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Full Length Article

Chemical Composition of Milk from Yak Breeds and Crossbreeds in Qinghai Tibetan Plateau

Zhongxin Yan[1], Yichao Jin[1*], Wei Li[1] and Xiaorong Xue[2]
[1]*Qinghai Academy of Animal Science and Veterinary Medicine, Qinghai University, Xining 810016, PR China*
[2]*Qinghai Livestock Improving Centre, Xining 810016, PR China*
[*]For correspondence: jinyichao88@163.com

Abstract

The current study was carried out to estimate the chemical contents and mineral concentrations in the milk from three yak breeds, Tianjun (n = 13), Wulan (n = 15) and Huanhu yaks (n = 14) as well as three yak crossbreeds, Wulan yak × yellow cow (n = 15), Tianjun yak × yellow cow (n = 15), and Huanhu yak × yellow cow (n = 18). Statistically significant differences ($P <$ 0.05) in the chemical and mineral concentrations have been observed among the milk samples from the three breeds. Total solids, fat, and protein contents in the milk from the yak breed were significantly greater ($P < 0.05$) than those in the milk from yak crossbreed. P and Fe concentrations in the milk from the yak crossbreed were significantly higher than the ones in the milk from the yak breed, and the concentrations of K reached extremely significant levels of differences ($P < 0.01$) between breed and crossbreed. The amount of Mg in the Huanhu yak milk was considerably greater ($P < 0.01$) than that in the milk from Wulan and Tianjun yaks. Huanhu yak milk possessed superior K, P, Ca, Mg, and Zn levels than Tianjun yak and Wulan yak milk. The concentrations of P, Ca, and Fe were notably different ($P < 0.05$) among the three crossbreeds. Certain correlations were observed in chemical composition and mineral concentrations between yak breeds and crossbreeds milk. © 2018 Friends Science Publishers

Keywords: Basic chemicals; Minerals; Yak crossbreeds milk; Yak milk

Introduction

Yak (*Bos grunniens*) is a unique semi-wild animal. China has 16 million yaks which constitute 95% of the global population (Zhang *et al.*, 2015). In the Qinghai Plateau, the population consists of approximately 5 million animals and ranks first in China's yak population. Based on Chinese provincial annals of livestock breeds, two major types exist in the country: Qinghai-Tibet Plateau (Plateau or Grassland type) and Henduan Alpine types (Alpine or Valley type), including 12 breeds of Chinese domestic yak (Wiener *et al.*, 2003). Huanhu yak, Tianjin yak, and Wulan yak belong to the Qinghai-Tibet Plateau category (Lu and He, 2009). Yak can endure temperatures as low as -40°C, low-normal atmospheric pressure, and low-oxygen environment (Neupaney *et al.*, 2015; Luo *et al.*, 2018). This animal and its milk have a central place in the Chinese economy and supply the chief products in the everyday diet (Zhang *et al.*, 2008). Evidence has confirmed that this mammal prefers cooler temperatures and yields highly nutritious milk which contains 16.9%–17.7% total solids, 4.0%–5.9% protein, 5.0%–7.2% fat, 4.5%–5.9% lactose, and 0.8%–1.1% mineral elements (Jiang *et al.*, 2004; Nikkhah, 2011; Cui *et al.*, 2016). Therefore, yak milk is of importance due to its distinct composition, making it a first-class starting material for preparation of pediatric and geriatric foods, as well as for specific fractions of the population with special requirements. However, yak milk foodstuffs are not widely popular, and Chinese yaks are grown predominantly for meat and wool. Thus, the global yield of yak milk is comparatively lower than that of cow and goat milk. Further development of yak milk products may possibly boost their value. Yak milk has an enormous economic potential as it is presently produced and regarded as organic, with no additives or drugs utilized.

