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ORIGINAL PAPER

BASIC AND MINERAL COMPOSITION OF COLOSTRUM FROM COWS IN DIFFERENT AGES AND CALVING PERIOD*

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Abstract

The aim of our research was to analyse the composition and the basic content of selected minerals of colostrum depending on the season of calving and lactation of cows. The research material consisted of 180 colostrum samples collected in the first lactation (1*st*) and further lactation together (*FLT*) of cows which calved in the summer season (*S*) and winter season (*W*). The scope of the experimental research covered determinations performed on colostrum samples collected in 4 lactation phases: 1st (1h), 8th (8h) hour as well as at 3rd (3*D*) and 5th (5*D*) day after calving. Studies have shown that the dry matter, fat, protein as well as FFA and IgG content decreased after calving. The lactose level increased and the concentration of urea remained on a relatively constant level (no statistically significant difference). The age of cows was another differentiating factor of the dry matter, fat, protein, FFA, urea and IgG content. It did not affect the change in the lactose content. It has been shown that the content of mineral components changed over the course of the colostral period. The highest values of Ca, Mg and Zn occurred in the first hour after calving, after which their content decreased. The content of K and Na was shaped slightly differently, since it was not possible to establish upward or downward trends. Significant changes also occurred in the content of elements depending on the age of cows. Colostrum with the highest Ca

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content may be obtained from older cows. However, the highest K, Mg and Na content was recorded in the primiparous cows' colostrum of collected in the first hours after calving. A significantly higher content of K, Mg, Na and Zn appeared in colostrum obtained in the first hour after calving of cows in the winter calving season in comparison to the summer season.

Keywords: colostrum, season, lactation, macro- and microelements, immunoglobulins, primiparous, colostral period.

INTRODUCTION

Colostrum is the first food of a newborn mammal. It begins to accumulate in the mammary gland at the end of pregnancy. Colostrum is rich in various nutrients, i.e. proteins, including very important immunoglobulin (Zwierzchowski et al. 2016), fat, macro- and micronutrients, and vitamins (Scammell 2001, Zachwieja et al 2007, Heinrichs, Heinrichs 2011, El-Fattach et al. 2012). The content of components in colostrum is different than in milk, which responds to the changing nutritional needs of offspring (Ontsouka et al. 2003, Miciński et al. 2008, Pecka et al. 2012). The composition of colostrum varies depending on a species, breed, age of an animal, its health and the applied feeding regime (Miciński, Klupczyński 2006, Minkiewicz et al. 2013).

Minerals are an important component of colostrum. The share of these components changes with time since the moment of birth, and is also affected by the age of cows and such environmental factors as nutrition, maintenance or the season of calving, which all have an effect on the concentration of elements (Pecka et al. 2012). Both colostrum and milk are a rich source of calcium. Calcium and phosphorus are not only fundamental building elements for the growth of bones and teeth, but they also affect the regulation of the nervous and muscle systems, are involved in blood coagulation and participate in the activation of certain enzymes (Skibniewska et al. 2002). In turn, by being the main component of the intercellular fluid, sodium is required for the regulation of osmotic pressure. It interacts with potassium, which affects the osmotic balance and acid-base balance. Magnesium is involved in many metabolic processes by activating various enzymes; it also supports functions of the nucleus and is incorporated into bones. Zinc and copper act as antioxidants, able to neutralise harmful effects of free radicals (Paunier 1992, Navarro et al. 1999, Scherz, Kirchoff 2006). Zinc is also an essential element for the proper functioning of the male gonads; it is required for optimal cell growth and development and it also affects the rate of regeneration processes, for example in the healing of wounds. Zn deficiency adversely affects the immune system and can cause repoductive disorders (Blum, Hammon 2000, Blum 2006, Poulsen et al. 2010, Hanušovský et al. 2014).

The aim of the work was to analyse the composition of colostrum and its basic content of selected minerals depending on the season of calving and lactation of cows.

MATERIALS AND METHODS

The research was performed on a herd of cows of the Polish Holstein-Friesian breed, kept on a plant and animal production farm in north-eastern Poland. Cows were kept in a loose housing barn and fed in the TMR system (total mixed ration). The research basis consisted of 180 colostrum samples collected in the first lactation (1^{st}) and further lactation together (*FLT*) of cows which calved in the summer season (*S*), i.e. in the months: May, June, July, August, September and October, as well as winter season (*W*), i.e. in November, December, January, February, March, and April. The material for the experimental research consisted of colostrum collected in 4 lactation phases: 1^{st} (1h), 8^{th} (8h) hour as well as 3^{rd} (3*D*) and 5^{th} (5*D*) day after calving. The basic colostrum content: fat, protein, lactose, dry matter, urea and free fatty acid (FFA) (MilkoScan FT120, FOSS), was analysed. An analysis of the level of IgG made using kits from Bethyl (E10-118, E103 and E115). An atomic absorption spectrometer Spectra A280FZ Varian was employed to determine the content of selected macro- and microelements: calcium, potassium, magesium, natrium and zinc.

