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Some Effects of Feeding Supplemental Fat to Beef Cattle

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SOME EFFECTS OF FEEDING SUPPLEMENTAL FAT TO BEEF CATTLE

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Introduction

Meeting nutrient requirements of the replacement of heifer and the pregnant or lactating heifer and cow is of critical importance in assuring optimum reproductive performance. It is well recognized that these nutrients include protein, energy, minerals, vitamins, dry matter, and water. Recent research has indicated adequate fat may be an additional nutrient that needs to be present in the diet. This presentation will review some of our recent work on the effects of feeding additional fat on potential cold tolerance in the newborn calf, development of the replacement heifer, rebreeding of the lactating dam, and weaning weight of her calf.

Cold Tolerance in Newborn Calves

Work in our laboratory has focused on methodology to increase neonatal calf survival. Lammoglia et al. (1999a) investigated effects of prepartum supplementation of dietary fat on cold tolerance and hormone and metabolite profiles in cold-exposed calves. In Study 1, dams received prepartum isocaloric-isonitrogenous diets containing 1.7 (basal control) or 4.7% dietary fat (basal plus safflower seeds with 37% oil and 79% of the oil was linoleic acid). Diets were fed from day 230 of gestation until parturition. At 4 hr of age, calves received jugular cannulae and at 5 hr of age were placed in a controlled temperature room at 32°F for 140 minutes. Rectal temperatures and blood samples were obtained throughout the cold exposure phase. Results are summarized in Figures 3 and 4.

The procedures for Study 2 (Lammoglia et al., 1999b) were similar to Study 1 with diet supplementation beginning on day 228 of gestation and continuing until parturition. Diets were formulated to be isocaloric-isonitrogenous and contained either 2.2% (basal control) or 5.1% (basal + safflower seeds with 37% oil and 79% linoleic fatty acid). In this study, we examined whether the effects on calf response to cold exposure was the same as in Study 1, and whether this response differed in double-muscled calves. At 4 hr of age, calves received a jugular cannula, and at 5 hr of age were placed in the controlled temperature room at 32°F for 140 min. This study included Piedmontese-cross calves as the double-muscled and Hereford-cross calves

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[1]This research was conducted under a cooperative agreement between USDA-ARS and the Montana Agric. Exp. Sta. Mention of a proprietary product does not constitute a guarantee or warranty of the product by USDA, Montana Agric. Exp. Sta., or the authors and does not imply its approval to the exclusion of other products that may also be suitable. USDA, Agricultural Research Service, Northern Plains Area, is an equal opportunity/affirmative action employer and all agency services are available without discrimination.

Figure 3. Rectal temperature of newborn calves exposed to 32 °F for 140 min and born to cows receiving 1.7% (LH) or 4.7% (HF) dietary fat 53 d before calving ($P < .01$).

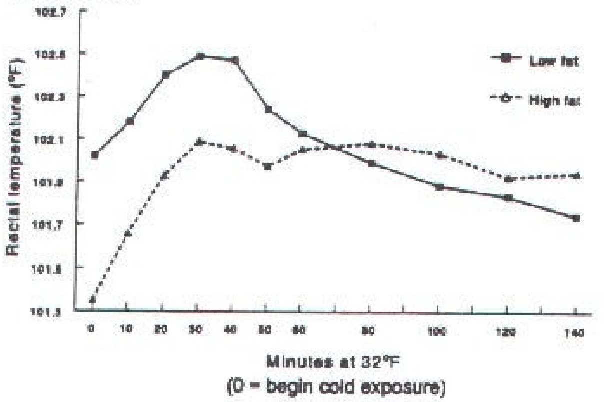


Figure 4. Plasma glucose concentrations of newborn calves exposed to 32 °F for 140 min and born to cows receiving 1.7% (LH) or 4.7% (HF) dietary fat 53 d before calving ($P < .01$).

