

Selenium and Vitamin E and Incidence of Retained Placenta in Parturient Dairy Cows¹

W. E. JULIEN² and H. R. CONRAD

Department of Dairy Science

J. E. JONES

Department of Veterinary Science, and

A. L. MOXON

Department of Animal Science

Ohio Agricultural Research and Development Center

Wooster 44691

ABSTRACT

In a $2 \times 2 \times 2$ factorial experiment, protein intake, selenium supplementation, and intake of phosphorus were related to the incidence of retained placenta in cows fed varying concentrations of these nutrients during the dry period. The population incidence of 38% retained placenta in 26 control cows was independent of phosphorus intake which ranged between 39 and 95 g per day. When a protein supplement was included in the concentrate as soybean meal, the incidence of retained placenta was reduced to 20% for supplemented animals from 50% for the animals that received no soybean meal. This increased protein in the ration was reflective of a mean increase from .02 ppm of selenium to .06 ppm of selenium in the ration. By increasing the mean daily intake of selenium at least 3 wk prepartum from .23 mg to .92 mg daily, overall incidence of retained placenta was reduced from 38% to 0%. A positive prophylactic effect was achieved regardless of whether alpha tocopherol was supplemented as well. These mature dairy cows were deficient in selenium, and supplementation of selenium reduced the incidence of retained placenta.

INTRODUCTION

Retained placenta is the failure of the fetal placenta to separate from the maternal pla-

centa. Placental retention occurs in about 10% of parturient dairy cows (2); incidence two to three times greater has been reported (1). Placental retention increased incidence of uterine infection to 54% in affected animals as compared to 10% for cows which expelled their fetal placenta normally (9). Since nearly 25% of the professionally treated diseases of dairy cattle are associated with genital infections (15), the economic significance of retained placenta should not be underestimated.

Fetal membrane retention has not been related to a specific syndrome but rather to a number of physiological, pathological, environmental, and nutritional factors. The general etiology of retained placenta has been reviewed by Roberts (15), Wetherhill (20), and Muller et al. (9).

The importance of prepartal nutrition as it affects the incidence of retained placenta has been suggested by several authors (3, 15, 20). It has increased in avitaminosis A (10, 15, 16) and iodine deficiency (6, 7). Pelissier (13) and Noorsdsy et al. (11) indicated that retention rate was correlated positively with imbalances in calcium and phosphorus metabolism. Trinder et al. (17, 18) observed higher retention rates in herds with correspondingly greater problems of nutritional muscular dystrophy and were able to reduce incidence through the supplementation of selenium and vitamin E. Observing an abnormally high incidence of retained placenta in an area with a history of white muscle disease, Trinder et al. (17) suggested that retention may be related to a deficiency of vitamin E but implicated the element selenium as well, white muscle disease being responsive to both. In a series of experiments, these workers found that injection of vitamin E and/or selenium significantly reduced retention rate and that injection of vitamin E and selenium together was more effective than

Received May 27, 1976.

¹Approved as Journal Article No. 91-76, Ohio Agricultural Research and Development Center, Wooster 44691.

²Data presented to the Graduate Faculty of The Ohio State University in partial fulfillment of the requirement for the degree Doctor of Philosophy (March, 1976).

either substance injected alone in its prevention. In a later study (18), dry cows fed a ration containing .025 to .047 mg per g of dry matter of selenium still had a high incidence of retention, although in another group of dry cows a combined injection of vitamin E and 15 mg of selenium 1 mo before the projected calving date was effective in reducing this incidence. Fifteen milligrams of selenium injected as potassium selenate were slightly less effective. Selenium in blood in herds with high retention rates was significantly lower than in herds with no history of retained placenta. These data indicate that there is a possible relationship between uterine health and selenium and/or vitamin E deficiency. This hypothesis is strengthened in that the herds were on summer pasture which more than adequately met their requirements for vitamin A, and the ration was balanced for all the nutrients except selenium and vitamin E. However, Horvath (4) in a study of 3 yr duration was unable to show a significant prophylactic effect when 15 mg of selenium and vitamin E were injected 20 days prepartum in dairy cows. Both source and concentration of selenium and vitamin E were identical to those in Trinder's study. The reason for the apparent discrepancy in results in the two studies is not known.

The importance of mineral metabolism particularly regarding phosphorus and selenium to this disorder, although suggested, has not been examined extensively. The importance of protein intake in the dry cow ration and its effect on parturient health also have been a concern of this laboratory (5). This study was initiated to determine the relation of each of these nutrients to retained placenta in the dairy cow.

