). The obsession with freshly synthesized atoms would create new effective medical therapies for curing illnesses, shielding creatures from virus or bacterial infections, and promoting wound healing. Additionally, these novel combinations can facilitate the delivery of drugs into cells for successful disease treatment (Bhatia, 2016).

Nano-theranostics is a form of therapy that incorporates drugs and diagnostics to measure treatment reactions and maximize drug efficacy and safety. Additionally, they offer an excellent ability to devise and refine those combination agents, allowing both clinical distribution and identification before and during the therapy regimen (Zhao et al., 2018). Nanopharmaceuticals are among the most exciting and beneficial uses of nanotechnology in veterinary medicine (Zhao et al., 2018).

1.1. Aims of the current report1

1. Drawing awareness to nanotechnology and its significance.
2. Focusing attention on nanotechnology's uses in veterinary medicine.

CHAPTER II-

NANOTECHNOLOGY-

REVIEW OF LITERATURE

2. Nanotechnology:

2.1. Classification of nanoparticles:

Nanoparticles are classified according to their origin, shape, structure, and intended use (Modena et al., 2019).

2.1.1. Based on its structure and its application in veterinary medicine:

1) ***Polymeric nanoparticles:***

Two polymers exist at the beginning of the process: polymers made, for example, polyethylene glycol (PGP), polymers marked with polysaccharides, inulin, and chitosan, whose constructions rely on the polymers. Dendrimers are identical in form, but the radiation from the middle of the branches is in different degrees. This nanoparticle structure is widely used as Newcastle in antibody preparation (Chan et al., 2010)

2) Liposomes:

PEGylated particles are spherical, biodegradable, non-destructive particles often disperse to include non-water dissolving remedies through a two-fold coating of the phospholipid cap covered different antigens. The outer surface protects the component from attack by the body is coated by polyethylene glycol film (Jiang et al., 2011).

Furthermore, fatty anticorps can be fitted on its exterior surface with chelated antigens. The ability for this kind of nanoparticles to carry on water-resolvable and non-water-resolvable treatments is generally illustrated (Malam et al., 2009). The different liposomes are very effective, water-soluble and water-insoluble, are very effective. Because of their biodegradable structure, they are seen by high prosperity. Another type of liposome is immunoliposomes conjugated to the outer layer of antigens for immunizations and connected antibodies (Gao et al., 2019). Finally, liposomes are very useful in drug distribution since they are found to be strongly biologically degradable. They often have a high ability to stack the water-soluble and insoluble simultaneously. It can be made accessible through diffusion to release the drugs loaded. In either event, their real obstacle lies in the low breadth of the laden drugs, their short combination, and their rapid arrival (Gurunathan et al., 2020).

3) Fullerenes and Bucky tubes:

Carbon fullerenes are nano-sized balls that enable pathogens and cells to have a face-to-to-face conversation. The tubes are half-sphere and half-cylinders. They can be used as biosensors for the detection of particular elements or immunological tools. Also, due to their hypodermicthyroid needle-like structure, they are highly able to reach cells, particularly for treatment of the disease (Omacrsawa, 2012).

4) Microbivores and respirocytes:

Independents carry red cells and white cells (red and white) instead of the quasispecies of red cells and lymphocytes. S when in a well-controlled way, they make use of O2 while discarding the accumulated CO2. Initially, the enzymes transformed the cleared out the nonnative microbes to form, based on nucleotides, unsaturated fats, and amino acids (Surendiran et al., 2009).

5) Nanoshells:

Circular in form, attached to the outer gold sheet, and used to examine malignant tumors using infrared laser irradiation. Because nanoshells are biocompatible, non-cytotoxic, and reduce the X-force beams can be used as an adjuvant in radiotherapy (Li et al., 2015).

6) Quantum dots:

Microscopic molecules (2 to 10 nm); exhibit semiconductivity when subjected to light allows them to be used in optoelectronic applications (Sattler, 2016). Cadmium, selenium, and zinc serve as the structural elements for semiconductor components. Made of an inorganic core and an organic shell, a fluid coating can be conjugated to various biomolecules. The center contains a diamond. The scale of the precious stone determines the color of the emitted light. They can design modest and straightforward, long-lasting tests that illuminate over an extended period of days. Quantum dots have a wide range of applications in diagnostics and immunodiagnostics (Afsharipour et al., 2020).