To promote milk quality and production, and enhance yak acclimatization to pasture setting, crossbreed techniques have been adapted in China to perform selective breeding and genetic enhancement. Earlier research has been conducted on nutrient profiles, such as protein profile, linoleic acid, vitamins, and fat and fatty acid profile (Or-Rashid *et al.*, 2008; Li *et al.*, 2011; Cui *et al.*, 2016). In addition, the amino-acid composition of Indian yak milk has been previously investigated and reported (Gyeltshen and Dorji, 2014). Moreover, the fatty acid, mineral, and protein composition of Maiwa yak milk, obtained in Hongyuan County (China), has been analyzed and described (Sheng *et al.*, 2008). It is noteworthy that the nutritional aspects of milk minerals have turned out to be ever more vital to human health than earlier expected (Park *et al.*, 2007; Ya and Tang, 2013).

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Milk minerals play a significant role in the immune protection, appropriate regulation and maintenance of osmotic pressure and the fluid acid-base balance, and the prevention of iron deficiency (Haddy and Pamnani, 1995; Ya and Tang, 2013). Conjugated K as a class of natural positional and geometric isomers of macro-minerals have attained scientific attention owing to their prospective positive impact on nerve health, eurhythmic and stroke disease (Mcbryde *et al.*, 2007). The mineral of Ca has an important role in the body skeleton, immune-protection and functional factor generation (Ya and Tang, 2013). Fe is required to avert iron deficiency and anemia in 6–9-month-old infants (Nikkhah, 2011). Even though the effect of minerals on health has been elucidated, it is essential to estimate mineral concentrations in yak and yak crossbreeds milk. Studies on yak milk were initiated a long time after those on milk of other animals owing to geographic, ecological, and socioeconomic limitations. Only a slight research interest has been focused on the mineral profile and the concentrations of macro-, micro-, and semi-microminerals in milk from yaks. Thus, the purpose of the present investigation was to determine the mineral profile of milk from Chinese yak breeds, which would contribute to the improvement of its yield and nutritional value.

Materials and Methods

Collection of Milk Samples

A total number of 90 milk samples from yak breeds (42 samples) and crossbreeds (48 samples) were collected and analyzed in the present study. The samples were obtained from three pure yak breeds of Tianjin (n = 13), Wulan (n = 15), and Huanhu yaks (n = 14) along with three yak crossbreeds of Wulan yak × yellow cow (n = 15), Tianjin yak × yellow cow (n = 15), and Huanhu yak × yellow cow (n = 18).

All milk samples were collected from yaks and yak crossbreeds grazing on natural pastures with no supplementary feeding. Fresh milk samples were collected from August to September. The samples were stored at 4°C prior to the analysis for determination of their chemical composition. The milk samples of yaks and yak crossbreeds used for the determination of minerals concentrations were stored at -20°C before use.

Analysis of the Chemical Composition

The frozen yak and yak crossbreed milk samples were thawed to 4°C ± 1°C, followed by gentle mixing by constantly inverting the bottle with no frothing or churning. Then, the samples were cooled to room temperature prior to analysis. Further, the below methods described by AOAC (2002) were employed for the analysis. The content of total solids was established using the forced-draft oven method, fat by the Rose Babcock method), and protein by the Kjeldahl method); the ash content was determined by the complete combustion method. In addition, the lactose content of the milk was measured by the Lane-Eynon method (National Food Safety Standard of China, 2010).

Mineral Analysis

The concentrations of calcium, phosphorus, potassium, magnesium, iron, and zinc in yak milk were determined by atomic absorption spectrophotometry, with a slight modification (Xin *et al.*, 2010; Cui *et al.*, 2016). The yak or yak crossbreed milk samples (0.5 g) were transferred into a digestion tank, and 10 mL of concentrated nitric acid (spectroscopic grade) was added to each of them. Sample digestion was conducted in a closed microwave digestion system (Models for MARS 6, CEM Company, USA) for 4 min at 140°C. Subsequently, each sample was transferred into a 50 mL volumetric flask, and deionized water was added to a total volume of 50 mL. Inductively coupled plasma-atomic emission spectroscopy (Models for iCAP6000, Thermo Company, USA) was used for mineral detection.