MATERIALS AND METHODS

Fifty-three dry cows of the Ohio Agricultural Research and Development Center dairy herd were placed in one of four groups for the entire dry period in a $2 \times 2 \times 2$ factorial design. All cows received a corn silage-concentrate ration that varied in concentrations of dietary selenium, protein, and phosphorus content. Groups 1 and 2 consumed an 8% crude protein diet which contained selenium at .02 ppm for the rations. Groups 3 and 4 received a ration which was 15% crude protein and contained a basal selenium of .07 and .05 ppm,

TABLE 1. Nutrient content of rations fed to groups 1, 2, 3, and 4.

Group no.	Ration constituents	Crude protein	Crude fiber	(% of dry matter)				Mg	Se (ppm)
				TDN	Ca	P			
1	60% Corn silage 40% D-401	8.5	22.0	72.6	.65	.29		.20	.02
2	60% Corn silage 40% D-402	8.5	21.0	70.1	.70	.70		.23	.02
3	61% Corn silage 24% Alfalfa pellets 15% D-403	15.0	23.0	68.7	.66	.30		.26	.07
4	70% Corn silage 30% D-404	15.2	31.0	70.1	.63	.65		.19	.05

TABLE 2. Ingredients list for grain mixes D-401, D-402, D-403, and D-404.

Ingredients	Grain mixes			
	D-401	D-402	D-403	D-404
	(%)			
Corn, rolled	67.128	64.578	15.798	16.228
Corn cobs, ground	26.29	25.33	...	...
Soybean meal	...	...	69.82	70.45
Molasses, Sweetone	1.23	1.37	7.9	2.12
Magnesium and potassium sulfate ^a	1.23	1.37	...	...
Dicalcium phosphate ^b	...	5.55	5.98	10.7
Salt, trace mineral ^c	.5	.5	.5	.5
Vitamin A-30 ^d	.01	.01	.01	.01
Limestone	3.62	1.30	...	...

^aAnalysis: S 22% min., K 18% min., Mg 11% min. "Dynamate," International Minerals and Chemicals Corp., Libertyville, IL.

^bAnalysis: P 21% min., Ca 15% min., F .21% max. "BioFos," International Minerals and Chemicals Corp., Libertyville, IL.

^cAnalysis: NaCl 9.5% min., Cu .035% min., I .007% min., Co .007% min. The Morton Salt Co., Rittman, OH.

^dAnalysis: 89% soybean mill run; 30,000 USP units of vitamin A per gram as vitamin A palmitate; 41% ethoxyquin; other additives include gelatin, sugar, starch, butylated hydroxy toluene, and butylated hydroxy anisol.

respectively. In groups 1 and 3, .68% of their dry matter intake was calcium and .29% phosphorus. The ration fed group 2 contained .70% calcium and .70% phosphorus while group 4 received .66% calcium and .65% phosphorus. The ingredients in these rations and their nutrient content are summarized in Tables 1 and 2. The average amounts of corn silage and grain concentrate fed varied with average body weight and number of animals that were in a treatment group at a particular time. This was based upon the estimated dry matter consumption of 2% of the body weight per head per day. Silage and grain concentrate were fed to allow for a 10% refusal over the estimate. Animals were fed once daily. Water and iodized salt were offered ad libitum.

Jersey or Holstein cows 3 yr of age or older were used in this study. Cows were assigned randomly to treatment subsequent to the final milking and maintained throughout the dry period in their respective treatment groups.

Selenium was administered to half the animals in each of the four groups. Initially, selenium was given orally as selenite in bolus form, 6 mg of selenium being administered at the time of treatment assignment. Selenium of plasma did not rise after these were adminis-

tered (Table 3), and the cows were excluded from the incidence data. Consequently 12.5 mg of selenium as sodium selenite were given as an oral bolus on a daily basis for 5 days on treatment assignment and weekly thereafter to subsequent cows. A second selenium treatment involved a 10 cc intramuscular injection of a selenium/vitamin E preparation (Mu Se, Burns Biotec, Oakland, CA), 50 mg of selenium as sodium selenite, and 680 IU of vitamin E as alpha tocopherol acetate, approximately 21 days prior to freshening. Both the revised oral method of supplementation and the 21 day prepartum injection adequately raised plasma selenium to values approaching the .1 ppm concentration at the time of parturition (Table 3).

Animals retained their fetal placenta if the membranes were still visible or palpable after a 12 h postpartum period.

