# IVERMECTIN AND COPPER RESPONSE TRIAL IN MIXED AGE RED DEER HINDS

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## INTRODUCTION

A client had an increasing number of thin hinds which were causing concern. In May 1992 four thin hinds out of six hundred were blood tested and the results showed adequate vitamin $B_{12}$ and low copper concentrations.

Copper "bullets" were given but the problem continued to increase slowly until about 2% of the hinds were extremely unthrifty

In August 1992 two thin hinds were necropsied. They were grossly emaciated and the abomasum of each had a "Morocco leather" appearance The laboratory report confirmed parasitic gastritis The liver coppers were 98 and 73 µmol/kg and the faecal egg counts were nil and 900, respectively. No evidence of Johne's disease was seen.

The snow in August 1992 resulted in the deaths of some of the very thin hinds. At necropsy the abomasa showed low grade parasitism and ulcers which may have been stress related.

After further consultations a trial was set up to try to evaluate any production response to copper supplementation and anthelmintic treatment in a group of unthrifty hinds.

## METHOD

Visit One (Early spring, 14/9/92)

1. Two hundred red deer hinds were selected according to the following weight criteria

| | | |
|---|---|---|
| 20 hinds | < 60 kg | (very light) |
| 60 hinds | 61-70 kg | (light) |
| 60 hinds | 71-80 kg | (moderate) |
| 60 hinds | 81-90 kg | (average) |

   Half of the hinds in each category were randomly allocated to receive Ivomec Pour-on (Ivo) at twice the cattle rate (1 ml/5 kg, ie, 1,000 µg/kg) and the other received no Ivomec Pour-on (No Ivo).

2. In both Ivo and No Ivo Groups, hinds in each weight category were paired according to weight rank (the heaviest, the next two heaviest and so on). One member of each pair was randomly selected (by coin toss) and treated with a 10 g "Copacap" (Rhône Merieux) (Cu) while the other received no Copacap (No Cu) (see Table 1 for Group number notation).

3. Hinds were individually identified. Weight and condition scores (1=emaciated to 5=fat) were recorded for each.

**Table 1. Tabular summary of number of animals in each experimental group and weight category**

| TREATMENT | | WEIGHT CATEGORY (kg) | | | | |
|---|---|---|---|---|---|---|
| | | < 60 very light | 61-70 light | 71-80 moderate | 81-90 average | Total |
| Group 1 | Ivo/Cu | 5 | 15 | 15 | 15 | 50 |
| 2 | Ivo/No Cu | 5 | 15 | 15 | 15 | 50 |
| 3 | No Ivo/Cu | 5 | 15 | 15 | 15 | 50 |
| 4 | No Ivo/No Cu | 5 | 15 | 15 | 15 | 50 |
| Total | | 20 | 60 | 60 | 60 | 200 |

4 Plain and EDTA blood samples were collected from the 20 hinds weighing < 60 kg (ie. 5 from each of the four groups) and the following tests carried out Total protein, Albumin, Pepsinogen, Ferroxidase (copper) and Glutathione peroxidase (selenium) Faecal samples collected *per rectum* and faecal egg count examinations carried out

5. Two very thin hinds from the original mob but not selected for the trial were slaughtered and necropsies carried out. Abomasal fluid pH was measured, and a total worm count and an abomasal digest count were carried out

Visit Two (Precalving, 3/11/92)

1 Liveweights and condition scores were recorded for all animals.

2 Hinds that had blood samples collected at Visit One were re-bled and the same tests carried out.

3 Faecal egg counts were repeated on the same animals that were tested at Visit One.

4 Groups 1 and 2 (Ivomec treated hinds) were run together but kept separate from Groups 3 and 4 (No Ivo) from Visit Two until Visit Three (at weaning) in order to reduce any exposure of Groups 1 and 2 hinds and calves to parasites originating from Groups 3 and 4 animals, and to record weaning percentages of Ivomec treated versus untreated hinds.

