INTRODUCTION

Milk is a sophisticated food that contains several essential nutrients. The genetic, physiological, and nutritional makeup of milk varies greatly among animals as well as in response to environmental influences (Malacarne et al., 2002; Weaver et al., 2013). On the global market, while cow's milk accounts for 82% of all milk production and consumption, the remaining portion is primarily derived from buffaloes, goats, and sheep, with less than 1% coming from other animals like camels, horses/donkeys, and yaks. Less than 0.1% of the world's total production is made up of mare milk (Faye & Konuspayeva, 2012; FAOSTAT, 2020). In recent years, there has been an increase in interest in using mare's milk in the growing interest in different types of alternative milks not only because of their nutritional composition and possible use in many aspects of human nutrition. One of them is mare's milk. The analyze the selected properties of Lipizzaner breed mare milk was the aim of this study. The Lipizzaner mares (n=6) were kept under the same conditions and fed the same ration, and they were 5-6 years old. Milk samples were tested for 6 months. The following parameters were evaluated: dry matter, titratable acidity, density, electrical conductivity, pH, and content of fat, calcium, and lactose. On the base of our results, we can state that the average value of titratable acidity was 2.07±0.74 °SH, electrical conductivity 1.61±0.80 mS.cm⁻¹, density 1028.64±3.98 kg.m⁻³, pH 7.25±0.21, the content of dry matter 9.55±0.22%, fat 0.92±0.26%, lactose 6.71±0.12%, and calcium 105.03±16.14 mg L⁻¹.

Table 1 Gross composition of mare milk in comparison to human and cow milk (Malacarne et al., 2002).

<table>
<thead>
<tr>
<th></th>
<th>Mare</th>
<th>Human</th>
<th>Cow</th>
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<tbody>
<tr>
<td>Fat (g.kg⁻¹)</td>
<td>12.1 (5–20)</td>
<td>36.4 (35–40)</td>
<td>36.1 (35–39)</td>
</tr>
<tr>
<td>Crude protein</td>
<td>21.4 (15–28)</td>
<td>14.2 (9–17)</td>
<td>32.5 (31–38)</td>
</tr>
<tr>
<td>Lactose (g.kg⁻¹)</td>
<td>63.7 (58–70)</td>
<td>67.0 (63–70)</td>
<td>48.8 (44–49)</td>
</tr>
<tr>
<td>Ash (g.kg⁻¹)</td>
<td>4.2 (3–5)</td>
<td>2.2 (2–3)</td>
<td>7.6 (7–8)</td>
</tr>
<tr>
<td>Gross energy (kcal.kg⁻¹)</td>
<td>480 (390–550)</td>
<td>677 (650–700)</td>
<td>674 (650–720)</td>
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</table>

In comparison to cow's milk, mare's milk contains a much lower concentration of short- and long-chain saturated fatty acids, a similar concentration of monounsaturated fatty acids, especially palmitoleic (C16:1) and oleic (C18:1) acids, and a much higher concentration of polyunsaturated fatty acids, especially linoleic (C18:2) and linolenic (C18:3) acids. The ratio of unsaturated to saturated fatty acids in mares' milk fat is ca. 1.3 compared to 0.45 in cows' milk fat (Salaroli, Pagliarini & Peri, 1993a; Barreto et al., 2019). Triglycerides from human, cow, and mare milk make up around 80% of the total lipids; phospholipids and sterols make up 5%; and free fatty acids make up 10% of the total lipids (Marangoni & Narine, 2002). Mare's milk has higher content of sterols than human and cow milk, and the sterol fractions of all three contain some cholesterol (Jensen et al., 1990). The range of cholesterol in mare's milk is 50 to 88 mg L⁻¹ (Malacarne et al., 2002; Bareto et al., 2008; Pilarczyk et al., 2015). In comparison to human milk, which is like cow's milk in terms of energy supply, mare's milk contains less energy (Doreau & Martin, 2008; Barreto et al., 2012).}

**Keywords:** milk, mare milk, Lipizzaner breed, physicochemical properties
belief that mare milk is better for human nourishment than cows’ milk (Marconi 
& Panfilí, 1998; Malcarne et al., 2002).
Mare’s milk differs from cows’ milk in terms by organoleptically. It is clear, 
whitish, and sweeter milk, making it like human milk (Curadi et al., 2000; 
Potonik et al., 2011). Mare milk smells like hay and has a distinctive coconut 
flavour (Heger, 1988; Di Cagno et al., 2004). In terms of the physical properties, 
the density, osmotic pressure, and freezing point of mare and cow milk are 
comparable. Mares’ milk is less viscous, titratable acidic, and electrically 
conductive than cows’ milk (Solaroli, Pagliarini & Peri, 1993b). The pH, ca. 7, 
is higher than that of cows’ milk, human milk (Solaroli, Pagliarini & Peri, 
1993b).
The aim of present study was to determine the selected physicochemical properties 
of Lipizzaner mare’s milk during the lactation period.

