

# Total protein, selected protein fractions and chemical elements in the colostrum and milk of mares (Short Communication)

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## Abstract

The study material consisted of the colostrum and milk of five noble half-blood mares housed under the same environmental conditions. Colostrum samples were collected 24 h after foaling, whereas milk samples were taken five times, every 30 days, with the first sampling on lactation day 30 (1st month). In the samples were determined the concentrations of total protein, pre-albumins, albumins,  $\alpha$ - and  $\beta$ -globulins, immunoglobulins and calcium (Ca), magnesium (Mg) and zinc (Zn). The presence of pre-albumins was observed only in mare colostrum. Total protein concentration was at the same level in the colostrum and in the milk in the 1st lactation month, whereas protein fraction concentrations underwent dynamic changes during the 1st month of lactation. When compared to the values determined in the colostrum, the level of  $\alpha$ -globulins increased 8 times during lactation, whereas that of immunoglobulins decreased almost 4 times. The highest concentrations of Ca, Mg and Zn were found in mare colostrum, with a decrease in the concentration of all chemical elements in the 1st month of lactation, confirmed statistically in case of Mg and Zn.

**Keywords:** mares, colostrum, milk, protein, chemical elements

## Zusammenfassung

### Gesamteiweiß, ausgewählte Eiweißfraktionen und Makroelemente in Stutenkolostrum sowie -milch (Kurzmittteilung)

Untersucht wurde Stutenkolostrum und -milch von 5 Halbblutstuten die unter gleichen Bedingungen gehalten wurden. Das Kolostrum wurde 24 h nach der Fohlengeburt, die Stutenmilch beginnend am 30. Tag nach der Geburt in monatlichen Abständen bis zum 5. Monat gemolken. In den Proben wurden folgende Inhaltstoffe erfasst: Gesamteiweiß, Präalbumin, Albumin,  $\alpha$ - und  $\beta$ -Globulin, Immunoglobulin sowie die Mineralstoffkonzentration von Kalzium (Ca), Magnesium (Mg) und Zink (Zn). Präalbumin fand sich nur im Kolostrum. Während der Gesamteiweißgehalt im Kolostrum auf dem gleichen Niveau wie im ersten Laktationsmonat lag und bis zum 4. Monat wenig abnahm, veränderten sich die Anteile der einzelnen Eiweißfraktionen bis zum 5. Laktationsmonat erheblich. So erhöhte sich z.B. der  $\alpha$ -Globulinspiegel um das achtfache während sich der Immunoglobulinspiegel um das vierfache verringerte. Die höchsten Ca-, Mg- und Zn-Gehalte fanden sich im Kolostrum und nahmen mit zunehmender Laktationsdauer ab.

**Schlüsselwörter:** Stuten, Kolostrum, Milch, Eiweiß, Makroelemente

## Introduction

In recent years, difficulties in assimilation of cow milk by children and adults have been more and more frequent. Therefore, a valuable initiative is to search for replacement products, the assimilability of which by human organism is better. The mare milk is commonly considered to be similar in its composition to the milk of woman and for that reason is better tolerated by human organism than that of cow. The milk of mare, like that of woman, belongs to the albumin type in respect of protein, composition, whereas that of cow and goat represents the casein type (MALACARNE *et al.* 2002, DANKÓW *et al.* 2006). However, the mare milk is not commonly available on the market in Poland, like for example goat's milk and its products. Large similarity of the woman and the mare milk is well promising as far as replacement of human maternal milk with the milk of mare in infant diet is concerned, which gives reasons for taking up studies on mare milk. The present study aimed at determining the concentration of total protein, selected protein fractions and Ca, Mg and Zn in the colostrums and milk of mares in respective lactation months.