Visit Three (Weaning, 24/3/93)

1 At weaning all hinds and calves were weighed and data collected on number of calves weaned for each group and weight category

Analysis

Analyses were carried out using analysis of variance (ANOVA) The protocol was designed to detect a mean between-group weight difference of 5 kg or more in hinds in the "moderate" weight category, at the 5% level of significance.

## RESULTS

Post-mortems

Four post-mortem examinations were carried out The two non-trial hinds on Visit One, a thin Group 4 hind on Visit Two and a thin Group 3 hind on Visit Three. All were very thin, with virtually no body fat. The findings of the total worm count, abomasal digest and pH are in Table 2.

**Table 2. Parasitology and abomasal pH results from four very light hinds killed at the start and during the trial**

| **Hind number:**<br>**Treatment group:** | | **1**<br>**Non-trial** | **2**<br>**Non-trial** | **3**<br>**Group 4** | **4****<br>**Group 3** |
|---|---|---|---|---|---|
| **Date:** | | **14/9/92** | **14/9/92** | **3/11/92** | **31/3/93** |
| Abomasum | Haemonchus | - | - | - | - |
| | Ostertagia-type | 5,800 | 3,800 | 100 | 400 |
| | Trichostrongylus | 1 000 | - | 1,400 | 6,800 |
| Small intestine | Nematodirus | - | - | 100 | - |
| | Trichostrongylus | - | - | - | - |
| | Cooperia | - | - | - | - |
| | Strongyloides | - | - | - | - |
| | Bunostomum | - | - | - | - |
| | Monezia | - | - | - | - |
| Large intestine | Trichuris | - | - | - | - |
| | Oesophagostomum | 434 | - | - | - |
| | Chabertia | - | - | - | - |
| Abomasal digest | Early 4th stage | - | 100 | 40 | 400 |
| | Late 4th stage | 1,700 | 1,400 | 10 | 800 |
| Abomasal pH | | 5 2* | 4 6* | 6 9 | Not done |

* pH papers used.
**Hind No 4 also had very low total serum protein (50 g/ℓ) and low albumin (19 g/ℓ) and a pepsinogen of 0 4 IU/ℓ

Mortality

In the six months of the trial none of the Ivomec-treated hinds (Ivo) died, compared with 10% of the untreated (No Ivo) animals (P<0.01) (see Table 3). The majority (7/10) died in late September soon after the trial started during a period of severe weather and food shortage. The animals that died were 9.3 kg lighter than the average in the group Treatment with copper needles did not affect the mortality rate.

**Table 3. Mortality rates in hinds in the four treatment groups: Ivomec plus Copper needles, Ivomec alone, Copper needles alone, untreated controls.**

| Groups | Treatments | | Period | | | 14/9-31/3 Total | Ivomec | Cu |
|---|---|---|---|---|---|---|---|---|
| | | | 14/9-3/11 | 3/11-24/3 | 24/3-31/3 | | | |
| 1 | Ivo | Cu | 0 | 0 | 0 | 0/50 | Ivomec 0/98 | Cu 5/100 |
| 2 | Ivo | No Cu | 0 | 0 | 0 | 0/48 | | |
| 3 | No Ivo | Cu | 3 | 1 | 1 | 5/50 | No Ivo 10/99 | No Cu 5/97 |
| 4 | No Ivo | No Cu | 4 | 1 | 0 | 5/49 | | |

Liveweight

The liveweight changes during the trial have been somewhat confounded by:

a) the stratified random selection of animals resulted in a significant mean liveweight difference between groups at the start of the trial (Ivomec treated 80 1 kg, No Ivo 77 8 kg):

b) the animals that died were all No Ivo and being 9.3 kg lighter than the group mean, this caused the mean of the surviving controls to rise considerably,

c) the hinds were grazed together until 3/11 when they were split into two calving groups

   i) Ivomec treated
   ii) No Ivomec;

d) a higher proportion of No Ivo hinds were not pregnant or lost their calves

The statistical analysis corrected for the effects of death and non-pregnancy. Weight-gains for the four groups are shown in Table 4. Although significant differences are seen for the two periods 14/9-3/11 and 3/11-24/3, when considered together the effects are cancelled out It is not possible to be sure that the grazing conditions were exactly equal for the two groups after 3/11 and therefore the analyses should be interpreted with caution. There were no significant effects due to copper supplementation.