Statistical Analysis

Data were analyzed *via* ANOVA with SPSS software, v 10.0 (SPSS, USA). The data are presented as mean ± SE; the asterisks indicate significant differences. The differences among the means were compared by Tukey's test at a significance level of $P < 0.05$.

Results

Chemical Composition of Milk from Yak and Yak Crossbreed

The chemical composition of yak and yak crossbreed milk samples is presented in Table 1. Significant differences ($P < 0.05$) were observed between the composition of milk samples from yak and yak crossbreed. The contents of total solids and protein in the yak milk samples were significantly greater ($P < 0.05$) than in those from the yak crossbreed. The differences in the fat levels between yak and yak crossbreed samples reached an extremely significant difference ($P < 0.01$). Nevertheless, no statistically significant differences ($P > 0.05$) were detected in the lactose and ash contents between yak and yak crossbreed milk samples.

Mineral Contents of Yak and Yak Crossbreed Milk

The mineral concentrations in the milk of yak and yak crossbreed are displayed in Table 2. Significant differences ($P < 0.05$) were detected for the mineral concentrations between yak and crossbreed. P and Fe concentrations in the milk of yak crossbreed were notably greater ($P < 0.05$) than those in the yak milk samples. The differences in the concentration of K between yak and yak crossbreed milk

Table 1: Chemical composition of the milk from yak and yak crossbreed

Characteristics	Milk of								Significance
	Yak				Yak crossbreed				
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Fat (%)	7. 2	0. 45	5. 3	7. 8	5. 5	0. 52	4. 4	6. 3	***
Total solids (%)	17. 1	0. 81	15. 5	17. 8	16. 2	0. 58	14. 8	16. 9	**
Protein (%)	5. 2	0. 41	4. 3	5. 9	4. 4	0. 25	4. 2	4. 6	**
Lactose (%)	5. 4	0. 26	5. 0	5. 9	5. 1	0. 36	4. 8	5. 5	ns
Ash (%)	0. 91	0. 11	0. 7	1. 1	0. 89	0.06	0. 7	1. 1	ns

ns $p > 0.05$; **$p < 0.05$; ***$p < 0.01$

Table 2: Concentrations of minerals in the milk from yak and yak crossbreed

Characteristics	Milk of								Significance
	Yak				Yak crossbreed				
	Mean	SD	Min	Max	Mean	SD	Min	Max	
K (mg/kg)	1168. 35	35. 05	772	1690	1476. 06	43. 66	923	1721	***
P (mg/kg)	1049. 46	27. 16	792	1583	1123. 13	31. 25	786	1550	**
Ca (mg/kg)	1674. 08	45. 50	1113	2451	1630. 42	40.05	908	2610	ns
Mg (mg/kg)	119. 67	3. 83	75	201	119. 67	4. 02	69	186	ns
Fe (mg/kg)	2. 43	0. 21	1. 67	3. 25	3. 18	0. 36	2. 04	5. 52	**
Zn (mg/kg)	5. 28	0. 35	4. 06	7. 05	5. 98	0. 55	4. 06	7. 65	ns

ns $p > 0.05$; **$p < 0.05$; ***$p < 0.01$

samples reached an extremely significant level ($P < 0.01$). Nevertheless, the concentrations of Ca, Mg, and Zn in the milk had no significant differences ($P > 0.05$) between yak and yak crossbreed. The concentrations of the milk minerals maybe influenced by the use of yak crossbreed. Yak milk minerals concentrations have correlated to yak crossbreed.

Mineral Concentrations in the Milk from Yak Breeds

Statistically significant differences were found in the mineral concentrations among the milk samples from Wulan, Huanhu, and Tianjun yak breeds ($P < 0.05$; Table 3). Huanhu yak milk contained higher K, P, Ca, Mg, and Zn concentrations than did the milk from Tianjun and Wulan yaks.