7) Solid lipid nanoparticles:

Lipids have a lipophilic nucleus, which enables them to be used to treat tumors. Their outer hydrophilic shell is conjugated to different hydrophilic drugs or antibodies. Additionally, the exterior membrane enhances the medication's bioavailability. Further, cationic solid lipid nanoparticles may legitimately connect nucleic acid segments by electrostatic linkage, enabling their use for high-quality therapies (Paliwal et al., 2020). This form of nanoparticles may be administered by topical, oral, or subcutaneous injection. They can successfully distribute drugs into the central nervous system by crossing the blood-brain barrier (Paliwal et al., 2020, Dudhipala, 2020)

8) Magnetic iron oxide nanoparticles:

Defined primarily by an external magnetic field that guided nanoparticles to their target cells by the bloodstream. Suited for imaging, heating, and medication distribution (Zhao et al., 2020). Their construction consists of an iron center enclosed by a fluorescent silica film on the outside that facilitates drug binding. An exterior layer made of rubber aids in particle modification. Due to their desirable, appropriate connections in various medicinal causes for disease diagnosis and treatment as multi-purpose theranostic structures. Polyethylene-glycol(PEglycol) is used to coat the particles to prevent them from aggregating and shield them from the immune reaction. By increasing light preservation, silica coats promote malignancy imaging (Israel et al., 2020).

9) Dendrimer:

They are highly soluble hyperbranched nanomaterials made from polymers that are incredibly thin and smaller than the body's cells. As injected into the flow, their limited size and concoction structure keep them strategically away from inducing undesired resistant reactions (Scott et al., 2005). They have an expanded dimension that looks like a three-dimensional tree. Medications on the surface of the dendrimer may be linked together. Various water-soluble and water-insoluble restorative compounds can be packed into dendrimers by physical and chemical linkage; moreover, these drugs may be filled into the empty centers via

nonbonding packing. Covalent conjugation of stacked drugs and dendrimers can increase the solidity and therapeutic productivity. They play a critical role in cancer care. Their massive branching describes dendrimers, and complex structure may be added to medications used for imaging (Carvalho et al., 2020). Numerous experiments have shown that dendrimer-containing nanocomposites are extremely successful antimicrobial agents against Pseudomonas aeruginosa, E. coli, and Staphylococcus aureus. Inside the tumor, movement is accomplished by the landing of their medication or nuclear compound supply. Finally, in a suitable procedure, messages are transmitted as unhealthy cells are eliminated (Kambhampati and Kannan, 2013).

10) Nanoemulsion

As bactericidal and virucidal agents, nanoemulsions have beneficial restorative effects. The oil drops bind to the envelope/layer and combine as they come into contact with a bacterial or viral coat due to the animal's surface tension, allowing the medication to reach the microbial cells. Additionally, nanoemulsions may be used as a medium for antigen transmission. Numerous antigens may be mixed in a single nanoparticle (Bhatt and Madhav, 2011). They are oily drops of nano-size trapped in water and covered with a thin surfactant cap to alter their physical properties. Oil in water and water in oil emulsions represent the types of nanoemulsions. The optimal storage temperature for nanoemulsions expressed

through low-essence methodologies is four degrees Celsius and room temperature, with a capacity period of more than two months (Mohammed et al., 2020). Due to the consistency in which the antigens are released, the water/oil nanoparticle emulsions function as adjuvants, enhancing the arrival of antibodies at high titers. A few analysts have noted the effects of fat loss on red blood cells and sperm cells. Numerous audits concluded that nanoemulsions are healthy to use on eukaryotic cells without causing any toxicity (Krishnamoorthy et al., 2018).

11) Nanobubbles

They remain stable at room temperature, but when ultrasonic waves slightly warm them. They are most frequently applied to the distribution of chemotherapeutic agents, particularly to cancer tissues. Liposomal nanoparticle suspensions may be used for gene therapy (Alheshibri et al., 2016).

12) **Aluminosilicate nanoparticles**

Short-chain polyphosphate is mixed with silica nanoparticles to accelerate the natural clotting mechanism, which reduces bleeding [38].