**Table 4. Mean liveweights of the four treatment groups at the start of the trial (14/9) and mean weight gains for the period 14/9-3/11, 3/11-24/3 and 14/9-24/3 on liveweights corrected for deaths in the non-treated Ivomec control group.**

| Groups | Treatments | | LWt (kg) 14/9 | Wt gain 14/9-3/11 | Wt gain 3/11-24/3 | Wt gain 14/9-24/3 |
|---|---|---|---|---|---|---|
| 1 | Ivo | Cu | 79 8 | 8 04 | 9 84 | 17 2 |
| 2 | Ivo | No Cu | 81 4 | 6 38 | 8 93 | 15 9 |
| 3 | No Ivo | Cu | 77 6 | 9 48 | 5 74 | 16 1 |
| 4 | No Ivo | No Cu | 78 1 | 10 39 | 5 64 | 16 1 |
| 1 & 2 | Ivomec combined | | 80 1[a] | 7 21[b] | 9 05[c] | 16 53 |
| 3 & 4 | No Ivomec | | 77 8[a] | 9 93[b] | 6 03[c] | 16 09 |
| 1 & 3 | Cu combined | | 78 7 | 8 76 | 7 79 | 16 6 |
| 2 & 4 | No Cu | | 79 7 | 8 38 | 7 29 | 16 02 |

Significant differences between groups [a] P<0 05, [b] and [c] P<0 01

Body condition scores

The analyses corrected for deaths and non-pregnancy rates and the results are shown in Table 5. Ivomec-treated animals showed significantly greater body score improvements during the trial. Copper-treated animals showed slightly greater, but non-significant, gains in body score Once again the differences between Ivomec and No Ivo hinds after they were separated on 3/11 could be associated with the environment rather than the treatment

**Table 5. Body condition scores**

| Groups | Treatments | | Body score at trial start 14/9 | Changes in body score 14/9-24/3 | Changes in body score 3/11-24/3 | Corrected changes in body score 14/9-3/11 |
|---|---|---|---|---|---|---|
| 1 | Ivo | Cu | 2 96 | 0 97 | 0 592 | 0 378 |
| 2 | Ivo | No Cu | 2 98 | 0 713 | 0 299 | 0 397 |
| 3 | No Ivo | Cu | 2 94 | 0 28 | 0 143 | 0 129 |
| 4 | No Ivo | No Cu | 3 00 | 0 23 | 0 183 | -0 015 |
| 1 & 2 | Ivomec combined | | 2 97 | 0 841[a] | 0 446[b] | 0 387[c] |
| 3 & 4 | No Ivomec | | 2 97 | 0 254[a] | 0 163[b] | 0 057[c] |
| 1 & 3 | Cu combined | | 2 95 | 0 624 | 0 368 | 0 254 |
| 2 & 4 | No Cu | | 2 99 | 0 241 | 0 241 | 0 191 |

Significant differences between groups [a] [b] [c] P<0 05

Weaning rates

Only data relating to Ivomec versus No Ivo were collected because the trial animals were calved in these two groups. Ivomec-treated hinds had a significantly higher ($P<0.05$) weaning percentage of 86.7% (85/98) compared with 68.7% (68/99) for the No Ivo hinds, including nine hinds that died pre-calving, or 75.6% for hinds alive at calving.

Weaning weights

The weaning weights of calves from Ivomec-treated hinds were 43.1 kg (female) and 47.6 kg (male) compared with 39.6 kg (female), and 43.15 kg (male) from untreated hinds. Although statistically significant, the differences between these groups are unreliable because the hinds and calves were grazed in different groups until weaning on 24/3.