## Material and methods

The study material consisted of the colostrum and milk of five noble half-blood mares housed under similar environmental conditions. Colostrum samples were collected 24 h after parturition, whereas milk samples were taken five times, every 30 days, with the first sampling on lactation day 30 (1st month). Altogether, 5 colostrum and 25 milk samples were collected and analysed. In the analysed samples, total protein concentration was determined with Lowry's method, whereas protein fraction distribution was made with agarose gel electrophoresis (Cormay). Ca, Mg and Zn concentrations were assayed by inductively coupled plasma optical emission spectroscopy (ICP-OES), using an Optima 2000 DV apparatus (Perkin-Elmer Instruments, Norwalk, CT, USA), after prior mineralisation of samples in a high-pressure microwave mineralisation system (Anton Paar GmbH, Graz, Austria), using a standard procedure for milk included within the appliance software. The obtained data were analysed statistically using the repeated measures analysis of variance with Tukey's test (Statistica 7.0 software package).

## Results

Table 1 presents mean total protein and selected protein fraction concentrations in mare colostrum and milk. The mean content of total protein in mare colostrum (Table 1) did not change significantly in the examined period. The highest level of total protein was observed in the 2nd month of lactation, whereupon its concentration decreased in the 5th month of lactation. Table 1 also presents protein fractions separated in the colostrum and milk of mares. The presence of pre-albumins was observed only in the colostrum of mares. The level of that fraction ranged in respective mares from 9.7 to 18.0%. Among mare milk protein fractions, albumins and  $\alpha$ -globulins prevailed quantitatively. The lowest mean level of albumins was found in the colostrum. The concentration of that fraction increased significantly in the 1st month of lactation, whereupon decreased in the

4th month. The concentration of  $\alpha$ -globulins was characterised by largest differences. In mare colostrum, the mean level of that fraction was significantly lower from the value determined in the 1st month of lactation, whereupon increased gradually in the 5th month. The mean concentration of  $\beta$ -globulins in mare colostrum changed to a small extend; its decrease was observed in the 2nd month of lactation, another increase in the 4th month and a drop in the 5th month. These changes were not confirmed statistically. The mean level of immunoglobulins in the examined milk decreased during lactation. In mare colostrum, mean immunoglobulin concentration showed a significant drop in the 1st month of lactation and a successive decrease to the 5th month.

Table 1

Mean total protein and selected protein fraction concentrations in mare colostrum and milk

*Durchschnittliche Gesamteiweiß- und ausgesuchte Eiweißfraktionkonzentration im Kolostrum und in den Stutenmilch*

Lactation stage	Total protein (g/l)	Pre-albumins (%)	Albumins (%)	$\alpha$ -globulins (%)	$\beta$ -globulins (%)	Immuno-globulins (%)
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Colostrum	64.6 $\pm$ 19.0	13.0 $\pm$ 4.4	*22.1 $\pm$ 1.0	*5.5 $\pm$ 0.8	15.2 $\pm$ 5.5	*44.2 $\pm$ 2.4
1st month	68.9 $\pm$ 11.5	–	*37.6 $\pm$ 1.6	*30.3 $\pm$ 5.8	13.1 $\pm$ 3.4	*19.1 $\pm$ 4.6
2nd month	73.0 $\pm$ 17.6	–	36.0 $\pm$ 3.2	38.0 $\pm$ 2.5	10.5 $\pm$ 3.6	15.4 $\pm$ 2.3
3rd month	62.3 $\pm$ 12.4	–	35.2 $\pm$ 2.4	38.8 $\pm$ 1.1	10.8 $\pm$ 2.4	15.8 $\pm$ 2.6
4th month	60.9 $\pm$ 10.6	–	32.9 $\pm$ 1.3	40.6 $\pm$ 0.6	11.7 $\pm$ 2.9	14.8 $\pm$ 2.5
5th month	46.9 $\pm$ 7.9	–	33.8 $\pm$ 3.4	43.5 $\pm$ 1.3	9.9 $\pm$ 2.4	12.9 $\pm$ 3.4

\* differences between samples from respective lactations stages significant at  $P \leq 0.05$ , SD standard deviation