Colostrum samples were mineralised in Mars Xpress (*Candela*) microwave ovens. 3 ml samples were mineralised in the presence of 6 ml of 65% nitric acid and 1 ml of 30% hydrochloric acid. Two blind samples and Certified Reference Material (GBC Poland) sample were made for each of the mineralisation series. The mineralised material was dissolved in 25 cm^3 volumetric flasks. The content of elements in the above mineralised samples was determined in an atomic absorption spectrometer with flame atomisation (*air-acetyl*). The content of Ca, K, Mg and Na was determined in the presence of modifiers: cesium chloride and lanthanum chloride. The results were statistically processed using a two-way analysis of variance. The mean ($\bar{x}$) and standard deviation (SD) were calculated. Significance of differences was verified using the Fisher test. The results were statistically analysed using a Statistica ver. 10.0 (StatSoft, 2011) computer programme.

RESULTS AND DISCUSSION

The data set in Table 1 are the evidence of significant changes in colostrum, especially during the first 24 h after calving. This is reflected by the content of dry matter, which equalled 25% in the first milking (1 h) of cows in every lactation, decreasing to above 15% at day 3 (3*D*) after calving. This was mostly a consequence of changes in the protein content. The protein level was the highest in the first hour after calving. Its content in colostrum from first-calf heifers (1^{st}) was then 15.13%, which equalled 58% of dry weight. In older cows, protein (*FLT*) accounted for 60% of dry weight of colo-

Table 1

The basic composition of colostrum in different lactation periods ($\bar{x}$ ± SD)

Traits	LA	Time after calving			
		1 h	8 h	3 D	5 D
Dry matter (%)	1st	26.03 ± 1.62^{A}	20.29 ± 0.96^{B}	15.12 ± 0.41^{C}	14.35 ± 0.31^{C}
	FLT	$27.62 \pm 1.20^{A(x)}$	$21.37 \pm 0.58^{B(x)}$	15.63 ± 0.35^{C}	14.73 ± 0.11^{C}
Fat (%)	1st	7.12 ± 0.25^{A}	6.75 ± 0.18^{Ba}	$5.90 \pm 0.18^{Bb(x)}$	$5.34 \pm 0.12^{Ba(x)}$
	FLT	7.01 ± 0.13^{Aa}	6.45 ± 0.09^{Ab}	4.92 ± 0.25^{Bc}	4.55 ± 0.06^{Bd}
Protein (%)	1st	15.13 ± 0.34^{A}	9.19 ± 0.30^{B}	4.51 ± 0.007^{Cb}	4.12 ± 0.01^{Cb}
	FLT	$16.78 \pm 0.35^{A(x)}$	$10.55 \pm 0.20^{B(x)}$	4.75 ± 0.02^{C}	4.23 ± 0.01^{C}
Lactose (%)	1st	2.77 ± 0.01^{A}	3.57 ± 0.02^{Ba}	3.94 ± 0.01^{Bb}	4.17 ± 0.01^{Bc}
	FLT	2.58 ± 0.01^{A}	3.39 ± 0.01^{Ba}	4.02 ± 0.01^{Bb}	4.27 ± 0.01^{Bc}
FFA (%)	1st	33.99 ± 4.74^{A}	24.34 ± 4.09^{B}	12.48 ± 1.79^{C}	9.59 ± 1.72^{D}
	FLT	$38.80 \pm 3.02^{A(xx)}$	$29.45 \pm 4.71^{B(xx)}$	$15.10 \pm 1.73^{Ca(x)}$	$11.19 \pm 1.14^{Db(x)}$
UREA (mg L^{-1})	1st	93 ± 16.67	$89 \pm 14.67^{(x)}$	87 ± 10.00	93 ± 8.67
	FLT	$96 \pm 12.03^{(x)}$	87 ± 15.70	$97 \pm 12.78^{(x)}$	$99 \pm 9.17^{(x)}$
IgG (g L^{-1})	1st	76.80 ± 7.02^{A}	41.44 ± 7.71^{B}	2.13 ± 0.73^{Ca}	1.16 ± 0.16^{Cb}
	FLT	$94.84 \pm 7.02^{A(xx)}$	$63.06 \pm 7.98^{B(xx)}$	$3.19 \pm 0.70^{Ca(x)}$	$2.12 \pm 0.19^{Cb(xx)}$

