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Livestock Vaccines: How They Work and How to Ensure They Do Their Job

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Vaccines are suspensions of microorganisms administered with the goal of stimulating the body's immune system against these same organisms, thereby preventing a clinical disease or reducing its severity. The agents included in vaccines are inactivated or modified such that, once introduced into the body, they do not cause clinical illness.

VACCINE TYPES

Inactivated ("killed") vaccines contain bacteria or viruses that have been inactivated by heat or chemicals. Whichever method is used needs to completely render the microbe incapable of growing and reproducing, while maintaining the microbe's structure enough to be recognized by the body.

Because inactivated organisms do not multiply inside the body, substances called **adjuvants** are included in such vaccine suspensions. Adjuvants are compounds (such as aluminum salts or oil-in-water emulsions) that non-specifically stimulate the immune system to respond to—and slow down the body's elimination of—the injected inactivated microbes.

Subunit vaccines, which contain only parts of the bacteria or virus of interest, and **toxoids**, vaccines created from inactivated toxins released from certain disease-causing bacteria, are also examples of inactivated vaccines. **Antitoxins**, preparations of antibodies against bacterial toxins, are not technically vaccines: they passively tie up toxins instead of actively stimulating an immune response, as is the case with

toxoids. However, like most components of vaccines, antitoxins are protein molecules, and the issues regarding handling and care of those products are the same as for vaccines.

Modified-live virus (MLV) vaccines contain whole viruses that have been altered such that, while they are able to multiply within the body, their ability to cause disease has been taken away. Vaccine manufacturers typically achieve this by making the microbe grow under prolonged or slightly abnormal growing conditions. Because the modified microbes actively grow within the host—stimulating the immune system in the process—fewer of them are needed in a vaccine dose compared to inactivated vaccines. MLV vaccines are typically packaged in two vials—one containing a freeze-dried cake that contains the modified microbes, and the other containing the diluent, which re-suspends the microbes.

HOW VACCINES WORK: DIFFERENCES BETWEEN INACTIVATED AND MLV

The goal of vaccines is to produce "immunity" against specific organisms. There are two major branches of the immune system: 1) **humoral immunity** refers to stimulating the production of antibodies against the microbes in the vaccine, and 2) **cell-mediated immunity** directs the cells of the immune system to neutralize the invading microbes or destroy the cells the microbes have infected. Each type of vaccine stimulates these branches in slightly different manners.

Inactivated vaccines depend on cells within the body called *antigen-presenting cells* to process the material in the vaccine. These cells are normally found in high numbers in skin, muscle, and subcutaneous tissue, especially in the presence of the inflammation that normally follows injections. Antigen-presenting cells carry important parts of the inactivated microbes between the injection site and areas that are active in creating the immune response, such as the lymph nodes. With inactivated vaccines, this important interaction is aided by the adjuvant, along with the relatively high number of inactivated organisms present in the dose of vaccine. These vaccines are especially good at stimulating humoral immunity.

MLV vaccines depend on their ability to infect living cells within the body, in addition to interacting with antigen-presenting cells, to activate the immune system. Significantly fewer organisms are needed per dose of vaccine, but these organisms need to be viable in order to adequately stimulate the immune system. If the organisms cannot do this, such as when they are inactivated through improper storage or handling, the immune system will not effectively respond, due to the smaller number of organisms and the lack of adjuvant. The action of modified live vaccines is especially good at stimulating cell-mediated immunity.

HOW VACCINES BECOME WORTHLESS

Proteins are the major components of the organisms that make up both killed and MLV vaccines. Proteins disintegrate according to two major factors: time and temperature.

As time passes, the proteins that make up the vaccine organisms disintegrate into smaller parts. Eventually, given enough time, there will no longer be enough intact organisms to effectively stimulate an immune response. This is especially important for rehydrated modified-live organisms, which rapidly lose their viability over time periods as short as 1-2 hours, depending on environmental conditions.

Effects of age apply to both inactivated and MLV vaccines. Expiration dates are placed on all vaccines and reflect the latest date upon which a dose of vaccine is considered to contain enough intact organisms to effectively stimulate the immune system. All expiration dates assume recommendations for storage and handling have been followed.