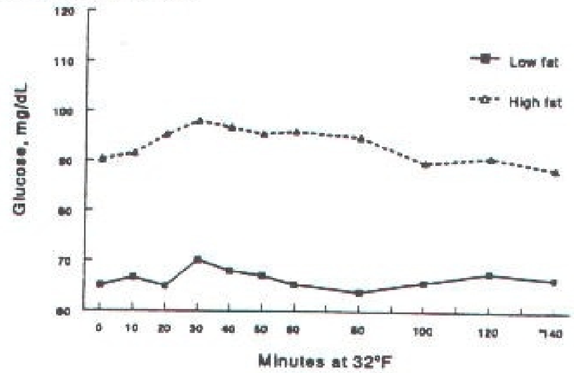


Figure 5. Rectal temperature of newborn calves exposed to 32 °F for 140 min and born to cows receiving 2.2% (LF) or 5.1% (HF) dietary fat for 55 d before calving ($P < .01$).

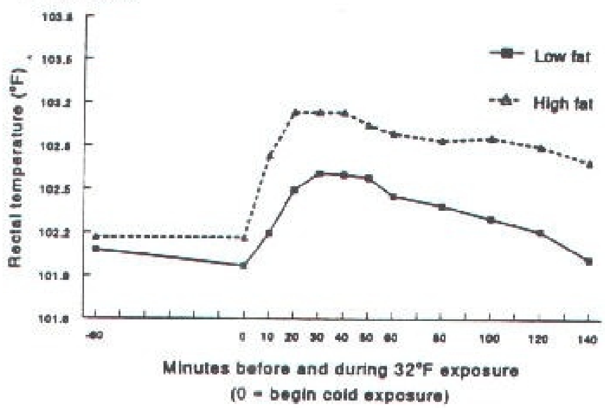


Figure 6. Plasma glucose concentrations of newborn calves exposed to 32 °F for 140 min and born to cows receiving 2.2% (LF) or 5.1% (HF) dietary fat for 55 d before calving ($P = .06$).

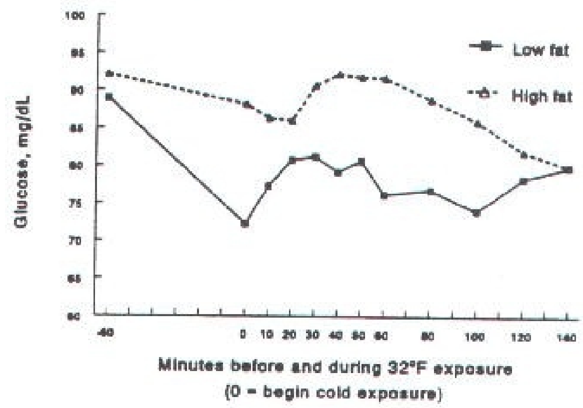


Figure 7. Rectal temperature of newborn Hereford-cross (F2HX) or Piedmontese-cross (F2PX) calves exposed to 32 °F for 140 min ($P < .01$).

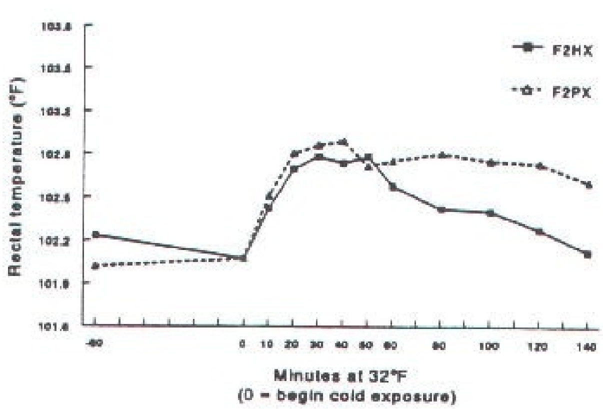
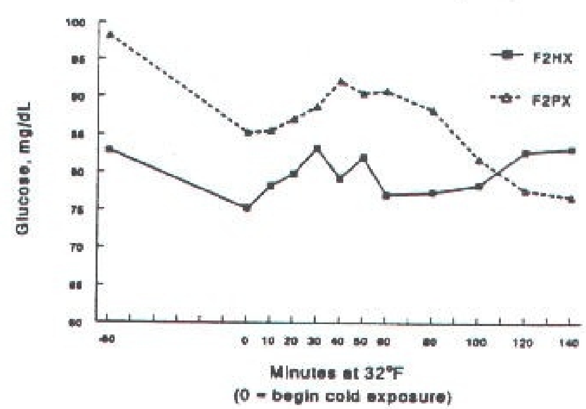