Statisticaly significant differenes are denoted with: big letters (*A*,*B*) at $p \leq 0.01$; small letters (*a*,*b*) at $p \leq 0.05$ between selected periods after calving, and (*x*) at $p \leq 0.01$; (*xx*) at $p \leq 0.05$ between lactations;
Data are means: ±SD – standard deviation, h – hour, D – days, LA – lactation, 1st – first lactation, *FLT* – further lactation together; FFA –free fatty acid; IgG – immunoglobulins G.

strum, which is the evidence of higher quality of colostrum collected from multiparous cows. These results were statistically significantly different between lactations at $p \leq 0.05$ and between time periods after calving at $p \leq 0.01$ and $p \leq 0.05$. Similar results were achieved by Zachwieja (1995). A high fat content was determined in colostrum of cows of both groups already in the first hour after calving. Such results can also be found in other papers (Zachwieja et al. 2002*a*,*b*, Sobczuk-Szul et al. 2013).

Statistical differences were observed in the lactose content between both lactation groups. The average values of this factor showed an upward trend along the passage of time since calving. The lowest content of lactose was noted in primiparous cows during the first hour after calving (2.58-2.77%), but the level of this sugar exceeded 4% at day 5 in every cow group. Those values were higher than the ones given by Zachwieja et al. (2002*a*).

The finding that colostrum with the highest protein content can be produced by the oldest cows is confirmed by the research of Quigley et al. (1994). In turn, the results achieved by Kehoe et al. (2007) concerning the protein, fat and lactose content in cow's colostrum collected up to 4 h after calving were similar to the data achieved in our research from determinations done on colostrum collected in the first hour after calving. Nardone et al. (1997) reported a slightly higher research, protein and lactose content. On the other hand, Quigley et al. (1994), Zachwieja (1995), Nardone et al. (1997), Blättler et al. (2001), Kehoe et al. (2007), Sobczuk-Szul et al. (2013) noted a lower dry weight content in colostrum.

While analysing the content of free fatty acids (FFA), it could be seen that the cows activated the biggest fat reserves to supply energy needs of their own bodies immediately after calving, as the FFA level in colostrum at 1^{st} hour (1h) after birth was the highest and amounted to 33.99%. As the energy demand in the cows' bodies stabilised in the following days after birth, the FFA content decreased in colostrum, down to the lowest value on day 5 post-partum (9.59%).

The level of urea (*UREA*) in colostrum was relatively low and did not exceed 93 mg L^{-1} in any of the studied period. These results slightly deviate from the level of urea in milk of cows which are fed properly, as given by Fleszar (2013) and Bermagambetowa et al. (2016).

Table 1 shows the levels of immunoglobulin (IgG) in the colostrum. It has been demonstrated that the IgG level was the highest in the 1^{st} hour after birth, when it reached 76.80 g L^{-1}, falling down to 41.44 g L^{-1} in the 8^{th} hour and subsequently to its lowest level, i.e. 1.16 g L^{-1}, at day 5 ($p \leq 0.01$). Błaszkowska and Twardoń (2006) showed that the concentration of antibodies in colostrum decreases rapidly. Studying Holstein-Friesian calves, they obtained a lower concentration of immunoglobulins in the first colostrum, amounting to an average of 58.4 g L^{-1}. Low levels of antibodies in colostrum do not guarantee proper calf rearing. In studies on the quality of colostrum, Prichett et al. (1991) and Quigley et al. (1994) found that the immunoglobulin content is influenced *inter alia* by a cow's consecutive lactations. The cited authors noted the highest level of IgG, up to 76.2 g L^{-1}, in colostrum from cows in the 3^{rd} and later lactations. Guliński et al. (2006) obtained higher levels of immunoglobulins in colostrum from cows in the second lactation than from primiparous cows.

