MILK FATTY ACIDS FROM DIFFERENT HORSE BREEDS COMPARED WITH COW, GOAT AND HUMAN MILK

Maria Claudia Curadi¹, Roberto Leotta¹, Giovanna Contarini², Mario Orlandi¹

¹DPA, Pisa University, Viale Piagge 2, 56123 Pisa, Italy
²CRA-FLC, Via Lombardo 11, 26900 Lodi, Italy
mccuradi@vet.unipi.it

The essential role of fatty acids (FA) in human nutrition was widely documented. Since unsaturated fatty acids amount in mare milk seems to be higher than in cow milk, an approach was considered to evaluate differences between some equine breeds and compare fatty acids composition in different species. Trial was carried out on 30 Haflinger, 6 Noriker and 12 Thoroughbred milk samples collected at 30, 60 and 90 days from delivery. FA profile was investigated referring to linoleic (LA), α-linolenic acid (ALA), LA/ALA ratio and saturated/unsaturated ratio. LA was higher in Thoroughbred milk at 30, 60 and 90 days, ALA in Noriker mares versus Thoroughbred and Haflinger, underlining an interesting genetic characteristic. LA/ALA ratio was 0.51, 0.49, 0.39 in Noriker at 30, 60, 90 days with a sat/unsat ratio about 1. In Thoroughbred sat/unsat ratio was 0.87, 0.71, 0.57; in Haflinger 1.24, 1.09, 1.28. Investigations concerned also milk FA from Haflinger, Noriker and Thoroughbred mares collected at 60 from delivery compared with cow, goat and human milk. Unsaturated FA were found about 55% in mare samples, higher than cow and goat (30–33%) and similar to human. Sat/unsat ratio was lower than 1 in mare milk, about 2 in cow and 2.3 in goat. All mare samples were rich in LA (6.22–15.41%) and ALA (7.09–12.50%). In human milk LA and ALA were 13.54% and 1.02%; lower in goat (2.62% and 0.63%) and in cow (1.86% and 0.57%). Sat/unsat ratio was between 0.70 and 1.09 in horses, 2.30 in goat, 1.88 in cow and 0.83 in human milk.

Key words: mare milk; horse breeds; milk fatty acids; linoleic acid; α-linolenic acid

МЛЕЧНИ МАСНИ КИСЕЛИНИ ОД РАЗЛИЧНИ РАСИ КОЊИ ВО СПОРЕДБА СО КРАВЈОТО, КОЗЈОТО И ХУМАНОТО МЛЕКО

Есенцијалната улога на масните киселините (FA) во човечката исхрана беше широко документирана. Откако се констатира дека количината на незаситените масни киселини во млекото од кобила е повисока отколку во крајното млеко, интересувале се процените на различните масни киселините во млекото од некои раси коњи и споредна на составот на масните киселни во различните видови млеко. Експериментот беше извршен на 30 грна од расата хафлингер, 6 грла од расата норикер и 12 полнокровни коњи, од кои беше земен променливост на млекото собрани на 30, 60 и 90 ден по породувањето. Профилот на масните киселините беше измерен во следните ниво на линоленска (LA) и алфа-линоленска киселина (ALA), односот на LA/ALA и односот на сат/незаситни масни киселини. Линоленската киселина беше повисока во млекото од незаситниот коњ во 30, 60 и 90 ден, альфа-линоленската киселина кај кобилите од расата норикер во споредба со полнокровните и коњите од расата хафлингер, потпишано на интерес и генетска характеристика. Односот LA/ALA кај расата норикер на 30, 60, 90 ден беше 0,51, 0,49, 0,39 со односот на сат/незаситни масни киселини околу 1. Кај полнокровните коњи односот на сат/незаситни масни киселини беше 0,87, 0,71, 0,57; кај хафлингер 1,24, 1,09, 1,28. Истражуваната се однесува исто така на споредба на млекните масни киселини од млекото на расата хафлингер, норикер и полнокровните коњи, собрани на 60 ден по породувањето, со крајното, коњото и хуманото млеко. Нивото на незаситните масни киселини беше околу 55% во споредба со коњите, повисено во однос на кравите и козите (30–33%) и слично со хуманото млеко. Односот на сат/незаситни масни киселини беше повисок од 1 кај кобилското млеко, околу 2 кај крајното и 2,3 кај коњото. Сите примероци на млекото од кобилите и беше богат на LA (6,22 – 11,41%) и ALA (7,09 – 12,50%). Во хуманото млеко LA и ALA беше 13,54% и 1,02%; повисено кај козите (2,62% и 0,63%) и кај кравите 1,86% и 0,57%. Односот на заставените масни киселини беше мешано кај кобилите, 2,30 кај козите, 1,88 кај кравите и 0,83 кај хуманото млеко.

