EFFECT OF COLOSTRAL FAT LEVEL ON FAT DEPOSITION AND PLASMA METABOLITES IN THE NEWBORN PIG

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ABSTRACT

The effects of colostral fat level on fat deposition and plasma concentrations of glucose, insulin, and free fatty acids (FFA) were determined in 28 newborn pigs during the first postnatal day. Soon after birth, pigs were allotted to four treatments groups. Group 1 was killed at birth. The remaining pigs were fed intragastrically sow colostrum that contained high (10.2%; HFC), normal (4.8%; NFC) or low (1.0%; LFC) levels of total fat at the rate of 15 to 18 g/kg birth weight at 65- to 70-min intervals. A total of 21 feedings was provided and pigs were killed 1 h after the last feeding. Body fat deposition increased linearly (P < .01) with the amount of ingested fat by .32 (± .04) g per 1-g increase in fat intake. Fatty acid composition of the pigs changed toward that of the colostrum with increased fat in colostrum. More liver glycogen was lost (P < .01) in pigs given LFC. Plasma concentrations of glucose and insulin were similar in pigs fed HFC and NFC. After the 11th feeding (14 h postnatal), LFC resulted in lower plasma glucose concentrations (P < .05) than HFC or NFC. Plasma insulin concentrations also were lower in pigs fed LFC. Plasma FFA concentrations remained unchanged in pigs fed LFC but increased with both fat content in colostrum (P < .05) and time (P < .05) in the other two groups. Colostral fat plays a major role in the supply of energy and in glucose homeostasis in the neonatal pig.

Key Words: Neonatal Pigs, Colostrum, Fats, Glucose, Insulin

Introduction

Susceptibility to cold and hypoglycemia usually are reported as major factors involved in the neonatal mortality of the pig (English and Morrison, 1984). Low energy reserves and poor insulative protection largely contribute to the limited thermoregulatory capacities of the newborn pig (Curtis, 1974; Mersmann, 1974). Glycogen is the predominant source of energy reserves, accounting for about 60% of the total readily available energy at birth (Mellor and Cockburn, 1986). However, glycogen stores are depleted rapidly after birth (Elliot and Lodge, 1977), and glucose metabolism can be impaired seriously during cold stress (Curtis et al., 1966; Close et al., 1985; Duée et al., 1988). At birth the body fat content is very low, ranging from 1 to 2% (Manners and McCrea, 1963; Okai et al., 1977). However, fats provide energy for heat production, and fatty acid oxidation is necessary to sustain active gluconeogenesis (Pégorier et al., 1985; Girard, 1986). Many attempts have been made to increase the energy stored as fat in the newborn pig, mainly by adding fat to the sow diet during late gestation (Petigrew, 1981). However, this has had a relatively small effect on the fat accretion by the fetus (Seerley, 1984) because only trace amounts of free fatty.
Acids cross the swine placenta (Elphick et al., 1980; Duée et al., 1987; Thulin et al., 1989). Nevertheless, the most consistent effect of feeding fat to the sow is an augmented fat content in colostrum and milk (Salmon-Legagneur, 1964; Boyd et al., 1978; Seerley, 1984). An increased fat content in colostrum would increase the energy supply as fat to the newborn pig.

The objectives of this study were to examine the effects of fat level in colostrum on fat deposition and on glucose homeostasis in the neonatal pig.

Materials and Methods

Animals. Twenty-eight female Large White pigs from seven litters were used. During gestation, the sows were fed approximately 2.5 kg/d of a diet based on barley, wheat, corn, and soybean meal (16.2% CP, 2,910 kcal ME/kg) that contained no supplemental fat. Two piglets were killed at 27 h after birth. Colostrum was warmed to 38°C and administered slowly with a syringe through the stomach tube. The amount of administered colostrum was measured by weighing (± 0.1 g) the syringe before and after feeding. A total of 21 feedings (7 each of C0, C12, and C24) of 15 to 18 g colostrum/kg body weight at birth was given at 65- to 70-min intervals (Le Dividich and Noblet, 1981). Because the colostrums contained different amounts of fat, energy intakes differed even though colostrum intakes did not differ.