13) Polymeric micelles:

They contain a hydrophobic center that aids in the transportation of hydrophobic drugs. They are highly water-soluble due to the hydrophobic backbone being covered with a water-soluble coat. In addition, amphiphilic

polymers such as caprolactone or PLGA have been developed. Generally used for targeted medication delivery, fewer water-soluble products, such as paclitaxel and amphotericin B, are supplied (Miller et al., 2013).

14) PolymeriNanospheresese:

They facilitate the organization of a macrophage-dependent solid nanosuspension delivery system for HIV infection and sequestration by inhibiting aggregation (Zheng et al., 2005). Biodegradable or non-biodegradable polymers were used to create round uniform structures with less than a micron diameter. Type 2 human epidermal advancement factor receptor and in-vitro integrin cancer cell growth can be studied using transdermal drug delivery technologies (Liao et al., 2010).

15) Metallic nanoparticles:

Some important metals primarily used in cancer treatment are gold and silver. Another form of a metallic nanoparticle is silver, manganese, and a core covered with a protective coating of manganese dioxide. Metallic nanoparticles are attached to multiple antibodies and radionuclides for complexing enhancement of imaging capabilities. Non-specific binding is aided by polyethylene glycol, which keeps non-target edible particles attached to polyethylene glycol. More metallic nanoparticles were used for treatment, particularly bimetallic nanoparticles, including silver/gold and silver–selenium (Thakkar et al., 2010)

2.1.2. According to their origin

Biological, inorganic, and hybrid nanoparticles are the three different kinds of nanoparticles (Hood et al., 2014).

1. Inorganic nanomaterials:

Preliminary studies have shown them to be stable, bioavailable, and less cytotoxic. When configured and mounted, they possess novel electrical and optical properties that the assembly can alter. Inorganic materials, such as gold, silver, and calcium phosphate, are included in this list (Rao et al., 2007).

2. Organic nanomaterials:

3. Proteins and peptide nanoparticles

Due to their low toxicity, biodegradability, and biosimilarity, these polymers are typically used in more sophisticated applications (e.g., high-quality bioproducts, such as gelatin). Differential reinforcement is possible, like cooperation with several payloads (Shemetov et al., 2012). Type A gelling is acid-extracted, whereas type B is base-separated and has a variable isoelectric point Heritable genetic content may be stigmas co-stored with available operands in egg white-based NPs (Wei et al., 2017).

4. Hybrid nanoparticles

They create a polymer-lipid hybrid framework by combining various nanoparticles, such as polymeric nanoparticles and liposomes. The resulting compound has a backbone of biodegradable hydrophobic polymers lined with hydrophilic drugs, allowing for simultaneous drug release. The amount of water that enters and the amount of drug emitted from the nanoparticles is controlled by the lipid layer (Sailor and Park, 2012).

2.1.3. According to Shape

The purpose classifies them as intended (therapeutic, diagnostic, vaccination distribution, or nutritional) (Calvaresi, 2020).

2.1.4. Miscellaneous classification

1. Immunostimulatory edifices: there are saponin adjuvant particles with a supramolecular structure. Their primary function is to absorb various viral antigens by forming a hydrophobic relationship to viral wrap proteins (Muluh et al., 2021).

2. Virus-like particles: Particles ranging in size from 20 nm to 800 nm that self-assemble. They will reactivate heavy insusceptible reactions in this manner without needing contamination since they lack nucleic corrosive (Zeltins, 2013).

3. They advocate for the usage of quaternary protein complexes in human and animal vaccines (López-Sagaseta et al., 2016).

Chapter III

PREPARATION AND CHARACTERIZATION OF NANOPARTICLES

3. Preparation and Characterization of Nanoparticles:

3.1. Nanoparticles may be prepared in a variety of ways:

3.1.1. Method of Emulsion-Solvent Evaporation:

It is divided into two stages. This procedure is further changed to provide high-pressure emulsification and another technique called solvent evaporation (G Nava-Arzaluz et al., 2012).

3.1.2. Technique of Twofold Emulsion and Dissipation:

By combining organic polymer solutions with hydrophilic drug solutions and vigorously shaking to create water/oil emulsions, the process encapsulates water-soluble drugs (Martins et al., 2018).

3.1.3. Salting Out Method:

A salting-out effect is used to remove a water-miscible solvent from a liquid solution (Galindo-Rodriguez et al., 2004).