Samples of corn silage and grain concentrate were taken at monthly intervals and analyzed for protein by Kjeldahl nitrogen; calcium and phosphorus were determined by atomic absorption spectroscopy after wet ashing (8). Selenium content of the rations fed was determined by the method of Olson (12). Twenty milliliters of whole blood were collected in heparinized

TABLE 3. Effect of route of administration and selenium supplementation upon selenium concentration in plasma of treated preparturient dairy cows.

Method of supplementation	Plasma selenium concentration			
	60 days prepartum	20 days prepartum	10 days prepartum	Day of parturition
	(ppm)			
Treatment A ^a	.021	.033	.031	.025
Treatment B ^b	.023	.082	.083	.084
Treatment C ^c	.024	.025	.065	.085

^aSingle 6 mg oral bolus of sodium selenite.

^bOral bolus of 12.5 mg of sodium selenite given for 5 days beginning at 60 days prepartum and supplemented once weekly with 12.5 mg of sodium until parturition.

^cAn intramuscular injection of 50 mg of sodium selenite and 680 IU of alpha tocopherol acetate given 20 days prepartum.

tubes either from jugular or tail vein of all cows prior to entering their respective treatments and at regular intervals thereafter. Plasma calcium and magnesium analyses were accomplished by atomic absorption spectroscopy (14). Phosphorus of plasma was found by colorimetric analysis with a modified AOAC procedure (13); selenium in plasma was measured by the method of Olson (12).

RESULTS AND DISCUSSION

Incidence of retained placenta was reduced in those cows treated with selenium or selenium and vitamin E ($P < .01$). Incidence also was affected by protein intake (Table 4). No effect

was noted when retention rates were correlated with phosphorus or calcium intake, however.

Selenium supplementation reduced the overall incidence of retained placenta from 38% in the control cows to 0% in those treated. This prophylactic action of selenium was similar regardless of the route of supplementation and did not appear to be dependent upon vitamin E (Table 4).

This study suggests that retained placenta may be a clinical expression of a selenium deficiency in the mature dairy cow. This is supported by several lines of evidence. A comparison of the incidence of retained placentas between control cows of groups 1 and 2 consuming a basal selenium concentration of

TABLE 4. Incidence of retained placenta in groups 1, 2, 3, and 4 in selenium and selenium and vitamin E treated and untreated parturient dairy cows.

	Group 1	Group 2	Group 3	Group 4
	(%)			
Protein	8	8	15	15
Calcium in diet	.65	.70	.66	.66
Phosphorus in diet	.29	.70	.30	.65
Treated incidence				
Oral ^a	0/2 = 0	0/3 = 0	0/3 = 0	0/3 = 0
Injected ^b	0/2 = 0	0/1 = 0	0/1 = 0	0/1 = 0
Total	0/4 = 0	0/4 = 0	0/4 = 0	0/4 = 0
Control incidence	4/8 = 50	4/8 = 50	1/5 = 20	1/5 = 20

^a12.5 mg of sodium selenite daily for 5 consecutive days at treatment assignment and 12.5 mg of sodium selenite once weekly until parturition.

^b50 mg of sodium selenite and 680 IU of alpha tocopherol acetate as an intramuscular injection 20 days prepartum.

.02 ppm (50%) and control cows of groups 3 and 4 consuming a ration containing an average of .065 ppm (20%) was suggestive of this fact. The total consumption of selenium in groups 1 and 2 was approximately .23 mg of selenium per head per day while in groups 3 and 4 basal consumption of selenium was approximately .76 mg per head per day. In this case the additional selenium, .53 mg per head per day, was supplied by the protein concentrate fed to groups 3 and 4. Based upon the selenium-75 studies of Waite et al. (19), the total amount of biologically available selenium contributed by the lower selenium ration would be less than or equal to .03 mg per day. This is compared to the .09 mg of available selenium contributed by the higher selenium diet. This amounts to a three-fold increase for cows on the higher selenium ration. Although unable entirely to alleviate the apparent deficiency condition, as indicated by low blood selenium in control cows (average .03 ppm) and the 20% retention rate, this difference in selenium intake apparently had a sparing effect upon the incidence of retained placenta.

Further evidence supporting the relative importance of selenium in the observed prophylactic action is only 5 of the 15 treated animals received additional vitamin E supplementation, yet no difference in efficacy was noted between vitamin E supplemented and unsupplemented (Table 4). As all groups were consuming diets that would be essentially similar in their alpha tocopherol content, the additional supplementation of 680 IU of vitamin E appears to be unnecessary.

