Coccidiosis in poultry

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Coccidiosis is a very important protozoan disease of poultry occurring world wide and causing great financial losses to the farmers. Nine different Eimeria species have been reported from domestic chicken.

Location: Generally, the organisms are intracellular parasites of the intestinal epitheleum.

Life cycle: Consists of three phases.

(i) Dispersion phase: It is an exogenous phase dealing with non-sporulated oocysts discharged in the faeces of an infected host, their sporulation and subsequent dissemination. Optimum conditions of temperature, moisture and oxygen are essential for the oocysts to sporulate.

(ii) Growth phase: This is an endogenous phase involving entry of the infective oocysts to a host, their excystation *in vivo*, penetration into host cells and finally asexual reproduction or schizogony leading to the formation of trophozoites, schizonts, merozoites etc.

(iii) Sexual phase: This is again an endogenous phase following schizogony resulting in the production of gamonts, gametes and the resultant zygote by syngamy.

Generally, the pre-patent period varies from five to seven days.

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Pathological characteristics

The location and nature of lesions of each species of *Eimeria* vary and are of diagnostic value.

(i) *E. tenella*: Located in the caecal pouches and causes acute haemorrhagic caecal coccidiosis with blood in the droppings and heavy mortality. The second-generation schizonts break the epithelial cells and expose the capillaries leading to massive haemorrhage. Petechiae on the caecal mucosa, which may be swollen, and inflammed form the prominent lesions.

(ii) *E. necatrix*: This affects the middle part of the small intestine. It causes severe bleeding and necrosis of the mucous membranes leaving a scar tissue which affects the feed efficiency especially in broilers. The accumulation of the large sized second generation schizonts as white opaque foci surrounded by a zone of erythema is easily visible from the serosa itself.

(iii) *E. maxima*: Affects the middle part of the small intestine but tends to spread to either side. Moderately pathogenic, producing a slight haemorrhagic and catarrhal enteritis.

(iv) *E. brunetti*: Affects the lower part of the small intestine, proximal part of rectum and cloaca. It is markedly pathogenic producing haemorrhagic ladder like lesions across the mucosa of the rectum and necrotic enteritis. It results in rectal coccidiosis. Faeces will be blood stained.

(v) *E. acervulina*: Affects the anterior part of small intestine or the duodenum. It produces a catarrhal enteritis with whitish diarrhoea. Gametes and immature oocysts form whitish ladder lesions across the mucosa, which may be visible on the serosa itself.

Diagnosis: Coccidia survive in an inhibited state in the gut and get activated by stress factors like overcrowding or inclement weather. The mere presence of oocysts in the faeces does not necessarily mean that the bird is suffering from a clinical condition. At the same time, we cannot completely rule out the possibility of coccidial infections, by the mere absence of oocysts in the faeces, since mortality can occur well before the extrusion of oocysts.

It is always better to examine the carcass of a dead bird, rather than droppings, to detect presence of coccidial infections.

Specific identification of the organisms can be carried out by noting the area of intestine affected, nature of lesions, oocyst morphology and sporulation time.

Prophylaxis

Effective control measures are greatly essential to reduce the severe economic losses faced by poultry farmers. Presently, we have both conventional and novel methods of control. The conventional methods consists of (1) managemental practices and (2) chemotherapy.

(1) Managemental practices

Hygiene: Coccidial oocysts are very resistant to environmental conditions and are able to survive for long periods. Strict hygiene is required to keep a check on the oocyst count in the litter.

Bedding and soil may be sterilised by 1.25% sodium hypochlorite or 0.5% phenol or cresol. Fumigation of the rooms with 10% formaldehyde is also good.

Litter should be dry and well drained. The thickness of the litter should not be more than 3" per sq.m.

Feeders and waterers should be placed high enough from the ground so as to avoid faecal contamination from the litter.

Lighting should be continuous. Intermittent lighting programme is not advised.

Diet of birds is very important. A diet rich in maize will help to prevent coccidiosis as it contains Vit. A and E, which will help in the tissue repair and intestinal injuries. Diets rich in wheat lead to the spread of coccidiosis as the niacin and riboflavin present in it favour the survival of schizogonous stages.

Over crowding and other factors leading to stress among birds should be reduced.

