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Effects of timing to start lipogenic diet on productive and reproductive responses in periparturient dairy cows

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ABSTRACT

The aim of this study was to evaluate productive, metabolic and ovarian responses of different timing to start lipogenic diet in dairy cows. Thirty-six multiparous cows were assigned randomly to 1 of 3 treatments in a completely randomized design. All cows were fed a similar glucogenic diet, 21 days before expected calving date. After parturition, they received a glucogenic diet until 42 days in milk (DIM; GGG) or shifted to a lipogenic diet at either 1 (GLL) or 21(GGL) DIM and remained on these diets until 42 DIM. After the day 42 postpartum, all cows returned to a common stall and received a mixed lipogenic and glucogenic (50:50) diet until 100 DIM. Postpartum dry matter intake (DMI) was lower ($P<0.05$) and body weight, body condition score, milk yield, milk protein, and milk lactose contents tended to be lesser ($P<0.1$) for the GLL group; however, negativity of energy balance, aspartate aminotransferase (AST), cholesterol, and urea concentrations were significantly higher ($P<0.05$). Glucose concentration and number of follicles ≥ 10 mm diameter were significantly higher ($P<0.05$) but BHBA and NEFA concentrations were lower ($P<0.05$) for the GLL group compared to other two groups. For the GLL group days to ovulation and cervical diameter were significantly higher ($P<0.05$). The conclusion is that providing a lipogenic diet immediately after calving has negative effects on energy balance, metabolic status and follicular dynamics of dairy cows. However, offering a glucogenic diet during −21 to +42 days relative to calving was more effective in improving animal performance and ovarian activity. This strategy may be enhancing the pregnancy rate.

1. Introduction

Transition period has been defined as a period between −21 and +21 days relative to calving (Grummer, 1995). Due to fetal growth and lactation onset, an increase in energy demand occurs in this period. So dry matter intake (DMI) often decreases and cows mobilize body fat to compensate the energy deficit. The extensive body fat mobilization predisposes cows to fatty liver and ketosis (Grummer, 1993) as well as reduces fertility rate (Butler, 2003).

It has been suggested that implementation of nutritional strategies with lipogenic or glucogenic diets during transition period is a principal route to avoid development of metabolic disorders and increases pregnancy rate (Thatcher et al., 2010; Walsh et al., 2011).

Several studies have been reported that feeding lactating dairy cows with lipogenic nutrients improve milk yield, milk fat and energy efficiency, and decreases milk

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protein and lipogenesis (Jenkins and McGuire, 2006; Rabiee et al., 2012).

However many studies showed that availability of glucogenic nutrients decrease the susceptibility of cows to metabolic disorders (Drackley, 1999; Kronfeld, 1976). Van Knegsel et al. (2007c) reported that glucogenic diet tend to decreases NEFA and increases insulin concentrations in early lactation compared to lipogenic diet. Moreover feeding a glucogenic diet in the first 50 days postpartum enhances circulating insulin concentrations, stimulated follicle development and increases proportion of cows ovulating before 50 days postpartum (Garnsworthy et al., 2008a; Gong et al., 2002).

However, diets designated to increase plasma insulin concentration (high starch) had negative effects on blastocyst development following *in vitro* maturation and fertilization (Fouladi-Nashta et al., 2009). Furthermore, a high-fat diet increases the blastocyst rate compared to a low-fat diet (Fouladi-Nashta et al., 2007) and decreases insulin concentration in plasma of the targeted cows (Garnsworthy et al., 2008a). Moreover, cows fed a high starch diet until the first rise of milk progesterone and then fed a high fat and low starch diet until 120 days postpartum had significantly shorter calving intervals (Garnsworthy et al., 2009a).

In relatively similar studies to this study, lipogenic nutrients were supplied at 50 DIM by Gong et al. (2002), 28 DIM by Cullens (2005), and during 26 to 32 DIM (after the first rise in milk progesterone) by Garnsworthy et al. (2009a).

However, none of them has implemented lipogenic diet at 21 DIM with a glucogenic diet in the transition period.

Therefore, the main objective of this study was to evaluate the hypothesis that energy balance, metabolic status and reproductive traits of dairy cows will be improved by starting a lipogenic diet from day 21 post calving with a transition glucogenic diet (GGL treatment). The second hypothesis to be tested was that feeding dairy cows with a lipogenic diet at the beginning of post calving (GLL Treatment) would have negative effects on energy balance, metabolic status and reproductive traits. These strategies were compared to continuous feeding of a glucogenic diet (GGG Treatment) during −21 to +42 days relative to calving.

