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Properties and Seasonal Variation of Milk Produced by One-humped Camels (*Camelus dromedarius*) and Two-humped camels (*C. bactrianus*) in the Republic of Kazakhstan

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Abstract: This study examined the components of the milk of one-humped and two-humped camels kept in same area in Kazakhstan, in May (rainy season) and August (dry season) 2015. Milk was sampled from camels of the same age that grazed on the same pastures. The general component analyses of camel milk involved the nutrition values, protein and fat content. The milk sampled from two-humped camels was found to contain greater densities of these components than milk sampled from one-humped camels. The values of calcium, phosphorus, zinc, aspartic acid, glutamic acid, phenylalanine, and lysine were higher in the two-humped camel milk samples. The densities of general components in the milk from both one-humped and two-humped camels were lower in the August samples than in those from May. Free amino acid densities in all milk samples were, however, higher in August than in May. The observed increase in August was considered to be related to the consumption of dry grasses that require longer rumination time and hence an increased activity of rumen microorganisms, and their nutritional byproducts. It may also be necessary to consider the grass type and nutrition ingested by the camels as well as the season for milking with regard to the quality and composition of milk.

Key Words: Bactrian, Dromedary, Kazakhstan, milk component.

1. Introduction

Eating a balanced diet is vital for the maintenance and functioning of a healthy body. In arid regions, the maintenance of a healthy diet becomes challenging and the keeping of livestock is important for the production of milk and meat. In such regions, camels are suitable livestock animals as they can tolerate marked dehydration and can eat prickly plants that are otherwise inedible to sheep, goats, horses, and cattle (Mason, 1986; Suzuki, 2004; Knoll and Burger, 2012). In addition to producing milk and meat, camels are also useful as mount and pack animals. Of all the camels in the world kept as livestock, ninety percent are one-humped camels (*Camelus dromedarius*). The breeding regions of one-humped camels span across North Africa, the Middle East, and continue eastward to Central Asia. Two-humped camels (*C. bactrianus*) occur in Mongolia, Inner Mongolian Autonomous Region of China, limited areas of Kazakhstan, and Tyva Republic of Russia. Camels are generally able to eat hard grasses that other livestock species cannot process, and their physiologies are well adapted to the climatic conditions of the arid environment.

Livestock milk compounds reportedly vary depending on the growth of the offspring and changes in diet. Previous studies concluded that Bactrian camel milk had significantly higher fat (Yagil, 1982; Baimukanov and Baimukanov, 2009), and also vitamin C, calcium, and phosphorus (Faye *et al*., 2008). Few reports have investigated milk harvesting time and the differences in milk components related to the individual characteristics of milked camels. In the present study, we studied and compared the seasonal variation in nutritional components of the milk from one-humped and two-humped camels, kept in the same territory and of the same age.

2. Research area and Methods

2.1. Surveyed household

Two farms, owners of which are father and son, were chosen to survey on the basis that it kept both one-humped and two-humped camels. The household chosen as our research site belongs to Mr. O (66 years old in 2016), who lives in the outskirts of the village, Akchi, situated 350 km north-west to Almaty City. We conducted our sampling on Mr. O's farm during March, May and August 2015. Mr. O's family, well known for breeding two-humped camels, began their breeding activities when they moved from the south of the Jambyl region in 2002, and bought 12 one-humped camels (six females and six colts) in Turkmenistan. After few years the family bought five more two-humped camels from Mongolia. The camel breeding of our chosen household survey site was summarized in **Table 1**.

This survey site is elevated 760 m above sea level, situated in arid land with salty well water that is not suitable for cattle breeding. Mr. O owns a total of 200 camels and his son, Mr. H (43 years old in 2016), owns 100 camels. These 300 camels are kept in the area of approximately 2,500 hectare. The 300 camels are split into herds of approximately 50 camels each; four

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Table 1. Life data of sampled camels.

