This work aimed to conduct a comparative analysis that helps to identify the effect of the developed technology on the chemical composition of drinking yogurts made from Australian and Kazakhstani dromedary camel milk.

Camel milk taken from Kazakhstan and Australia has been processed into drinking yogurt and its amino, fatty acid, vitamin, and mineral content was assayed. These identifications enabled us to compare how our developed technology is suitable for both milk types.

The results of determination can be interpreted as follows. The essential and non-essential amino acid content in Kazakhstani yogurt was significantly higher compared to Australian yogurt. Aspartic and Glutamic acids were not identified in Kazakhstani yogurt. As a counterpart, Lysine and Histidine were not found in Australian yogurt.

The fatty acid results demonstrated that Linoleic acid in Kazakhstani yogurt was significantly higher than in Australian yogurt, and there was more Linolenic acid in Australian yogurt than in Kazakhstani yogurt. The atherogenicity index for Kazakhstani yogurt was at a low level (0.045 %) compared to Australian yogurt (1.90 %). The ratios of omega 6 and omega 3 in Kazakhstani yogurt were 16 % greater than in Australian yogurt.

Thiamine level in Kazakhstani yogurt was lower compared to Australian by up to 57 %. However, Riboflavin results in both samples were identical. The Calcium, Potassium, Sodium, and Phosphorus contents in Australian yogurt are defined as 5, 34, 34, and 30 % respectively compared to Kazakhstani yogurt. Nevertheless, Magnesium (47 %) and Iron (60 %) levels were lower in Australian yogurt than in Kazakhstani yogurt.

These study results could be useful as preliminary work for scientists and producers of gerodiet products, who intend to work with camel milk as a geroprotector

Keywords: camel milk technology, gerodiet, drinking yogurt, geroprotector

UDC 637
DOI: 10.15587/1729-4061.2021.235831

STUDYING THE EFFECT OF THE DEVELOPED TECHNOLOGY ON THE CHEMICAL COMPOSITION OF YOGURT MADE FROM CAMEL MILK

Fatima Dikhanbayeva
Doctor of Technical Sciences, Professor*
Elmira Zhaxybayeva
Corresponding author
Postgraduate Student*
E-mail: elmirazhaxybayeva@gmail.com
Zhechko Dimitrov
Doctor of Science in Molecular Biology, Professor
Head of Accredited Laboratory of Food Safety
Research and Development Center LB-Bulgaricum PLC
Malashevska str., 14, Sofia, Bulgaria, 1225
Meruert Baiysbayeva
PhD, Associate Professor
Department of Technology of Bread Products and Processing Industries**
Gulmira Yessirkep
PhD, Associate Professor
Department of Technology and Standardization
Kazakh University of Technology and Business
Pushkina str., 166/8, Nur-Sultan, Republic of Kazakhstan, 010000
Nidhi Bansal
PhD, Associate Professor
School of Agriculture and Food Sciences
The University of Queensland-Saint Lucia Campus
Brisbane, Queensland, Australia, 4072
*Department of Food Technology**
**Almaty Technological University
Tole bi str., 100, Almaty, Republic of Kazakhstan, 050012

Received date 20.04.2021
Accepted date 09.06.2021
Published date 30.06.2021

How to Cite: *Dikhanbayeva, F., Zhaxybayeva, E., Dimitrov, Z., Baiysbayeva, M., Yessirkep, G., Bansal, N. (2021). Studying the effect of the developed technology on the chemical composition of yogurt made from camel milk. Eastern-European Journal of Enterprise Technologies, 3 (11 (111)), 36–48. doi: https://doi.org/10.15587/1729-4061.2021.235831*

1. Introduction

Camel is one of the most significant domesticated animals in the arid and semiarid zones of tropical and sub-tropical countries. Camels can not only survive under specific conditions of severe water and heat stress, but they additionally provide a substantial source of valuable nutrients in desert communities, especially important during critical periods of prolonged drought [1].

There are three primary species of camel in the world. Camelus dromedarius also called one-humped camel make up an historical average of 94 % and the rest 6 % naturally belong to Camelus bactrianus (two-humped) among the world's camel population. What is more, there are wild camel species in the world. Scientifically present information sufficiently concerning camel milk products is related primarily to the Arabian, Indian, African, Mongolian, Afghanistan *Camelus dromedarius* and Kazakhstan's *Camelus bactrianus* species. For desert people in Asia and Africa, camels are vital to routine life as a source of food and a means of transportation, and just as importantly, their milk has been used as medicine for diverse ailments since ancient times.