Biochemical changes (see Table 6)

The mean age of the groups was biased by chance when the 20 very light hinds were randomly allocated to the four treatment groups and therefore the results were corrected for this on analysis. There was a positive relationship between age and liveweight. Serum ferroxidase (Cu containing enzyme) levels were below the normal range (16-27 IU/ℓ) in 90% of animals at the start and levels were significantly elevated by copper needle treatment ($P<0.05$). Over this period untreated hinds' copper levels declined. However both groups remained below normal levels. Total protein levels were significantly elevated by both Ivomec ($P<0.05$) and Cu ($P<0.01$) whereas only Ivomec resulted in raised albumin levels ($P<0.01$), suggesting that Cu only affects serum proteins other than albumin.

Mean pepsinogen levels remained approximately the same in both Ivomec and Copper needle treated animals while they rose significantly in untreated animals ($p<0.05$). However, at November 3, 3/10 Ivomec treated animals had pepsinogen levels >1.0 (1.1, 1.1 and 2.0) and 3/7 untreated animals had levels >1.0 (1.3, 1.3 and 2.9). Glutathione peroxidase levels were quite elevated in all animals at the start of the trial. Selenium pills are used on the property. By chance the animals chosen to receive copper needles had significantly lower glutathione peroxidase levels than those not treated with copper ($p<0.05$). Three months later the group not treated with copper had a significantly greater fall ($p<0.05$) in glutathione peroxidase levels cancelling out the effect.

**Table 6. Liveweight and biochemical changes in the 20 very light hinds (<60 kg)**

| Groups | Treatment | | Liveweight and biochemical values at the start (14/9) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Liveweight (kg) | Serum ferroxidase (IU/l) | Total protein (g/l) | Albumin (g/l) | Pepsinogen (IU/l) | GSHpx (ku/l) |
| 1 | Ivo | Cu | 69 3 | 7 9 | 62 2 | 26 78 | 0 5 | 20 2 |
| 2 | Ivo | No Cu | 79 5 | 4 8 | 67 9 | 25 22 | 0 76 | 19 3 |
| 3 | No Ivo | Cu | 71 8 | 7 4 | 63 4 | 26 78 | 0 65 | 10 6 |
| 4 | No Ivo | No Cu | 70 5 | 12 6 | 65 4 | 28 72 | 0 79 | 27 3 |
| 1 & 2 | Ivo Combined | | 74 4 | 6 3 | 65 1 | 26 00 | 0 63 | 19 7 |
| 3 & 4 | No Ivo | | 71 2 | 10 0 | 64 4 | 27 75 | 0 72 | 18 9 |
| 1 & 3 | Cu Combined | | 70 6 | 7 6 | 62 8 | 26 78 | 0 58 | 15 4[a] |
| 2 & 4 | No Cu | | 75 0 | 8 7 | 66 7 | 26 97 | 0 77 | 23 3[a] |

Significant difference between groups [a] P<0 05

| Groups | Treatment | | Liveweight and biochemical changes between 14/9 and 3/11 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Liveweight gain (kg) | Serum ferroxidase (IU/l) | Total protein (g/l) | Albumin (g/l) | Pepsinogen (IU/l) | GSHpx (ku/l) |
| 1 | Ivo | Cu | 6 0 | 4 96 | 11 33 | 2 29 | -0 075 | -4 9 |
| 2 | Ivo | No Cu | 6 6 | 0 26 | 1 44 | 3 00 | 0 076 | -6 2 |
| 3 | No Ivo | Cu | 2 2 | 10 23 | 4 29 | -3 45 | 0 189 | 4 0 |
| 4 | No Ivo | No Cu | 1 5 | -4 43 | 0 69 | -5 05 | 0 552 | -17 2 |
| 1 & 2 | Ivo combined | | 6 3 | 2 61 | 6 38[f] | 2 65[b] | 0 001[c] | -5 6 |
| 3 & 4 | No Ivo | | 1 8 | 2 9 | 2 49[f] | -4 25[b] | 0 370[c] | -6 6 |
| 1 & 3 | Cu combined | | 4 1 | 7 59[d] | 7 81[e] | -0 58 | 0 057[f] | -0 5[g] |
| 2 & 4 | No Cu | | 4 0 | -2 08[d] | 1 06[e] | -1 02 | 0 314[f] | -11 7[g] |

