VACCINES AGAINST ANIMAL PARASITES

Bindu Lakshmanan, Reghu Ravindran, Devada.K, Lucy Sabu and Subrahmanian. H
Department of Veterinary Parasitology, College of Veterinary and Animal Sciences, Pookot, Wayanad

Parasites have been long identified as major animal health problem for decades. Parasites are currently controlled by a variety of chemicals. The most serious drawback of chemotherapy is the emergence of resistance. Secondly there is a growing public health concern about the long term implications of chemical residues in environment and food. Thirdly, the majority of chemical t\treatments have a very short residual activity in the host and therefore applications must be frequent which makes effective control expensive.

Clearly, an alternative approach based on preventive vaccination would be expected to be the most attractive and cost effective. But achievements in the field of parasitic vaccinology have lagged behind degree of success, which has been attained with vaccines against other infectious organisms due to various factors.

The development of a vaccine necessitates a thorough understanding of the immunological interactions between hosts and parasites.In this paper we review the antiparasitic vaccines which are either commercially or experimentally successful.

Advantages of antiparasitic vaccines

- Offer sustained action
- Are free of residues and environmentally safe
- Are intrinsically specific
- Lesser cross-species action than with chemical
- Resistance is less likely to develop than with a chemical
- Above all, they reflect the commonly perceived advantage offered by immunological technology

Limitations in the production of antiparasitic vaccines

- Lack of knowledge of the mechanisms involved in protective immune response. The complex life cycles of the parasite presents a number of developmental stages in different locations in the body and the knowledge of the parasitic stages that are vulnerable to immune attack remains insufficient
- Lack of knowledge of the antigens that elicit protective immunity. The parasite carries a myriad of surface proteins, glycoproteins and glycolipids, only a few of which may be of critical importance.
- Inability to produce antigens in sufficient quantity. Proper in vitro culture systems are lacking in the case of many parasites.
- Highly developed immune evasive mechanisms are expressed by parasites.
- Inspite of the many problems faced in the development and production of vaccines against parasites it has been possible to produce several highly effective antiparasitic vaccines of veterinary importance. The types of vaccines are;

1) LIVE VACCINES:

they include administration of viable or live parasites as such into the hosts. They can revert

to virulence and cause pathogenic effects.The metodolologies adopted are

a) Infection with virulent parasites followed by treatment

b) Attenuation by irradiation, *in vitro* passage, *in vivo* passage in normal/experimental hosts or by selection of precocious lines. Precocious lines are those strains with the shortest patent period in the host producing least pathogenicity but retain immunogenicity.

2) KILLED VACCINES: they include

a) Excretory/secretory proteins

b) Culture supernatants

c) Defined antigens/subunit vaccines

d) Recombinant antigen

3) Nucleic acid vaccines

VACCINES AGAINST NEMATODES

a) Irradiation attenuated Vaccines

Irradiated larval vaccines are available for the control of parasitic bronchitis in cattle and sheep caused by *Dictyocaulus* sp. Two doses of 1000 infective larvae, X-ray irradiated at 40 Krads and given 4 weeks apart induces about 90 per cent protection. The vaccine is commercially available as DICTOL (against *D.viviparous*) and DIFIL (developed in India against *D.filaria*).

An irradiated larval vaccine was developed against hookworm (*Ancylostoma* sp) infections in dogs and used commercially for sometime since 1973. However this failed to impart complete résistance and was eventually withdrawn in favour of anthelminthic treatment.

b) Novel Vaccines

The term 'novel' can be applied to any vaccine, which operates, by an immunological mechanism or against an immunological target, which is not seen as a consequence of prolonged natural infection.

Most research is directed towards the 'HOT' species *(Haemonchus sp, Ostertagia sp., Trichostrongylus sp.).*'Contortin' is a hidden antigen loosely associated with the intestinal epithelium of *H.contortus* that offered good protection in immunization trials in sheep. H-45, H-gal-gp, H-111 are other protective hidden antigens used in recombinant vaccines.

VACCINES AGAINST LIVER FLUKES

The most economically important trematode infection of animals is by *Fasciola hepatica* and *Fasciola gigantica*. Cathepsin L ,fatty Acid Binding Protein(FABP) and Glutathione-S-transferase(GST) offered high protection when used as recombinant vaccine antigen.