Ключни зборови: кобилско млеко; раси коњи; млекните масни киселини; линолна киселина; альфа-линоленска киселина
INTRODUCTION

Fatty acids (FA) play an important role in human nutrition moreover by regulating several biological and metabolic processes. Dietary fat is a very important factor influencing human health, particularly cardiovascular diseases (Noble, 1999; Pikul and Wojtowsky, 2008). Health quality would really be improved not only by a general reduction in fat dietary intake, but with an accurate evaluation on saturated/unsaturated fatty acids ratio in favour of the latter (Noble, 1999). Equine milk’s composition has been recently investigated because some characteristic protein fractions suggested an utilization of this product, more similar to human milk than cow’s, in diets to cow’s milk allergic children (Businco et al., 2000; Curadi et al., 2001), in the opposite to what’s happen with goat milk, where a certain cross-reactivity between cow and goat’s milk has been demonstrated (Luccenti et al., 1999). Mare’s milk and donkey’s milk are also important for fat composition, particularly for fatty acids content, that they in fact play an important role in several biological processes; in medicine an increase of blood saturated/unsaturated fatty acid ratio is considered an important risk factor; long-chain polyunsaturated fatty acids (PUFA) are furthermore basic components of cellular membranes (Pikul and Wojtowsky, 2008; Csapó et al., 1995).

Equine milk seems to contain remarkable amounts of alpha-linolenic (ALA) and linoleic (LA) acids, usually called essential fatty acids (EFA) and respectively precursors of n-3 and n-6; they are much higher than in cow milk (Csapó et al., 1995), although its content of long-chain polyunsaturated fatty acids seems to be limited. LA and ALA are precursors of eicosanoids, whose imbalanced synthesis has also implicated in various pathological conditions including cardiovascular diseases and are considered cardioprotective factors. LA and ALA are not synthetized in the human body or are synthetized at such a slow rate, that they must be supplied by the diet. Infants may benefit from long chain polyunsaturated fatty acids unsupplemented formulae containing high ALA amounts, since recent studies (Clark et al., 1992) demonstrate that preterm infants are able to form arachidonic (AA) and docosahexaenoic acid (DHA). DHA can be synthetized by a complex series of chain elongation-desaturation reactions from ALA and plays an important function in infant nutrition, because of unusually concentrations found in their brain. Plasma DHA is available for developing brain and retina and is involved in dopamine and serotonin metabolism (Innis, 2000). A n-6 EFA deficit leads to an inflammatory skin condition both in animals and in humans; in atopic dermatitis a low blood EFA concentration was pointed out. Mare’s milk fat content is lower compared to human and moreover dairy cows and FA composition showed smaller amounts of stearic and palmitoleic acids and higher quantities of oleic, linoleic and linolenic acids (Malacarne et al., 2002; Pellizzola et al., 2006). High FA unsaturated/saturated ratio, as found in equine milk, contributes to a lower fat melting temperature, higher iodine number and higher antimicrobial activity in comparison to cow milk (Lozovich. 1995).

Some previous work (Orlandi et al., 2002) evaluated FA amounts in the first months of lactation in Thoroughbreds and Haflinger mares, considering mainly the changes on milk fat content due to the lactation period, as reported also by some other authors (Hoffman et al., 1998; Mariani et al., 2001; Doreau and Martuzzi, 2006); only a few numbers of studies concern the influence of lactation on fatty acids composition in equine milk (Csapó et al., 1995, Hoffman et al., 1998; Orlandi et al., 2002). Since unsaturated fatty acids amounts in mare’s milk seem to be higher than in cow’s milk, it was interesting to consider to study in detail an approach to evaluate differences between some equine breeds and compare fatty acids composition with cow, goat and human’s milk samples.