Figure 8. Plasma glucose concentrations of newborn Hereford-cross (F2HX) or Piedmontese-cross (F2PX) calves exposed to 32 °F for 140 min ($P < .01$).



as normal-muscle calves. Piedmontese-cross calves were genotyped in our Molecular Genetics lab by Dr. M. Grosz, and all calves contained at least one copy of the double muscle allele. Rectal temperatures and blood samples were obtained throughout the cold-exposure phase. Results are summarized in Figures 5-8.

In both studies we found that calves from dams that received supplemental fat during late gestation had a better rectal temperature response to cold exposure than calves from dams on the low fat diet. Their temperature response to cold was greater, and they were able to maintain the increased temperature longer. This difference was related to these calves having more glucose available for metabolism and heat production (Figures 4 and 6) and possibly more brown adipose tissue. Double-muscle calves and normal-muscle calves showed a similar response to cold exposure for the first 50 min. From 60 min to the end of the sampling period, rectal temperatures in double-muscle calves were higher than those of normal-muscle calves (Figure 7). The glucose response (Figure 8) showed double-muscle calves with greater glucose concentrations up to 100 min of cold exposure and then reversing with higher glucose in normal-muscle calves.

Additional data were obtained in Studies 1 and 2, and results are summarized in Table 1. Calf birth weights, calving difficulty scores, and calf vigor scores were not affected by feeding the high linoleic safflower diets. Pregnancy rates were greater in dams that received fat supplementation during gestation. This increase in pregnancy rate is of special interest since the dams had not received fat supplementation for an average of 55 days before the beginning of the 53 day breeding season which suggests a carry over effect on subsequent reproduction of supplemental fat during gestation.

Table 1. Effects of gestation dietary fat on calf and dam data (Studies 1 and 2 combined).

	Gestation Diet	
Trait	Control	Fat Supplemented
Number animals	89	179
Avg. birth wt. (lb)	80	81
Dystocia score	1.7	1.6
Calf vigor score	1.2	1.3
Pregnancy rate (%)[a]	56	70*

[a]Fifty-five and 53 day breeding seasons.
*P < 0.5.

These results are similar to those reported by Williams (1989) and Lammoglia et al. (1996) who reported supplementing diets with fat affected hormone profiles, cholesterol concentrations, and ovarian follicular activity. Gambill et al. (1995) reported feeding 10% supplemental fat (Alifet) to range beef cows before the breeding season resulted in an 18% increase in estrous activity and a 50% increase in pregnancy rate. Alifet contains 27% palmitic, 37% stearic, and 31% oleic fatty acid with a 67%:33% saturated-unsaturated fat composition.

The positive response to fat supplementation may be dependent on the lipid used.

Anderson et al. (1992) found that fat supplementation starting 30 days prior to estrus induction by calf removal had no effect on interval to the induced ovulation or on luteal lifespan. This work did report an enhanced progesterone production in supplemented cows. Oss et al. (1993) found that fat supplementation from the third trimester of gestation through the third postpartum estrous cycle had no effect on gestation length, dystocia, calf vigor, or birth weight, but did cause longer postpartum intervals to first estrus (+30 days) and extended luteal life span. The lipid supplement used in these studies was a commercially available rumen escape fat (Megalac, Church and Dwight Co., Inc.) containing 51% palmitic, 35% oleic fatty acid with a 57%:43% saturated-unsaturated fat composition.