In the minerals class, it consists of three macrominerals (K, P, and Ca), two microminerals (Fe and Zn) and one semi-micromineral (Mg). In the macrominerals, the predominant Ca concentration was significantly different ($P < 0.05$) among Huanhu (2,021.75 mg/kg), Wulan (1,580.25 mg/kg), and Tainjun (1,422.78 mg/kg) yak milk. Otherwise, the K and P concentrations were also significantly different ($P <0.05$) among Huanhu (1,493.18 mg/kg and 1,272.65 mg/kg), Wulan (954.56 mg/kg and 938.35 mg/kg) and Tainjun (1,061.44 mg/kg and 940.02 mg/kg) yak milk. Concerning the microminerals, the concentrations of Fe and Zn were significantly different ($P < 0.05$) among Huanhu (2.33 mg/kg and 6. 51 mg/kg), Wulan (3.05 mg/kg and 4.99 mg/kg) and Tainjun (1.92 mg/kg and 4.34 mg/kg). The concentration of Fe in Wulan yak milk (3. 05 mg/kg) was significantly higher than that in the samples of Huanhu yak (2. 33 mg/kg) and Tianjun yak milk (1. 92 mg/kg). However, only the concentration of Mg in Huanhu yak milk (164.26 mg/kg) was significantly greater ($P < 0.01$) than in Wulan (109.21 mg/kg) and Tianjun (86.79 mg/kg) yak milk.

Minerals in the Milk of Yak Crossbreeds

Alterations of the mineral composition of milk have attracted considerable interest due to their potential to positively impact human health. The mineral composition of the milk from the three yak crossbreeds (Wulan yak × yellow cow, Huanhu yak × yellow cow and Tianjun yak × yellow cow) is displayed in Table 4. Significant differences ($P < 0.05$) in the concentration of minerals have been detected among the crossbreeds studied. Nevertheless, no notable variations in K, Mg, and Zn concentrations ($P > 0.05$) have been found among the three crossbreeds.

The amounts of minerals in the milk samples from Wulan yak × yellow cow (mg/kg), Huanhu yak × yellow cow (mg/kg) and Tianjun yak × yellow cow (mg/kg) were determined respectively. In the macrominerals (K, P, and Ca), the P and Ca concentrations were considerably different ($P < 0.05$) among the three crossbreeds. Within microminerals (Fe and Zn), the Fe has been significantly different ($P < 0.05$) among Wulan yak × yellow cow, Huanhu yak × yellow cow and Tianjun yak × yellow cow. The semi-micromineral concentration of Mg was not significantly diverse ($P > 0.05$) in the three crossbreeds.

Discussion

The concentration of several chemical compounds can be affected by the use of yak crossbreed milk, which confers a value to genetic improvement programs and the implementation of selective breeding. The contents of a few

Table 3: Mean, standard deviation and minimum and maximum concentrations of milk minerals (mg/kg) from 3 pure yak breeds

Characteristics	Milk of												Significance
	Wulan yak				Huanhu yak				Tianjun yak				
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
K (mg/kg)	954. 56	25. 56	772	1201	1493. 18	33. 82	902	1690	1061. 44	38. 83	883	1298	**
P (mg/kg)	938. 35	18. 98	873	1038	1272. 65	22. 65	920	1583	940.02	16. 56	792	1105	**
Ca (mg/kg)	1580. 25	32. 25	1113	2025	2021. 75	41. 01	1224	2451	1422. 78	42. 35	1187	1806	**
Mg (mg/kg)	109. 21	3. 22	88	159	164. 26	7. 21	123	201	86. 79	5. 56	75	103	***
Fe (mg/kg)	3. 05	0. 45	2. 56	3. 25	2. 33	0. 42	1. 99	2. 49	1. 92	0. 39	1. 67	2. 21	**
Zn (mg/kg)	4. 99	0. 78	4. 06	5. 89	6. 51	0. 80	5. 80	7. 05	4. 34	0. 75	4. 11	5. 16	**