Table 2

Mean Ca, Mg and Zn concentrations in mare colostrum and milk (mg/l)

*Durchschnittliche Ca-, Mg- und Zn-Konzentration im Kolostrum und in den Stutenmilch*

Lactation stage	Ca	Mg	Zn
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Colostrum	1088.5 $\pm$ 199	*181.3 $\pm$ 104	*5.1 $\pm$ 4.5
1st month	868.8 $\pm$ 205	*57.1 $\pm$ 15.0	*1.6 $\pm$ 0.1
2nd month	710.0 $\pm$ 240	53.8 $\pm$ 14.6	1.7 $\pm$ 0.5
3rd month	713.9 $\pm$ 161	50.9 $\pm$ 5.5	2.1 $\pm$ 0.4
4th month	657.1 $\pm$ 137	48.7 $\pm$ 6.7	2.5 $\pm$ 0.7
5th month	453.1 $\pm$ 217	40.4 $\pm$ 11.3	1.8 $\pm$ 0.9

\* differences significant at  $P \leq 0.05$ , SD standard deviation

Table 2 presents mean Ca, Mg and Zn concentrations in the colostrum and milk of mares. As it results from the table, the colostrum of mares was characterised by highest concentrations of chemical elements discussed when compared with milk. Mean Ca concentration in mare colostrum decreased during lactation. Mean Mg concentration in mare colostrum exceeded over three times the mean concentration of Mg determined in the 1st month of lactation. During lactation, mean Mg concentration in milk decreased gradually. Like in case of Ca and Mg, mean Zn concentration in the colostrum was decidedly higher when compared to mare milk, too. The mean concentration of that chemical element did not show however a regular downward trend during lactation.

## Discussion

As reported in the literature, total protein level in mare colostrum and milk differs greatly. Colostrum protein level is influenced among others by the time of its collection. PASQUINI *et al.* (2005) found that total protein level in the colostrum of mares on parturition day amounted to 93.61 g/l, while 12 h after parturition to 60.15 g/l. This is a similar value to that obtained in the present study for the colostrum collected 24 h after parturition. Lower total protein levels in mare colostrum were found by TISHNER *et al.* (1996) 12 and 24 h after parturition, i.e. 36.42 and 31.75 g/l, respectively. On the other hand, WŁODARCZYK-SZYDŁOWSKA *et al.* (2005) observed higher total protein values in the colostrum of Thoroughbred mares collected directly after parturition, i.e. 112.4 g/l on average; similarly, CSAPÓ-KISS *et al.* (1995) also reported high total protein level in mare colostrum, i.e. 164.1 g/kg. DANKÓW *et al.* (2006) observed that total protein concentration in the colostrum of the Wielkopolski mares was 1.75 time higher 24 h after foaling than on the second day. PIESZKA (2005) found, in the milk of Arabian mares, that total protein concentration on the 2nd day of lactation was 3.43%, being the highest one, followed by a decrease to 2.09% on day 30. Other authors reported (CSAPÓ-KISS *et al.* 1995, MALACARNE *et al.* 2002, DANKÓW *et al.* 2006) that total protein level in mare milk ranges from 1.7 to 3%. As it results from Table 1, total protein concentration in the milk of mares was decidedly higher than the values reported by aforementioned authors. From among protein fractions of mare colostrum and milk, immunoglobulin concentrations are examined most frequently. WŁODARCZYK-SZYDŁOWSKA *et al.* (2005) determined mean immunoglobulin concentration in mare colostrum directly after parturition at a mean level of 58.8%, which is a higher value than that presented in Table 1 for the colostrum collected 24 h after foaling. PASQUINI *et al.* (2005) and TISHNER *et al.* (1996) observed a significant decrease in the immunoglobulin content in mare colostrum during 12 h after parturition. In the study of aforementioned authors, the level of immunoglobulin – amounting to 110.7 g/l after birth – decreased to 20.6 g/l 24 h after foaling. In the present study, immunoglobulin concentration in the colostrum collected in the same time was higher and amounted to 50.1 g/l on average (44.16%). MALACARNE *et al.* (2002), basing on the research of other authors, reported that the level of immunoglobulins in mare milk amounts on the average to 19.77%. This is a similar value to that found in the present study in the 1st month of lactation. As it is seen in Table 1, this value decreased gradually during lactation. In the present study, a higher mean concentration of albumins in the colostrum of mares was found than that reported by WŁODARCZYK-SZYDŁOWSKA *et al.* (2005), who determined it at 14.5% on average. The mean concentration of  $\alpha$ -globulins in our study was almost 2 times lower, while that of  $\beta$ -globulins was similar to that obtained by the aforementioned authors.