Significant differences between groups [a c f g] P<0 05, [b d e] P<0 01

Faecal egg counts

There was insufficient data to be interpreted Both Ivomec-treated and untreated groups fell from 60-70% with≥100 e p g at the start of the trial to 10% with ≥100 e.p g 3 months later

## DISCUSSION

The 140 hinds in this trial weighing 80 kg or less were the bottom 20% of the hind mob on this farm. The feed situation over the prolonged cold winter of 1992 in Canterbury had deteriorated so all the hinds were losing condition. The post-mortem examinations and the blood tests suggested that parasitism and copper deficiency were contributing to the problem of underfeeding and were seriously affecting a proportion of the hinds.

The decision to use double the cattle dose of Pour-on Ivomec was based on preliminary findings at Invermay and subjective assessments in the field that suggested this dose rate gave higher efficacy against abomasal adults and inhibited larvae in deer than the normal dose rate. Copper needles were used to increase their copper status and to investigate possible interactions with abomasal parasitism.

The most obvious result of the trial was the high mortality rate in hinds not receiving Ivomec Pour-on versus no deaths in Ivomec treated animals. The ten hinds that died were lighter than average. This and the necropsy data from the sacrificed hinds strongly suggest that parasitism was a significant factor contributing to the poor condition of these hinds. The loss of these light hinds from the non-Ivomec treated groups then tended to confound the liveweight response of the groups over the first period 14/9-3/11 For the second period the hinds were split into two mobs, Ivomec treated (1 and 2) and untreated (3 and 4). Efforts were made to graze both mobs similarly but the separation makes the results open to question Nevertheless, the weaning percentages showed very significant differences and this is unlikely to have been caused by small feed differences Overall the Ivomec treated hinds subjectively looked better, gained more weight and had better body scores over the summer period (3/11-24/3) The weaning percentage of Ivomec treated hinds was 86.7% versus 68.7% for untreated hinds (or 75.6% of hinds that survived to calving) Assuming that equal proportions of hinds were pregnant at the start of the trial this difference is presumably due to foetal death or abortions in spring, neonatal deaths and calf deaths prior to weaning, although no information is available on these components The calf weaning weights were also significantly higher for Ivomec treated hinds, although feed differences may also have affected this result

Copper supplementation did not produce any significant liveweight or bodyscore gains, although in the small group of very light hinds copper treatment was associated with significantly higher mean serum ferroxidase and total protein levels and significantly lower pepsinogen levels. However, the copper status of all the animals still remained low, even after treatment. Elevated abomasal pH may have reduced the availability of copper and ostertagiasis has been shown to result in the loss of copper in sheep (Bang, *et al.*, 1990b).

Ivomec treatment also significantly raised mean total protein and albumin levels and lowered pepsinogen levels in serum This suggests that treatment with Ivomec, by reducing abomasal parasitism, reduced protein loss from the gastrointestinal tract Low albumin levels are a consistent finding in the "fading elk" syndrome, which is now considered to be due to chronic severe abomasal parasitism in the majority of cases (Waldrup and Mackintosh, 1992) Copper may also have a local effect in the abomasum resulting in a reduction in serum pepsinogen levels possibly by reducing local inflammation as shown to occur in mice (Jones, 1984). Copperoxide needles have also been shown to reduce the establishment of some abomasal parasites in sheep (Bang, *et al*, 1990a). Nevertheless the mean pepsinogen levels in the present trial were fairly low and it did not appear to be a very useful measure of parasitism in these deer. The effects of copper treatment on the Se containing enzyme glutathione

peroxidase are hard to explain. Over the spring, GSHpx levels fell in most animals but significantly more in animals not receiving copper.

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