**$p < 0.05$; ***$p < 0.01$

Table 4: Mean, standard deviation and minimum and maximum concentrations of milk minerals (mg/kg) from 3 yak crossbreeds

Characteristics	Milk of												Significance
	Cross breed (Wulan yak × yellow cow)				Cross breed (Haunhu yak × yellow cow)				Cross breed (Tianjun yak × yellow cow)				
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
K (mg/kg)	1431. 37	36. 27	1029	1721	1513. 55	32. 50	1112	1684	1496. 28	40. 23	923	1606	ns
P (mg/kg)	1215. 46	29. 36	786	1485	1165. 73	26. 68	996	1550	1014. 55	22. 15	792	1338	**
Ca (mg/kg)	1912. 25	50. 42	1401	2610	1452. 48	29. 15	908	1617	1531. 72	33. 50	1012	1887	**
Mg (mg/kg)	123. 72	5. 65	96	186	124. 35	4. 52	87	165	112. 85	7. 28	69	155	ns
Fe (mg/kg)	2. 67	0. 78	2. 04	4. 22	4. 41	0. 92	3. 69	5. 52	2. 46	0. 86	2. 15	4. 05	**
Zn (mg/kg)	6. 30	0. 64	5. 89	7. 65	6. 22	0. 85	5. 07	7. 20	5. 42	0. 73	5. 18	6. 89	ns

ns $p > 0.05$; **$p < 0.05$; ***$p < 0.01$

chemical constituents of yak milk were greater than those reported for yak crossbreed milk (Park *et al.*, 2007; Costa *et al.*, 2016). The elevated concentrations of fat, protein, and total solids in the milk from the breeds were possibly related to the inferior milk production (1.71 kg/d) compared with that of the crossbreeds (3.35 kg/d) (He *et al.*, 2011). The contents of some chemical components in the milk were negatively correlated with milk yield (Abd and Shibiny, 2013). Our results obtained are similar to those available in literature.

Breeds effect for milk fatty acid and altitudes effect for milk mineral have been studied in yak and yak crossbreed in literature, but there is little data on the effect of breeds on minerals concentration (He *et al.*, 2011; Cui *et al.*, 2016). Milk mineral concentration is affected by action of internal factors (breeds and ages), as well as by external factors (seasonal changes and environmental conditions) (Li *et al.*, 2009; Medhammar *et al.*, 2012; Poulsen *et al.*, 2017). The differences in yak milk mineral composition (K, P, Ca, Fe, Zn, and Mg) described here may possibly be related to breed variations and environment, compared with the values earlier reported for Maiwa yak, Qilian yak, and Indian yak milk (Chatterjee *et al.*, 2003; Li *et al.*, 2011; Sun *et al.*, 2012). Ca and Mg contents of those reported were superior to those of Maiwa yak milk (Sheng *et al.*, 2008; Li *et al.*, 2011). Although Wulan, Huanhu, and Tianjun yak live in different regions of the Qinghai Tibetan plateau, they graze in the border of these adjacent areas. Hence, this situation permitted the assessment of the mineral concentrations in the milk of yaks reared in similar environments. On the other hand, crossbreeding is a method through which milk yield and quality can be enhanced, and animal acclimatization to pasture environment can be promoted (He *et al.*, 2011). The relationship of milk minerals between yak breeds and crossbreeds has not well recognized. Crossbreeding is an impactful method that can increase milk quality and hasten yak milk industrialization.

In the future, genetic selection techniques might be employed to modify the mineral profiles to make them more beneficial to human health.

