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Research Article

Composition, physicochemical properties and nitrogen distribution pattern of Gir cow colostrum

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Abstract

Colostrum is secreted by mammals after the parturition for nourishment of its new borne. Colostrum of three Gir cows were collected after the parturition and analysed. The mean values of total solids (TS), fat, solids-not-fat (SNF), protein, lactose, ash and chloride content in Gir cow colostrum were 17.59 (13.47-22.40), 4.48 (3.00-5.95), 12.47 (8.59-19.49), 8.37 (3.56-16.43), 3.85 (2.93-4.32), 0.76 (0.70-0.81) and 0.1356 (0.1622-0.2290) per cent, respectively. The mean values of specific gravity, viscosity, surface tension, refractive index, electrical conductivity, titratable acidity and pH of the Gir cow colostrum were1.045 (1.032 to1.069), 4.13 cP (1.64 to 11.40), 59.31 dynes/cm (49.69 to 61.87), 1.3493 (1.3429 to 1.3636), 5.60 mS/cm (5.23 to 5.88), 0.301 per cent lactic acid (0.218 to 0.345) and 6.24 (6.15 to 6.48), respectively. The mean values of total nitrogen (TN), non-casein nitrogen (NCN), non-protein nitrogen (NPN), casein nitrogen (CN) and whey protein nitrogen (WPN) content of Gir cow colostrum were 1.3131 (0.5632-2.5752), 0.7108 (0.1392-1.8205), 0.0416 (0.0319-0.0541), 0.6023 (0.4240-0.7547) and 0.6693 (0.1073-1.7664), respectively. °Brix of the colostrum of Gir cow I, II and III were 23.6, 25.8 and 23.9, respectively in the 1st milking, decreased over successive milkings and reached to 12.2, 12.5 and 12.7 at the 6th milking during a period of 72h postpartum. The immunoglobulins content (g/L) in the colostrum of Gir cow I, II and III were 85, 90 and 90, respectively in the 1st milking, decreased over successive milkings and reached to 8.2, 8.5 and 8.5 at the 6th milking during a period of 72 h postpartum.

Keywords: °Brix, Gir colostrum, Immunoglobulins, Nitrogen distribution, Physicochemical properties,

Highlights

- Gir cow colostrum has a distinct composition, physicochemical properties, Igs content, °Brix, etc
- TS, SNF, protein and ash followed a gradual decrease during successive milking
- Fat and chloride values fluctuated, while, lactose content increased in successive milkings
- TN, NCN, WPN, Igs and °Brix were highest in first milking
- NPN and CN content fluctuated in successive milkings

INTRODUCTION

Gir, Kankrej, Dangi, Dagri, etc., are known cattle breeds of Gujarat. Gir holds a promising place for its milk productivity. The observed mean (%) values of fat, solids-not-fat, protein and lactose content in milk of Gir cows were 5.38, 9.60, 3.85 and 5.29, respectively (Patbandha et al., 2020).

After parturition in mammal, the first secreted milk is known as colostrum. It is rich source of nutrients and antibodies. The quality of the colostrum is mainly depending on immunoglobulins concentration. Colostrum is differing than mature milk in term of its composition, physicochemical properties and nitrogen distribution patterns. Gir cow is famous with respect to their milk production and is very important indigenous breed.

Patoo et al. (2014) determined the compositional changes in colostrum during first five postpartum days of Hill cow of Uttarakhand. Akhter et al. (2020) examined the day-to-day variation in colostrum composition at the udder quarter level of 3 Holstein Frisian crossbred cows and observed that the concentration of major colostrum constituents (fat, protein, lactose, total solids, solids-not-fat, ash, pH, specific gravity) changed significantly (pd”0.05).

People, now-a-days, have generated inclination to purchase and consume milk of indigenous breeds, particularly in the milks of cattle. The information of compositional parameters of colostrum of indigenous breeds like Gir would provide useful information to regulatory agencies like Food Safety and Standards Authority of India (FSSAI), which is revising the

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standards for different milks on regular intervals. Even, dairy industries manufacture products like freeze dried colostrum powders from the colostrum. The immunoglobulins content in such powder impart quality to the product. Hence, Studies on colostrum of Gir cow for composition, physicochemical properties, immunoglobulins content, °Brix, etc., provide valuable information about its quality.