Camel can produce more milk for a lengthier period in arid zones and harsh environments than any other domestic

livestock species. The daily yield of camel milk ranges from 3.5 to 11 kg in a lactation period. Camel milk has similar protein content, lower lactose content, and lower fat-containing less saturated fatty acids, and more vital total cholesterol compared to cow milk. Camel milk has supremer contents of vitamin C, ash, sodium, potassium, phosphorus, zinc, iron, and manganese than cow milk.

Qualified scientists also reported that camel milk improved long-term glycemic control and reduced insulin dose in patients with type-1 diabetes. In the western world, camel milk is vicariously experiencing a novel awareness these days and even the FAO has stepped in properly promoting camel milk.

Most camel milk is consumed in a fresh or sour state [2], it has predominantly an opaque white color and produces a faint sweetish odor and sharp taste; every so often it can be salty [3]. Its opaque white color is due to the fats finely homogenized throughout the milk, whereas changes in taste are caused by the type of fodder and availability of drinking water [4]. Its density ranges from 1.026–1.035 and the optimal pH from 6.2–6.5, both are lower than those of cow fluid milk and the maximum buffering capacity of skim milk is at pH 4.9 [5].

The unique chemical composition of camel milk allows us to suggest it as a main raw material to be processed into gerodiet sour-milk products. There is limited information about processed camel milk products for the gerodiet, and our developed technology is a first investigated work. Moreover, comparative studies on the effect of technology on the chemical composition of yogurts between Kazakhstan and Australia were carried out for the first time. Further research works in this field can improve the provision of elderly people with high nutritional products, which can enhance their nutritional behavior, and enlarge the classification of special food products for the gerodiet.

2. Literature review and problem statement

A few scientific works presented that [6, 7] the camel milk composition varies due to differences in geographical origin and year of data publication but other factors like the physiological stage, feeding conditions, seasonal or physiological variations, breeds, genetic or health status of camels also have paramount importance for product development. Another research results also reported that considerable differences in composition between camel and cow milk [8] could lead to the milk behaving erratically during processing and thus could affect the absolute quality of camel milk dairy products. The camel milk compositional studies [9, 10] defined that camel milk does not form conventional gel through lactic acid fermentation because of its unique composition. They found some visible characteristics of fermented camel milk products, which include watery texture and frail and modest structure [11]. This specific characteristic was explained by the other scientists [12–14] and according to their study, the special character of camel milk is due to the massive size and standard distribution of casein micelles and the notable absence of b-lg casein protein. Camel milk casein has high beta-casein properly compared to cow milk (65 % versus 39 %), low alpha-casein (22 % versus 38 %), and low kappa-casein (3.5 % versus 13 %) [15]. Scientists predicted [16] that caseins are natively unfolded proteins with an extended coil-like structure or in the form of subunits that can be characterized as supermolecules [17].

Nevertheless, till these days various products were produced from camel milk including mild cheese [18–20], fermented milk [21], yogurt [22], ice cream [23], and butter [24]. Even more, commercial production of camel cheese was possible by using active camel chymosin produced by expression in yeast strain, Pichia pastoris GS115 [25].

Nowadays, low-fat camel milk products are preferred over full-fat products in several markets. This trend has been particularly visible for ice cream over the last few years and by the conclusion of producers and scientists, camel ice cream is safe for consumers with lactose intolerance and contains 3 times more vitamin C than cow milk [26].

The fermented raw camel milk products, such as “gariss” in Sudan or “suusac” in Kenya and Somalia, which are often initiated through continuous utilization of vessels and back slopping, play an important role in the diet of pastoral communities [27]. Camel milk is also used for the preparation of “kheer”, and it is very much famous among the Rakia’s community of Rajasthan, India.