	One- humped camel	Two- humped camel
Age	10 years	10 years
Number of colts born in 2015	One	One
Month of colt birth	March	March
Birth place of the camel	Turkmenistan	Mongolia
Breeding style	Pasturage	Pasturage
A hovel	Take	Take
Drinking water	Well water (salty)	Well water (salty)
The grass which a camel likes	Gramineous grass, a dandelion	Gramineous grass, a dandelion
Camel feed	Gramineous grass, a dandelion	Gramineous grass, a dandelion
The number of milking per day	May ; Four times /day	May ; Four times /day
	August ;Three times /day	August ;Three times /day
Milking person	Woman and Man	Men
Sampling time	Evening	Evening

herds consist solely of one-humped camels and two herds consist of a mixture of one-humped and two-humped camels.

2.2. Characteristics of milked camels

Two 10-year-old one-humped camels, which belong to Mr, O and Mr, H respectively, and had given birth to colts in March of 2015, were selected to sample milk. Milk samples were collected from each individual on the same days and during the same hours in May and August. Also one two- humped camel form the Mr. H's farm was selected to sample milk. All milked, 10 year-old camels were healthy and in good physical condition.

2.3. Milk component analysis methodology

In both May (rainy season) and August (dry season), milk samples were taken from each of the study animals on three separate days. The milk was immediately heated to 72 °C for 15 minutes and then cooled. Samples were then stored at 5 °C and transported to Japan. The general composition analysis was performed in accordance with conventional methods; each sample was analyzed twice and the mean values were calculated. The general mineral composition analysis was conducted by ICP spectrometry method. Only phosphorus content was determined using a vanado-molybdic acid absorption spectrophotometry. The composition of free amino acids in the samples was analyzed using the automatic amino acid analyzer (Hitachi high amino acids analyzer L-8900).

3. Results and Discussion

3.1. Uses of camel milk

When asked about the drinking of camel milk, interviewers replied that "during the 'old days' (including also the Soviet era time) camel milk was not used for drinking". However, in recent times the drinking of camel milk has received more popularity as it is thought to be a "good revitalizer for ill people", and is thought "to reduce stress". Even so, globally, the consumption of camel milk remains far lower than the consumption of cattle milk. Historically, camel milk was the main ingredient for the ethnic, low-alcohol containing beverage named "shubat" which, in appearance, is similar to the alcoholic Japanese rice drink, "doburoku". "Shubat" is made by fermentation raw camel milk with some lactic acid bacteria and yeasts, such as "qaris" or "garris" in Sudan (Sulieman *et al*., 2006) and "hoormog" in Mongolia (Ishii and Komiyama, 2010). Traditionally, the milk from two-humped camels was used for "shubat".

During the socialist era, the traditional nomadic style of living changed into a more settled way of life. This influenced and changed the number and types of livestock that homesteads kept. After the democratic reforms in the arid suburbs of the Almaty, households in our surveyed area had started a new business in camel breeding. Owing to the higher milk yield and smaller size of one-humped camels, the latter of which is important for easier handling, the two-humped camels in Kazakhstan became largely replaced by the one-humped camels. Currently, manufactures of "shubat" use milk from one-humped camels (Rahman *et al* ., 2009 ; Ishii and Nurtazin, 2014).

3.2 Milking the camels

Sampled camels gave birth in March. In the area that we conducted our survey, the annual milk yield per one-humped camel averaged 2000 L, and per two-humped camel averaged 700 L. Camel milking is carried out by two people, using a method similar to that performed by Mongolian nomads (Ishii and Komiyama, 2010).

Table 2. General composition analysis of the milk from one-pumped and two-humped camels.