Table 2 shows the basic composition of colostrum in some of the phases of the colostral period, according to the season of calving. No statistically significant differences in the content of dry matter, protein and lactose in colostrum depending on a calving season were noted. There was only some impact of the season of cows' calving on the fat content in colostrum of cows immediately after giving birth (1h). Some differences were also recorded in the content of FFA, correlated not only with the passage of time since birth, but also with the season of calving. The FFA values were significantly higher in the summer colostrum compared to the winter assessment period ($p \leq 0.05$). Similar relationships, predominantly in the colostrum of summer calved cows, were noted in the urea content. These differences proved to be statistically significant at $p \leq 0.05$. In the case of IgG, a slightly higher content in each of the colostrum assessment periods of cows calved in the winter

Table 2

The basic composition of colostrum in selected evaluation periods depending on the season of cows' calving ($\bar{x}$ ± SD)

Traits	Season	Time after calving			
		1 h	8 h	3*D*	5*D*
Dry matter (%)	*S*	26.94±1.33$^{A(x)}$	22.30±0.44$^{B(x)}$	16.31±0.21$^{Ca(x)}$	14.56±0.29^{Cb}
	W	25.72±1.26^{A}	21.04±1.58^{B}	15.14±037^{Ca}	13.82±0.52^{Cb}
Fat (%)	*S*	6.92±0.26$^{A(x)}$	5.98±0.12$^{B(x)}$	5,08±0.13^{C}	5.26±0.10^{C}
	W	6.05±0.18^{a}	6.01±0.11^{a}	5,17±0.12^{b}	5.36±0.11^{b}
Protein (%)	*S*	16.34±0.58^{A}	11.90±0.13$^{B(x)}$	4,68±0.06^{C}	4.13±0.01^{C}
	W	16.26±0.36^{A}	10.62±0.08^{A}	4,95±0.08^{B}	4.26±0.01^{B}
Lactose (%)	*S*	2.62±0.01^{Aa}	3.53±0.01^{b}	3,78±0.02^{b}	4.24±0.01^{Bc}
	W	2.66±0.01^{A}	3.80±0.01^{Ba}	3,99±0.01^{Ba}	4.24±0.01^{Bb}
FFA (%)	*S*	39.07±3.74$^{A(xx)}$	31.04±5.09$^{B(xx)}$	22.44±2.79$^{C(xx)}$	14.50±1.12$^{D(xx)}$
	W	33.10±2.02^{A}	22.41±6.70^{B}	16.22±3.79^{C}	10.17±2.15^{D}
UREA (mg L^{-1})	*S*	108±16.67$^{(xx)}$	119±14.67$^{(xx)}$	96±10.00$^{(x)}$	93±8.67$^{(x)}$
	W	88±10.22	77±13.79	80±11.58	66±7.16
IgG (g L^{-1})	*S*	76.80±7.02^{A}	41.44±7.71^{B}	2.13±0.73^{Ca}	1.16±0.16^{Cb}
	W	77.64±5.01^{A}	44.05±8.75$^{B(x)}$	3.13±0.04^{Ca}	1.19±0.11^{Cb}

Key: cf. Table 1; *W* – winter, *S* – summer

period was noted compared to the values determined in colostrum of cows calved during summer.

Generally, the data on the basic composition of colostrum determined in our study do not differ from the information reported by other authors (Quigley et al. 1994, Zachwieja 1995, Nardone et al. 1997, Kehoe et al. 2007, Sobczuk-Szul et al. 2013).

Table 3 shows the content of selected macro- and microelements in colostrum depending on the cows' lactation and the time after calving. The highest share of mineral components was reported in the colostrum from the first yield (1^{st}). In the first hour after calving, 2990 mg L^{-1} of calcium was determined in the colostrum of primiparous cows, while older cows' colostrum had a much higher concentration of this element (3792 mg L^{-1}).

In the research by Pecka et al. (2012), the Ca level in primiparous colostrum exceeded 3000 mg L^{-1}, whereas in older cows it was similar to our determinations. In our study (Table 3), a significant drop in Ca occured on the third day (3*D*) after calving in both age group, which is evidenced by statistically confirmed differences ($p \leq 0.01$). These results, as well as the data provided by Kehoe et al. (2007) and Pecka et al. (2012), indicate the impact of age on the Ca content in colostrum. No such dependence was noted for the potassium content, as there was a lower K content (1478 mg L^{-1}) among the

Table 3

The mineral composition of colostrum (mg L^{-1}) in different lactation cows ($\overline{x}$ ± SD)