Vessels and utensils should be washed thoroughly with hot caustic soda.

Poultry cages may be sterilized with a blowlamp before the new stock arrives.

Restrict the movement of visitors or workers from one building to another.

Isolation of sick or diseased birds from the healthy flock is very important.

(ii) Chemotherapy

Regular supplement of various anticoccidials in the daily ration of birds will aid to control the entry of infection into a flock or farm.

In broilers, anticoccidials may be used continuously for the entire period but withdrawn for a few days just before marketing.

In growers, anticoccidials may be added continuously for the first six weeks and then either discontinued or use of a drug, which doesn't require a withdrawal period before marketing is recommended.

In layers and replacement stock, use of anticoccidials is not as common as in broilers. For better economics and safety, immunisation is advised in these long-lived birds.

Some of the anticoccidials widely used are,

(1) Ionophores:

(1)Monesin [ELANCOBAN] 100 ppm

(2) Lasalocid [AVATEC] 90 ppm

(3) Salinomycin [COXISTAC, SACOX] 66 ppm

(4) Maduramycin [CYGRO] 5 ppm

(2) Diclazuril [CLINACOX] 1 ppm

(3) Toltrazuril [BAYCOX] 25 ppm

(4) Robenidine [CYCOSTAT] 33 ppm

(5) Dinitrotoluamide [DOT] 125 ppm

(6) Amprolium hydrochloride

[AMPROL, AMPROLMIX, PANCOXIN] 125-250 ppm

(7) Sulphonamides: Important in outbreaks of coccidiosis 150-200 mg/kg for three days

Drawbacks

Practical difficulties encountered in the management aspect obstruct smooth conduct.

Development of drug resistant strains due to over or incomplete dosing.

Enormous costs involved by use of chemotherapy and in the discovery and development of new anticoccidials.

Immunisation

The disadvantages and failure of the conventional methods have led many research workers to think of

an alternate method of prophylaxis i.e., immunisation. The various immunisation programmes exploit the natural immunity of birds.

Factors affecting immune response

(i) Species specificity: Species of *Eimeria* affecting domestic chicken differ in their immonogenic potentiality with *E. maxima* being the most immunogenic species followed by *E. acervulina, E. tenella* and *E. necatrix.*

Another striking feature is that immunity is species specific. Birds immune to one species will be susceptible to other species of coccidia. But cross immunity between *E. maxima* and *E. brunetti* has been reported.

(ii) Endogenous stages: Asexual stages especially the first and second generation schizonts have been proved to be highly immunogenic.

(iii) Route of administration: Oral route appears to be the best route of inoculation to induce effective immunisation.

(iv) Age: Coccidiosis is a disease of young birds. Soon after exposure to infection, immunity develops and protects the hosts against subsequent infections.

Unfortunately, absence of cross immunity between species of *Eimeria*, may result in coccidial outbreaks due to other species.

Coccidiosis is a self-limiting disease and in the absence of further infections, it gets cleared off.

(v) Immunosuppressive diseases: Viral infections like infectious bursal disease or Marek's disease render the birds more susceptible to coccidiosis due to a break in immunity.

The following are the milestones in the path of effective immunisation programme.

Active immunisation

(1) Natural infection chemically modulated

(a) From the litter

This type is widely used in layers and breeders. In these classes of stock, it is essential to achieve immunity by the time of egg-lay, in order to avoid the drop in egg production due to coccidiosis. Hence, natural infections from the litter itself are relied on to induce immunity in the flock of birds. The severity of the disease is reduced by use of drugs of modest efficacy or by step-down dosing. All drugs are withdrawn before the point of lay.

(b) Viable parasites administered parentrally

Introduction of virulent strains by uncharacteristic routes like cloacal administration or directly into the caecum has seen to provide immunity against coccidiosis.

(2) Live unattenuated vaccines

(i) Immunisation with fully viable oocysts

The ability of chicken to develop strong immunity against re-infection with coccidia has been exploited by deliberately exposing the birds to a controlled low level infection consisting of many species of *Eimeria.* This is done by trickle immunisation where a known or measured quantity of oocysts (50 oocysts per day) of four to seven species are encapsulated in alginate beads and mixed in the starter feed. Chicks can be immunised at 0-13 days of age. Better results are attained if the immunisation starts at an early age. Low level medication with anticoccidials should be applied from 13 days and continued up to 5 to 6 months. The choice of drugs are 0.0125% Nitrophenide, 0.0125% sulphaquinoxaline, 0.0055% nitrofurans etc.