Storage temperatures higher than label recommendations will result in a quicker rate of disintegration and will render any vaccine, whether inactivated or MLV, impotent. Reconstituted MLV vaccines are particularly sensitive to rapid inactivation by high temperatures.

At the other extreme, freezing temperatures will also adversely affect vaccines. In the case of certain inactivated vaccines, freezing temperatures result in physical changes to the adjuvants included in the vaccine. These altered adjuvants may cause a reduced immune response or an increase in the number of adverse reactions to the vaccine. The microbes present in rehydrated MLV vaccines are very sensitive to freezing and may be rapidly inactivated by freezing temperatures as well.

Most common disinfectants will render modified-live organisms inactive. Traces of disinfectant left in syringes, tubing, or transfer needles following cleaning will reduce the effectiveness of such vaccines. In addition, ultraviolet light has an adverse effect on the viability of modified-live organisms. Such vaccines should be stored in their original packaging away from light sources prior to use.

HANDLING, STORING AND USING VACCINES: RECOMMENDATIONS

1. Purchasing Vaccines

- Observe expiration dates prior to purchase. Will you use the vaccine before it expires?
- For MLV vaccines: purchase smaller (10-dose) instead of larger (50-dose) vials unless you're sure you will use the whole bottle in a short period of time.
- Purchase the appropriate type and sufficient number of needles for the vaccine. Plan on replacing needles when they become bent, dull, or dirty, and before drawing up vaccine into the syringe. In general, this will mean replacing the needle every 5-10 animals.

2. Transporting and Storing Vaccines

- Keep boxes and bottles cool and out of sunlight while in transport. Use frozen ice packs in an insulated box in the summer, and prevent vaccines from freezing in the winter.
- Prior to use, store vaccines in a properly working refrigerator. Check refrigerator temperatures periodically and assure that

a range of 35-45 °F is being maintained. Refrigerators in controlled environments, such as a house or heated/cooled office, will do a better job of staying in the desired temperature range.

3. Equipment and Work Area

- Use clean syringes, but not those that have had internal parts cleaned with soap or chemical disinfectants, including alcohol.
- Set up an area for syringes such that they are shaded and kept cool and dust-free while working.

4. While Working

- Keep vaccine bottles in a closed cooler with ice packs (summer) or hot packs (winter) until they are needed.
- When using MLV vaccines, rehydrate the vials either one at a time as they are needed or as many as you will use within an hour:
 - When rehydrating vaccine, use a clean transfer needle that has not been cleaned with soap or chemical disinfectants.
 - Use only the diluent supplied by the manufacturer to rehydrate the vaccine.
- Do not contaminate contents of the bottle by using a “dirty” needle (one that has been used on animals) to enter the bottle and draw up vaccine. Always use a brand-new needle to draw vaccine into the syringe.
- When using needle-free injection systems, or syringes that draw doses from a tube attached to the vaccine bottle, care should be taken to assure the bottle and tubing stay cool and shaded from sunlight.

5. After the Job is Complete

- Discard any unused MLV vaccine that has been reconstituted. The vaccine organisms will not be viable unless used within an hour or two after reconstitution.

- Discard any partial bottles of inactivated vaccine that have been contaminated by dirty needles.
- Return unmixed MLV and unused inactivated vaccines to a properly working refrigerator as soon as possible.
- Clean syringes, transfer needles, and tubing. Rinse internal surfaces with distilled water near the boiling point. Do not clean internal parts with soap or chemical disinfectants, including alcohol, because residues can remain and inactivate vaccines before they are ever given to an animal.
- Follow manufacturer’s directions on proper cleaning and maintenance of needle-free injection systems.
- Burn empty vaccine bottles or follow label directions for disposal.

The success of any livestock vaccination program depends on the effectiveness of the vaccine used. Vaccines—which in essence are suspensions of biological organisms—will become ineffective if proper storage and handling recommendations are not followed. Allowing these important tools for preventive health to become ineffective means a wasted investment by producers, and the potential for increased livestock illness and death loss due to diseases that might have been avoided.



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