Conclusion

In this study, we established that yak breeds and crossbreeds have significant differences in the chemical composition and minerals concentration of their milk. Total solids and protein contents of yak breeds were considerably greater ($P < 0.05$) than those of yak crossbreeds. Moreover, the differences between yak breeds and yak crossbreeds in the quantity of fat reached extremely significant levels ($P < 0.01$). No variations were detected in the amounts of lactose and ash ($P > 0.05$) between breeds and crossbreeds.

The concentrations of Ca, Mg, and Zn in the milk exhibited no notable differences ($P > 0.05$) among breeds and crossbreeds. However, the P and Fe concentrations in the milk of the yak crossbreeds were considerably greater ($P < 0.05$) than in that of yak breeds. Additionally, the differences in the concentrations of K between the yak breeds and crossbreeds reached an extremely significant level ($P < 0.01$). Milk minerals among Wulan, Huanhu and Tianjun yak have been significant difference ($P < 0.05$), only the concentration of Mg was extremely significantly differences ($P < 0.01$). The concentrations of P, Ca, and Fe have been significant difference ($P < 0.05$) in the three crossbreeds. However, K, Mg, and Zn concentrations in the milk of the three crossbreeds exhibited no significant variation ($P > 0.05$). Our findings indicate that the breed affects the quality of milk. Therefore, yak crossbreed techniques should be employed to increase the nutritional value of the milk and promote consumer acceptance.

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References

Abd, M.H. and S. Shibiny, 2013. Bioactive peptides of buffalo, camel, goat, sheep, mare, and yak milks and milk products. *Food Rev. Int.,* 29: 1–23

AOAC International, 2002. *Official Methods of Analysis of AOAC International*, 17th edition. 1st revision. Association of Analytical Communities, Gaithersburg, USA

Chatterjee, A., D.N. Das, M. Sarkar and P. Bora, 2003. Chemical composition including mineral constituents of yak milk. *Ind. J. Dairy Sci.,* 56: 115–116

Costa, R.G., E.M.B. Filho, S.S. De, C.G. Da, R.C. Queiroga and C.E. Da, 2016. Physicochemical and sensory characteristics of yoghurts made from goat and cow milk. *Anim. Sci. J.,* 87: 703–709

Cui, G.X., F. Yuan, A.A. Degen, S.M. Liu, J.W. Zhou, Z.H. Shang, L.M. Ding, J.D. Mi, X.H. Wei and R.J. Long, 2016. Composition of the milk of yaks raised at different altitudes on the qinghai–tibetan plateau. *Int. Dairy J.,* 59: 29–35

Gyeltshen, T. and N. Dorji, 2014. Evaluation of milk yield and composition in nomadic yak and yak crosses. *Ind. J. Anim. Sci.,* 84: 1332–1333

Haddy, F.J. and M.B. Pamnani,1995. Role of dietary salt in hypertension. *J. Amer. Colleg. Nutr.,* 14: 428–438

He, S., Y. Ma, J. Wang, Q. Li, X. Yang, S. Tang and H. Li, 2011. Milk fat chemical composition of yak breeds in china. *J. Food Composit. Anal.,* 24: 223–230

Hu, Z. and W. Zhou, 2010. Determination of inorganic elements in the soil-grass-animal system by sealed microwave digestion ICP-AES. *Spectrosc. Spectr. Anal.,* 30: 546–550

Jiang, X.P., G.Q. Liu, C. Wang, Y.J. Mao and Y.Z. Xiong, 2004. Milk trait heritability and correlation with heterozygosity in yak. *J. Appl. Genet.,* 45: 215–224

Li, H.M., Y. Ma, Q. Li, J. Wang, J. Cheng and J. Xue, 2011. The chemical composition and nitrogen distribution of chinese yak (maiwa) milk. *Int. J. Mol. Sci.,* 12: 4885–4895

Li, H.M., S.H. He, T.Y. Liu and Y. Ma, 2009. Research development in physical and chemical characters of yak milk. *Chin. Dairy Ind.,* 37: 35–40

