THE INCLUSION OF DIATOMACEOUS EARTH IN THE DIET OF GRAZING RUMINANTS AND ITS EFFECT ON GASTROINTESTINAL PARASITE BURDENS

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Abstract

Two studies were carried out to assess the efficacy of diatomaceous earth as an alternative to anthelmintics in grazing ruminants. Animals treated with anthelmintics and groups of untreated animals were included for comparison. Cattle and sheep which received a specifically chosen diatomaceous earth supplement had low Faecal Egg Counts (FEC) for the duration of the experimental period, similar to animals in the anthelmintic groups. Inclusion of a certain grade of diatomaceous earth in the diet of grazing ruminants may offer some benefits in controlling internal parasites.

Introduction

Organic systems seek to develop sustainable methods of production which balance output with high standards of animal welfare (Lampkin, 1990). Developing EU standards for organic livestock production have put downward pressure on the use of allopathic veterinary treatments (Keatinge, 1996), which in turn increases the urgency for the development of effective alternative strategies, if animal welfare is not to be comprised. In addition there is a need to substantiate popular claims for alternative treatments as to their efficacy and impact on animal welfare.

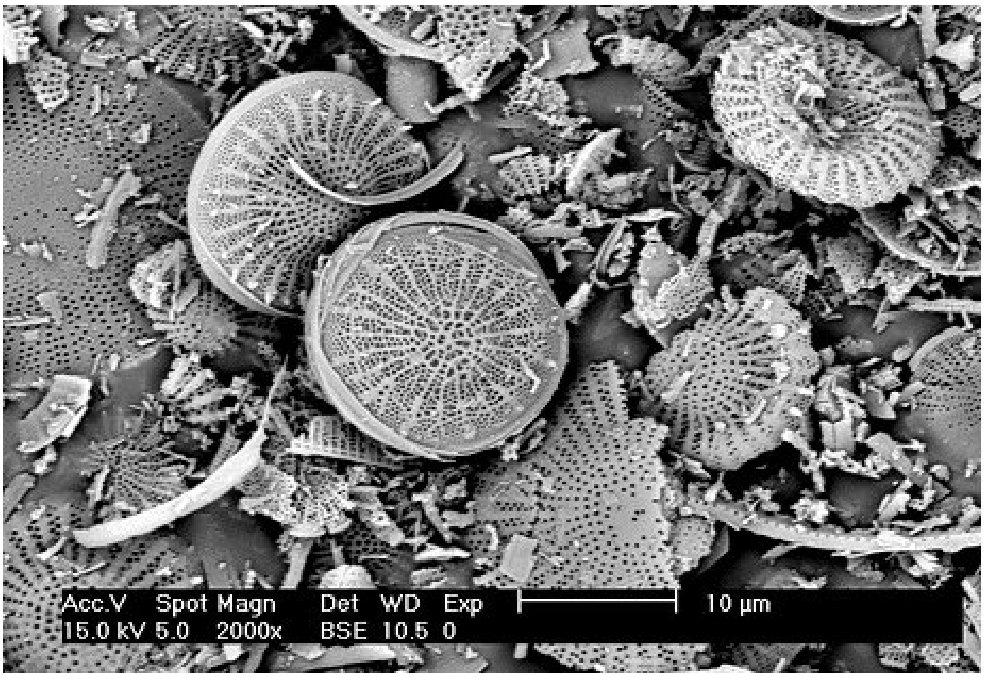
Heavy infestations of internal parasites in sheep result in poor performance of both ewe and lamb. Performance of young cattle is also affected by heavy parasite burdens. Under organic regulations, anthelmintics are permitted as a strategic dose in accordance with the farmer's overall strategy to reduce/eliminate the use of anthelmintics or where the farmer can show a need to drench i.e. faecal egg counts (FEC) of mobs or individuals are high and the animals are losing condition.

Alternative treatments to anthelmintics include diverse species grassland, nematode trapping fungi, mineral supplementation, herbal and homeopathic remedies. More recently the use of diatomaceous earth has also been advocated as an alternative treatment. Diatomaceous earth is the fossilised remains of diatom shells. After quarrying, crushing and milling, a fine light dust is obtained with certain abrasive properties and the ability to absorb lipids to about three times or more of the particle mass (Korunic, 1998). The action of diatomaceous earth on parasites is unclear but it has been suggested that the abrasive action of the powder pierces or scratches the outer protective layer of invertebrates including internal parasites, resulting in death by dehydration. However, diatomaceous earth is also rich in trace elements and it may be the enhanced nutritional status of the animals that has allowed them to cope with a parasite burden. However, to date only two papers have appeared in the scientific literature regarding the effect of diatomaceous earth on specific parasites and animal performance (Fernandez *et al*, 1999, Jordan, 1987) despite a plethora of popular press articles (Weehler, 1986, Sharabok, 1991, Macher, 1992, Cockrell, 1993, Wood, 1993). In addition a few state agriculture departments have also undertaken studies (Deutschlander, 1993, Osweiler & Carson, 1997). The results from all documented studies to date have been inconclusive with some studies reporting successful outcomes and others reporting little or no effect.