3.1.4. Emulsions-Diffusion Method:

It is accomplished by partially dissolving the polymer in a water-miscible solution and then immersing it in water. In the long term, the emulsion formed an aqueous arrangement comprising a stabilizer, resulting in dissolvable diffusion to the outdoor stage and the formation of nanospheres or nanocapsules. The disadvantages include the massive amounts of water that must be disposed of, which slows down exemplification implementation (Tiruwa, 2016).

3.1.5. Precipitation/ Displacement-Solvent Method:

Precipitation of a preformed polymer from a fixed structure and dispersion of normally soluble material in a fluid medium without using a surfactant. Medicines like CH3)2CO or ethanol are dissolved in semi-polar water. This method is suitable for inefficient pills until dissolved (Hernández-Giottonini et al., 2020).

3.2. Numerous techniques for characterization of nanoparticles

3.2.1. Nanoparticles Size:

The particle size affects the drug dispersion. The surface size of small objects is greater. The drug stacked limit may be exposed to the molecule surface as a final product to accelerate medication discharge (Haiss et al., 2007).

3.2.1.1.Determining nanoparticle size:

3.2.1.1.1. Scanning Electron Microscope(SEM):

The scanning Electron microscope is constrained data on the dispersion of the actual population and its normal distribution. This approach is time-consuming, expensive, and often needs mutual insights into distribution estimation (Medetalibeyoğlu et al., 2018).

3.2.1.1.2. Transmission Electron Microscope(TEM):

TEM is primarily used to verify the morphology of nanoparticles after they have been processed (Zhu et al., 2018).

3.2.1.1.3- Atomic Force Microscopy(AFM):

Surface topography and roughness profiles of nanoparticles are determined using 2D and 3D AFM photographs (Takechi-Haraya et al., 2018).

3.2.1.1.4. Zeta potential(ZP):

The ZP is used to determine the scale and the surface load of nanoparticles (Parizad et al., 2018).

3.2.1.1.5. Surface Hydrophobicity(SH)

The size of prepared nanoparticles was determined using various methods, including hydrophobic interaction chromatography, biphasic partitioning, and probe adsorption (Valsesia et al., 2018).

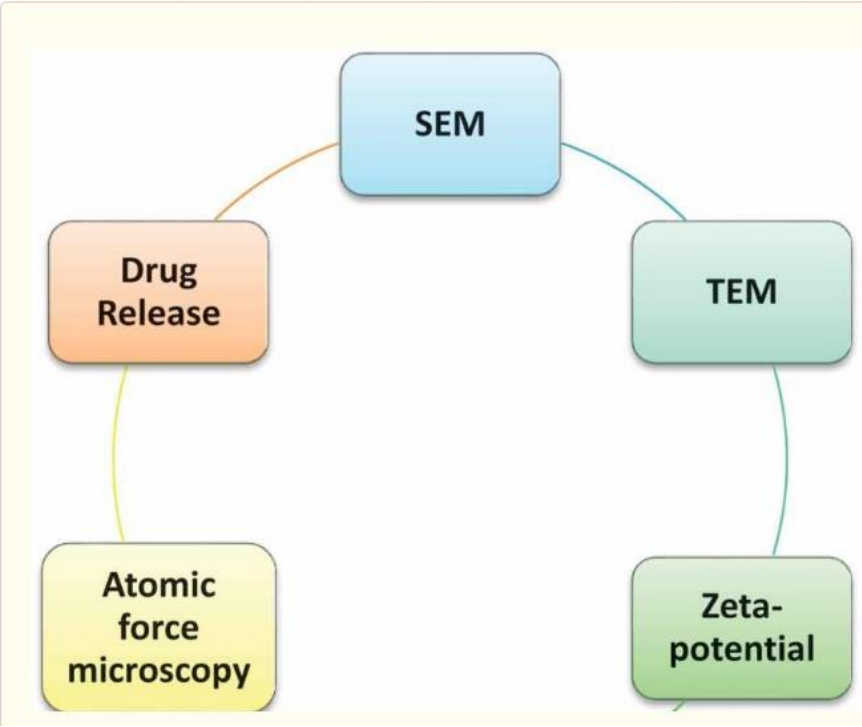

Figure 3.1. Different tools for nanoparticle size determination (Lundqvist et al., 2008).

CHAPTER IV

NANOTECHNOLOGY APPLICATION

4. Nanotechnology Application:

Nanotechnology is hailed as a game-changing approach to various problems, including animal health and production (Figure 4.1).