Among these products, there are a lot of research works related to producing yogurt from camel milk. However, the manufacture of camel milk yogurt poses a texture problem, with the product appearing sticky and ultimately unpleasant to the palate [28–31]. For instance, the study [28] aimed to examine the influence of different concentrations of monk fruit sweetener on the physicochemical properties and microbiological counts of drinking yogurt made from camel milk. The results of this work demonstrated that the monk fruit sweetener can be added to camel milk yogurts as a health-beneficial 0-calorie sweetener. In another work, the effect of partial replacement of camel milk with oat milk on the physicochemical, rheological, microbiological, antioxidant, and sensory properties of probiotic stirred camel milk yogurt during storage was investigated [29]. The study concluded that camel milk could be replaced with oat milk until 40 % as a source of bioactive components and dietary fiber in the manufacture of probiotic camel stirred milk yogurt. This replacement improved the physicochemical, rheological, microbiological antioxidant, and sensory properties of the resultant yogurt. Other authors have attempted to improve the manufacture of camel milk yogurt by mixing it with milk from other species. The study [30] on physicochemical, rheological, and microstructural properties of yogurts produced from mixtures of camel and bovine milk evaluated the influence of supplementing bovine milk with increasing levels of camel milk (0–60 %) on different properties of yogurt. The results obtained in this work are of particular interest especially in the understanding of how variation in milk protein composition may affect its gelation properties. In any case, the final product corresponds at best to liquid yogurt. These difficulties explain why there is a limited industrial production of camel milk yogurt at present. Some researchers proposed to solve the problems of the weak acid-induced gelation ability of camel milk by the synergistic effect of trisodium citrate and microbial transglutaminase (mTGase). As a result, this study indicated that smaller casein particles with a higher level of covalent crosslinking can form a camel milk gel with better textural properties, which has enormous potential for the manufacture of acid-induced camel milk gel products [31].

Analysis of the scientific literature presented by us shows that camel milk yogurts are mainly intended for general consumption. Until now, there are a limited number of developed camel milk products as functional or specialized

products and, accordingly, there is limited information about their formulation and development technology. Because of these issues, we encountered several problem formulations during the product development process. One of them was how the nutritional value of native milk will change during processing and how the chemical composition of the resulting products will change, whether they will meet the requirements of the gerodiet. Solutions to these problems are indicated in the following sections of the study.

3. The aim and objectives of the study

The aim of this study was to assess the effect of the developed technology on the chemical composition of drinking yogurts for a gerodiet from Kazakhstani and Australian camel milk. This will allow considering the possibilities of using new technology for processing camel milk for special nutrition in big manufacturing places, expanding the classification of gerodiet products and ensuring the high nutritional value of yogurts.

To achieve the aim, the following objectives have been set:

– to process camel milk into drinking yogurts, which includes FO, AP, TGSe, FOS;

– to study the chemical indicators (amino acid, fatty acid, vitamin and minerals content) of native camel milk and drinking yogurts, manufactured according to the developed technology;

– to calculate the quantity significance of the analyzed data and to evaluate differences and similarities between the two products by describing the possibility of using one processing technology for both milk types.

4. Materials and methods

The objects of research are Kazakhstan's fresh camel milk, which was collected from a local camel farm near Almaty city ("Makhanov" EP, Koshmambet, Kazakhstan) and Australian camel milk was kindly delivered by the Summer Land Camels farm (Harrisville, QLD, Australia). The yogurts were produced with a lyophilized commercial lactic acid culture, starter cultures were purchased from "Cheeselink" company (McClelland Ave Lara, VIC, Australia). Fructooligosaccharide (FOS) was purchased from BioCare* Limited company (Birmingham, UK). Apple pectin powder (AP) (esterification degree 61–64 %) and microbial transglutaminase (MTGase) powder were obtained from the Melbourne Food Ingredient Depot (Melbourne, Australia). Flaxseed oil was obtained from Melrose Laboratories Pty Ltd (Victoria, Australia). Other chemicals and reagents used were of superior grade analytically and were obtained from other reputable commercial suppliers.

Both milk types and yogurt samples were analyzed with standard methods for fat, total protein, lactose, total solids, and ash content. Drinking yogurts were prepared as described below (Fig. 1).