Feeding. The first feed was given about 2 h after birth. Colostrum was warmed to 38°C and administered slowly with a syringe through the stomach tube. The amount of administered colostrum was measured by weighing (± 0.1 g) the syringe before and after feeding. A total of 21 feedings (7 each of C0, C12, and C24) of 15 to 18 g colostrum/kg body weight at birth was given at 65- to 70-min intervals (Le Dividich and Noblet, 1981). Because the colostrums contained different amounts of fat, energy intakes differed even though colostrum intakes did not differ.

Blood Sampling and Slaughter Procedure. Blood samples were collected in heparinized tubes at birth and before the 1st, 4th, 6th, 11th, and 21st feedings. Samples were centrifuged immediately at 5,200 x g for 4 min and the plasma was stored at -20°C until it was analyzed. After blood sampling, the catheter was filled with heparinized saline. One hour after the final feeding the catheter and the stomach tube were removed. Each pig then was anesthetized, weighed, and killed by exsanguination. Blood was collected and stored at -20°C. The digestive tract and liver (without gall bladder) were removed and weighed. A sample of liver (1.0 to 1.5 g) and
of pancreas (.5 g) was removed from each pig and frozen in liquid N. The digestive tract was emptied and weighed. The carcass, including the emptied digestive tract and the remainder of the liver, were frozen in liquid N for subsequent mincing and homogenization. The various materials were stored at -20° C until they were analyzed. The empty body weight (EBW) was defined as the live weight minus weight of the digestive tract contents.

Analysis. Samples of colostrum, blood, and carcass were freeze-dried and analyzed for DM, N (Kjeldahl), and GE using an adiabatic bomb calorimeter. Total lipid of colostrum and carcass were determined by the methods of Rose-Gottlieb (AOAC, 1975) and Folch et al. (1957), respectively, and methyl esters were prepared. Fatty acids were determined by gas phase chromatography. Carcass lipid extract also was analyzed for phospholipids from phosphorus determination (Bartlett, 1959). Liver glycogen was measured by the glucose-oxidase method (Trinder, 1969) after dissolution of the pulverized tissue in hot KOH, subsequent precipitation with cold ethanol, and acid hydrolysis of the purified glycogen. The pancreas homogenate was analyzed for lipase according to the method of Rathelot et al. (1975) using an olive oil substrate. Lipase activity was expressed as millimoles of fatty acid produced per minute per gram of tissue. Colostrum lactose was estimated using an enzymatic method (Gill and Hafs, 1971). Pigs were defined as the experimental units with treatment (colostral fat level) as the main plot and sampling time (feeding number) as a repeated measure (subplot). Effects of colostral fat level were tested using the animal within treatment mean square as the error term. Effects of time and time × colostral fat level were tested by the residual error. Linear and quadratic effects of time were extracted to determine the nature of the response of each criterion over time. Data obtained at birth were not included in the analysis. Additionally, linear regressions of plasma concentrations of glucose against time (between the 1st and the 11th feeding) were computed. Slopes of the regression lines were used to determine the effect of colostral fat level on the rate of increase in plasma glucose concentration.

Results

Composition of Colostrum and Weight Gains. Table 1 shows the composition of colostrum when values for CO, C12, and C24 were combined. The colostrums had similar levels of CP and lactose, averaging 9.1 and 4.2%, respectively. As expected, large differences were observed in fat content and, thereby, in GE and moisture content. Fat provided 60, 41, and 12% of the total energy supplied by HFC, NFC, and LFC, respectively. The fatty acid (FA) profile was similar for the three colostrums; therefore, only the average composition is given in Table 2. Palmitic, oleic, and linoleic acids, the major FA, accounted for 80% of total FA.