MATERIALS AND METHODS

Colostrum of three Gir cows were collected up to 72 h after the parturition of the cows from Livestock Research Station (LRS), Kamdhenu University, Anand (Gujarat) and analysed for total solids (TS), fat, lactose, ash, specific gravity and titratable acidity (Bureau of Indian Standards [BIS] Handbook, SP 18: 1981). Nitrogen distribution pattern was determined by Micro Kjeldahl Method (Association of Official Analytical Chemists [AOAC], 2010).

Chloride, viscosity, surface tension and refractive index were analysed using methods described by Roy and Sen (1991). Electrical conductivity was determined by electrical conductivity meter (Make: Systronic) and pH using a pH meter (Make: LABMAN).

°Brix of colostrum was determined using digital refractometer (ATAGO). Igs were determined using a colostrometer - a kind of hydrometer (Fleenor & Stott, 1980).

Statistical analysis

Descriptive statistical tools were employed as and when required in data analysis. Differences between treatments was analysed at 5% level of significance using Analysis of Variance (James et al., 2013).

RESULTS

Proximate composition, physicochemical properties, nitrogen distribution pattern and quality parameters of Gir cow colostrum were analysed for different milkings starting from first to sixth milking with 12 h interval up to 72 h postpartum duration.

Proximate composition: The mean values (%) along with the range of compositional parameters like TS, fat, SNF, protein, lactose and ash content in Gir cow colostrum were 17.59 (22.40-13.47), 4.48 (5.95-3.00), 12.47 (19.49-8.59), 8.37 (16.43-3.56), 3.85 (4.32-2.93) and 0.76 (0.81-0.70) and 0.1356 (0.1622-0.2290), respectively for the said parameters (Table 1).

Physicochemical properties: Mean values with range of various physicochemical properties like specific gravity, viscosity (cP), surface tension (dynes/cm), refractive index, electrical conductivity (mS/cm), titratable acidity (% lactic acid) and pH of successive milkings starting from first to sixth with a 12 h milking interval up to 72 h postpartum duration of Gir cow colostrum were 1.045 (1.032 to1.069), 4.13 (1.64 to 11.40), 59.31 (49.69 to 61.87), 1.3493 (1.3429 to 1.3636), 5.60 (5.23 to 5.88), 0.301 (0.218 to 0.345) and 6.24 (6.15 to 6.48), respectively (Table 2).

Nitrogen distribution pattern: Casein nitrogen (CN), whey protein nitrogen (WPN), and non-protein nitrogen (NPN) are the three major fractions that make up nitrogen containing portion of milk (Li et al., 2011). The mean values along with the range of TN, NCN, NPN, CN and WPN of Gir cow colostrum were 1.3131 (0.5632-2.5752), 0.7108 (0.1392-1.8205), 0.0416

Table 1. Proximate composition of Gir cow colostrum

Milkings post-partum (12 h Milking Interval)	Proximate composition (%)						
	TS	Fat	SNF	Protein	Lactose	Ash	Chloride (%)
First	22.40±0.48	3.00±0.05	19.49±0.34	16.43±0.46	2.93±0.03	0.81±0.01	0.2290±0.01
Second	19.49±0.87	4.05±0.50	15.44±1.37	10.75±1.96	3.78±0.62	0.73±0.06	0.2118±0.01
Third	17.30±0.05	3.95±0.95	11.43±2.82	7.43±2.85	3.66±0.39	0.75±0.01	0.2290±0.02
Fourth	17.05±0.13	5.23±0.23	10.40±1.78	6.58±1.96	4.15±0.25	0.71±0.01	0.1830±0.01
Fifth	15.84±0.68	5.95±0.25	9.46±0.87	5.48±1.48	4.28±0.01	0.71±0.07	0.1626±0.01
Sixth	13.47±0.39	4.68±0.28	8.59±0.09	3.56±0.28	4.32±0.32	0.70±0.08	0.1622±0.03
Overall	**17.59**	**4.48**	**12.47**	**8.37**	**3.85**	**0.76**	**0.1356**
CD	0.94	0.85	2.73	3.14	0.61	0.09	0.026
CV	2.96	10.58	12.19	20.85	8.92	6.49	7.971

The values are mean of three replications.