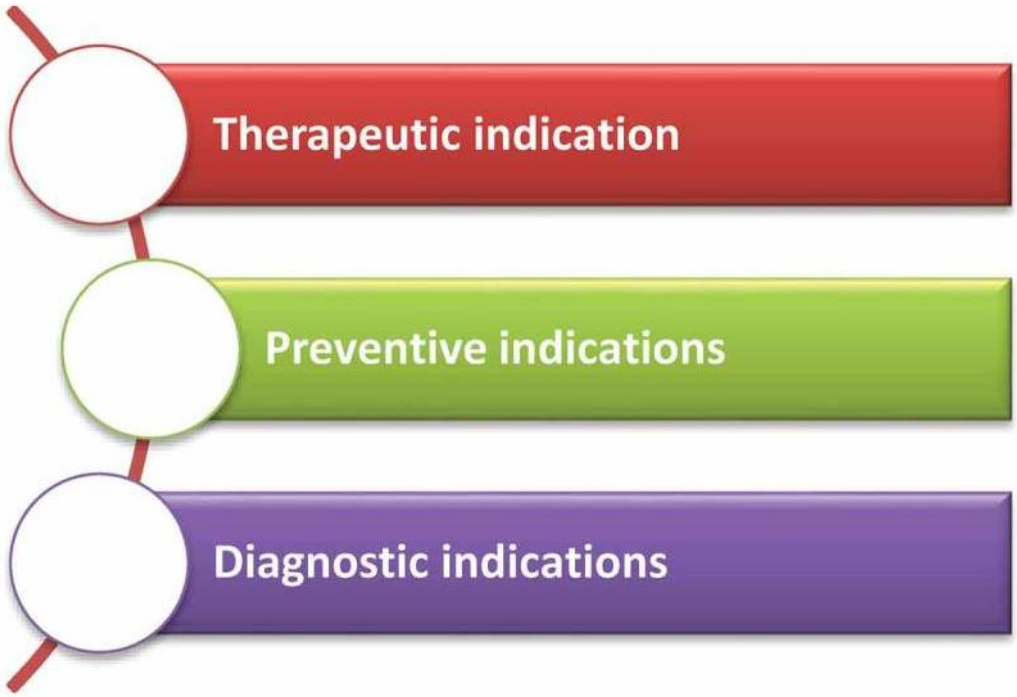

Figure 4.1. Variety uses of nanotechnology in veterinary medicine (Bai et al., 2018).

4.1. Potential Uses of Nanotechnology in Medical Research

4.1.1. Therapeutic purposes:

The physical/chemical characteristics of nanoparticles (NPs) during the fabrication process following the intended application, resulting in an endless variety of releases. As a result, personalization of the healing and diagnostic definition is allowed (Kamaly et al., 2016). It allows meanings to be assembled in a solitary context containing every supportive and demonstrative operator. Due to the high ratio of surface area and extent, their usage allows for large payloads (Lim et al., 2018). Their resiliency describes NPs under extreme conditions of weight and temperature. Owing to their limited scale, they can pass the blood-brain barrier; additionally, they can easily enter their target sites of operation and prevent identification and removal. NPs will quickly become consolidated with the organism's normal configuration, eliciting heinous immunological responses. Allows for administering a variety of preparations through capsules injected with local usefulness (Varoufakis, 2015).

Permit continuous monitoring of treatment/diagnosis. NPs are prepared to exercise authority over drug dispensing. NPs successfully and precisely target neurotic sores and accumulate inside them, resulting in more proficient therapy, increased drug bioavailability, and a decrease in the required treatment part, both of which

have a financial impact. Sustain the release of various hormones, antibiotics, antioxidants (Nagaich et al., 2016). Allow eradicating intracellular pathogens like brucella and leishmaniasis and multidrug-resistant pathogens like MRSA. Cancer cells may be eliminated using NPs by transporting chemotherapeutic chemicals, warming the cells, and explicitly immunologically ambushing the cells. The use of tumor-coated nanoparticles allows for eradicating metastatic malignant growth cells that have spread far from the original site of injury (Nathwani et al., 2009). Several materials, such as polymers, lipids, and metals, may be used; they often contain a variety of diverse elements, such as chemotherapeutics and tranquilizing medications, Specific imagery and discovery authorities, nucleic acids, and proteins, as well as antimicrobial additives. Nanostructured antimicrobials may be used to treat various microbe infections, including tuberculosis (Nathwani et al., 2009). Nanocarriers are considered an essential component of nanomedicine, as shown by many studies showing their effectiveness in treating many diseases using traditional pharmacological concepts. As exemplified by the nanoparticle, the development of chemotherapeutic operators is proving to be more effective in treating chronic conditions with far fewer toxicity and cell blocking than traditional chemotherapy specialists. The effectiveness of nanoparticles in controlling tumor growth with reduced toxicity was demonstrated by the formulation of doxorubicin and paclitaxel active against most cancer-resistant cell lines (Kim et al., 2010).