Weight gains and colostrum intakes are shown in Table 3. Expressed as grams per kilogram of average BW, the amount of colostrum administered to pigs fed HFC was
TABLE 2. AVERAGE FATTY ACID COMPOSITION OF COLOSTRUM

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>% of total fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>C14:0</td>
<td>2.0</td>
</tr>
<tr>
<td>C16:0</td>
<td>26.0</td>
</tr>
<tr>
<td>C16:1</td>
<td>8.2</td>
</tr>
<tr>
<td>C18:0</td>
<td>5.9</td>
</tr>
<tr>
<td>C18:1</td>
<td>37.9</td>
</tr>
<tr>
<td>C18:2</td>
<td>18.4</td>
</tr>
<tr>
<td>C18:3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

11% lower \((P < .05)\) than the amount of that given to pigs fed LFC. This was due to the faster weight gain of pigs fed HFC, because when expressed as grams per kilogram of birth weight there was no difference in the amount of administered colostrum. Nevertheless, as a result of imposed differences in fat contents, energy intake in piglets fed HFC was 38 and 84% higher \((P < .01)\) than in those fed NFC and LFC, respectively. Pigs fed HFC gained 17 and 52% more live weight \((P < .01)\) than those fed NFC and LFC, respectively. However, because of the increase in the weight of gut contents with more fat in colostrum, differences in EBW gains were less, amounting to 10 and 33%, respectively. Measurements made on three to four pigs per treatment indicated that the stomach contents accounted for 75, 70, and 63% of total weight of digesta in pigs fed HFC, NFC, and LFC, respectively. In addition, the amount of fat in the stomach contents represented 48, 36, and 28% of the total fat consumed by pigs fed HFC, NFC, and LFC, respectively. Fat in stomach contents of pigs fed HFC averaged 27%.

Body Chemical Composition. The empty body composition of pigs is given in Table 4. Compared with newborn pigs, the 27-h pigs had more body moisture \((P < .05)\), CP \((P < .01)\), total lipid \((P < .01)\), and energy content \((P < .05)\) and less ash \((P < .01)\) and phospholipid to total lipid ratio \((P < .05)\). In the 27-h pigs, moisture and ash were not affected by the type of colostrum. In contrast, the increase in the fat level in colostrum resulted in a linear increase \((P < .01)\) in the level of total body fat and energy and a linear reduction \((P < .05)\) in the level of CP and phospholipid fraction. In the 27-h pigs, liver weight was higher \((P < .01)\) than at birth and it increased linearly \((P < .05)\) with fat level in colostrum. Percentage of liver glycogen was 66% \((P < .01)\) lower in the 27-h pigs than in the newborns. At 27 h, liver glycogen concentration was similar in pigs fed HFC and NFC and higher \((P < .01)\) than in those fed LFC. The amount of liver glycogen mobilized was calculated by subtracting the amount measured at 27 h from that estimated at birth using data obtained in the control pigs killed at 0 h. Values obtained indicated that the rate of mobilization of liver glycogen was similar in pigs fed HFC and NFC and averaged 50%, which was lower \((P < .01)\) than the 70% found in pigs fed LFC.

The amount of total fat deposited was estimated from the empty body chemical composition at birth and 27 h of age. Results presented in Table 5 show that fat deposition

TABLE 3. BIRTH WEIGHT, GAIN, AND AMOUNT OF COLOSTRUM ADMINISTERED TO PIGS FED HIGH- (HFC), NORMAL- (NFC), OR LOW- (LFC) FAT COLOSTRUM

<table>
<thead>
<tr>
<th>Item</th>
<th>HFC</th>
<th>NFC</th>
<th>LFC</th>
<th>SEM^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth wt, g</td>
<td>1,150</td>
<td>1,220</td>
<td>1,225</td>
<td>28</td>
</tr>
<tr>
<td>Killing wt, g</td>
<td>1,348</td>
<td>1,400</td>
<td>1,361</td>
<td>32</td>
</tr>
<tr>
<td>Killing EBW, g</td>
<td>1,256</td>
<td>1,320</td>
<td>1,304</td>
<td>31</td>
</tr>
<tr>
<td>BW gain, g/kg avg BW(^b)</td>
<td>160</td>
<td>137</td>
<td>105</td>
<td>10.5</td>
</tr>
<tr>
<td>EBW gain, g/kg avg EBW(^d)</td>
<td>116</td>
<td>105</td>
<td>87</td>
<td>9.9</td>
</tr>
<tr>
<td>Digestive tract content, g/kg avg BW(^b)</td>
<td>74</td>
<td>62</td>
<td>44</td>
<td>8.0</td>
</tr>
<tr>
<td>Total colostrum intake, g/kg avg BW(^b)</td>
<td>306</td>
<td>319</td>
<td>341</td>
<td>9.0</td>
</tr>
<tr>
<td>Total energy intake, kcal/kg avg BW(^a)</td>
<td>497</td>
<td>360</td>
<td>269</td>
<td>12.5</td>
</tr>
</tbody>
</table>

*^aLinear effect of colostral fat level \((P < .01)\).