Traits	LA	Time after calving			
		1 h	8 h	3*D*	5*D*
Ca	1st	2990±21.83^{A}	2730±31.12^{B}	1570±15.23^{C}	1710±12.31^{D}
	FLT	3792±59.54$^{A(xx)}$	3045±26.33$^{B(xx)}$	2005±14.29$^{C(xx)}$	1997±12.31$^{C(xx)}$
K	1st	1590±2.70$^{A(x)}$	1720±5.85$^{B(x)}$	1590±6.36^{A}	1720±3.96^{B}
	FLT	1478±4.47^{A}	1684±7.63^{Ba}	1511±2.44^{Bb}	1689±1.10^{Ba}
Mg	1st	340±0.04$^{A(x)}$	250±0.23^{B}	150±0.15$^{C(x)}$	100±0.02^{D}
	FLT	311±0.27^{A}	230±0.13$^{B(x)}$	135±0.01^{C}	120±0.02$^{C(x)}$
Na	1st	680±0.75$^{Aa(x)}$	710±1.28$^{Ab(xx)}$	570±0.86^{B}	570±0.68^{B}
	FLT	610±1.12^{a}	550±0.32^{b}	600±0.34$^{c(x)}$	580±0.42^{b}
Zn	1st	24±2.4^{A}	15±1.05^{B}	8±0.48^{Ca}	6±0.12^{Cb}
	FLT	24±0.16^{A}	14±0.74^{B}	7±0.05^{C}	7±0.06^{C}

Key: cf. Table 1

older cows (*FLT*) during the first hour after calving, afterwards an increase of this component was noted 8 h after calving and that level (around 1700 mg L^{-1}) was maintained until the end of the colostral period in cows in both lactation periods. The K level given by Pecka et al. (2012) ranged from 2200-2800 mg L^{-1}, and was similar to that observed by Kehoe et al. (2007).

Magnesium is a another particularly important colostrum component. Its special role lies in the activation of intestinal peristalsis by making meconium less dense and easier to be expulsed (Jankowska, Baliński 2009). In our experiment, the magnesium content in colostrum was the highest, exceeding 340 mg L^{-1}, in the first hour (1st) after calving. A lower level of Mg in colostrum from the first yield was noted by Navarro et al. (1999) or Pecka et al. (2012), whereas El-Fattah et al. (2012) found that the Mg content in colostrum collected at that time interval was higher (420 mg L^{-1}). In the subsequent periods, a slight decrease in the content of magnesium in colostrum was noted and on the 5th day after calving the amount of magnesium was 120 mg L^{-1} in the colostrum of older cows and 100 mg L^{-1} in the colostrum of primiparous cows. Kehoe et al. (2007) report a much lower Mg content (73 mg L^{-1}).

The highest content of sodium was found in the colostrum of cows in 1st lactation and 8 h after calving (710 mg L^{-1}). The lowest content (550 mg L^{-1}) appeared at the same time, but in the collostrum of older cows (*FLT*). A much lower sodium content during the first milking of cows after calving (approximately 300-400 mg L^{-1}) was obtained by Pecka et al. (2012), but a much higher Na content was reported by Kehoe et al. (2007).

During the first hour after calving, the zinc level in colostrum exceeded 24 mg L^{-1}. As the time from calving passed, the content of this element in colostrum lowered down to 6 mg L^{-1} (primiparous) and 7 mg L^{-1} (older cows) on the fifth day. El-Fattah et al. (2012) also reported a similar tendency for the Zn level to decrease with time from calving. In their research, the content mineral components (mg L^{-1}) in colostrum of Holstein-Friesian cows for the periods shown below was as follows: immediately after calving (Ca = 2814, Mg = 429, Na = 213, K = 1795, Zn= 27), 6 h after calving (Ca = 2848, Mg = 377, Na = 214, *K* = 1711, Zn = 20), 12 h after calving (Ca = 2966, Mg = 269, Na = 201, K = 1600, Zn = 22), 72 h after calving (Ca = 1998, Mg = 157, Na = 147, K = 1006, Zn = 16), 120 h after calving (Ca = 1152, Mg = 144, Na = 901, K = 806, Zn = 15).