Table 2. Physicochemical properties of Gir cow colostrum

Milkings post-partum (12 h Milking Interval)	Specific gravity	Viscosity (cP)	Surface tension (dynes/cm)	Refractive index	Electrical conductivity (mS/cm)	Titratable Acidity (% LA)	pH
First	1.069±0.01	11.40±0.47	61.87±2.01	1.3636±0.01	5.83±0.16	0.345±0.01	6.15±0.08
Second	1.053±0.01	4.85±1.22	60.99±1.29	1.3530±0.01	5.62±0.49	0.326±0.01	6.16±0.09
Third	1.043±0.01	2.57±0.89	62.76±2.07	1.3474±0.01	5.88±0.08	0.320±0.03	6.19±0.02
Fourth	1.039±0.01	2.23±0.50	60.15±1.30	1.3451±0.01	5.53±0.35	0.304±0.04	6.27±0.04
Fifth	1.035±0.01	2.06±0.43	60.37±1.20	1.3441±0.01	5.50±0.32	0.295±0.02	6.35±0.02
Sixth	1.032±0.01	1.64±0.06	49.69±2.19	1.3429±0.01	5.23±0.09	0.218±0.07	6.48±0.30
Overall	**1.045**	**4.13**	**59.31**	**1.3493**	**5.60**	**0.301**	**6.24**
CD	0.01	1.25	5.47	0.003	0.51	0.06	0.24
CV	0.45	16.96	5.18	0.13	5.14	12.10	2.14

The values are mean of three replications.

Table 3. Nitrogen distribution pattern of Gir cow colostrum

Milkings post-partum (12 h Milking Interval)	Nitrogenous fractions (%)				
	Total nitrogen	Non casein nitrogen	Non protein nitrogen	Casein nitrogen	Whey protein nitrogen
First	2.5752±0.07	1.8205±0.03	0.0541±0.02	0.7547±0.04	1.7664±0.05
Second	1.6855±0.31	1.0508±0.10	0.0551±0.02	0.6348±0.20	0.9957±0.12
Third	1.1648±0.45	0.5565±0.21	0.0379±0.01	0.6083±0.23	0.5186±0.22
Fourth	1.0314±0.31	0.3888±0.18	0.0359±0.01	0.6426±0.13	0.3529±0.18
Fifth	0.8586±0.23	0.3092±0.12	0.0345±0.01	0.5494±0.12	0.2747±0.11
Sixth	0.5632±0.04	0.1392±0.01	0.0319±0.01	0.4240±0.02	0.1073±0.01
Overall	**1.3131**	**0.7108**	**0.0416**	**0.6023**	**0.6693**
CD	0.49	0.24	0.02	0.26	0.24
CV	20.84	18.43	24.40	24.23	20.13

The values are mean of three replications.

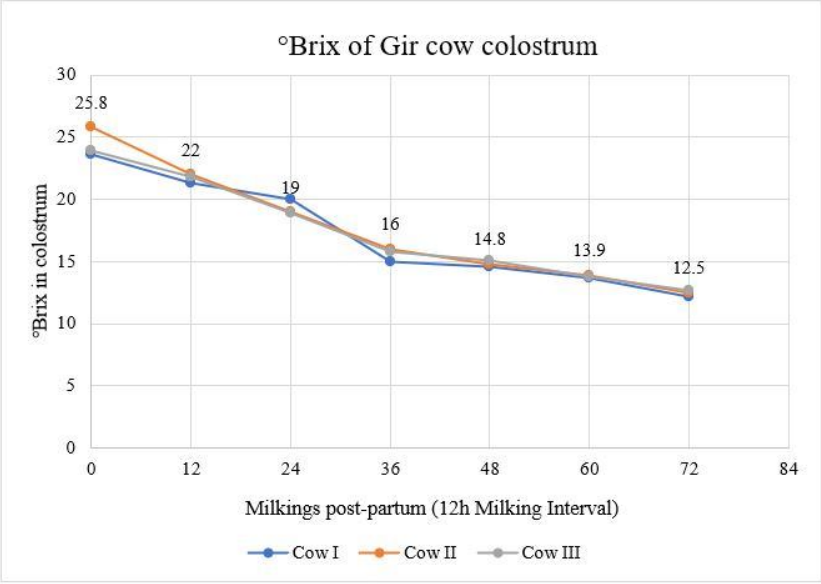

Fig. 1. °Brix of Gir cow colostrum

(0.0319-0.0541), 0.6023 (0.4240-0.7547) and 0.6693 (0.1073-1.7664) per cent, respectively (Table 3).