*^bLinear effect of colostral fat level \((P < .05)\).

*^cAverage body weight (avg BW) was defined as (BW at birth + BW at killing)/2.

*^dAverage empty body weight (avg EBW) was defined as (EBW at birth + EBW at killing)/2. EBW at birth was assumed to represent 975 x birth weight, as found in control pigs killed at birth.
TABLE 4. EMPTY BODY COMPOSITION OF PIGS AT BIRTH AND 27 HOURS OF AGE

<table>
<thead>
<tr>
<th>Item</th>
<th>Birth</th>
<th>HFC</th>
<th>NFC</th>
<th>LFC</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moistureb (N × 6.25)%cd</td>
<td>79.49</td>
<td>80.19</td>
<td>80.28</td>
<td>80.20</td>
<td>.26</td>
</tr>
<tr>
<td>Protein, %de</td>
<td>11.69</td>
<td>11.90</td>
<td>12.00</td>
<td>12.37</td>
<td>.12</td>
</tr>
<tr>
<td>Total lipid, %de</td>
<td>1.40</td>
<td>2.29</td>
<td>1.88</td>
<td>1.44</td>
<td>.05</td>
</tr>
<tr>
<td>Phospholipid/total lipidbe</td>
<td>.45</td>
<td>.31</td>
<td>.36</td>
<td>.44</td>
<td>.03</td>
</tr>
<tr>
<td>Ash, %e</td>
<td>4.04</td>
<td>3.55</td>
<td>3.49</td>
<td>3.73</td>
<td>.11</td>
</tr>
<tr>
<td>GE, kcal/kgf</td>
<td>.89</td>
<td>.95</td>
<td>.92</td>
<td>.89</td>
<td>.01</td>
</tr>
<tr>
<td>Liver wt, g/kg EBWcde</td>
<td>26.82</td>
<td>32.54</td>
<td>31.16</td>
<td>29.48</td>
<td>.89</td>
</tr>
<tr>
<td>Liver glycogen, %ef</td>
<td>13.74</td>
<td>5.28</td>
<td>5.54</td>
<td>3.29</td>
<td>.53</td>
</tr>
</tbody>
</table>

*HFC, high-fat colostrum (10.2%); NFC, normal-fat colostrum (4.8%); LFC, low-fat colostrum (1.0%).

bBirth vs 27 h (P < .05).

cBirth vs 27 h (P < .01).

dLinear effect of colostral fat level within 27-h pigs (P < .05).

Composition toward that of colostrum (composition shown in Table 1) with the increase in colostrum fat.

At birth, pancreatic lipase activity averaged 1,265 ± 96 mmol fatty acid produced/(min·g). At 27 h of age, the activity amounted to 534 ± 73, 590 ± 70, and 630 ± 54 mmol fatty acid produced/(min·g) in pigs fed HFC, NFC, and LFC, respectively. Activity during the first 27 h declined (P < .01) independently of the fat level in colostrum.

**Blood Criteria.** Blood hematocrit averaged 42 ± 1% before the first feeding and fell to 32 ± 2% (P < .01) before the last feeding. This decline was independent of the type of

TABLE 5. EFFECT OF COLOSTRUM FAT LEVEL ON FAT DEPOSITION AND FATTY ACID COMPOSITION OF EMPTY BODY OF PIGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Birth</th>
<th>HFC</th>
<th>NFC</th>
<th>LFC</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat deposition, g</td>
<td>13.2</td>
<td>8.3</td>
<td>2.1</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Fatty acids, % of total fatty acids</td>
<td>5.0</td>
<td>3.0</td>
<td>3.4</td>
<td>3.2</td>
<td>.45</td>
</tr>
<tr>
<td>C14:0f</td>
<td>39.5</td>
<td>32.5</td>
<td>35.3</td>
<td>38.1</td>
<td>1.20</td>
</tr>
<tr>
<td>C16:1</td>
<td>7.7</td>
<td>8.6</td>
<td>7.9</td>
<td>8.6</td>
<td>.42</td>
</tr>
<tr>
<td>C18:0bc</td>
<td>15.9</td>
<td>10.9</td>
<td>12.5</td>
<td>15.9</td>
<td>.55</td>
</tr>
<tr>
<td>C18:1bc</td>
<td>25.9</td>
<td>31.8</td>
<td>28.8</td>
<td>27.4</td>
<td>.91</td>
</tr>
<tr>
<td>C18:2bc</td>
<td>4.6</td>
<td>12.1</td>
<td>10.2</td>
<td>5.7</td>
<td>.30</td>
</tr>
<tr>
<td>C18:3f</td>
<td>.3</td>
<td>.5</td>
<td>.4</td>
<td>.2</td>
<td>.06</td>
</tr>
</tbody>
</table>