Table 4 shows the mineral composition of colostrum from cows calving in the summer or winter season. It has been shown that the content of the

Table 4

The mineral composition of colostrum (mg L^{-1}) in the selected evaluation periods depending on the season of cows' calving ($\bar{x} \pm$ SD)

Traits	Season	Time after calving			
		1 h	8 h	*3*D	*5*D
Ca	*S*	3450 ± 20.70^{A}	$3120 \pm 18.30^{B(x)}$	$2108 \pm 17.10^{Ca(xx)}$	$2040 \pm 20.20^{Cb(xx)}$
	W	$3650 \pm 61.69^{A(xx)}$	2910 ± 23.14^{B}	1808 ± 22.11^{C}	1720 ± 13.47^{C}
K	*S*	1330 ± 2.93^{A}	1430 ± 2.43^{Ba}	1580 ± 2.22^{C}	$1740 \pm 5.92^{Db(x)}$
	W	$1680 \pm 4.03^{a(xx)}$	$1620 \pm 2.30^{b(xx)}$	$1651 \pm 2.73^{b(x)}$	1670 ± 3.17^{a}
Mg	*S*	290 ± 0.23^{A}	187 ± 0.04^{Ba}	$160 \pm 0.21^{Bb(x)}$	120 ± 0.04^{C}
	W	$350 \pm 0.35^{A(x)}$	199 ± 0.07^{B}	147 ± 0.29^{C}	110 ± 0.02^{D}
Na	*S*	560 ± 0.78^{A}	683 ± 0.62^{Ba}	648 ± 0.45^{Bb}	$600 \pm 0.09^{Bc(x)}$
	W	$680 \pm 0.95^{a(xx)}$	671 ± 0.84^{a}	622 ± 0.74^{b}	530 ± 0.64^{c}
Zn	*S*	22 ± 0.13^{a}	10 ± 0.26^{b}	7 ± 0.29^{b}	6 ± 0.012^{a}
	W	$25 \pm 0.23^{A(x)}$	11 ± 0.25^{Ba}	8 ± 0.28^{Bb}	6 ± 0.012^{Bc}

Key: cf. Table 1; *W* – winter, *S* – summer

analysed mineral components 1 h after calving was higher in the colostrum of cows calved during winter. With the passage of time after calving, the calcium content decreased in both of the calving seasons. At the end of the colostral period (5*D*), a lower level of Ca was observed in the colostrum of cows calved in the winter period (1720 mg L^{-1}). In the group of cows calving in the summer, it was about 320 mg L^{-1} higher. The content of potassium in the subsequent colostrum assessment periods increased in the case of cows calving during the summer (an increase from 1330 mg L^{-1} to 1740 mg L^{-1}). There were not any changes in the potassium content in colostrum of cows calving during the winter period. Its content was at a stable level amounting to 1650 mg L^{-1} in average. In the case of magnesium, a downward tendency in the content of this mineral over time since the last calving was recorded in both seasons.

Slight differences in the Na content occurred only in the first and last period of the examination of this element in the colostrum of cows. In the first hour after calving, the content of this element was 680 mg L^{-1} in the colostrum of cows calving in winter and it was 120 mg L^{-1} lower in the colostrum of cows calving in summer. In the subsequent periods of the assessment, the Na content slightly exceeded 620 mg L^{-1}. At the end of the colostral period (*5D*) there was a decrease in the sodium content to 530 mg L^{-1} in cows calving in the winter season. Irrespective of the cows' calving season, a decreasing zinc content in colostrum of cows in the period from calving to the 3rd day was noted. At the end of the colostral period, the zinc content stabilized at 6 mg L^{-1} in the first and second season of calving.

In the studies of Sugeil et al. (1989) and Ruiz et al. (2015), it was shown that the season only slightly differentiates the colostrum content. A similar conclusion can be derived from Pecka et al. (2012).

CONCLUSIONS

The experiment has shown that the colostral period, lasting for 5 days, effected a significant change in the basic composition of colostrum and the proportion of FFA and IgG. The dry matter, fat, protein as well as FFA and IgG content decreased. The lactose level increased and urea remained on a relatively constant level (no statistically significant difference). The age of cows was another differentiating factor of the dry matter, fat, protein, FFA, urea and IgG content. It did not affect a change in the lactose content only.

It has been shown that the content of mineral components changed over the course of colostral period. The highest values of Ca, Mg and Zn occurred in the first hour after calving, after which their content decreased. The content of K and Na was shaped slightly differently, since it was not possible to establish upward or downward trends. Significant changes also occurred in the content of elements depending on the age of cows. Colostrum with the highest Ca content may be obtained from older cows. However, the highest K, Mg and Na content was recorded in the colostrum of primiparous cows in the first hours after milking. A significantly higher content of K, Mg, Na and Zn appeared in the colostrum obtained in the first hour after calving in the winter calving season in comparison to the summer season.