Quality parameters of colostrum: The °Brix of the colostrum of Gir cow I, II and III were 23.6, 25.8 and 23.9, respectively in the 1st milking, decreased over successive milkings and reached to values of 12.2, 12.5 and 12.7 at the 6th milking during a period of 72 h postpartum (Fig. 1).

The immunoglobulins content (g/L) in the colostrum of Gir cow I, II and III were 85, 90 and 90 respectively in the 1st milking, decreased over successive milkings and reached to values of 8.2, 8.5 and 8.5 at the 6th milking during a period of 72 h postpartum (Fig. 2).

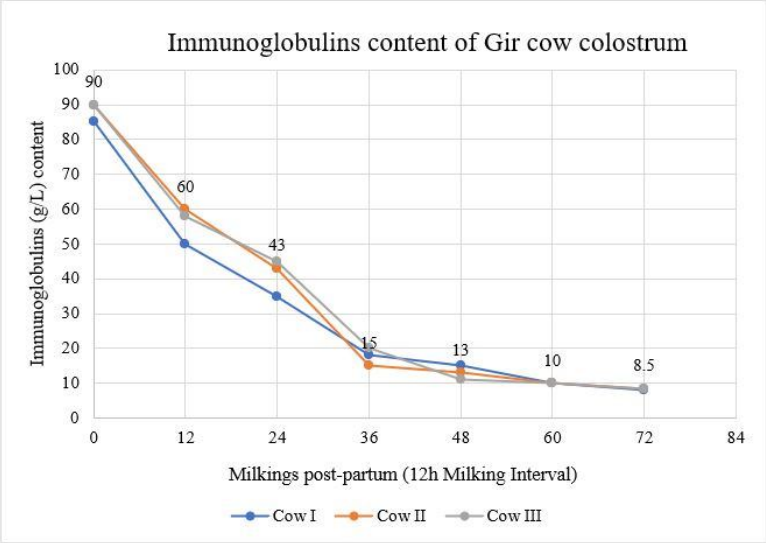

Fig. 2. Immunoglobulins content of Gir cow colostrum

DISCUSSION

Proximate composition: First milking post-partum of Gir cow contained the highest values of TS, SNF, protein and ash with a gradual decreasing trend on successive milkings. With respect to the levels of fat and chloride content of colostrum, a fluctuating trend was observed. On the contrary, the lactose content has a lowest value in first milking followed with an increase in onward milkings.

The data for various compositional parameters as reported in literature are cited below.

Madsen et al. (2004) in his study reported that fat varied widely as number of the milking increased up to 12th milking. Lactose concentration increased from 2.6 to 4.4 per cent throughout the period up to 12th milking. Protein decreased from 13.90 to 3.55, and casein decreased from 9.24 to 2.73 per cent during the period. Immunoglobulin IgG_1 declined during the period. Kehoe et al. (2007) reported mean values (%) of TS, fat, protein, lactose and ash content as 27.64±5.84, 6.70±4.16, 14.92±3.32, 2.49±0.65 and 0.05±0.01, respectively. Kertz (2008) reviewed that the total solids content (%) of colostrum at 1st milking was 23.9 with a decreasing trend and reaching up to 12.9 at 5th milking. The fat (%) at 1st milking was 6.7, followed by 5.4, 3.9. 4.4, 4.3 and 4.0 at successive milkings. The solids-not-fat content (%) at 1st milking was 16.7, followed with a decreasing trend and reaching to 8.8 at 5th milking. The total protein (%) at 1st milking was 14, followed a decreasing trend and reached up to 3.1 at 5th milking. The lactose content (%) at 1st milking was 2.7, followed by an increasing trend and reaching up to 5.0 at 5th milking. The ash content (%) at 1st milking was 1.1, followed by a decreasing trend and reaching up to 0.74 at 5th milking. Patoo et al. (2014) studied the effect of lactation on colostrum of Hill cows of Uttarakhand and observed mean values of TS, fat, protein, lactose and ash content of as 18.33, 5.92, 9.27, 3.35 and 0.88 per cent during first five postpartum days, respectively. Puppel et al. (2019) reviewed composition and factor affecting the quality of bovine colostrum and showed that chloride content in bovine colostrum was 0.118 per cent at the time of calving. Dande and Nande (2020) analysed the colostrum of Sahiwal and found the mean TS, fat, SNF, protein, ash and chloride content as 15.92, 2.18, 13.74, 7.98, 0.92 and 0.13 per cent at first day postpartum.