Sample	Water (%)	Solid (%)	Protein (%)	Fat (%)	Ash (%)	Insolubled nitorogen (%)	kcal
March 2013, Mr. O's farm, one-humped	85.3	14.7	5.2	3.4	0.7	5.4	73
May 2015, Mr. O's farm, one-humped*	85.7	14.3	3.1	4.6	0.8	5.8	77
August 2015 , Mr. O's farm, one-humped *	87.6	12.4	2.5	4.7	0.8	4.4	70
May 2015, Mr. H's farm, one-humped **	88.9	11.9	3.1	3.6	0.9	4.3	64
August 2015, Mr. H's farm, one-humped**	87.3	12.7	3.2	3.9	0.9	4.7	67
May 2015, Mr. H's farm, two-humped***	85.0	15.0	4.0	4.8	0.9	5.3	80
August 2015, Mr. H's farm, two-humped***	86.1	13.9	3.9	4.6	0.9	4.5	75
Holstein[1)]	85.9	14.1	3.2	3.7	0.7	4.7	80
Cattle milk[2)]	87.7	12.3	3.3	3.8	0.7	4.8	66
Human milk[3)]	88.0	12.0	1.1	3.5	0.2	7.2	65

*, ** ,*** ; Each milk sample is from the same camel.

1), 2) ,3) ; Source: Japanese food composition table 2015.

Table 3. General mineral analysis of the milk from one-pumped and two-humped camels.

Sample	Na (mg/100ml)	K (mg/100ml)	Ca (mg/100ml)	Mg (mg/100ml)	P (mg/100ml)	Fe (mg/100ml)	Zn (mg/100ml)
March 2013, Mr. O's farm, one-humped[a)]	36	130	160	15	100	0.1	2.1
March 2013, Mr. O's farm, one-humped[b)]	47	170	120	7	88	0.1	0.3
May 2015, Mr. O's farm, one-humped*	53	180	130	12	90	0.1	0.3
August 2015 , Mr. O's farm, one-humped *	63	180	100	7	75	0.1	0.2
July 2015, Mr. O's farm, one-humped[c)]	39	140	130	8	78	0.1	0.3
May 2015, Mr. H's farm, one-humped **	70	220	110	8	75	0.1	0.4
August 2015, Mr. H's farm, one-humped**	56	190	110	8	95	0.1	0.4
May 2015, Mr. H's farm, two-humped***	64	170	160	12	130	0.2	0.7
August 2015, Mr. H's farm, two-humped***	53	190	130	8	99	0.1	0.5
August 2015, Mr. H's farm, two-humped	48	190	140	11	100	0.1	0.6
Holstein[1)]	40	140	110	10	91	Tr	0.4
Cattle milk[2)]	41	140	110	10	93	0.02	0.4
Human milk[3)]	15	48	27	3	14	0.04	0.3

* , ** , *** ; Each milk sample is from the same camel.

a), b), c) ; Each milk sample is from the not same camel.

1), 2) ,3) ; Source : Japanese food composition table 2015.

In May, milking is carried four times per day, in the morning, noon, evening, and night. In August, the camel milking is carried three times per day, in morning, evening, and at night. Female camels come back from the pastures to feed colts at noon. Before milking, colts are first given time to drink.

3.3. One-humped and two-humped camel milk compounds

Besides the individual differences that exist within the livestock, milk composition may also differ depending on the kind and amount of grasses eaten, the temperature and the season, and as mentioned previously, the different species.

The results of the milk general composition analyses are shown in **Table 2**. Although the camel milk had originated from the same-aged camels that grazed on the same pastures, the nutritional value, and protein and fat content were higher in samples from two-humped camels, in both May and August. Regardless, however, camel milk from either one-humped or two-humped camels has a higher nutritional value and content of protein and fat than does cattle milk.

The nutritional composition of milk from both camel species was lower in density and quality in the August samples. Such a decline may be attributable to the dry season in Kazakhstan, when a camel's diet must adapt to both the reduced amount and the different species of grasses they eat during this time. Mr. O confirmed this thinking by sharing his observation: "they may eat a lot of grass in May, but in August the pasture conditions worsen and the camels lose their appetite". With the increase or maintenance of milk yield, and without a stable nutritional input, the components of milk may become less dense in the milk that is produced.