REFERENCES

Bermagambetova N.N., Naimanov D.K., Papusza N.W., Miciński J. 2016. *Milk yield and chemical and mineral composition of milk from Kazakh black-variegated cows, offspring of Holstein--Friesian bulls from three lines*. J. Elem., 21(3): 653-667. DOI: 10.5601/jelem.2015.20.3.1005

Blättler U., Hammon H.H., Morel C., Philipona C., Rauprich A., Romě V., Hueron-Luron., Guilloteau P., Blum J.W. 2001. *Feeding colostrum, its composition and feeding duration* *variably modify proliferation and morphology of the intensine and digestive enzyme activities of neonatal calves*. J. Nutrit., 131(4): 1256-1263.-b

Blum J.W., Hammon H. 2000. *Colostrum effects on the gastro-intestinal tract, and on nutritional, endocrine and metabolic parameters in neonatal calves*. Liv. Product. Sci., 66(2): 151-159. DOI: 10.1016/S0301/62-26(00)00222-0

Blum, J. 2006. *Nutritional physiology of neonatal calves.* J. Anim. Phys. Anim. Nutrit., 90(1-2): 1-11. DOI: 10.1111/j.1439-0396.2005.00614

Błaszkowska M., Twardoń J. 2006. *Influence of the total immunoglobulin level in the colostrum and serum of cows on the passive immunity level in calves*. Med. Wet., 62(2): 185-188. (in Polish)

El-Fattah A., Rabo F., El-Dieb S., El-Kashef H. 2012. *Changes in composition of colostrum of Egyptian buffaloes and Holstein cows*. BMC Vet. Res., 8(19): 1-7. DOI: 10.1186/1746-6148-8-19

Fleszar J. 2013. *Analysis and evaluation of milk composition as an indicator of the correctness of cows feeding on the organic farm*. J. Res. Applic. Agricult. Engin., 58(3): 111-118. (in Polish)

Guliński P., Niedziałek G., Salamończyk E., Górski T. 2006. *Immunoglobulin content in colostrum of cows within selected genetic and environmental factors*. Med. Wet., 62(3): 339-342. (in Polish)

Hanušovský O., Bíro D., Gálik B., Rolinec M., Šimko M., Juráček M., Rušinová M. 2014. *Changes in the average concentration of minerals in the colostrum of sows during the first 48 hours after parturition*. Res.Pig Breed., 8(1): 32-35.

Heinrichs A.J., Heinrichs B.S. 2011. *A prospective study of calf factors affecting first-lactation and lifetime milk production and age of cows when removed from the herd*. J. Dairy Sci., 94: 336-341. DOI: 10.3168/jds.2010-3170

Jankowska M., Baliński J. 2009. *Changes in active acidity and specific weight of colostrum depending on the selected factors*. Rocz. Nauk. PTZ, 5(2): 75-81. (in Polish)

Kehoe S.I., Jayarao B.M., Heinrichs A.J. 2007. *A survey of bovine colostrum composition and colostrum management practices on Pennsylvania dairy farms*. J. Dairy Sci., 90(9): 4108-4116. DOI: 10.3168/jds.2007.0040

Miciński J., Jastrzębski M., Klupczyński J. 2008. *Yield and composition of milk from Polish Holstein-Friesian and Jersey cows in particular months of the first lactations as dependent on milk protein polymorphism*. Arch. Tierz.- Arch. Anim. Breed., 51(3): 216-223.

Miciński J., Klupczyński J. 2006. *Correlations between polymorphic variants of milk proteins, and milk yield and chemical composition in Black-and-White and Jersey cows*. Pol. J. Food Nutrit. Sci., 15/56(SI 1): 137-143.

Minkiewicz P., Miciński J., Darewicz M., Bucholska J. 2013. *Biological and chemical databases for research into the composition of animal source foods*. Food Rev. Intern., 29(4): 321-351. DOI: 10.1080/87559129. 2013.818011

Nardone A., Lacetera N., Bernabucci U., Ronchi B. 1997. *Composition of colostrum from dairy heifers exposed to high air temperatures during late pregnancy and the early postpartum period*. J. Dairy Sci., 80(5): 838-844. DOI: 10.3168/jds.S0022-0302(97)76005-3

Navarro J. F.,Mora C., Macia M., Garcia J. 1999. *Serum magnesium concentrations an independent predictor of parathyroid hormone levels in peritioneal dialysis patients*. Perit. Dialysis Intern., 19(5): 455-461.

Ontsouka Q., Bruckmaier R. U., Blum J.W. 2003. *Fractionized milk composition during removal of colostrum and mature milk*. J. Dairy Sci., 86: 2005-2011.