The data of average TS, fat, SNF, protein, lactose and ash content of Gir cow colostrum observed in this study are in corroboration with the data reported in the literature for indigenous cows and pooled samples. The exception is fat content of colostrum which is lower than those reported in the literature.

Physicochemical properties: Physicochemical properties of the colostrum varied in successive milkings post-partum. Specific gravity was highest in the first milking immediately after calving followed with a gradual decrease on successive milkings. Such decrease is well correlated with a decreasing level of TS and SNF content in colostrum as lactation advances. Madsen et al. (2004) in his study reported the density of 1.048 at first milking after calving followed by a decreasing trend with successive milkings till 12th milking. Kertz (2008) reported the specific gravity of colostrum at 1st milking to be 1.056 followed by a decreasing trend with a value of 1.033 at 5th milking post-partum. Jeong et al. (2009) analysed the samples of colostrum of cows of dairy farms from Gyeonggi-do and observed the specific gravity of first colostrum to be 1.055±0.01. Sobezuk-Szul et al. (2013) found the specific gravity of first colostrum of Jersey and Polish Holstein–Friesian cows to be 1.065 and 1.056, respectively. On comparison with the values reported in the above studies, the specific gravity values of Gir cow colostrum were higher which is indicative of high content of total solids in colostrum.

The viscosity was highest in first milking immediately after calving, followed with a gradual

decrease on successive milkings. Hassan et al. (2020) analysed colostrum of Holstein cows and reported mean value of dynamic viscosity of first postpartum colostrum samples as 34.55 cP with a range of 4.9–219 cP. Studies on viscosity values of colostrum are scanty.

The values of surface tension of Gir cow colostrum fluctuated throughout the milkings. Data on surface tension of cow colostrum are not available in literature for comparison.

The highest refractive index was observed in first milking immediately after calving with a gradual decreasing trend on successive milkings. Such trend can be corelated to a decrease in total soluble solids content on successive milkings post-partum. Morrill et al. (2015) analysed 58 samples of colostrum from Jersey cattle and reported value of refractive index of fresh colostrum to be 1.3669±0.0074. Hassan et al. (2020) analysed total 40 fresh postpartum colostrum samples of Holstein cows and found the average refractive index to be 1.3640 with a range of 1.3454–1.3905. The refractive index of Gir cow colostrum in this study is slightly lower than the values reported in the literature.

Electrical conductivity of the Gir cow colostrum showed fluctuating trend throughout various milkings. Ontsouka et al. (2003) reported mean value of electric conductivity of colostrum of Red Holstein x Simmental cows as 5.6±0.2 mS/cm at 2 days postpartum. Nazir et al. (2018) the mean electrical conductivity of colostrum from Kashmir to be 4.9±0.08 mS/cm during three days postpartum. The electrical conductivity of Gir cow colostrum found in this study corroborates with the value reported by Ontsouka et al. (2003), however, it was higher than the value reported by the Nazir et al. (2018).

With respect to the titratable acidity of Gir cow colostrum, first milking immediately after calving had a highest acidity with a gradual decrease on successive milkings. Tsioulpas et al. (2007) analysed the milk samples of Friesian cows and found the mean value of titratable acidity to be 0.461±0.05 %LA at 1st day postpartum. Jeong et al. (2009) analysed the samples of colostrum of cows of dairy farms from Gyeonggi-do and reported mean value of titratable acidity of first colostrum as 0.50±0.06 per cent LA. The data on titratable acidity of Gir cow colostrum in this study are on lower side than values reported in the literature.