aHFC, high-fat colostrum (10.2%); NFC, normal-fat colostrum (4.8%); LFC, low-fat colostrum (1.0%).

bLinear effect of colostral fat level within 27-h pigs (P < .01).

cBirth vs 27 h (P < .01).
colostrum and largely reflected an increase in plasma volume that is associated with colostrum consumption.

At birth, mean values for plasma glucose and insulin concentrations were \(0.52 \pm 0.07\) g/liter and \(8.7 \pm 1.0\) \(\mu\)U/ml, respectively. Changes in plasma glucose and insulin in response to successive colostrum feedings are presented in Figures 1A and B. Pigs fed HFC and NFC had similar glucose patterns, which were somewhat different from that recorded in pigs fed LFC. In the three groups of pigs, plasma glucose rose linearly \((P < .01)\) up to the 11th feeding. However, the rate of increase was slower and plasma glucose level was lower \((P < .05)\) in pigs fed LFC than in the other two groups after the 11th feeding. Plasma glucose level tended \((P < .10)\) to decline between the 11th and the 21st feeding in pigs fed LFC but remained constant in the other two groups.

Plasma insulin showed a pattern that paralleled that of glucose (Figure 1B). It varied considerably with successive feedings of colostrum \((P < .01)\) and the levels of fat \((P < .01)\). At all times, plasma insulin levels were similar in pigs receiving HFC and NFC but were higher \((P < .01)\) than in those in pigs fed LFC.

Before the first feeding, the plasma level of FFA was very low, averaging \(0.1\) mM (Figure 1C). Feeding LFC had no effect on plasma FFA levels, which showed a tendency to decrease with age. In contrast, in pigs fed HFC and NFC, there was a steady rise in plasma FFA levels over time that was dependent on the fat level in colostrum. At each sampling, values were different \((P < .05)\) from one another.

**Discussion**

Results of the present study confirm the lack of fat stores in the newborn pig. The value of 14.0 g total fat per kilogram EBW, of which 6.3 g \((14.0 \times 0.45, \text{see Table 4})\) can be classified as phospholipids, is in the range of values reported in the literature \(\text{Sarkar et al., 1985; Patience and Farnworth, 1989)}\). Our data demonstrate that increasing fat level in the colostrum stimulated fat deposition in the neonatal pig and consequently its availability as an energy source. This deposition did not result from lipogenesis because, in the absence of this fat source, fat deposition was negligible. This is in agreement with the low activity of lipogenic enzymes reported by Mersmann et al. (1973) in the suckling pig and the very low incorporation of radioactivity from \([\text{U}^{14}\text{C}]\text{glucose}\) into fatty acids \(\text{Sarkar et al., 1985)}\). In agreement with the findings of Wolfe et al. (1977) and Sarkar et al. (1985), the results of our study indicated that the deposited