Paunier L. 1992. *Effect of magnesium on phosphorus and calcium metabolism*. Monatsschr. Kinderheilkd., 140(9, s.1): 17-20. PMID:1331782

Pecka E., Zachwieja A., Góralska-Kowalska M. 2012. *The level of selected macroelements and* *selenium in cow colostrum, depending on their age and the number of somatic cells.* Przem. Chem., 91(5): 926-928. (in Polish)

Poulsen, K. P., A. L. Foley, M. T. Collins, McGuirk S.M. 2010. *Comparison of passive transfer of immunity in neonatal dairy calves fed colostrum or bovine serum-based colostrum replacement and colostrum supplement products.* J. Am. Vet. Med. Assoc., 237: 949-954.

Prichett L.C., Gay C.C., Besser T.E., Hancock D.D. 1991. *Management and production factors influencing immunoglobulin G_1 concetration in colostrum from Holstein cows.* J. Dairy Sci., 74(7): 2336-2341. DOI: 10.3168/jds.S0022-0302(91)78406-3

Quigley J.D., Martin K.R., Dowlen H.H., Wallis L.B., Lamar K. 1994. *Immunoglobulin concentration, specific gravity and nitrogen fractions of colostrums from Jersey cattle.* J. Dairy Sci., 77(1), 264-269. DOI:10.3168/jds.S0022-0302(94)76950-2

Ruiz P., Sesena S., Rieiro I., Palop M.L. 2015. *Effect of postpartum time and season on the physicochemical characteristics of Murciano-Granadina goat colostrum.* Int. J. Dairy Technol., 68(1): 88-96. DOI: 10.1111/1471-0307.12163

Scammell A.W. 2001. *Production and uses of colostrum.* Austral. J. Dairy Tech., 56(2): 74-82.

Scherz H., Kirchhoff E. 2006. *Trace elements in foods: zinc contents of raw foods – A comparision of data orginating from different geographical regions of the world.* J. Food Comp. Anal., 19(5): 420-433. DOI:10.1016/j.jfca.2005.10.004

Skibniewska K.A., Kozirok W., Fornal Ł., Markiewicz K. 2002. *In vitro availability of minerals from oat products.* J. Sci. Food Agric., 82(14): 1676-1681. DOI: 10.1002/jsfa.1243

Sobczuk-Szul M., Wielgosz-Groth Z., Wroński M., Rzemieniewski A. 2013. *Changes in the bioactive protein concentrations in the bovine colostrum of Jersey and Polish Holstein-Friesian cows.* Turk. J. Vet. Anim. Sci., 37: 43-49. DOI:10.3906/vet-1107-42

Statsoft, Inc. 2011. *Statistica (data analysis software system)*, version 10.0.

Sugeil K.A., Zakharenko N.A., Melnikova N.N. 1989. *Seasonal changes in the mineral composition of colostrum and milk serum of cows.* Ukrain. Bioch. J., 61(1): 92-94.

Zachwieja A. 1995. *Conditions causing variation in the composition of the colostrum of cows and the level of protein fractions in the blood serum of calves.* Part 1. *The effect of the herd, age of cows and season of birth.* Zesz. Nauk. AR Wrocław., 40(271): 155-175. (in Polish)

Zachwieja A., Chrzanowska J., Szulc T., Dobicki A. 2002*a*. *Immunoglobulin levels in the blood serum of calves in relation to physicochemical properties and trypsin inhibitory activity of the colostrum.* Med. Wet., 58(11): 874-876. (in Polish)

Zachwieja A., Chrzanowska J., Szulc T., Dvořák J., Dobicki A. 2002*b*. *Immunoglobulin levels in calves' blood serum in relation to the physicochemical properties and trypsin inhibitory activity of colostrum.* Med. Wet., 58(12): 989-991. (in Polish)

Zachwieja A., Szulc T., Potkańska A., Mikuła R., Kruszyński W., Dobicki A. 2007. *Effect of different fat suplements used during dry period of cows on colostrum physico-chemical properties.* Biotech. Anim. Husb., 23(5-6-2): 67-75. DOI: 10.2298/BAH07020672

Zwierzchowski G., Miciński J., Pogorzelska J., Siwicki A., Wójcik R., Kobzhassarov T.Z., Bermagambetova N., Shaikamal G.I., Fijałkowska M. 2016. *Influence of a diet containing ß-carotene and omega-3 fatty acids on the biochemical and non-specific humoral immunity indicators and on the results of experimental calf rearing.* J. Elem., 21(1): 283-302. DOI: 10.5601/jelem.2015.20.1.913