The yogurt was developed according to our previous work with some modifications [32]. Camel milk from both countries was prepared for processing in different batches and filtrated, heated to 35–40 °C and cream and skim milk were separated using an electric milk centrifuge separator. Milk was standardized till the fat content of 1.5±0.2 %. Then 0.5 %/1,000 kg of flaxseed oil (FO) was added and stirred on the Multimix disperser (CKL Multimix, Malaysia) at 2,000 rpm for 3 min on the heat plate (50 °C). Then milk was heated to 55±1 °C and homogenized in a two-stage Twin Panda homogenizer (GEA Niro Soavi NS2002H 'Ex-Demo' Lab Homogeniser, Italy) (200/30 bar). According to other scientific works, camel milk does not need homogenization, because of small sizes of fat globules. However, we are adding FO to camel milk, therefore it must be homogenized. After that, milk with FO was pasteurized at 82±1 °C for 40–45 sec. After pasteurization (T25 digital ULTRA-TURRAX, IKA, Malaysia) at 2,000 rpm, 5 min while it melted appropriately in milk. In our case, AP powder is going as high etherified, and the etherification degree is 61–64 %, gelation temperature is 55–75 °C, and also gives more gelation than citrus pectin. When the temperature decreased to 60±1 °C, 0.4 %/1,000 kg TGSe were added, stayed for 1 h and 2 %/1,000kg FOS were added, and cooled to 42±1 °C. TGse activation time starts between 55–60 °C and FOS was needed to finish the gelation process with the interaction of the mentioned above additives. At this stage, the standard starter culture for yogurt was added and the milk mixture was inoculated at 42±1 °C until the pH reached 4.5–4.6. After gaining the necessary pH, yogurts were poured into plastic containers and stored for 2 weeks at 4 °C.

An ultra-high performance liquid chromatography (UHPLC) (Shimadzu, Japan) method was developed for determining essential and non-essential amino acids in yogurt samples. The 1 uL volume of injection was used for both samples and standards. Detector for λ_{ex} and λ_{em} is 254 and 630 nm, respectively. Retention time is between 7–30 min, mV from 0 to 37.5.

Fatty acid content in yogurts was determined using a gas chromatograph (Shimadzu GC, Japan). The samples (1 uL) were injected into the GCMS. GC is equipped with a flame ionization detector and a capillary column Rtx – 2,330 (105 m×0.25 mm×0.20 μm) (Restek Corporation, Bellefonte, USA). Injector and detector temperatures were set as 230 °C and 250 °C, respectively. Column temperatures were 40/180/235 °C. Results were taken as mg FA per mL sample.

The following fatty acid combinations and ratios were calculated by using the fatty acid data:

$$IA = \frac{(C12:0+4xC14:0+C16:0)}{(C10:1+C14:1+C16:1+C17:1+C18:1+C18:2+C18:3)}, \quad (1)$$

$$SCFA = \sum C4:0 \text{ to } C7:0, \quad (2)$$

$$MCFA = \sum C8:0 \text{ to } C13:0, \quad (3)$$

$$LCFA = \sum C14:0 \text{ to } C20:1, \quad (4)$$

$$OI=(0.02\cdot C18:1+1\cdot C18:2+2\cdot C18:3)/100, \quad (5)$$

where *IA* – index of atherogenicity, *SCFA* – short-chain fatty acids; *MCFA* – medium-chain fatty acids; *LCFA* – long-chain fatty acids; *OI* – oxidability index.

The calculation of IA and OI is essential for products, where oil and fat additives were used.

Identification of water- and fat-soluble vitamins was performed according to standard methods on the Ultra High Perfomance Liguid Chromatograph (UHPLC) (Shimadzu,

Japan). The UHPLC conditions were as follows: Waters Acquity UPLC I-Class with Waters ACQ-PDA diode array detector; column: Acquity UPLC BEH C18 1.7 µm, 2.1×50 mm; (Waters, SN 01983130825688); column heating: 30 °C; flow rate: 0.3 mL/min; LC programmed – 1.5, 3.5, 9, 10.5, 12, 13, 16, 17, 20 min; % B – 0, 40, 60, 80, 80, 100, 100, 0 respectively to time. 5 uL of samples were injected into the UHPLC.