Lu, Z. and X. He, 2009. Humble Opinion on Development and Utilization of Yak Milk. *Chin. Cattle Sci.,* 5: 46–48

Luo, J., Z. Huang, H. Liu, Y. Zhang and F. Ren, 2018. Yak milk fat globules from the Qinghai-Tibetan plateau: membrane lipid composition and morphological properties. *Food Chem.,* 245: 731–737

Mcbryde, F.D., S.J. Guild, C.J. Barrett, J.W. Osborn and S.C. Malpas, 2007. Angiotensin ii-based hypertension and the sympathetic nervous system: the role of dose and increased dietary salt in rabbits. *Exp. Physiol.,* 92: 831–840

Medhammar, E., R. Wijesinha-Bettoni, B. Stadlmayr, E. Nilsson, U.R. Charrondiere and B. Burlingame, 2012. Composition of milk from minor dairy animals and buffalo breeds: a biodiversity perspective. *J. Sci. Food Agric.,* 92: 445–474

National Food Safety Standard of China, 2010. *Determination of Lactose and Sucrose in Foods for Infants and Young Children Milk and Milk Products: GB 5413*, pp: 21–2010. Published by the state food and drug administration of China, Beijing, China

Neupaney, D., J. Kim, M. Ishioroshi and K. Samejima, 2015. Study on some functional and compositional properties of yak butter lipid. *Anim. Sci. J.,* 74: 391–397

Nikkhah, A., 2011. Science of camel and yak milks: human nutrition and health perspectives. *Food Nutr. Sci.,* 2: 667–673

Or-Rashid, M.M., N.E. Odongo, B. Subedi, P. Karki and B.W. McBride, 2008. Fatty acid composition of yak (*Bos grunniens*) cheese including conjugated linoleic acid and trans-18: 1 fatty acids. *J. Agric. Food Chem.*, 56: 1654–1660

Park, Y.W., M. Juarez, M. Ramos and G.F.W. Haenlein, 2007. Physico-chemical char-acteristics of goat and sheep milk. *Small Rumin. Res.,* 68: 88–113

Poulsen, N.A., M. Glantz, A.K. Rosengaard, M. Paulsson and L.B. Larsen, 2017. Comparison of milk protein composition and rennet coagulation properties in native swedish dairy cow breeds and high-yielding swedish red cows. *J. Dairy Sci.,* 100: 8722–8734

Sheng, Q., J. Li, M.S. Alam, X. Fang and M. Guo, 2008. Gross composition and nutrient profiles of chinese yak (maiwa) milk. *Int. J. Food Sci. Technol.,* 43: 568–572

Sun, W., S. Ghidini, Y. Luo, E. Zanardi, H. Ma and A. Ianieri, 2012. Macro and micro elements profile of yak (*Bos grunniens*) milk from qilian of qinghai plateau. *Ital. J. Anim. Sci.,* 11: 570–584

Wiener, G., J.L. Han and R.J. Long, 2003. Origins, domestication and distribution of yak. *In: The Yak,* 2nd edition, pp: 1–16. Wiener, G. (ed.). Published by the Regional Office for Asia and the Pacific and the FAO, Bangkok, Thailand

Ya, G.E. and Z.H. Tang, 2013. Trace elements and health of human body. *Bever. Ind.,* 7: 7–9

Zhang, H., J. Xu, J. Wang, T. Sun, H. Li and M. Guo, 2008. A survey on chemical and microbiological composition of kurut, naturally fermented yak milk from qinghai in china. *Food Contr.,* 19: 578–586

Zhang, L., B. Sun, P. Xie, H. Li, H. Su, K. Sha, C. Huang, Y. Lei, H. Liu and H. Wang, 2015. Using near infrared spectroscopy to predict the physical traits of *Bos grunniens* meat. *LWT-Food Sci. Technol.,* 64: 602–608

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