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Research on nutritional properties of mare's milk

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ABSTRACT

This article studied mare's milk as an alternative raw material for baby food production as its protein composition and structure are similar to those of human breast milk. Unsaturated fatty acids facilitate the physiological action of vitamins (thiamine, ascorbic acid), increase the body's resistance to infections, and play the role of hormones.

Key words: *Mare's milk, Composition, Lactose, Protein, Fat*

Introduction

Dairy horse breeding is the branch of agriculture, which has not become widespread yet, but is gaining in popularity. The Jabe horses originating in southern areas of the Aktobe Region (Kazakhstan) have become rather popular with specialists. The horse under consideration is short in height but robust. Average characteristics are the following: height at the withers – 1.32 to 1.38 m; body length – 1.42 m; chest circumference – 1.56 to 1.64 m; and weight – up to 360 kg. (Akïmbekov 2011).

Materials and Methods

The composition of milk was studied according to the generally accepted GOST standards with test reports attached; crude protein calculation – by refractometry according to ISO 8968-3:2014 (IDF 20-3:2014), determination of fat content – by the Gerber method (ISO 488:2008 (IDF 105:2008)), determination of lactose content– by polarimetry (IDF 79-2: 2002), determination of dry substance – by drying (GOST 3626-73), determination of ash – by burning milk at a temperature of 550-600°C, and determination of phosphorus and calcium – by calorimetry and complexometry. Milk acidity was determined by titration (GOST 3624-67), and density – by lactodensimetry (GOST 3625-84). The data obtained were processed by the A.N.Plohinsky variation statistics method using computer programs and statistical analysis packages StatgraphicsPlus 3.0 and Excel 5.0. Calculations were carried out using the MS Office 2007 software suites (including MS Excel 2007) and StatgraphicsPlus 3.0.

Results and Discussion

As a rule, cow's milk is used for the production of various baby foods as it is the main raw material in the dairy industry. However, mare's milk can become an alternative raw material in baby food production as its protein composition and structure are similar to those of human breast milk.

The physical and chemical properties of mare's milk are unstable and fluctuate within considerable limits (Table 1). It has been found that that they depend on the age of mares, the number of lactations,

the consistency of nutritional level, as well as horse breeding technology and conditions.

Analyzing the chemical composition of milk of the Kazakh mares, the authors found that milk of the mares in the Kyrykkudyk area was the richest in essential nutrients. For instance, broodmares in the Kyrykkudyk area have more fat than the ones in Saryomir. The average fat content in the mare's milk produced in the Kyrykkudyk area was 1.71 %, which was by 0.51 %more than that of the milk produced in the Saryomir area.

In the secretory process of the mammary gland, the mechanism regulating the osmotic balance between milk and blood plasma plays an important role. Lactose and soluble salts (sodium, potassium, and calcium) are osmotically active substances of milk: their ratio affects the iso-osmolality of milk and blood, and this is a prerequisite for the normal synthesis of milk constituents. The lactose content and salt concentration in milk are closely related. If one increases, the other decreases, and vice versa. It means that the total concentration of osmotically active substances is preserved, and the iso-osmolality of milk and blood does not change. The ratio of osmotically active substances in milk changes dramatically during lactogenesis. The authors note that the lactose content in cows increases from 3.18 (0.07 %) to 4.71 (0.04 %) during the first decade after labor, while the concentration of sodium decreases from 36.0 (1.61) to 24.0 (1.05) mEq /L. (Dwysembaev and Akïmbekov 1986; Dwysembaev and Akïmbekov 2016). Some works also provide evidence testifying that, during lactogenesis, these mechanisms ripen unevenly: the first mechanism – the sodium-potassium ion exchange – may be totally ready for the mammary gland to start functioning; the second one, associated with the exchange of sodium for lactose, develops gradually and is fully formed only a week after labor. (Doreau and Martin-Rosset 2002; Oftedal and Jenness 1988).

