

The relationship between plasma progesterone concentration during the early luteal phase and embryo survival in dairy heifers

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Introduction In cattle, early embryo death is a major cause of cow reproductive wastage. Low post ovulatory systemic progesterone (P4) or a delay in the normal increase in P4 concentrations during the early luteal phase have been associated with reduced embryo survival rate in dairy cows. However, the relationship(s) between systemic concentrations of P4 during the early luteal phase and the repeatability of these from cycle to cycle is as yet unequivocal. The objective of this study was to establish i) the relationships between plasma concentrations of P4 during the early luteal phase and subsequent embryo survival rate and ii) the repeatability of P4 concentrations during the early luteal phase from cycle to cycle in dairy heifers.

Materials and methods A total of 118 Holstein-Friesian heifers were used in the study. Oestrus was synchronised using two injections of a synthetic prostaglandin F_{2α} analogue administered intramuscularly 11 days apart. At the oestrus following the second PGF_{2α} injection, heifers were artificially inseminated (AI) by one of two operators using thawed frozen semen from one high fertility bull. Embryo survival was determined by ultrasonography on day 30-35 after AI. A positive pregnancy diagnosis was based on the presence of an apparently viable foetus with a visible heartbeat and clear amniotic fluid. Following pregnancy diagnosis all heifers were injected with PGF_{2α} to induce embryo loss and return to oestrous cycles. Six weeks after the induced embryo loss, the entire experimental protocol was repeated on all heifers. All inseminated heifers were blood sampled twice daily (am and pm) on days 4, 5, 6 and 7 following each insemination. Concentrations of P4 were determined by radioimmunoassay (Coat-a-Count) and a mean concentration of P4 was calculated for each day. Logistic regression was used to evaluate the relationship between plasma concentrations of P4 on days 4,5,6 & 7 post insemination and embryo survival rate. Quadratic components included in the final model were significant. Regression analysis was used to evaluate the relationships between P4 on different days. Repeatability estimates (r_c) for P4 were derived from an analysis of variance as the intraclass correlation among records on the same heifer on the same day for the two different rounds of insemination

Results Embryo survival rate of heifers was 67 and 79% (P=0.06) following inseminations 1 and 2, respectively. There was a positive linear (P<0.01) and quadratic (P<0.01) association between concentrations of P4 on days 4, 5, 6 and 7 post insemination and changes (Δ) in P4 on days 4 to 5 and 7 and embryo survival rate (Table 1). Higher embryo survival rates were initially associated with increasing concentrations of P4 while embryo survival rates declined at the highest concentrations of P4.

Table 1 The relationship between early luteal phase concentrations of P4 and embryo survival (presented as Odds Ratios (OD)) in dairy heifers with upper and lower confidence intervals (CI)

	Adj R ²	Progesterone fitted as Linear Component				Progesterone fitted as Quadratic Component			
		OD	Lower CI	Upper CI	Significance	OD	Lower CI	Upper CI	Significance
Day 4	0.085	11.986	2.559	56.138	P<0.002	0.554	0.372	0.827	P<0.004
Day 5	0.01	5.098	1.550	16.765	P<0.01	0.789	0.641	0.972	P<0.03
Day 6	0.11	3.732	1.695	8.219	P<0.001	0.874	0.791	0.965	P<0.01
Day 7	0.17	14.803	3.267	67.068	P<0.001	0.770	0.661	0.897	P<0.001
Δ4-7	0.15	9.810	2.502	38.459	P<0.001	0.723	0.592	0.883	P<0.001
Δ5-7	0.08	3.142	1.280	7.71	P<0.01	0.784	0.638	964	P<0.02
Δ6-7	0.003	0.049	0.762	1.445	P>0.801	-	-	-	-

Repeatability estimates for plasma concentrations of P4 on days 4 to 7 varied from 0.05 to 0.20. The relationships between concentrations of P4 on days 4, 5, 6 to concentration on day 7 are presented in Table 2.

Table 2 The relationship between concentrations of P4 on days 4, 5 and 6 to that on day 7

Dependent Variable	Relationship to Day 7 Concentration	R ²	Significance
Progesterone on Day 7	3.01+1.94(P ₄ on Day 4) -0.066(P ₄ on Day 4) ²	0.22	P<0.001
Progesterone on Day 7	1.97+1.14(P ₄ on Day 5) -0.04(P ₄ on Day 5) ²	0.39	P<0.001
Progesterone on Day 7	1.24+1.066(P ₄ on Day 6) -0.04(P ₄ on Day 6) ²	0.57	P<0.001

Conclusions There was both a linear and quadratic relationship between concentrations of P4 on days 4 to 7 and changes in P4 between these days and embryo survival rate. Increasing concentrations of P4 were associated with increasing embryo survival rates while embryo survival declined at higher concentrations of P4. Early luteal phase concentrations of P4 had a low repeatability from cycle to cycle. Early luteal (days 4-5) concentrations of P4 were a reasonable predictor of concentrations on day 7 and could be used to predict animals at risk of embryo loss.

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