J. Dairy Sci. 95:3997–4005
http://dx.doi.org/10.3168/jds.2011-5174

Nationwide evaluation of quality and composition of colostrum on dairy farms in the United States

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ABSTRACT

The objective of this study was to characterize the quality of maternal colostrum (MC) fed to newborn dairy calves in the United States and identify the proportion of MC that meets industry standards for IgG concentration and total plate count (TPC). Samples of MC (n = 827) were collected from 67 farms in 12 states between June and October 2010. Samples were collected from Holsteins (n = 494), Jerseys (n = 87), crossbred (n = 7), and unidentified dairy cattle (n = 239) from first (n = 49), second (n = 174), third or greater (n = 128), and unknown (n = 476) lactations. Samples were identified as fresh (n = 196), refrigerated (n = 152), or frozen (n = 479) before collection, as well as whether the sample was from an individual cow (n = 734) or pooled (n = 93). Concentration of IgG in MC ranged from <1 to 200 mg/mL, with a mean IgG concentration of 68.8 mg/mL (SD = 32.8). Almost 30% of MC contained <50 mg of IgG/mL. The IgG concentration increased with parity (42.4, 68.6, and 95.9 mg/mL in first, second, and third and later lactations, respectively). No differences in IgG concentration were observed among breeds or storage method; however, IgG was highest in samples collected in the Midwest and lowest in samples collected in the Southwest (79.7 vs. 64.3 mg/mL). Total plate count of samples ranged from 3.0 to 6.8 $\log_{10}$ cfu/mL, with a mean of 4.9 $\log_{10}$ cfu/mL (SD = 0.9) and was greater in samples collected in the Southeast compared with other regions of the country. Pooled samples had greater TPC than individual samples and refrigerated samples had greater TPC than frozen and fresh samples. Almost 43% of samples collected had TPC >100,000 cfu/mL, 16.9% of the samples had >1 million cfu/mL. Only 39.4% of the samples collected met industry recommendations for both IgG concentration and TPC. Almost 60% of MC on dairy farms is inadequate, and a large number of calves are at risk of failure of passive transfer or bacterial infections, or both. Also, these data indicate that regional differences exist in colostrum quality.
Key words: colostrum, total plate count, immunoglobulin G, coliform

INTRODUCTION

Maternal colostrum (**MC**) provides the neonate with IgG essential for passive immunity. Carbohydrates, fat, and protein in MC are also essential as metabolic fuels to the newborn (NRC, 2001). Vitamins and minerals in MC are essential as cofactors for enzymes and general maintenance functions.

The newborn calf is born with relatively few energy reserves, with lipids comprising only 3% of BW. Much of this lipid content is structural and does not contribute to energy needs of the calf. Newborn calves rely on lipids and lactose in MC and milk as energy sources for thermogenesis and maintenance of body temperature. The energy content of MC can vary greatly.

Non-IgG proteins in MC provide nutrition; enhancement of the immune system; act as a defense against pathogenic bacteria, viruses and yeast; and are important for the development of the gastrointestinal tract (Bösze et al., 2008). The biological properties of proteins in MC work to facilitate nutrient assimilation, whereas peptides potentially influence the growth and differentiation of various neonatal tissues (Talukder et al., 2002). Large quantities of AA are also needed for the rapid protein accretion that occurs independent of IgG accumulation in the digestive tract (Davis and Drackley, 1998).

Colostral IgG concentration is essential to ensuring adequate passive transfer (Nocek et al., 1984); however, bacterial contamination of MC is another critical quality parameter. Bacteria in MC may bind free IgG in the gut lumen or block uptake and transport of IgG molecules into the enterocytes (James and Polan, 1978;

Received November 22, 2011.
Accepted March 13, 2012.
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James et al., 1981), thus reducing apparent efficiency of IgG absorption (Johnson et al., 2007). Current industry recommendations include discarding MC that contains <50 mg of IgG/mL and >100,000 cfu/mL total plate count (**TPC**; McGuirk and Collins, 2004). Previous survey data has focused on colostrum management practices: volume of MC fed, timing of first feeding, if MC is tested and how, or how the MC was stored before feeding (NAHMS, 2007a; Fulwider et al., 2008). Kehoe et al. (2007) reported both management practices and nutrient composition of MC collected from 55 Pennsylvania dairy farms. Only 1 MC sample from each farm was collected within 4 h of parturition for analysis; bacterial counts as well as lactation and breed breakdowns were not reported. Their study concluded that although improvements had been made in colostrum management practices, there was room for further improvement.