The results of the general mineral analysis are shown in **Table 3**. The values of general milk composition were lower in the August samples than in those from May. The values of calcium, phosphorus, and zinc were higher in two-humped camel milk. During Mr. O's interview, he expressed the great importance of the magnesium content in camel milk. The content of free amino acids in the milk samples is shown in **Table 4**. The free amino acids density in the milk of both one-humped and two-humped camels was higher in August than in May. The values of aspartic acid, glutamic acid,

Table 4. Contents of free amino acids in the milk from one-pumped and two-humped camels.

Sample	Asp (mg/100ml)	Thr (mg/100ml)	Ser (mg/100ml)	Glu (mg/100ml)	Gly (mg/100ml)	Ala (mg/100ml)	Cys (mg/100ml)	Val (mg/100ml)	Met (mg/100ml)
March 2013, Mr. O's farm, one-humped	100	0	0	150	0	10	0	50	0
May 2015, Mr. O's farm, one-humped*	12	0	10	313	138	37	28	29	88
August 2015 , Mr. O's farm, one-humped *	152	6	0	310	246	30	20	129	7
May 2015, Mr. H's farm, one-humped **	5	0	0	102	221	0	0	60	0
August 2015, Mr. H's farm, one-humped**	37	26	34	191	318	39	0	134	0
May 2015, Mr. H's farm, two-humped***	40	0	0	288	114	57	0	84	326
August 2015, Mr. H's farm, two-humped***	174	0	0	947	0	50	0	113	117
August 2015, Mr. H's farm, two-humped	27	0	107	204	0	144	31	69	131
Holstein[1)]	250	130	150	620	59	100	29	210	88
Cattle milk[2)]	250	140	170	690	61	100	26	200	80
Human milk[3)]	36	43	47	170	22	36	24	56	15

Sample	Leu (mg/100ml)	Tyr (mg/100ml)	Phe (mg/100ml)	Lys (mg/100ml)	Trp (mg/100ml)	Arg (mg/100ml)	Pro (mg/100ml)	Lle (mg/100ml)	His (mg/100ml)
March 2013, Mr. O's farm, one-humped	0	0	10	0	0	0	0	100	0
May 2015, Mr. O's farm, one-humped*	46	48	0	128	0	43	0	7	3
August 2015 , Mr. O's farm, one-humped *	12	0	0	24	0	55	0	26	9
May 2015, Mr. H's farm, one-humped **	37	0	0	35	0	14	0	5	0
August 2015, Mr. H's farm, one-humped**	13	0	0	24	0	19	0	28	0
May 2015, Mr. H's farm, two-humped***	73	45	148	228	0	0	0	10	0
August 2015, Mr. H's farm, two-humped***	42	157	171	284	0	84	0	0	102
August 2015, Mr. H's farm, two-humped	221	0	0	54	0	77	0	0	0
Holstein[1)]	310	120	150	260	41	100	300	170	88
Cattle milk[2)]	320	150	160	270	45	110	300	170	92
Human milk[3)]	99	40	42	66	15	32	92	51	26

*,**,*** ; Each milk sample is from the same camel.
1), 2) ,3) ; Source: Japanese food composition table 2015.

phenylalanine, and lysine were higher in two-humped camel milk. Such increase is considered to be related to eating dry grasses that require a longer time of rumination and an increased activity of rumen microorganisms. During the heating of camel milk, the prolines, used in biosynthesis of proteins, were not detected. This lack of prolines may negatively influence the process of making cheese with camel milk. We suggest that further research efforts could steer in this direction.

Given that the milk composition of the two-humped camel occurs in a higher density despite the concerning lowering of the amount of available energy in grass from May to August. In addition, we also wish to highlight the potential necessity to consider the grass type and nutrition ingested by camels, as well as the milking season as these factors have impacts on the quality and composition of camel milk.

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