In mares, the lactose content in milk in the first months of lactation increased in the Saryomir and Kyrykkudyk areas reaching up to 7.2 mol/L and 7.1 mol/L, respectively. But then the lactose content gradually decreased, having reached 6.58 mol/L and 6.7 mol/L, respectively, and the cation content increased.Based on the obtained data, one can note that in the mares of the Saryomir and Kyrykkudyk areas the lactose correlates with the cations only negatively (Table 2). According to the research, since the mare's milk has more lactose compared to the milk of other animals, the sodium concentration in the mares is low from the start of lactation, and, apparently, its exchange for lactose is not enough to ensure the iso-osmolality of colostrum and blood. Therefore, another mechanism is activated – the exchange of potassium for lactose.At the same time, the data provided in Table 3 show that the fatty acid composition of milk features low content of capron (0.1), myristic (6.07), and stearic (1.05) fatty acids. At the same time, the contents of unsaturated fatty acids such as oleic acid (32.97 %), linoleic acid (9.00 %), and linolenic acid (5.43 %) are much higher than those in the cow's and camel's milk. Thus, cow's

Table 1. Physical and chemical indicators of milk of mares of the Kazakh breed

Area	Saryomir				Kyrykkudyk			
Month of year	5th	6th	7th	8th	5th	6th	7th	8th
Acidity, ^{0}T	6.8	7.1	7.2	6.8	6.9	7.1	7.2	6.8
Density, g/cm^3	1,032.3	1,035.6	1,033.0	1,033.8	1,032.7	1,035.6	1,033.0	1,033.8
Dry skim dairy residue mass-fraction, %	8.57	9.81	9.42	8.99	8.57	9.81	9.42	8.99
Fat, %	0.99	1.08	1.20	1.18	1.07	1.33	1.71	1.50
Protein, %	2.0	2.1	2.05	2.03	2.04	2.3	2.1	2.09

Table 2. State of mare's milk in different lactation stages of mares (M ± m)

Indicators	Unit	Saryomir area		Kyrykkudyk area	
		1st month	4th month	1st month	4th month
Sodium	mol/L	7.2 ± 2.73	6.58 ± 2.11	7.1 ± 2.80	6.7 ± 2.17
Potassium	mol/L	18.8 ± 2.73	14.6 ± 0.80	19.1 ± 2.73	14.3 ± 0.80
Lactose	%	6.87 ± 0.10	6.90 ± 0.33	6.89 ± 0.07	6.93 ± 0.27

and camel's milk differ a lot from mare's milk in the content of the above mentioned acids. Apparently, this is due to the differences in the technological properties of mare's milk compared to cow's and camel's milk. This also explains higher biological activity of mare's milk in exchange processes. This may also be the reason why newly drawn mare's milk (saumal) is used in the treatment of various diseases in the traditional Kazakh medicine.

The content of fatty acids in mare's milk is many times higher than that of fermented milk products made from the cow's milk and camel'smilk – shubat. The content of these unsaturated fatty acids in ayran is minimal. The same is true for linoleic and linolenic acids contained in shubat (Table 4). Perhaps, this explains the healing properties of mare's milk in case of such diseases as immune disorders and gastric ulcer. It is used for treating acute catarrh and diarrhea in children. Kumis, the product made from mare's milk, is considered a dietary and health boosting product.

The nutritional value and healing properties of mare's milk and kumis are significantly influenced by the content of amino acids. The analysis of the amino acid composition of mare's milk and kumis compared to cow's milk –ayran – and camel's milk shows (Tables 5, 6) that due to microbiological processes taking place in the production of fermented milk products, the content of almost all amino acids increases.In particular, 1 kg of mare's milk contains 270.06 mg of amino acids, while 1 kg of kumis contains1,577.73 mg. That is, the content has increased to 82.9 %.

Thus, it can be assumed that due to microbiological processes taking place in the production of kumis, the properties of milk improve because of the increasing content of amino acids. In addition, it is well-known that the digestibility of the nutrients contained in fermented milk products is much better than that of the nutrients contained in normal milk.

Table 4. Fatty acid composition of fermented milk products (% of total fatty acids)

Fatty acids	Ayran	Shubat	Kumis
Caproic acid (6:0)	0.26	0.34	0.17
Caprylic acid (8:0)	0.43	0.37	2.16
Capric acid (10:0)	0.06	0.33	4.43
Lauric acid (12:0)	0.22	1.41	5.71
Myristic acid (14:0)	0.68	17.68	6.76
Myristoleic acid (14:1)	0.37	1.11	0.75
Pentadecanoic acid (15:0)	0.08	1.58	0.34
Palmitic acid (16:0)	0.87	36.03	22.20
Palmitoleic acid (16:1)	0.12	10.02	7.26
Heptadecanoic acid (17:0)	0.23	0.62	0.64
Stearic acid (18:0)	0.26	10.66	1.25
Oleic acid (18:1)	0.81	18.69	26.99
Linoleic acid (18:2)	0.20	0.90	18.31
Linolenic acid (18:3)	0.04	0.25	3.04

