# Technical Bulletin

**Information from Phibro Technical Services**

## *Immunological Effects of Deccox® in Calves*

***Coccidiosis prevention with Deccox maintains immune system function of cattle by eliminating the immunosuppressive effects of coccidiosis.***


### Summary

- The immunological impacts of feeding Deccox (decoquinate) to prevent coccidosis in calves were explored in two studies.[1]
  - Steer calves with subclinical coccidial infections were fed diets with or without Deccox (0.5 mg/kg body weight/day).
  - Some steers also received dexamethasone injections to mimic stress-induced immunosuppression.
- Results demonstrated that Deccox favorably influenced neutrophil function in both normal and immunosuppressed cattle.
  - Compared to the group treated with dexamethasone alone, immunosuppressed calves fed Deccox demonstrated improved neutrophil function, reduced shedding of coccidia oocysts, and no clinical signs of coccidiosis.
  - Positive impacts on immune system function resulting from Deccox were associated with the anticoccidial activity of Deccox and not from any direct action of the medication on the immune system.
- By preventing coccidiosis, Deccox eliminated the suppressive effects that coccidia exert on the immune system, thus allowing calves to respond normally and effectively to secondary disease challenges like respiratory infections.


Deccox (decoquinate) is an anti-protozoal, non-antibiotic feed additive approved for the prevention of coccidiosis caused by *Eimeria bovis* and *E. zuernii*. Deccox prevents coccidiosis by stopping the development of coccidia early in their life cycle, thus controlling both clinical and subclinical coccidiosis and reducing treatment costs and performance losses associated with clinical outbreaks.

Prevention of coccidiosis with Deccox allows calves to respond effectively to secondary diseases like respiratory infections reducing morbidity and mortality.[2] Calves fed Deccox experienced reduced incidence of respiratory disease, fewer setbacks, and less mortality compared to untreated groups. These benefits may be related to nonspecific enhancement of immune function.

Deccox could potentially influence immune function in cattle by: 1) directly altering neutrophil or lymphocyte function; or 2) reducing the number of coccidia in the intestinal tract and thereby reversing or preventing any immunosuppression that may develop because of coccidiosis. To help differentiate between these hypotheses, 2 studies were conducted to determine if Deccox could enhance neutrophil function or lymphocyte blastogenesis in

cattle infected with coccidiosis.

## Experiment Design: Study 1

The first study involved 20 Holstein steer calves (approximately 650 lb) that were subclinically infected with coccidia as determined by the presence of oocysts in the feces.[1] Calves were randomly assigned to 4 treatment groups of 5 animals each and fed hay and grain rations for the duration of the 45-day experiment:

1) Non-medicated controls
2) Dexamethasone injection: 0.04 mg/kg BW/d (1.81 mg/100 lb BW/d) IM on days 30-34
3) Deccox: approximately 0.5 mg/kg BW/d (22.7 mg/100 lb BW/d ) added to the grain ration
4) Deccox+dexamethasone injection

Dexamethasone is an anti-inflammatory drug known to cause immunosuppression, thus mimicking stressors (e.g., severe weather, weaning, shipping, ration changes, etc.) that are also known to cause immunosuppression and trigger coccidiosis breaks.

Blood samples were obtained from all animals at the start of the study and after 25 days (Table 1) for assessment of immune system activity as determined by:

- Lymphocyte blastogenesis (numbers typically rise in response to a specific antigen)
- Neutrophil function (random migration, chemotaxis, *Staphylococcus aureus* ingestion, cytochrome C reduction, iodination, and antibody-dependent and -independent cell-mediated cytotoxicity)

Blood samples were again obtained and evaluated for a 3-day period beginning on day 38, 4 days after the 5-day period of dexamethasone treatment (Table 1). Fecal samples were also collected during the study (Table 1) for determination of coccidia oocyst counts.

## Results: Study 1

***Anticoccidial evaluation***

***Deccox lowered oocyst shedding and prevented clinical coccidiosis.***

At day 38, 4 days after administration of the dexamethasone (immunosuppression) treatments, cattle in the dexamethasone group showed signs of clinical coccidiosis and the number of coccidia oocysts shed in the manure dramatically increased (Table 2). In contrast, the Deccox+dexamethasone group experienced no clinical coccidiosis and no spike in the number of shed oocysts (Table 2), demonstrating the anticoccidial effectiveness of Deccox even in severely immunosuppressed cattle.