MATERIAL AND METHODS

Mare samples from 30 Haflinger (H), 6 Noriker (N) and 12 Thoroughbred (TH) pluriparious mares aged 5–9 years were collected at 30, 60 and 90 days from delivery. Haflinger and Noriker were located in the same breeding and were fed with the same pasture (Tab. 3) Thoroughbred come from a different breeding center and were mainly fed with hay and concentrate. We have also used in this trial samples from 5 Trotter (T), and compared 60 days samples from all evaluated horse breeds with cow, goat and human 60 days pool samples and Literature values (Tab. 2). Every equine milk sample was obtained as a pool of two milkings before feeding time from every mare. All samples were frozen at –20 °C. FA composition was performed according to the Roese-Goettlieb extraction (FIL-
Milk fatty acids from different horse breeds compared with cow, goat and human milk

In the Table 1 we observe that LA was higher in Thoroughbred milk at 30, 60 and 90 days. In Noriker samples ALA was always higher versus Thoroughbred and Haflinger, underlining an interesting genetic characteristic. LA/ALA ratio was 0.51, 0.49, 0.39 in Noriker at 30, 60, 90 days with a sat/unsat ratio less than as average 1. In Thoroughbred LA amounts were about 15–16% in all periods while ALA amounts were respectively 8.20, 9.11, 10.58 % total FA; sat/unsat ratio was 0.87, 0.71, 0.57. In Haflinger samples the same was 1.24, 1.09, 1.28.

Table 2 reports LA and ALA composition of different administered feed

Table 3 shows the results related to 60 days milk samples composition from 4 different horse breeds compared with cow, goat and human’s.

---

**RESULTS AND DISCUSSION**

In the Table 1 we observe that LA was higher in Thoroughbred milk at 30, 60 and 90 days. In Noriker samples ALA was always higher versus Thoroughbred and Haflinger, underlining an interesting genetic characteristic. LA/ALA ratio was 0.51, 0.49, 0.39 in Noriker at 30, 60, 90 days with a sat/unsat ratio less than as average 1. In Thoroughbred LA amounts were about 15–16% in all periods while ALA amounts were respectively 8.20, 9.11, 10.58 % total FA; sat/unsat ratio was 0.87, 0.71, 0.57. In Haflinger samples the same was 1.24, 1.09, 1.28.

Table 2 reports LA and ALA composition of different administered feed

Table 3 shows the results related to 60 days milk samples composition from 4 different horse breeds compared with cow, goat and human’s.

---

**Table 1**

Linoleic acid (LA), α-linolenic acid (ALA), LA/ALA and saturated/unsaturated ratio (SAT/UNSAT) at different sampling time (30, 60, 90 days from birth) in Thoroughbred (TH), Haflinger (H) and Noriker (N) milk samples

<table>
<thead>
<tr>
<th></th>
<th>30 days</th>
<th></th>
<th>60 days</th>
<th></th>
<th>90 days</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TH</td>
<td>H</td>
<td>N</td>
<td>TH</td>
<td>H</td>
<td>N</td>
</tr>
<tr>
<td>LA</td>
<td>15.06 a</td>
<td>9.89 b</td>
<td>8.23 c</td>
<td>15.41 a</td>
<td>10.21 b</td>
<td>6.22 c</td>
</tr>
<tr>
<td>ALA</td>
<td>8.20 a</td>
<td>6.06 b</td>
<td>15.82 c</td>
<td>9.11 a</td>
<td>7.09 b</td>
<td>12.50 c</td>
</tr>
<tr>
<td>LA/ALA</td>
<td>1.89</td>
<td>1.80</td>
<td>0.51</td>
<td>1.70</td>
<td>1.54</td>
<td>0.49</td>
</tr>
<tr>
<td>SAT/UNSAT</td>
<td>0.87</td>
<td>1.24</td>
<td>1.01</td>
<td>0.71</td>
<td>1.09</td>
<td>0.74</td>
</tr>
<tr>
<td>FAT %</td>
<td>1.80</td>
<td>2.12</td>
<td>2.84</td>
<td>1.05</td>
<td>1.98</td>
<td>2.06</td>
</tr>
</tbody>
</table>

a, b, c = P < 0.05

**Table 2**

LA and ALA (% total FA) feed composition

<table>
<thead>
<tr>
<th></th>
<th>TH</th>
<th>H, N</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
<td>7.96</td>
<td>–</td>
</tr>
<tr>
<td>ALA</td>
<td>3.98</td>
<td>–</td>
</tr>
<tr>
<td>Concentrate</td>
<td>21.61</td>
<td>–</td>
</tr>
<tr>
<td>Pasture</td>
<td>–</td>
<td>5.01</td>
</tr>
</tbody>
</table>