2. Materials and methods

2.1. Animals, experimental design and treatments

Thirty-six multiparous Holstein cows in parity 2 to 4 were housed in tie-stall barns during per and postpartum periods. Animals were blocked by parity, expected calving date, previous lactation 305-d milk yield, body weight (BW), body condition score (BCS) and allocated randomly to 1 of 3 treatments, 21 days before expected calving date. The experiment was conducted in two phases; −21 to +42 days (phase 1) and +42 to +100 days (phase 2) relative to calving date.

Diets were formulated to be isoenergetic and isonitrogenous (Table 1) and fed *ad libitum* as a total mixed ration (TMR) twice a day to allow for 5–10% orts (as-fed basis). Feed intake was recorded daily in phase 1.

Table 1
Ingredient and chemical composition of the experimental diets.

Parameter	Prepartum	Postpartum	
	Glucogenic	Glucogenic	Lipogenic
Ingredient(% of DM)			
Corn silage	30.31	16.16	16.46
Alfalfa hay	19.27	30.83	31.40
Wheat-straw	11.76	1.18	1.20
Corn grain	11.34	15.28	–
Barley grain	11.32	15.26	–
Cottonseed, whole	–	–	12.19
Soybean meal	9.92	13.39	9.09
Canola meal	2.83	3.81	5.43
Beet pulp, dehydrated	–	–	9.74
Wheat bran	–	–	9.07
Fish meal	–	2.32	1.58
Energizer (RP10)[a]	–	–	2.04
Oyster shell - Ground	–	0.24	0.24
Magnesium oxide	–	0.12	0.12
$NaHCO_3$	–	0.65	0.66
Ammonium sulfate	0.67	–	–
Calcium chloride	0.66	–	–
Magnesium chloride	0.66	–	–
Mineral/vitamin mix[b]	0.80	0.48	0.49
Vita. E–Se Premix[c]	0.40	0.24	0.24
Toxin binder (Mycosorb)	0.07	0.04	0.04
Nutrient composition[d]			
NE_L (MJ/ Kg of DM)	5.94	6.65	6.69
CP (% of DM)	14.90	18.70	18.80
Fat (% of DM)	3.20	4.20	8.10
NFC[e] (% of DM)	33.00	38.00	27.00
Starch (% of DM)	28.48	32.95	23.65
NDF (% of DM)	41.60	32.40	40.30
Ca (% of DM)	0.84	0.79	0.82
P (% of DM)	0.29	0.42	0.51
DCAB (meq/Kg of DM)	−19.00	133.0	247.0

[a] International Foodstuffs Company (IFFCO), Malaysia. Fatty acids profile by analysis (g/kg): 0.2C8:0, 0.4C10:0, 4.3C12:0, 35.4C14:0, 1.7C15:0, 856C16:0, 1.5C16:1 cis, 0.8C17:0, 12.5C18:0, 70.7C18:1 cis 9 and 10, 1.4C18:1 cis 11, 15.1C18:2.

[b] Contained per kilogram of mix: 195 g Ca, 20 g Mg, 280 mg Cu, 2 g Mn, 3 g Zn, 100 mg Co, 100 mg I, 3 g Fe, 90 g P, 55 g Na, 1 mg Se, 500,000 IU vitamin A, 100,000 IU cholecalciferol, 100 mg vitamin E.

[c] Vitamin E–Selenium Premix contained: 11,200 mg vitamin E and 200 mg se.

[d] Values represent averages of samples composited pre- and postpartum.

[e] NFC = 100 − (CP + NDF + ether extract + ash).

During the perpartum period, all animals were fed a similar glucogenic diet (Table 1). After parturition, they received a glucogenic diet until 42 DIM (GGG treatment) or shifted to a lipogenic diet at either 1 (GLL treatment) or 21 DIM (GGL treatment) and remained on these diets until 42 DIM. After the day 42 postpartum, all cows returned to a common stall and received a mixed lipogenic and glucogenic (50:50) diet until 100 DIM.

Cows were weighed weekly after morning milking at 06:30 h, and BCS was recorded using a 5-point scale (Edmonson et al., 1989).

2.2. Diet sampling and analyzes

Total mixed rations (TMR) were sampled weekly at the time of feeding and frozen in plastic bags. Samples were