***Immune system evaluation***

After the initial 25 days of the study (before immunosuppression), neutrophils collected from Deccox-medicated calves demonstrated ($P < 0.05$) enhanced functionality compared non-medicated animals (Table 3: decreased random migration; enhanced cytochrome C reduction and iodination). No differences in lymphocyte counts were observed between treatment groups.

**Table 1. Design of Immunosuppression Study 1**

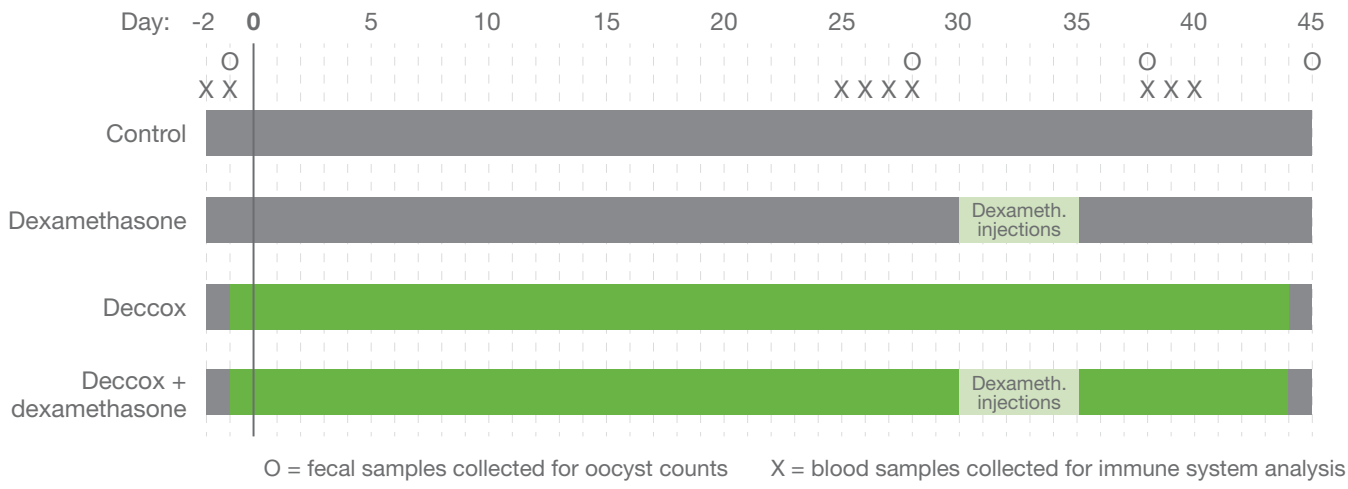

**Table 2. Estimated Number of Coccidia Oocysts/gram of Fecal Material (n=5/group)**

| Sample Day | Controls | Dexamethasone | Deccox | Deccox+ Dexamethasone |
|---|---|---|---|---|
| Day 0 | 173 | 95 | 120 | 215 |
| Day 38 | 155 | 34,350 | 60 | 333 |

***Calves fed Deccox had less suppression of neutrophil activity compared to control calves.***

**Table 3. Neutrophil Function (Before Dexamethasone Treatment) for the 4-Day Period Beginning 25 Days After the Start of Deccox Feeding (n=10/group)**

| Neutrophil Function Assay[a] | Controls | Deccox |
|---|---|---|
| Random migration, $mm^2$ | 37.5[b] | 34.1[a] |
| *Staphylococcus aureus* ingestion, % | 25.9 | 27.7 |
| Cytochrome C reduction, OD | 0.392[a] | 0.451[b] |
| Iodination, nmole of NaI/$10^7$ neutrophils/h | 24.9[a] | 31.1[b] |

[a]Favorable neutrophil function indicated by: reduced values for random migration; increased values for *S. aureus* ingestion, cytochrome C reduction, iodination.
[a,b] $P < 0.05$ vs controls

***Immunosuppressed calves treated with Deccox showed better neutrophil function than non-medicated, suppressed animals.***

Results of neutrophil function assessments at day 38 (after immunosuppression) are summarized in Table 4. In the dexamethasone group, several parameters of neutrophil activity were reduced compared to controls ($P < 0.05$; Table 4), suggesting compromised immune function with less capability of combating infection. In contrast, the administration of Deccox to immunosuppressed cattle (Deccox+dexamethasone group) improved neutrophil function compared to the dexamethasone group (Table 4):

- Prevented the inhibition of cytochrome C reduction (enhanced generation of super-oxide anion)
- Lessened the inhibition on neutrophil iodination (increased bactericidal activity)
- Tended to increase the suppression of random migration (increased ability of neutrophils to adhere to surfaces)

No differences were observed between treatment groups for chemotaxis or cell-mediated cytotoxicity. In addition, induced immunosuppression inhibited the ability of lymphocytes to reproduce in all dexamethasone-treated animals, including those fed Deccox.