Given the proposed mechanism for the action of diatomaceous earth on parasites and the trace element effect, care was taken to choose a particular diatomaceous earth grade with an exceptional high surface area and oil absorption. The particular grade used in this study had previously been shown to have the greatest efficacy on insects in an independent study commissioned by World Minerals.

Base physical properties of the material chosen for this study are:-

Oil Absorption ASTM D281	220.0
Surface Area (m^2/g)	33.0
Particle Size d10 microns	4.9
Particle Size d50 microns	13.3
Particle Size d90 microns	26.6
Base Diatom Species	*Cyclostephanos*



SEM of the particular diatomaceous earth used

Chemical Composition

SiO_2	91	%	Cl	328	ppm	Co	5	ppm	Ge	1	ppm	Sm	0.4	ppm
LOI	3.54	%	F	118	ppm	Ga	3	ppm	Mo	1	ppm	Dy	0.3	ppm
Al_2O_3	2.29	%	V	172	ppm	Pd	3	ppm	W	1	ppm	Er	0.21	ppm
CaO	0.77	%	Ba	106	ppm	La	2.3	ppm	Br	<1	ppm	Ag	0.2	ppm
Fe_2O_3	0.66	%	Sr	83.8	ppm	Nd	2.3	ppm	Hf	0.7	ppm	Yb	0.2	ppm
MgO	0.42	%	Zr	19.5	ppm	Sc	2.2	ppm	U	0.69	ppm	Cd	<0.2	ppm
Na_2O	0.33	%	B	15	ppm	As	2	ppm	Pr	0.57	ppm	Eu	0.13	ppm
C(total)	0.27	%	Zn	14.2	ppm	Nb	2	ppm	Be	<0.5	ppm	Tl	<0.1	ppm
K_2O	0.25	%	Cr	9	ppm	Pb	2	ppm	Bi	<0.5	ppm	Ho	0.06	ppm
C(org)	0.14	%	Ni	9	ppm	Sn	<2	ppm	In	<0.5	ppm	Tb	0.06	ppm
TiO_2	0.12	%	Rb	8.4	ppm	Sb	1.7	ppm	Se	<0.5	ppm	Lu	<0.05	ppm
S	0.06	%	Cu	7	ppm	Cs	1.5	ppm	Ta	<0.5	ppm	Tm	<0.05	ppm
MnO	0.02	%	Li	6	ppm	Y	1.5	ppm	Te	<0.5	ppm	Pt	<10	ppb
P_2O_5	<0.01	%	Ce	5.2	ppm	Th	1	ppm	Gd	0.42	ppm	Au	<2	ppb

It is proposed that one possible explanation for the lack of reliable data in this area is that the choice of diatomaceous earth is critical to the effect seen. There is tremendous variation between these properties from source to source and as such make the results seen particular to a specific grade and source of diatomaceous earth.

Methodology

Two studies were carried out to assess the efficacy of diatomaceous earth as an alternative to anthelmintics in grazing ruminants. Study 1 was carried out with yearling Welsh Black Heifers. Study 2 was carried out with single rearing organic ewes.

Both studies were carried out under conditions of naturally acquired infections, with all heifers grazing the same pasture and all ewes and lambs grazing the same pasture. In both studies an anthelminitc treatment was included to replicate conventional farming practice in the UK. This treatment was administered regardless of FEC at the start of the trial.

In study 1, 18 yearling welsh black cattle were assigned to one of three treatment groups.

- Group 1: a control group where no treatments were applied
- Group 2: were treated with an anthelmintic drench prior to turn out
- Group 3: received a daily supplement of diatomaceous earth (2% of daily DM intake).