4.1.2. Preventive indications:

Provides new directions for the advancement of new antibodies by highly stable adjuvants. Numerous preliminary studies resulted in the creation of remote sensors implanted under patients' skin to monitor the number of specific target proteins (Ai et al., 2021).

4.1.3. Diagnostic indications:

By combining nanoparticles with tumor-specific antibodies, it is possible to predict the prognosis of most cancers early, based on increased longevity ratings for metastatic accidents and control of the whole case. As imaging technicians, the substance may be used continuously without risking liver or kidney damage, and it has been operating for a long time. Nanorobotics may be used in investigative and repair operations on a miniature scale. Additionally, they can transport nanocameras for continuous assist surgeries (Baetke et al., 2015). It possesses an incredibly rapid scanning and diagnostic capability. Owing to the usage of high-density nanoarray chips, they can identify an extensive range of genes and proteins (Anselmo and Mitragotri, 2016)

4.2. Nanotechnology in veterinary medicine and Science

In fields such as therapeutics, diagnostics, tissue engineering, vaccine manufacturing, and disinfectants, nanotechnology has a significant effect on veterinary prescribing. Animal wellbeing, rearing, proliferation, and sustenance are both being aided by nanotechnology. Since the treatment is delivered directly to the target cells, it may be provided in small amounts, reducing opioid retention and withdrawal times in farm animals (Bai et al., 2018).

4.2.1. Potential uses in animal production

Several future nanotechnology applications in animal agriculture involve a drug, vitamin, probiotics, and dietary supplement executives and identify and eliminate infectious agents without surgery utilizing nanoparticles. However, routine antibiotic usage in animal manufacturing will leave a trace that will affect the final customer, even though nanotechnology narrows the antibiotic range open, confirmed by Fattal et al. (Fattal et al., 1989). They investigated the impact of ampicillin loaded onto nanoparticles on Salmonella typhimurium-infected mice. The findings showed that mice treated with ampicillin and nanoparticles had a comparable survival ratio to those in the control group, except that the control group needed 40 times the amount of antibiotics to produce the same outcome (Singh et al., 2020). Animal production must take advantage of this period by

using nano-fertilizers that provide vitamins to particular locations inside forages in the required quantities, which can be accomplished using magnets' valuable resource (Singh et al., 2020). Similarly, nanomaterials combined with hydrogels or zeolites may increase the consistency of drinking water by absorbing poisonous compounds (Servatan et al., 2020).

4.2.2. Animal Health and Nutrition

Nano minerals are cheap, can be used in small amounts, and serve as growth promoters and immune stimulators, providing several benefits for animal feed development (Manuja et al., 2012). Similarly, they may aid in manipulating feed pathogens and enhancing the rumen fermentation method. Nano zinc oxide is a promising Nano mineral used to increase growth rate, immune response and treat diseases affecting livestock reproduction. Nano zinc should be used to prevent more diarrhea in young piglets. Nano zinc reduces the number of somatic cells in subclinical mastitis-affected dairy cows (Patil et al., 2009).

Microencapsulation of feed ingredients protects them from oxidation and degradation caused by light and oxidation; it also protects them from lysis by digestive system enzymes such as proteases; it also improves the consistency of lipophilic additives at a range of pH values, resulting in improved dispersion and mixing, thus extending their operation. Mycotoxicosis is a significant issue that

affects both livestock and humans. They have been found in about 25% of animal feed (Tatli Seven et al., 2018).