Researchers concluded that the feeding of Deccox favorably influenced neutrophil function in both normal and immunosuppressed cattle. However, trial data did not allow determination of whether Deccox exerted a direct influence on neutrophil function or whether the changes in neutrophil function were attributable to decreased coccidial burden and, therefore, removal of the suppressive effect of coccidial infection on the immune system. Regardless of the mechanism, study results help explain why the feeding of Deccox to stressed cattle has been associated with decreased morbidity and mortality from respiratory disease.

**Table 4. Neutrophil Function for the 3-Day Period Beginning 4 Days After the Last Dexamethasone Treatment and 38 Days After the Start of Deccox Feeding (n=5/group)**

| Neutrophil Function Assay[a] | Controls | Dexamethasone | Deccox | Deccox+ Dexamethasone |
|---|---|---|---|---|
| Random migration, $mm^2$ | 132.6 | 109.1* | 121.3 | 99.0* |
| *Staphylococcus aureus* ingestion, % | 40.5 | 49.8* | 39.6 | 46.4 |
| Cytochrome C reduction, OD | 0.965 | 0.883* | 0.956 | 0.950† |
| Iodination, nmole of NaI/$10^7$ neutrophils/h | 44.0 | 28.2* | 46.4 | 34.4* |

[a]Favorable neutrophil function indicated by: reduced values for random migration; increased values for *S. aureus* ingestion, cytochrome C reduction, iodination.
*$P < 0.05$ vs controls, † $P < 0.05$ vs dexamethasone group

## Experiment Design: Study 2

A shorter follow-up study was conducted because the first study did not delineate whether the enhanced neutrophil activity observed in Deccox-medicated calves resulted from a direct drug effect on the immune system or was due to reduced coccidial burdens. The study was 6 days in duration, thus providing a reduced feeding time for Deccox (far less than the 28-day coccidial life cycle). As a result, Deccox effects on immune system function after induced immunosuppression could be evaluated in the absence of anticoccidial impacts.

The study involved 24 Holstein steers approximately 3 to 4 months of age that were divided into 4 treatment groups (6 calves/group):

1) Non-medicated controls
2) Dexamethasone daily injection for days 2-5
3) Deccox (approximately 0.5 mg/kg BW/d; 22.7 mg/100 lb BW/d)
4) Deccox+dexamethasone injection

Blood samples were obtained from all animals on day 6 (1 day after the conclusion of the immunosuppressive dexamethasone treatments) and assessed for immune system activity.

## Results: Study 2

Deccox did not impact immune system function nor alleviate immunosuppression associated with dexamethasone treatment. These results helped clarify the mechanism by which Deccox impacts neutrophil activity:

- Coccidiosis prevention by Deccox eliminates immunosuppression often triggered by coccidial burdens, thus allowing normal and effective immune system function in response to disease challenges (e.g., respiratory pathogens).

## Conclusions

Immunosuppression research revealed that calves treated with Deccox maintained immune system function. The feeding of Deccox favorably influenced neutrophil function in both dexamethasone-treated (immunosuppressed) steers and animals not treated with dexamethasone.

***Deccox removes the suppressive effects that coccidia exert on the immune system.***

The positive impacts on immune system function resulting from Deccox (i.e., less suppression of neutrophil activity) were associated with the excellent anticoccidial activity of Deccox and not from any direct action of the medication on the immune system.

Results of these studies help explain why the feeding of Deccox to stressed cattle has been associated with decreased morbidity and mortality from respiratory disease. By preventing coccidiosis, Deccox® removes the suppressive effects that coccidia exert on the immune system, thus allowing calves to normally and effectively respond to secondary disease challenges like respiratory infections.

### References

1. Roth J.A., J.A. Jarvinen, D.E. Frank, J.E. Fox. 1989. Alteration of neutrophil function associated with coccidiosis in cattle: influence of decoquinate and dexamethasone. Am. J. Vet. Res.; 50:1250-1253
2. Hutcheson D.P., J.M. Cummins. 1982. The use of decoquinate in the receiving diets of stressed feeder calves. Proc. West. Sect. Amer. Soc. Anim. Sci. 33:181.

This information has been prepared for industry technical professionals.