The concentration of all elements (Table 2) decreased in the 1st month of lactation, with differences in case of Mg and Zn being confirmed statistically ( $P \leq 0.05$ ). This corroborates the opinion of TISHNER *et al.* (1997) that macro- and microelement concentrations in mare colostrum are higher than in their milk. The aforementioned authors determined the content of Ca in mare colostrum at 709.4 mg/l, whereas that in milk at 336.67 mg/l. These results are considerably lower than those obtained in the present study. CSAPÓ-KISS *et al.* (1995) and MARTUZZI *et al.* (1997) reported that the

content of Ca in mare milk ranged from 485 to 1355 mg/kg, observing at the same time its decrease during lactation. The aforementioned authors observed large individual differences between samples (660-1670mg/kg). Higher milk Ca concentration, than that presented in Table 2, was found in Arabian mares in the 1st month of lactation, i.e. 913.5mg/kg (PIESZKA 2005), and in Italian Saddle Horse mares within the whole lactation, i.e. 1065 mg/kg (MARTUZZI *et al.* 1997). CSAPÓ-KISS *et al.* (1995) reported that Mg concentration in mare milk can amount to 29 to 118 mg/kg. The Mg concentrations in the milk of mares in respective lactation months (Table 2) are within the given range, except for that in the colostrum, which was higher. Mean Mg concentration in the milk of Arabian mares in the 1st month of lactation found by PIESZKA (2005) amounted to 95.86 mg/kg, while that in the milk of Italian Saddle mares found by MARTUZZI *et al.* (1997) to 76 mg/kg. The authors observed a decrease of those elements during lactation, like in our study. Mean Zn concentration in the analysed colostrum significantly ( $P \leq 0.05$ ) exceeded that in milk in the 1st month of lactation, and no systematic decrease in milk Zn concentration was observed in next lactation months. KAVAZIS *et al.* (2002) found that mean Zn level in colostrum in mare groups fed with mineral supplements amounted on the 1st day after parturition to 2.23 to 3.95 mg/kg but they did not observe a systematic decrease in mare milk Zn concentration in next lactation months either, with mean concentration value on lactation day 112 being 1.67 mg/kg. Mean Zn concentration in milk in our study was similar to that obtained by PIESZKA (2005) in Arabian mares in the 1st month of lactation, i.e. 2.55 mg/kg.

The obtained results confirm the fact that colostrum is a food of most abundant protein and mineral composition, and the same of high biological value. The 1st month of lactation was the period of most dynamic changes in chemical composition of milk. Total protein concentration was at the same level in the colostrum and in the milk in the 1st lactation month, whereas protein fraction concentrations underwent dynamic changes during the 1st month of lactation, with an increase in albumin and  $\alpha$ -globulin concentrations and a decrease of immunoglobulin levels during lactation. When compared to the values determined in the colostrum, the level of  $\alpha$ -globulins increased 8 times during lactation, whereas that of immunoglobulins decreased almost 4 times. The highest concentrations of Ca, Mg and Zn were found in mare colostrum, with a decrease in the concentration of all chemical elements in the 1st month of lactation. Small number of reports referring in particular to changes in concentrations of respective protein fractions in mare colostrum and milk inspires, however, to take up further studies in this field.

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