4.2.3. Breeding and Reproduction:

Numerous nanotechnology applications are used to diagnose and manage fertility conditions, such as oestrus identification, sperm freezing, and direct calving intervention (Patil et al., 2009). Additionally, nanotechnology may be used to treat a variety of fertility issues, such as preserved placenta. Further, nanoparticles contribute significantly to protecting and maintaining sexual hormones such as steroid hormones and gonadotropic hormones (El-Sayed and Kamel, 2020).

Nanotubes are one of the most advanced and powerful devices in creature production. Because of the high expense of rearing and spreading a nanotube, modifications of the organized estradiol of the blood may be precisely inserted under the skin (Woldeamanuel et al., 2021). Nanotubes can be used to detect oestrus in animals due to their ability to attach to the oestradiol antibody during oestrus through fluorescence or infrared. Additionally, microfluidics has facilitated in vitro fertilization processes in the modern era. Based on the toxicity of specific metallic nanoparticles, including cadmium, sterilization nanoparticles may be used as contraceptives in animals (Woldeamanuel et al., 2021).

4.2.4. Veterinary Therapeutics

Nanotechnology is expected to play a significant role in veterinary therapeutics in the future (Meena et al., 2018). A case in point is the efficacy of mixture nanocarrier-mediated therapy in treating diseases involving animals that provide food for human consumption. According to recent studies, quantum dots (QD) can be used for Vivo imaging in small animals (Meena et al., 2018). Additionally, nanotechnology is being used to handle trypanosomes, shown by the enhanced distribution of diminazene (DMZ) to the site of operation. The porous cationic nanoparticles used advanced the ability for trypanosomes to be targeted. Health parameters were evaluated following nanoparticle therapy and showed a partial decrease in allergic conditions (Şenel, 2020).

4.2.5. Nano vaccines and Nano Adjuvants

Due to their potential to enhance immunological responses, nanoparticles are increasingly being used in veterinary vaccine development. Additionally, they can function as an adjuvant, slowing the release of antigens, which improves vaccine performance. The use of nanoparticles to load antigens improves vaccine performance by targeting lymph nodes (Oyewumi et al., 2010).

4.2.5.1. Examples explain the various types of nano vaccines used in veterinary medicine

A. Recombinant Bacillus anthracis spore-based vaccine and influenza vaccine are two examples of nanoemulsion vaccines (Youssef et al., 2019).

B. After oral administration of vaccines loaded on PLGA nanoparticles, they develop Immunoglobulin type G and Immunoglobulin type A immune responses. These vaccinations include those against Helicobacter pylori, Tetanus toxoid, Bordetella pertussis, and Bovine parainfluenza type III (Sarti et al., 2011).

C. The recombinant Leishmania SOD vaccine is an example of a vaccine loaded on chitosan nanoparticles and administered subcutaneously. Additionally, the tuberculosis vaccine loaded on chitosan is administered through the respiratory tract. Additionally, the pneumococcal antigen a vaccine and *Streptococci Equi* vaccine are loaded on chitosan and administered intranasally. A vaccine made of gold nanoparticles is issued to protect against foot and mouth disease (Youssef et al., 2019).

D. Vaccinations against the virus's empty capsid and center-like particles harm horses and are referred to as African horse sickness (Youssef et al., 2019)

4.2.6. Pet Animal Care

Nanotechnology was often used in pet animal treatment to develop novel products. Due to their physicochemical properties, they are used to increase the performance of surface fresheners and disinfectants. For instance, silver nanoparticles are incorporated into topical shampoos (Devaraj et al., 2009).

4.2.7. Drug delivery systems

In pharmacology, nanoparticles are an ideal drug delivery mechanism for protecting animals from viruses or bacterial diseases, enhancing wound healing, and relieving discomfort (Wilczewska et al., 2012). Additionally, these novel substances facilitate the delivery of medicines to specific tissues and organs. These frameworks may affect the rate of assimilation, appropriation, digestion, and discharge of medications or other substances throughout the body, allowing for the observation of drug dynamics, ensuring bioavailability and stability, extending the duration of movement, reducing the frequency of doses required to maintain therapeutic responses, and reducing toxin production (Suri et al., 2007).