The supplement of diatomaceous earth was mixed with rolled barley and fed every morning to the group. Groups 1 and 2 also received a similar ration of rolled barley. Cattle were turned out onto improved grass pastures which had previously been grazed by sheep during the late autumn and then stock free during winter and early spring. Faecal samples were taken and cattle were weighed prior to treatments being applied. Individuals were then randomly allocated to treatments so that each treatment was balanced for FEC and liveweight. Cattle were then weighed at weeks 4, 8 and 10. Faecal sample were taken from individuals on a weekly basis

In study 2, 45 single bearing pregnant ewes were allocated to one of three treatment groups.

- Group1: A control group where no treatments were applied
- Group2: All ewes were drenched prior to turning out with lamb on to grazing pasture
- Group3: All ewes were given a daily supplement of Diatomaceous Earth post lambing

Faecal samples were taken prior to treatments being applied. Ewes were weighed and CS x weeks prior to lambing. Ewes were then randomly allocated to treatment groups, balanced for FEC and liveweight. The supplement of diatomaceous earth was mixed with rolled barley and fed every morning to the group. Groups 1 and 2 also received a similar ration of rolled barley. Ewes and lambs were turned out onto improved grass pastures which had not been grazed for at least three months.

Faecal samples were taken on a weekly basis for at least six weeks post lambing. Ewes were weighed and condition scored at four and eight weeks post lambing. Lambs were weighed at birth, four weeks, eight weeks and ten weeks of age.

In both studies, all liveweight data was analysed by ANOVA (Genstat, Lawes Agricultural Trust). All FEC data was Square root transformed prior to carrying out ANOVA. This transformation was performed to reduce the variation between animals in FEC. After statistical analysis FEC data was power transformed back to epg data.

Results and brief discussion

The physical performance results from study 1 are summarised in Table 1 below. In the cattle study (Study 1) there were no significant differences between treatment groups in terms of liveweight gain. There were significant differences in FEC (see Figure 1) however, with cattle in the control group (untreated) having significantly higher ($P<0.05$) FEC (404 epg) at week 7 compared to cattle in the drench group (137 epg). Cattle in the diatomaceous earth group had lower FEC (172 epg) in week 7 than cattle in the control group but this just missed significance.

Table 1: Physical performance of cattle in Study 1

	Control	Drench	Diatomaceous earth	SED	Significance
<u>Liveweight (kg)</u>					
Week 0	251.2	255.5	255.2	14.69	NS (P>0.05)
Week 4	256.0	257.0	250.0	12.60	NS (P>0.05)
Week 8	279.2	281.8	276.7	12.63	NS (P>0.05)
Week 10	289.8	283.8	280.5	10.05	NS (P>0.05)
Weekly liveweight gain	4.01	3.57	2.97	0.854	NS (P>0.05)
Daily liveweight gain	0.57	0.51	0.42	0.122	NS (P>0.05)