A major limitation to previous colostrum composition studies is that MC samples have been collected immediately following milking and may not necessarily represent MC that is eventually fed to the newborn. Following collection, potential exists for additional bacterial contamination (Stewart et al., 2005; Godden, 2008).

Few data are available regarding the percentage of MC fed in the United States that meets both quality recommendations and whether regional differences exist in colostrum composition. The objectives of this study were to 1) determine the IgG concentration, nutrient, and bacterial composition of MC available on US dairy farms, 2) determine nutrient and bacterial differences in MC across regions, storage methods, breeds, and parity, and 3) estimate the percentage of MC available that meets industry standards for both IgG concentration and bacterial contamination.

MATERIALS AND METHODS

Farm Selection

Dairy farms (n = 67) in 12 states participated in the study between June and October 2010 (Table 1). Participating farms were required to feed supplemented and unpasteurized MC. Farms were also required to complete 2 management surveys. Farms ranged from 70 to over 5,000 lactating dairy cows. States were grouped into 4 regions: Northeast (New Hampshire, New York, and Pennsylvania), Southeast (Florida, Georgia, and Virginia), Midwest (Iowa, Minnesota, and Wisconsin), or Southwest (Arizona, California, and Texas).

Colostrum Sample Collection

The number of MC samples collected from each dairy was based on availability of MC at the time of site visit. Frozen, refrigerated, or fresh MC was selected. The MC was sampled from individual cows or from multiple cow pools according to the normal management of the farm. A 50-mL sample of MC was collected using a sterile dipper and divided into 2 sample vials (45 and 3 mL), frozen (−20°C), placed on dry ice, and shipped to the

Table 1. Colostrum samples collected across region, state, breed, lactation, and storage method

Region and state[1]	No. of farms	No. of samples	Breed (n)				Lactation					Storage[2]		
			Holstein	Jersey	Crossbred	N/A[3]	1	2	3	4+	N/A[3]	1	2	3
Northeast														
NH	1	18	18	—	—	—	—	6	3	9	—	18	—	—
NY	5	59	41	3	—	15	4	11	4	2	38	17	29	13
PA	5	51	42	9	—	—	—	5	17	22	7	—	23	28
Southeast														
FL	4	35	33	2	—	—	1	22	—	—	12	17	9	9
GA	2	30	30	—	—	—	—	30	—	—	—	11	19	—
VA	7	60	22	3		35	—	2	1	—	57	25	20	15
Midwest														
IA	1	40	40	—	—	—	—		—	—	40	—	—	40
MN	11	97	35	—	—	62	8	10	4	5	70	2	6	89
WI	6	27	27	—	—	—	—	5	—	—	22	—	—	27
Southwest														
AZ	2	61	40	—	—	21	2	7	—	—	52	7	9	45
CA	14	173	161	8	—	4	34	76	—	—	63	93	34	46
TX	9	176	5	62	7	102	—		61	—	115	6	3	167
Total	67	827	494	87	7	239	49	174	90	38	476	196	152	479

[1]Region and state in the United States. NH = New Hampshire; NY = New York; PA = Pennsylvania; FL = Florida; GA = Georgia; VA = Virginia; IA = Iowa; MN = Minnesota; WI = Wisconsin; AZ = Arizona; CA = California; TX = Texas.

[2]Location where colostrum was stored before sampling: 1 = fresh/not stored; 2 = refrigerator; 3 = freezer.

[3]Unidentified.