4.3. Current limitation and safety of nanoparticles

While most nanoparticles are healthy, others can have adverse effects, such as prolonged pulmonary exposure to carbon nanotubes may cause reproductive issues in pharmaceutical industry employees (Hofmann-Amtenbrink et al., 2015). Also, the formation of enticing nanoparticles formed from iron oxide inside the edge, or by damages, is accelerated due to a broken authoritarian relationship between the drug and the particles, which can deliver the medication into firm tissues rather than objective tissues. The direction's incomplete arrival away from the target tissue or organ would now result in toxicity to healthy tissue and the delivery of dosages at a subtherapeutic stage to the target portion (Singh et al., 2018). Their capacity to cross multiple organic barriers inside the shell, such as the blood-brain firewall, commits any mistake with exceptional consequences, equally distributed globally, such as the growing need for radionuclides. Additionally, carbon nanofibers are involved in the biological system's ozone layer depletion (Hasan et al., 2018).

CHAPTER V

CONCLUSIONS

5. Conclusions:

We addressed the use of nanosystems in antimicrobial drug supply in veterinary medicine, with a particular focus on silver and chitosan and the different forms and other methods for their preparation and characterization. Our willing study would be proposed to boost the efficacy of selected antibiotics against pathogenic bacteria, overcome antibiotic resistance, decrease antibiotic toxicity, and increase antibiotic bioavailability. The suggested technique is to prepare antibiotic-loaded chitosan and silver nanoparticles, classify them using the following methods (XRD, Raman, FTIR, AFM, TEM, SEM, zeta seize, and potential), and perform in-vitro experiments comparing the tested medication and the prepared nanoparticles to a standard, susceptible, and resistant strain of microorganism (sensitivity and MIC). Based on the findings of the in-vitro trials, we can perform in-vivo tests. These may provide comparative effectiveness trials of the studied medications and nanoparticles in infectious animals such as rabbits infected with Pasteurella, E. coli inflammation in mice, and an untreated wound in a mouse, comparative pharmacokinetics relative protection, and toxicity assessments of the

studied medications and nanoparticles. It is well established that the studied nano-drug has anti-inflammatory properties when combined with chitosan.

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الملخص:

لقد أثر تطوير الأساليب الحديثة لمعالجة المواد على المقياس النانوي على البحث الطبي بعدة طرق. يوجد حاليًا الآلاف من المواد النانوية المصنفة بناءً على هيكلها أو أصلها أو استخدامها. قدمت تقنية النانو مناهج جديدة للقضايا القديمة. يتم استخدام تقنية النانو في البحوث الطبية للأغراض التشخيصية والطبية. كما يمكن استخدامها لصنع لقاحات نانوية ومواد مساعدة نانوية ، من بين أشياء أخرى كثيرة. أدى استخدام تقنية النانو لأبحاث السرطان والعلاج الجيني إلى دخول عصر حديث في الطب. بدأت تطبيقات النانو المختلفة في الآونة الأخيرة في شق طريقها إلى القطاع البيطري. حيث استخدمت في العلاجات الحيوانية ، والتشخيص ، وتصنيع اللقاحات البيطرية ، ومطهرات المزارع ، وفي قطاع تربية الحيوانات والتكاثر ، وحتى تغذية الحيوانات. إن استبدال تقنية النانو بالمضادات الحيوية المستخدمة على نطاق واسع له تأثير كبير على الصحة العامة. حيث ان تقنية النانو تقلل من تحمل الأدوية في كل من الطب البشري والبيطري ومخلفات الأدوية في الحليب واللحوم.

علاوة على ذلك ، فان لها تاثير اقتصادي كبير جداً من خلال تقليل حجم الحليب المهدر وكمية العجول المنبوذه في قطعان الألبان. تم استخدام تقنية النانو أيضًا لإنشاء مستلزمات رعاية الحيوانات الأليفة والأدوات الصحية. تناقش هذه الدراسة مزايا استخدام المواد النانوية، والمجموعات المختلفة للجسيمات النانوية ، وتطبيقاتها وأهمية تكنولوجيا النانو في الطب البيطري.

جمهورية العراق
وزارة التعليم العالي و البحث العلمي
جامعة القادسية
كلية الطب البيطري

عنوان المشروع:

تطبيقات تقنية النانو في الطب البيطري

مشروع تخرج مقدم لكلية الطب البيطري / جامعة القادسية استيفاءً جزئياً لمتطلبات بكالوريوس العلوم في الطب البيطري والجراحة.

اعداد:

مصطاف كاظم محسن

تحت إشراف:

الأستاذ المساعد الدكتور حسن خلف عليوي القرغولي