This type of vaccination is used on birds reared on litter only. The efficacy of the vaccine depends upon adequate re-infection from the litter by the oocysts discharged as a result of the immunising dose. It is used mainly for replacement, breeding and egg producing stock.

One such vaccine developed, based on this principle is the Coccivac. It contains oocysts of *E. tenella, E. necatrix, E. mivati* and *E. praecox.* It is administered in drinking water or moist feed at 4-10 days of age, with low level medication.

Advantages

Development of immunity in chicks by 4 weeks of age to five or seven species of *Eimeria.*

Reduction in lesion score and oocyst counts after challenge infections.

Reduction in drug resistance and cost of drugs.

Improvement in the feed conversion rate.

Disadvantages

Inability to control the amount of inoculum ad-

ministered to the flock.

Over exposure to infection will result in pathogenesis and mortality.

Affections with oocysts lead to poor growth rate.

(3) Live attenuated vaccines

(i) Immunisation using attenuated oocysts

The difficulties encountered in the previous method may be solved by the use of attenuated oocysts.

Attenuation can be achieved by serial embryo passage in the chorioallantois of chicken embryos. *Eimeria tenella* and *E. mitis* were the first coccidial organisms to be attenuated by this method. Immunisation of chicken with caecal extracts intra-abdominally prepared by birds infected with chicken embryo adapted *E. tenella* has given promising results. Recently, *E. necatrix* too has been attenuated in this way.

Other methods of attenuation include heat treatment, freezing, exposure to ultrasonic vibrations and most notably ionising radiations. A dose of 10-20 kRad radiations of gamma rays have been used to reduce the virulence of *E. maxima*. Irradiation helps to prevent the merogonic development in the intestinal epitheleum.

(ii) Vaccines based on precocious strains

The word precocious means "prematurely developed". This deals with the production of avirulent strains of *Eimeria*, obtained by sequential selection of parasites, which show the most rapid development in vivo, or in the host. The infections are repeatedly initiated with the first oocysts produced after each infection. Precocious strains are set up from the organisms that have the shortest patent period *in vivo* and that which produce oocysts in the minimum possible time.

It has been reported that precocious strains produce only 70,000 oocysts from an initial dose of 100 oocysts in comparision to 30 million by the field/wild strain. Precocious strains have (1) lower pathogenesis, (2) rapid rate of maturation in the host, (3) abbreviated life cycle and (4) high immunogenicity.

A commercial vaccine based on precocious lines is Paracox (Pitman-Moore, UK). It is a live attenuated vaccine comprising of a stabilised suspension of sporulated oocysts of seven species of *Eimeria* viz., *E. acervulina, E. brunetti, E. maxima, E. mitis, E. necatrix, E. praecox* and *E. tenella*. It is administered in drinking water to broilers, broiler breeders, and layers as single dose at 5-9 days of age. No need of anticoccidial medication.

(3) Non-living vaccines

(i) Sub unit maternal vaccines

It is found that maternally derived IgG antibodies can be used as an anticoccidial vaccine. A 230-kDA protein isolated from IgG associated with maternally derived immunity to *E. maxima* in chicken was found to be highly protective and immunogenic. Hatchlings from the eggs laid by hens given intramuscular injection of this protein were comparatively resistant to coccidiosis.

(ii) Recombinant antigens

Recombinant technology has led to the identification of coccidial proteins, which are immunogenic. Such proteins have been isolated from *E. tenella* and designated as 66/200 kDA, 28 kDA and SO7 and from *E. acervulina*, P250.

Non-specific immunisation: It has been found that non-specific immunisation with Marek's Disease vaccine stimulates the immune response in chicken against coccidiosis.

Conclusion

Coccidiosis is a dreadful disease, producing substantial production losses in the poultry industry. Problems with drug resistance and the expense involved in coccidiosis control have encouraged research into the development of living, avirulent and non-living parasite vaccines. Development of a vaccine protecting against all antigenically diverse strains of coccidia should be our next goal.

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