We have recently completed additional studies on effects of feeding fat to replacement heifers, and during gestation in both heifers and cows. Prepuberal Fl heifers from crossbred dams bred to either Hereford, Limousin, or Piedmontese sires were held in feed lots and were fed either 1.9% (LF) or 4.4% (HF) dietary fat from 254 days of age until puberty or the breeding season started. The feeding period was for 162 days. At the beginning of the breeding season, heifers were placed on irrigated pastures and supplemental feeding was stopped. We determined age at puberty and subsequent pregnancy rate in a 54-day AI breeding season. Results are summarized in Table 2. Effects on age at puberty in heifers puberal at the beginning of the breeding season and final pregnancy rates were not significant. However, sire effects were important for all three endpoints with the general pattern being that Limousin-sired were the oldest with fewest puberal at the beginning of the breeding season, Piedmontese the youngest and highest percentage puberal at begin breeding, with Herefords intermediate.

Table 2. Effects of supplemental fat on reproduction in replacement heifers.[a]

Item	Diet	N	Breed of Sire: Hereford	Limousin	Piedmontese	Diet Means	Statistical Significance: Source	Probability
Puberal begin breeding, (%)	LF	123	74	70	76	73	Diet	P = .08
	HF	123	76	61	98	78	Sire breed	P < .01
	Sire means		75	65	87		D x B	P < .05
Puberal age begin breeding, (d)	LF	92	357	379	338	358	Diet	NS
	HF	95	361	381	349	364	Sire breed	P < .01
	Sire means		359	380	344		D x B	NS
Pregnancy, (%)	LF	119	80	83	65	76	Diet	NS
	HF	121	82	68	68	73	Sire breed	P > .10
	Sire means		81	76	67		D x B	NS

[a]Fed for 162 days prebreeding.

The diet x sire breed interaction was significant for its effect on the percentage of heifers puberal at the beginning of the breeding season. This interaction is summarized in Table 2. Feeding fat had little effect on the percentage of heifers puberal in the Hereford-sired group (74 vs 76%), reduced the percentage in Limousin-sired (70 vs 61%), but increased the percentage in the Piedmontese-sired group (76 vs 98%). Numerous studies have indicated the Piedmontese is a double-muscled, low fat breed. Does this interaction suggest the fat "requirement" for breeds of lower body fat content may be different than those for breeds with greater body fat content? We also hypothesize the 162 day fat-feeding period may have been too long for the Hereford and Limousin breeds, and the results may have been more favorable if the feeding period would have been for approximately 60 days prior to the breeding season.

Our recent work on effects of fat feeding during gestation in heifers has included different vegetable seeds as fat sources. These have been safflower seeds, raw soybeans, and sunflower seeds (Bellows et al. 1999). Oil seeds were run through a roller mill to crack the hulls on approximately 90% of the seeds, but without oil loss. Diets were formulated to contain approximately equal amounts of protein and energy and contained 2.0, 4.2, 3.3, or 4.5% fat for the control, safflower, soybean, and sunflower diets, respectively. Diets were group fed in dry lot for an average of 65 days precalving with supplemental fat feeding ending at calving. Heifers were synchronized with two injections of prostaglandin and bred in a 35-37 day breeding period. Results are summarized in Table 3.

Table 3. Effects of supplemental fat on reproduction in first-calf heifers.[a]

		Diet			Calving Difficulty		Fall Data	
Diet of Fat Source	N	Seeds Fed (lb)	Fat (%)	Calf Birth Wt (lb)	Incidence (%)	Average Score	Pregnancy (%)	Calf Weaning Wt (lb)
Control	38	--	2.4	82	32	1.6	79	402
Safflower seeds	39	2.8	4.7	83	39	1.7	94	427
Soybeans	39	6.5	3.5	87	30	1.6	90	435
Sunflower seeds	38	2.8	5.1	86	38	1.7	91	434
				Fat: +3.3	Fat: +3.7	Fat: +.1	Fat: +13% P < .05	Fat: +30 lb P = .09

[a]Fed for last 65 days of gestation.

There did not appear to be differences among the three fat sources so the comparisons discussed will be for the average of the diets containing supplemental fat vs the control diet. There was a non-significant increase in calf birth weight and in the incidence and severity of calving difficulty. But the interesting increase found was a 13 percentage point increase in fall pregnancy rate ($P < .05$) and a 30 lb increase in calf weaning weight ($P = .09$).