**Table 3**

Linoleic acid (LA), α-linolenic acid (ALA), LA/ALA and saturated/unsaturated (SAT/UNSAT) ratio at 60 days from birth in Thoroughbred (TH), Trotter (T), Haflinger (H) and Noriker (N) samples and cow, goat, human (> 30 days from delivery) compared with cow, goat, human from Literature

<table>
<thead>
<tr>
<th></th>
<th>TH</th>
<th>T</th>
<th>H</th>
<th>N</th>
<th>Cow</th>
<th>Goat</th>
<th>Human</th>
<th>Cow(1)</th>
<th>Goat(2)</th>
<th>Human(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
<td>15.41</td>
<td>17.95</td>
<td>10.21</td>
<td>6.22</td>
<td>1.86</td>
<td>2.62</td>
<td>13.54</td>
<td>1.60</td>
<td>1.03</td>
<td>13.00</td>
</tr>
<tr>
<td>ALA</td>
<td>9.11</td>
<td>8.39</td>
<td>7.09</td>
<td>12.50</td>
<td>0.57</td>
<td>0.63</td>
<td>1.02</td>
<td>1.80</td>
<td>0.32</td>
<td>1.40</td>
</tr>
<tr>
<td>LA/ALA</td>
<td>1.70</td>
<td>2.14</td>
<td>1.54</td>
<td>0.49</td>
<td>0.49</td>
<td>0.15</td>
<td>3.23</td>
<td>0.89</td>
<td>3.22</td>
<td>9.29</td>
</tr>
<tr>
<td>SAT</td>
<td>41.86</td>
<td>41.30</td>
<td>52.13</td>
<td>42.13</td>
<td>60.39</td>
<td>69.47</td>
<td>45.24</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>UNSAT</td>
<td>58.14</td>
<td>58.70</td>
<td>47.87</td>
<td>57.87</td>
<td>33.49</td>
<td>30.21</td>
<td>54.62</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

(1) Jensen et al. (1990), (2) Zan et al. (2005)

Unsaturated FA were found about 55% in mare samples, higher than goat and cow (30%–33%) and similar to human. Sat/unsat ratio was lower than 1 in mare milk, 1.88 in cow and 2.30 in goat. All mare samples were rich in LA (6.22%–15.41% FA) and ALA (7.09%–12.50%). In human milk LA and ALA were 13.54% and 1.02%; LA values reached 13.0%, ALA 1.40% from Literature (Jensen et al., 1990). Lower values were found in goat (2.62% and 0.63%); data from Literature (Zan & al., 2005) reported 1.03% and 0.32% respectively. Lower values were also found in cow samples (1.86% LA and 0.57% ALA); 1.6% and 1.8% (Jensen et al., 1990). Sat/unsat ratio was between 0.70 and 1.09 in horses (0.81 as average), 2.30 in goat, 1.88 in cow and 0.83 in human milk.

CONCLUSIONS

Linoleic acid was significantly higher in Thoroughbred’s milk at 30, 60 and 90 days but very interesting amounts were also found in Haflinger and Noriker mares. Linolenic acid (ALA) was significantly higher in Noriker mares not only versus Thoroughbred but also versus Haflinger living in the same breeding and nutrition conditions, and so we suggest interesting genetic characteristics of those horse breed. These last conditions make LA/ALA ratio about 0.51, 0.49 and 0.39 in Noriker milk samples at 30, 60 and 90 days of lactation with a saturated /unsaturated fatty acids ratio less than 1; in the other two breeds we observe a LA/ALA and saturated /unsaturated very interesting for human nutrition. Mare LA and ALA amounts were generally higher than in goat and cow milk and total unsaturated FA levels were also higher. In human milk LA level resulted similar as in mare’s while ALA was lower. Unsaturated FA and sat/unsat FA ratio appeared similar in human and equine milk and lower than saturated FA. In goat and cow samples saturated FA resulted predominant.

REFERENCES