![Figure 1](image-url)
fat is primarily derived from dietary fat. This is suggested, first, by the close relationship between the amount of body fat deposited and the amount of fat consumed and, second, by the increasing resemblance of the fatty acids profile of the pig and of the colostrum as fat content of colostrum was increased. However, the value of .32 found for the efficiency of ingested fat for deposition is rather low. This may be caused by an insufficient activity of the pancreatic lipase and(or) by a delayed emptying of the stomach. Indeed, the activity of pancreatic lipase per gram of tissue dropped by about 50% by the end of the first day of life. This result, also observed in the newborn infant (Zoppi et al., 1972), is not peculiar to lipase; intestinal lactase also shows a similar decline (Widdowson, 1984). However, if we consider the 60% increase in the weight of the pancreas during the first postnatal day (Widdowson and Crabb, 1976), the total activity of the gland was not reduced. The fact that a large fraction of the ingested fat remained in the stomach at slaughter suggests that the delayed emptying of the stomach caused by a high level of fat in colostrum was the major factor limiting the digestion and the deposition of fat and, hence, its availability as an energy source for the newborn pig. This is consistent with the fact that diets high in fat, especially those high in long-chain fatty acids (Hunt and Knox, 1968; Siegel et al., 1985), as in colostrum, are known to reduce the rate of emptying of the stomach. Nevertheless, from the present data one can calculate that feeding a 1.2-kg newborn pig with normal colostrum during the first 27 h postpartum was associated with a deposition of 6.7 g of mobilizable (non-phospholipid) fat. Feeding with high-fat colostrum was associated with deposition of an additional 5 g of mobilizable fat, which represents a considerable increase.

At birth, the concentration of liver glycogen was within the range of published values (Swiateck et al., 1968; Elliot and Lodge, 1977; van Lith et al., 1988). According to Elliot and Lodge (1977), 82% of the liver glycogen stores are mobilized during the first 24 h postpartum. In the present study the rate of depletion was lower, averaging 50% in pigs fed HFC and NFC and 70% in those receiving LFC. However, this indicated a greater contribution of liver glycogen to glucose homeostasis in pigs fed colostrum low in fat.

Plasma concentrations of glucose, FFA, and insulin at birth were typical of those reported previously (Swiateck et al., 1968; Bengtsson et al., 1969; Pégouri et al., 1981; Lepine et al., 1989). The rapid rise in plasma FFA by pigs fed HFC and NFC agrees well with data recorded in suckling pigs (Bengtsson et al., 1969). However, in those fed LFC, the FFA level remained extremely low, similar to that observed in fasted neonatal pigs (Swiateck et al., 1968).

In pigs fed HFC, both the pattern and the absolute values for plasma glucose concentrations during the first postnatal day were very similar to those reported by Parker et al. (1980) in suckling pigs. The pattern and the absolute values for plasma insulin recorded in these pigs also were similar to those found by Brenner et al. (1981). However, in our study the difference in plasma glucose concentrations between pigs fed HFC or NFC and those receiving LFC was of interest. Despite a higher supply of glucose from liver glycogenolysis and from colostral lactose because of the higher intake of colostrum, pigs fed LFC did not sustain an elevated plasma glucose concentration, as did those fed HFC and NFC. The mechanisms by which feeding low-fat colostrum failed to support elevated plasma glucose level cannot be determined from our study. However, this could have been caused by a higher rate of glucose use and(or) a lower rate of glucose production from gluconeogenesis. Because FFA were not available for oxidation in peripheral tissues, a higher rate of glucose use would be expected in pigs fed LFC. However, this is inconsistent with the lower level of plasma insulin found in these pigs. In addition, the glucose-sparing effect of FFA is not consistently reported in the newborn pig. Although palmitate decreases glucose oxidation by 50% in the isolated working heart (Werner et al., 1983), Campion et al. (1986) did not observe any effect of palmitate on glucose oxidation rate in skeletal muscle. However, the lack of FFA could be involved in the limitation of glucose production from gluconeogenesis because fatty acid oxidation by liver is necessary to sustain active hepatic gluconeogenesis (Girard, 1986). This has been demonstrated in the newborn of several species, including the rat (Ferré et al., 1978), the rabbit (El Manoubi et al., 1983), and the pig (Pégouri et al., 1985).
In conclusion, colostrum fat plays a major role in the supply of energy and in glucose homeostasis of the newborn pig.

Implications

The energy available as fat in the newborn pig during the first day of life is closely dependent on the intake of colostral fat. Manipulation of the sow diet to increase the fat level in colostrum should provide supplemental energy to the newborn pig for the maintenance of body temperature. Fat seems to play a key role in glucose homeostasis. Future research should focus on determining the effects of fat levels in colostrum on colostral consumption under practical conditions and on the ability of the newborn to use colostral fat.

Literature Cited