VACCINES AGAINST CESTODES

Cestode parasites are important because they cause production losses, particularly in sheep, beef and pig meat industries and because some species are zoonotic.In contrast to the situation with the definitive host, immunity plays a central role in the regulation of transmission of teaniid cestodes through their intermediate hosts. The first registered recombinant vaccine was against *Taenia ovis* in the year 1990.Above 90 percent protection is offered by the recombinant vaccines containing 47-52 kDA oncosphere antigens.

Vaccines against Protozoan parasites

Babesiosis

The haemoprotozoan parasites of *Babesia* sp. are economically important cattle and buffalo pathogens transmitted by ticks.

a) Live vaccines

Early attempts to vaccinate cattle used deliberate infection with virulent parasites from 'bleeder' cattle, which had recovered from babesiosis. Later attenuated vaccines were produced by sequential passage through splenectomised calves. Vaccines containing 10^7 parasites were stored refrigerated and used within one week. Later progress has been made with the use of cryopreserved vaccine in straws or vials in liquid nitrogen containers.

Neveretheless, there were inherent problems associated with live vaccines including

- **Short shelf life**
- **Reversion to virulence**

- **Reversion to transmission by tick vector**
- **The production of erythrocytic isoantibodies with the resultant haemolytic disease.**
- **Transmission of other haemoparasitic or haemorickettsial diseases**

c) Exoantigens

Exoantigens secreted into Microaerophiluos Stationary Phase cultures (MASP) have been used to develop dead vaccines against *Babesia bovis.* Such a vaccine was found to be stable for 2 years at 4°C and protected the cattle for 12 months. A similar vaccine against *B.canis* is "PIRODOG".

c) Recombinant Vaccines

Recombinant vaccine using merozoite antigens of *Babesia* were found to afford some protection

Theileriosis

Parasites of the genus *Theileria* are blood borne parasites involving the lymphocytes of the host.

a) Early immunization trials included deliberate inoculation of blood from animals suffering from acute disease and also infecting the calves with ticks. However there was always the risk of death of the recipient animals and of transmission of other diseases.

b) Tissue culture attenuated vaccine

In vitro attenuated vaccine containing schizonts of *T.annulata* was developed at NDDB, Anand. It is marketed as "Raksha vac-T", stored in liquid nitrogen containers to be reconstituted in buffer saline and injected @ 3ml subcutaneously. It provides protection for a minimum period of 36 months and is effective in calves above 2 months of age and is safe in pregnant cows.

c) Recombinant vaccine containing cloned sporozoite antigens of *Theileria*

was found to be highly protective.

AVIAN COCCIDIOSIS

a) Live Vaccines comprising of unattenuated lines of oocysts of all important *Eimeria sp.* was used in drinking water

b) Live attenuated vaccines: *Eimeria sp* of chicken have been attenuated by rapid passage *in vivo* selecting the precocious lines which are avirulent but immunogenic. "PARACOX", "LIVACOX" and "COCCIVAC" are commercially available vaccines.

c) Recombinant Vaccines: Genes encoding the potentially important antigens of *Eimeria sp* have been identified and subunit vaccines are a future possibility. Identification of partially defined peptide and *Eimeria* rhoptry proteins are promising breakthroughs in the field.

VACCINES AGAINST ECTOPARASITES

Ticks act as major vectors for many human and animal viral , rickettsial ,bacterial and protozoan diseases. Immunisation of dogs and guinea pigs against *Rhipicephalus sanguineus* ticks using gut extracts resulted in the death of engorged females prior to oviposition. A vaccine against *Boophilus microplus* containing Bm 86, a membrane bound protein of the tick gut has been commercially marketed as TickGARD plus in Australia and GAVAC in Cuba.Vaccination has reported to reduce the tick population on cattle as well as the incidence of Babesiosis.

Several antigens derived from ticks has also been tested. Extracts of whole body homogenates, organs such as salivaryglands, midgut of partially fed female ticks and ovaries when injected into animals induced variable degree of protection manifested as reduction in feeding , reduction in egglaying and even death of ticks.

Protective immune response has been observed against the blow fly, *Lucilia cuprina* by using PM44 antigen. Encouraging results have been obtained with a number of other ectoparasites like fleas, lice and mosquitoes.

Conclusion

A decade of molecular parasitology is beginning to bear fruit with the appearance of several new, highly effective practical vaccines against the parasitic diseases.With the development of tools that enables identification of protective antigens progress towards development of vaccines is likely to be faster. ❑