In 1998, we fed mature crossbred cows and utilized supplements containing processed safflower seeds (run through the roller mill) fed in tubs or blocks. Tubs and blocks were formulated and furnished by Dr. Danny Simms, Consolidated Nutrition, Omaha, NE and contained 20 or 8% fat, respectively.

Control cows received 3 lb pelleted alfalfa cubes daily and all cows received mixed alfalfa-grass hay at a rate of 22 lb daily as dictated by cold weather and snow cover. Need for supplemental hay was based on the judgement of experienced herdsmen, but total hay supplement amounts were minimal because weather conditions were very moderate. Results are summarized in Table 4. Comparing fat vs the control diet shows a 6 percentage point increase in pregnancy rate and a 13 lb increase in calf weaning weight. These differences, while interesting, were not statistically significant.

Table 4. Effects of supplemental fat on reproduction in mature crossbred cows.[a]

		Composition			Fall Data	
Supplement and Delivery System	N	Protein (%)	Fat (%)	Amount Fed (lb/day)	Pregnancy (%)	Calf Weaning Wt (lb)
Control	47	20	1.4	3	84	487
Tub	47	22	20	4.4	86	506
Block	49	23	8	4.1	94	494
					Fat: +6%	Fat: +13 lb

Summary

Results of research indicate supplemental dietary fat can affect reproductive end points in cattle. Studies on feeding supplemental fat to beef cattle have resulted in positive, negative, and no effect on reproductive performance. Results of our work suggest a positive-response in pregnancy rate and calf weaning weights in both lactating heifers and cows when supplemental fat was fed for the last 60 to 75 days of gestation. However, the magnitude of the response has been greater in heifers. The mechanisms of action are not clear at this time and answers await further work.

Literature Cited

Anderson, K.A., Kniffen, D.M., Sanderman, J.P., Young, J.W., Holland, M.D., and Odde, K.G. 1992. Effects of a hyperlipidemic diet on postpartum beef cows. Proc. West. Sect. Amer. Soc. Anim. Sci. 43:16-18.

Bellows, R.A., Simms, D.D., Grings, E.E., Phelps, D.A., Bellows, S.E., Bellows, N.R., Short, R.E., Funston, R.N., and Geary, T.W. 1999. Effects of feeding supplemental fat during gestation on reproduction in primiparous beef heifers. J. Anim. Sci. 77 (Suppl. 1):236 (Abstr.)

Gambill, D.M., Petersen, M.K., Hawkins, D.E., Luna, I.T., Corona, J.S.S., Dunlap, D., and Havstad, K.M. 1995. Post-partum anestrus and fall pregnancy in two-year-old range cows supplemented with protein and fat. J. Anim. Sci. 73 (Suppl. 1):255 (Abstr.).

Lammoglia, M.A., Bellows, R.A., Grings, E.E., and Bergman, J.W. 1999a. Effects of prepartum supplementary fat and muscle hypertrophy genotype on cold tolerance in newborn calves. J. Anim. Sci. 77:2227-2233.

Lammoglia, M.A., Bellows, R.A., Grings, E.E., Bergman, J.W., Short, R.E., and MacNeil, M.D. 1999b. Effects of feeding beef females supplemental fat during gestation on cold tolerance in newborn calves. J. Anim. Sci. 77:824-834.

Lammoglia, M.A. Willard, S.T., Oldham, J.R., and Randel, R.D. 1996. Effects of dietary fat and season on steroid hormonal profiles before parturition and on hormonal, cholesterol, triglycerides, follicular patterns and postpartum reproduction in Brahman cows. J. Anim. Sci. 74:2253-2262.

Oss, G.M., Schutz, D.N., and Odde, K.G. 1993. Effects of a high fat diet on reproductive performance in pre- and postpartum beef heifers. Proc. West. Sect. Amer. Soc. Anim. Sci. 44:44-47.

Williams, G.L. 1989. Modulation of luteal activity in postpartum beef cows through changes in dietary lipid. J. Anim. Sci. 67:785-793.