The significant reduction in retained placenta between protein intake groups (Table 4) suggests that protein as well as selenium is involved in the etiology of this condition. Protein is also the natural dietary source of selenium in these rations. The protein consumed thus correlates with selenium in the diet. Thus, the apparent positive effect of increased protein consumption possibly is mediated by the increased intake of selenium.

The proposed relationship between retained placenta and calcium and more importantly phosphorus nutrition was not confirmed in this study. The reduction in incidence in all cases is correlated significantly only with selenium supplementation and not with calcium and phosphorus intake.

It appears that retained placenta in the parturient dairy cow, when not induced mechanically or pathogenically, can be controlled effectively by either an intramuscular injection of 50 mg of selenium as selenite and 680 IU of vitamin E given approximately 21 days prepartum or by feeding an equivalent average daily intake of .92 mg of selenium as selenite during the last 60 days of the dry period. The correlation between supplementation of selenium and reduction in incidence of retained placenta and the inverse relationship between selenium content in the diet and retention incidence indicate that retained placenta is an expression of a selenium deficiency in the mature dairy cow.

REFERENCES

- 1 Callahan, C. J. 1969. Postparturient infection of dairy cattle. *J. Amer. Vet. Med. Ass.* 155:1963.
- 2 Erb, R. E., P. M. Hinze, E. M. Gildow, and R. H. Morrison. 1958. Retained fetal membranes—The effect on prolificacy of dairy cattle. *J. Amer. Vet. Med. Ass.* 133:489.
- 3 Guicero, R. T. C. 1959. Retained fetal membranes in cows. *J. Amer. Vet. Med. Ass.* 135:475.
- 4 Horvath, D. J. 1975. Personal communication.
- 5 Julien, W. E., and H. R. Conrad. 1975. Dietary components affecting metabolic disorders at parturition. Ohio Agr. Res. Dev. Center, Dairy Sci. Dep. Series 19(6).
- 6 McDonald, R. J., G. W. McKay, and J. D. Thompson. 1961. The use of organic iodine in the treatment of repeat breeder cows. *Proc. 14th Int. Congr. Anim. Reprod.* 3:679.
- 7 Moberg, R. 1961. Possible influence of supplementary iodine, administered by evaporation on reproductive performance in cattle. *Proc. 14th Int. Congr. Anim. Reprod.* 3:682.
- 8 Muir, L. A. 1970. Estrogen and progesterone balance and the control of calcium mobilization in the bovine. Ph.D. Dissertation. The Ohio State University, Columbus.
- 9 Muller, L. D., and M. J. Owens. 1974. Factors associated with the incidence of retained placentas. *J. Dairy Sci.* 57:725.
- 10 Nicholasan, J. W. G., and H. M. Cunningham. 1965. Retained placenta, abortion and abnormal calves from beef cows fed all barley rations. *Cornell Vet.* 6:275.
- 11 Noordsy, J. L., H. W. Leipold, D. L. Carmahan, R. A. Frey, J. Vestweber, M. G. Robl, G. Kennedy, J. R. Dunham, T. E. Chapin, and W. E. Moore. 1973. Metabolic disturbances in the dairy cow influenced by managerial practices—Case reports and epidemiological studies. Rumen Function Conf., Chicago, IL.
- 12 Olson, O. E. 1969. Fluorometric analysis of selenium in plants. *J. Ass. Off. Agr. Chem.* 42:627.
- 13 Pelissier, C. L. 1972. Herd breeding problems and

- their consequences. *J. Dairy Sci.* 55:385.
- 14 Preston, R. L. 1970. Procedures book.
- 15 Roberts, S. J. 1961. Page 225 in *Veterinary obstetrics and genital diseases*. Edwards Bro., Ann Arbor, MI.
- 16 Ronning, M., E. R. Berousek, A. H. Kuhlman, and W. D. Gallup. 1953. The carotene requirements for reproduction in Guernsey cattle. *J. Dairy Sci.* 36:52.
- 17 Trinder, N., and C. P. Rentan. 1973. The relationship between the intake of selenium and vitamin E on the incidence of retained placentae in dairy cows. *Vet. Rec.* 93:641.
- 18 Trinder, N., C. D. Woodhouse, and C. P. Rentan. 1969. The effect of vitamin E and selenium on the incidence of retained placentae in dairy cows. *Vet. Rec.* 85:550.
- 19 Waite, R., H. R. Conrad, and A. L. Moxon. 1975. Metabolism of selenium and selenium-75 in dairy cows. *J. Dairy Sci.* 58:749. (Abstr.)
- 20 Wetherhill, G. D. 1965. Retained placenta in the bovine: A brief review. *Can. Vet. J.* 6:290.