MATERIAL AND METHODS

Material

The monitored Lipizzaner mares (n=6) came from a private breeder and were fed 
the same rations per mare/per day during the entire lactation period: 
• 3 kg of oats, 
• 4 kg of hay, 
• 2 kg of bedding straw, 
• pasture and water ad libitum
Milk samples were collected at monthly intervals after two weeks from the foaling 
of the mares. The mare’s milk was obtained by one make milking in the morning 
between seven and eight o'clock into sterile sample bottles in a volume of 500 ml. 
Subsequently, it was stored in a mobile cooling device (cooled below 10 °C) and 
transported to the laboratory of the Institute of Food, SUA in Nitra.

Methods

As part of the physicochemical analysis, we determined the following selected 
physicochemical indicators: 
- density by lactodensimeter device at a temperature of + 20 °C. The results 
were expressed in units kg m⁻³; 
- electrical conductivity by conductometer Mini digi Conductivity Meter 
OK-113 expressed in units m S cm⁻¹.

Table 2 Physicochemical properties of Lipizzaner mare’s milk during lactation period (n=6)

<table>
<thead>
<tr>
<th></th>
<th>TA (°SH)</th>
<th>EC (mS·cm⁻¹)</th>
<th>D (kg·m⁻³)</th>
<th>LC (%)</th>
<th>pH</th>
<th>DM (%)</th>
<th>FC (%)</th>
<th>CC (mg L⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>3.07±0.33</td>
<td>1.35±0.72</td>
<td>1029.17±0.68</td>
<td>6.57±0.21</td>
<td>7.16±0.07</td>
<td>9.77±0.18</td>
<td>1.35±0.40</td>
<td>120.63±6.46</td>
</tr>
<tr>
<td>M2</td>
<td>2.97±0.15</td>
<td>1.70±0.80</td>
<td>1031.58±0.49</td>
<td>6.55±0.41</td>
<td>7.12±0.08</td>
<td>9.71±0.21</td>
<td>1.06±0.66</td>
<td>114.33±8.89</td>
</tr>
<tr>
<td>M3</td>
<td>2.07±0.10</td>
<td>1.44±1.10</td>
<td>1031.17±0.68</td>
<td>6.84±0.36</td>
<td>7.07±0.17</td>
<td>9.73±0.18</td>
<td>0.92±0.04</td>
<td>104.96±8.46</td>
</tr>
<tr>
<td>M4</td>
<td>1.67±1.00</td>
<td>1.32±1.14</td>
<td>1031.25±0.88</td>
<td>6.71±0.35</td>
<td>7.22±0.09</td>
<td>9.51±0.14</td>
<td>0.78±0.62</td>
<td>93.42±7.88</td>
</tr>
<tr>
<td>M5</td>
<td>1.43±0.20</td>
<td>1.53±2.88</td>
<td>1030.17±1.17</td>
<td>6.75±0.29</td>
<td>7.36±0.21</td>
<td>9.37±0.23</td>
<td>0.62±0.27</td>
<td>95.30±22.49</td>
</tr>
<tr>
<td>M6</td>
<td>1.27±1.00</td>
<td>2.29±3.05</td>
<td>1027.30±0.84</td>
<td>6.81±0.77</td>
<td>7.54±0.15</td>
<td>9.24±0.14</td>
<td>0.76±0.32</td>
<td>101.52±19.39</td>
</tr>
<tr>
<td>Average</td>
<td>1.67±1.00</td>
<td>1.32±1.14</td>
<td>1031.25±0.88</td>
<td>6.71±0.35</td>
<td>7.22±0.09</td>
<td>9.51±0.14</td>
<td>0.78±0.62</td>
<td>93.42±7.88</td>
</tr>
</tbody>
</table>

Legend: Values shown as mean ± SD (standard deviation); M1 - M2 – the month of the lactation period, TA – titratable acidity, EC – electrical conductivity, D – density, LC – lactose content, DM – dry matter, FC – fat content, CC – calcium content.

In our study, the average value of titratable acidity of Lipizzaner mare milk ranged 
during the lactation period from 3.07 °SH (M1) to 1.27 °SH (M6). Mariani et al. 
(2001) stated titratable acidity in Haflinger nurse mare milk throughout 6 lactation 
months from 6.08 °SH to 2.01 °SH. The Average titratable acidity 2.51 °SH mare 
milk of Croatian Coldblood horse breed was observed by Čagalj et al. (2014), and 
2.65 °SH of Polish Coldblood horse breed in mid-lactation Cais-Sokoliska et al. 
(2018). The average pH value of 7.25 was determined. The publications of some 
authors emphasized the significant pH fluctuations in mare’s milk. Mariani et al. 
(2001) stated that, the pH of mare’s milk steadily increased throughout lactation, 
rising from 6.6 (right after delivery) to 6.9 (on the 20th day), or up to 7.1. (on the 
180th day).