The lowest pH was observed in first milking immediately after calving with a gradual increasing trend on successive milking. Madsen et al. (2004) reported the pH to be 6.37 at first milking with an increasing trend as milking advanced till 12th milking. Kertz (2008) reported the specific gravity of colostrum at 1st milking to be 6.32followed by an increasing trend with a value of 6.50 at 5th milking post-partum. He also reported the pH of first colostrum to be 6.32 followed by increase in pH values on successive postpartum milking reaching to a value of 6.50 in normal milk. Patoo et al. (2014) studied the effect of lactation on colostrum and milk samples of Hill cows of Uttarakhand and reported mean pH value of colostrum to be 6.21±0.07 at first five postpartum days.

The data on pH of Gir cow colostrum found in this study are in corroboration with majority of the reported studies. Some reported values are higher than that of ours. The lower pH values of colostrum are suggestive of high content of protein components.

Nitrogen distribution pattern: Nitrogen distribution pattern of Gir cow colostrum were analysed for different milkings starting from first to sixth milking with 12 h interval up to 72 h postpartum duration.

The highest TN, NCN and WPN was observed in first milking immediately after calving with a gradual decreasing trend on successive milking. NPN, CN showed fluctuating trend upon successive milking.

Quality parameters of colostrum: °Brix of the colostrum corresponds to total dissolved solids content. Majority of functional proteins are in soluble state in colostrum and it gives a fair idea about soluble protein content in colostrum. The °Brix incolostrum of the individual Gir cows was highest at the 1st milking, followed by gradual decrease on successive milkings in order to attain the normal composition of milk.

Quigley et al. (2013) analysed total 183 colostrum samples of Holstein cow and observed mean °Brix as 23.8 per cent. Fahim and Imbabi (2021) analysed colostrum samples of 132 Montbeliard x Holstein cross dairy cows and observed mean value of °Brix as 23.97. Silva et al. (2021) analysed total 225 colostrum samples of Jersey cow up to five-time milking interval after calving and reported values of °Brix were 29.45±0.65, 26.19±0.92, 20.28±0.99, 16.16±0.61 and 13.94±0.59, respectively.

The data of °Brix of first milking of Gir cow colostrum was in general agreement with the reported values.

Immunoglobulins content: In this study, immunoglobulins content in colostrum of the individual Gir cows were highest at the 1st milking, followed by gradual decrease on successive milkings in order to attain the normal composition of milk.

Bartier et al. (2015) analysed total 519 samples of cow colostrum and studied the immunoglobulin content using colostrometer and reported mean value as 82.3 mg/mL with a range of 79.8-84.8 mg/mL. They kept cut off point for good quality colostrum as 80 mg/mL immunoglobulins. Morrill et al. (2015) analysed 58 samples of colostrum from Jersey cattle and observed the mean immunoglobulins content of fresh colostrum to be 72.91 mg/mL with a range of 12.82 to 154.26 mg/mL. Yaylak et al. (2017) analysed total 42 colostrum samples of Holstein cow and reported mean value of immunoglobulins content as 91.0±4.48 mg/mL. Schogor et al. (2020) studied the effect of genetics, management, physiology and freezing with the quality of colostrum and observed values of immunoglobulins content to be 77.65 and 82.77 mg/mL for Jersey and Holstein, respectively. Silva et al. (2021) analysed total 225 colostrum samples of Jersey cow up to five-time milking intervals after calving and reported the value of immunoglobulins as 105.71±5.23 mg/mL in first milking after parturition.

The data pertaining to immunoglobulins content of Gir cow colostrum in the study are on higher side which is an indication of good immune power of the Gir colostrum. According to cut off point for quality evaluation of colostrum reported by Bartier et al. (2015), Gir cow colostrum has good quality.

From the study, it is evident that compositional parameters and physicochemical properties of colostrum of Gir cow varied over various milkings post-partum up to 72 h duration. Values of several parameters corroborated with the values reported in literature. The deviations in these parameters are being influenced by factors like breed, individuality of animal, feeding practices, season, parity, etc. The nitrogen distribution pattern in Gir cow colostrum is in agreement with the reported values. From the point of view of quality parameters like °Brix and immunoglobulins content, the Gir cow colostrum is of good quality.

Conflict of interest: Authors have no conflict of interest in this research study.

Author's contributions: SCPe: Investigation and data generation; SCPa: Supervision and preparation of manuscript; AKJ, AIS: Engaged in data curation; CND: Editing of the manuscript; JHP: Collection of colostrum samples.

Data availability statement: Data will be provided on request to the corresponding author.

Use of artificial intelligence tools: AI tools are not used in the study.

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