Figure 1: Effect of treatment on FEC of yearling cattle post turnout

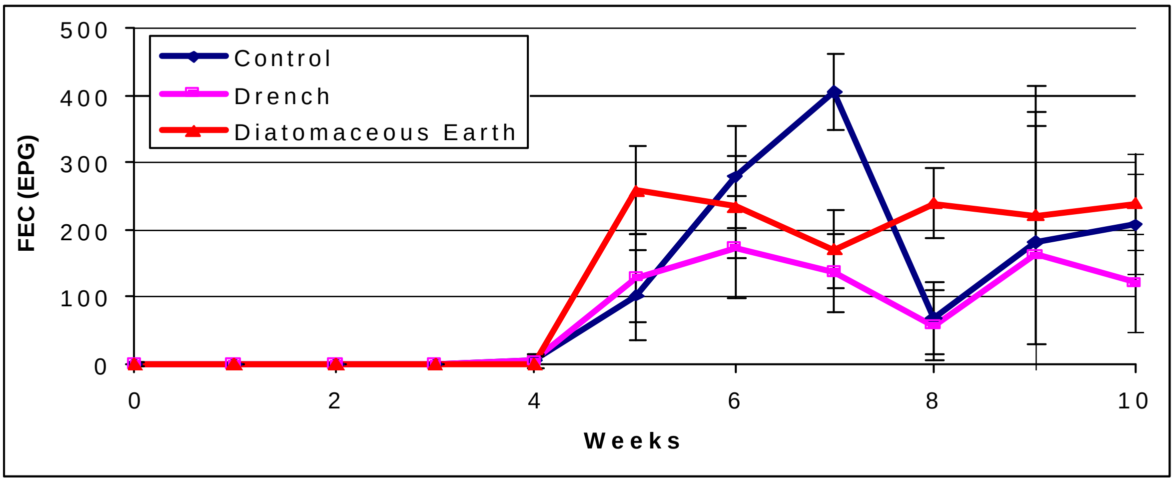


Table 2: Effect of treatment on FEC of yearling cattle post-turnout

	CONTROL	DRENCH	DIATOMACEOUS EARTH	SED	Significance
WEEK 0	0	1	0	1.5	NS
WEEK 2	0	0	0	0.0	NS
WEEK 3	0	0	0	0.0	NS
WEEK 4	4	6	1	11.1	NS
WEEK 5	102	130	259	65.6	NS
WEEK 6	279	174	234	75.7	NS
WEEK 7	404[a]	137[b]	172[ab]	57.6	*
WEEK 8	69	58	240	52.3	NS
WEEK 9	182	164	222	192	NS
WEEK 10	207	121	240	73.0	NS

NS – Not significantly different
Values not sharing common superscripts differ significantly (P<0.05)

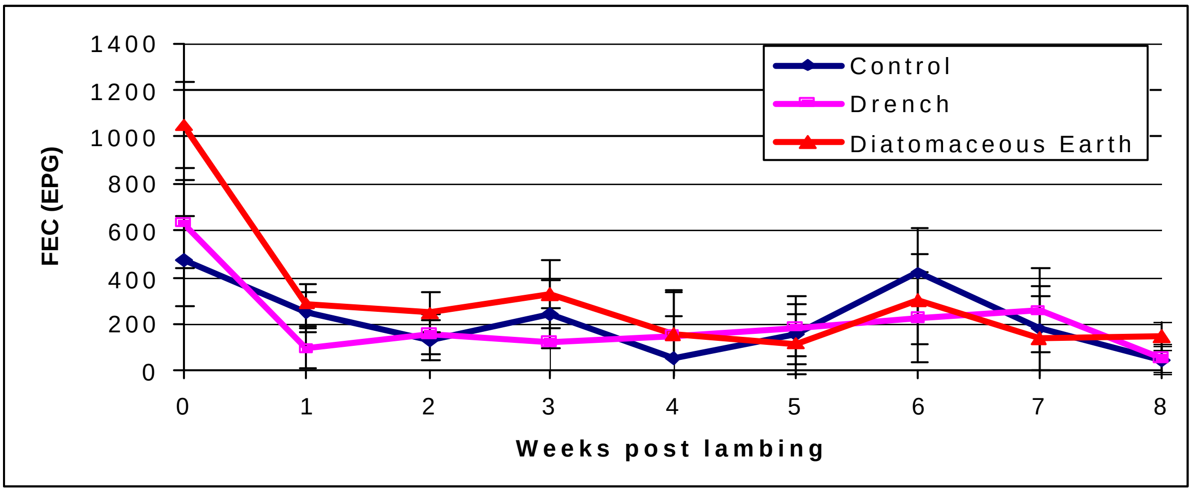
The physical performance results from study 2 are summarised in Table 3 below. In the sheep study (Study 2) ewes in the diatomaceous group had significantly heavier (P<0.05) liveweights than ewes in the drench group (51.6 *vs*. 45.9 kg respectively) at eight weeks post lambing. There were no differences between the diatomaceous earth group and the control group. By 10 weeks of age lambs from ewes receiving the diatomaceous earth treatment were significantly heavier (P<0.05) than lambs from ewes in the drench group (24.4 *vs*. 20.1 kg respectively). There were no significant difference in FEC between treatment groups prior to or post lambing (See Figure 2). There was however a trend for the ewes in the drench group to have lower FEC than the other two groups. It was noted that the group treated with anthelmintics, did not have 0epg after treatment. This may be due to two reasons, either treated ewes have populations of anthelmintic resistant parasites in their gastro-intestinal tract or the anthelmintic was not administered correctly. Follow-up studies on anthelmintic resistance is being followed up with this group of ewes.

Table 3: Physical performance of lambs in study 2

	Control	Drench	Diatomaceous earth	SED	Significance
Liveweight (kg)					
Birth	3.94	4.03	4.45	0.308	NS (P>0.05)
Week 4	11.0	11.1	12.8	1.484	NS (P>0.05)
Week 8	18.2	18.2	20.9	1.820	NS (P>0.05)
Shearing	21.1[ab]	20.1[a]	24.4[b]	1.997	* (P<0.05)

Values on the same row bearing different superscripts differ significantly

Figure 2: Effect of treatment on FEC of ewes post lambing



Conclusions

Inclusion of a specific type of diatomaceous earth in the diet of grazing ruminants may offer some benefits in controlling internal parasites, however longer term studies are required to determine optimal quantities and duration of inclusion.

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