While Pagliarini et al. (1993) suggested a pH value of 7.2, Kücküçetin et al. 
(2003) stated that the average pH of mare’s milk is 7.0. The pH value of colostrum, 
which was 6.69 according to Cosentino et al. (2017), fluctuated dramatically 
throughout lactation; the value seen at 15 days (6.85) was noticeably lower than 
those seen at 90 and 150 days. Tomczynski, Roman & Szybinska (1999) stated 
the average pH value of mare’s milk from mares of the Wielkopolska and Konik Polski 
breeds during lactation was 6.7 and 6.4, respectively. The pH, ca. 7, is slightly 
higher than that of cows’ milk, like human milk (Solaroli, Pagliarini & Peri, 
1993b). The variable pH values are probably the result of different contents of 
protein and salt concentrations (Čagalj et al., 2014).

Due to the presence of salts and other charged substances, milk exhibits conductive 
properties (Fox & McSweeney, 1998). Milk from infected quarters has higher 
concentration of sodium and chloride ion concentrations, which leads to increase 
the electrical conductivity of the milk (Kitchin, 1981). The stage of lactation, the 
time of year, and the feed are just a few of the variables that can impact electrical 
conductivity. Additionally, elements like milk’s pH, temperature, and fat content 
might affect how electrical conductivity is measured. According to Danków et al. 
(2006), the mean electrical conductivity of mare milk during lactation was 4.0 
mS/cm², whereas according to Kuy (1998), the electrical conductivity of mare’s milk 
ranged from 1.9 to 4.3 mS/cm³. During lactation, the average electrical 
conductivity of tested mare milk samples was 1.60 mS/cm³. The density of the mares’ 
and cows’ milk is comparable (Solaroli, Pagliarini & Peri, 1993b). Titrated milk samples from Lipizzaner mares had an average density of 1028.64 kg.m⁻³ throughout 
lactation. According to Unilacs-Lowe (2011), the much higher protein content of mare’s colostrum accounts for its higher density (1028 to 1035 kg.m⁻³) compared to mare’s milk. In the first 12 hours after birth, 
density is at its maximum and rapidly declines. According to Cais-Sokoliska et al. 
(2018), Polish Coldblood milk had a milk density of 1.037 kg.m⁻³. The density of 
Haflinger mare milk at 15 °C ranged from 1.0377 to 1.0245 g.cm⁻³, according to 
Mariani et al. (2001). In a study Nurliyani, Aryuanti & Indratiningish (2015) 
mare milk had a density of 1.033 g.cm⁻³. Summer et al. (2000) stated similar 
findings, the density of mare milk at 15 °C in the 20–180 day lactation stage ranged 
from 1.0345 to 1.0361 g.cm⁻³. With rising temperatures, density of milk decreases, 
milk loses density primarily due to water expansion. Fat, protein, lactose, and other 
solids compositions were the most important elements in density estimation (Ueda, 
1999). 
Mare’s milk has a significantly different major component composition from the 
milk of domestic cattle. Mares milk may be blended with goat, sheep and, most 
importantly, cow milk for a variety of practical reasons (health, functional, 
technological, and marketing) (Kecskeméti et al., 2003; Cais-Sokoliska, 
Wójtowski & Píkul, 2016a,b; Cais-Sokoliska et al., 2017). The first month of 
lactation had the highest dry matter content (9.77%) and the seventh month of 
lactation had the lowest (9.24%). Additionally, in the 1st month of lactation, milk 
samples contained, on the average, more total solids in relation to the rest of 
the lactation. According to Gibbs et al. (1982), Schryver et al. (1986b), and Salimey, 
Varisco, and Rosi (2002), the dry matter content of mature milk ranges from 10 
and 12% and declines over the course of lactation. Nurliyani, Friska Aryuanti 
&
Lipizzaner mare's breed. However, to obtain more information about the Lipizzaner mare's milk and to define its quality aspects, it is necessary to carry out further studies.

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REFERENCES


CONCLUSION

With the growing interest in new, ethnic alternative dairy products, a few research teams are dealing with the use of mare's milk. Its nutritional composition, as well as its properties, can predestinate it for human nutrition as well as the production of a certain group of dairy products. However, information on its physicochemical and biochemical properties is needed to apply the quality aspects and to standardization of technological processes. Therefore, this work was aimed at determining the selected physicochemical parameters of milk originating from the Lipizzaner mare's breed.