Conclusion

Analyzing the chemical composition of mare's milk and kumis, one can conclude that by producing and consuming these products, it is possible to improve the quality of human nutrition. It is assumed that by increasing the content of essential amino acids and improving the amino acid composition of the prod-

Table 3. Fatty acid composition of milk (% of total fatty acids)

Fatty acids	Cow's milk	Camel'smilk	Mare's milk
Caproic acid (6:0)	1.5-3.0 (2.3)	0.18	0.13
Caprylic acid (8:0)	1.0-2.0 (1.9)	0.19	1.48
Capric acid (10:0)	2.5-2.8 (2.7)	0.17	2.77
Lauric acid (12:0)	2.8-3.5 (3.1)	0.99	3.40
Myristic acid (14:0)	10.6-11.8 (11.2)	15.30	6.07
Myristoleic acid (14:1)	-	1.09	0.66
Pentadecanoic acid (15:0)	-	1.73	0.39
Palmitic acid (16:0)	27.8-30.2 (29)	35.73	25.61
Palmitoleic acid (16:1)	1.5-2.0 (1.6)	11.30	7.26
Heptadecanoic acid (17:0)	-	0.83	0.78
Stearic acid (18:0)	9.5-12.5 (11)	10.11	1.05
Oleic acid (18:1)	23-27 (25)	20.97	32.97
Linoleic acid (18:2)	2.5-2.9 (2.7)	1.08	9.00
Linolenic acid (18:3)	0.3-1.6 (0.95)	0.31	5.43

Table 5. Amino acid composition of milk

Amino acids		Cow's milkmg/kg	Camel's milk,mg/kg	Mare's milk,mg/kg
Alanine	ALA	2.4	5.26	21.40
Glycine	GLY	-	2.57	2.99
Valine	VAL	6.6	6.72	13.10
Leucine	LEU	9.6	23.34	59.24
Isoleucine	ILE	5.5	3.58	10.61
Threonine	THR	4.3	3.22	1.07
Serine	SER	4.9	9.31	6.68
Proline	PRO	7.4	43.70	27.96
Asparagine	ASN		2.23	0.00
Aspartic acid	ASP	5.1	18.70	1.92
Methionine	MET	2.5	5.29	6.48
Glutamic acid	GLU	20.6	99.75	64.72
Phenylalanine	PHE	5.2	7.41	12.42
Glutamine	GLN	0.00	42.47	0.00
Lysine	LYS	7.8	8.82	1.27
Histidine	HIS	5.9	7.77	4.08
Tyrosine	TYR	4.3	8.69	2.30
Tryptophan	TRP	0.00	2.90	0.00
Cystine	CYS	1.2	3.28	0.00
Arginine	ARG	3.5	8.21	33.83
	total	**96.8**	**313.22**	**270.06**

Table 6. Amino acid composition of dairy products

Amino acids		Cow's milk, mg/kg	Camel's milk, mg/kg	Mare's milk, mg/kg
Alanine	ALA	10.6	64.69	92.17
Glycine	GLY	4.6	33.15	33.27
Valine	VAL	13.5	61.34	33.46
Leucine	LEU	27.7	109.36	161.03
Isoleucine	ILE	16.0	28.64	26.20
Threonine	THR	11.0	22.92	25.78
Serine	SER	18.2	86.93	79.87
Proline	PRO	27.2	206.21	169.02
Asparagine	ASN		15.97	26.61
Aspartic acid	ASP	21.6	27.04	68.18
Methionine	MET	8.1	29.35	30.01
Glutamic acid	GLU	49.7	215.87	317.06
Phenylalanine	PHE	14.1	46.65	51.27
Glutamine	GLN		76.08	129.88
Lysine	LYS	23.0	31.35	25.77
Histidine	HIS	7.8	5.75	78.24
Tyrosine	TYR	15.5	5.76	65.14
Tryptophan	TRP	4.3	8.43	15.08
Cystine	CYS	2.9	3.87	7.30
Arginine	ARG	10.5	98.66	142.40
	total	**286.3**	**1,178.01**	**1,577.73**

uct, respectively, one improves its nutritional value and therapeutic properties.

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