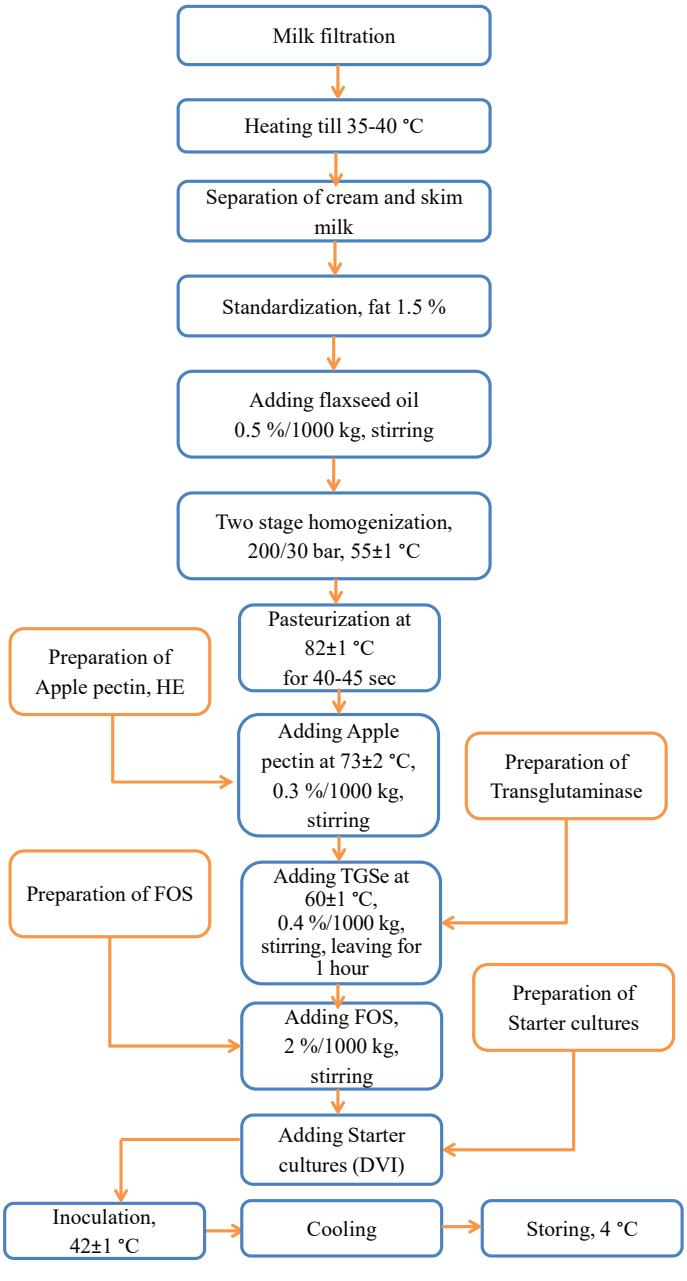

Fig. 1. Flow diagram of the production of drinking yoghurt for the gerodiet

Minerals Nitric-Perchloric Acid Digestion for ICP was analyzed according to the methods described by the work of Martlnie and Schilt (1976) [35]. For the ICPOES analysis, the samples were analyzed on a Varian (brand, Melbourne Australia), Vista Pro (model) radial instrument. Sample uptake into the ICPOES was done at 2 mL/min using a Seaspray nebuliser into a Tracey cyclonic spray chamber (both manufactured by Glass Expansion, Melbourne Australia). The wavelengths of the analytical lines used in the ICPOES analysis for the samples are as follows: Ca – 317.933, Fe – 238.204, K – 766.491, Mg – 285.213, Na – 588.995, P – 213.618, Se – 196.026, Zn – 213.857.

Instrument power would have been 1,200 W. ICP gives solution results in ppm.

This is converted to a dry-weight basis of sample according to equation:

$$\text{Sample mg/kg} = \text{Solution ppm} \times \times 40 \,/\text{dry sample weight}. \quad (6)$$

The calculated results were converted from mg/kg to mg/100 g of sample for a better comparison of results. This is more suitable to evaluate the nutritional status of the sample, as many research works and required daily consumption index given in this model.

The results are reported as means ± standard deviation. Statistical analysis was carried out using Microsoft Excel, Statistica 12.6. Statistical Software (StatSoft, Russia). Significant differences between average values of replicate measurements at each data point were analyzed by analysis of variance $p \leq 0.05$. All experiments were conducted in triplicate and the results presented are the average of three runs.

5. Results of studying the developed drinking yogurts

5. 1. Processing camel milk into yogurt according to the developed technology

During the fermentation period, a highly significant decrease ($P \leq 0.01$) in the pH of both yogurt samples with mean values of 5.07 after 4 h and 4.51 after 6 h of fermentation was recorded (Fig. 2).

The chemical composition of the essential components of camel milk is crucial, once it will be used for processing. Therefore, the initial chemical composition of camel milk from both countries and its products is presented as a comparison in Table 1. Based on the results, we have noticed that milk from different origins exhibits different chemical characteristics.

The comparable percentage of fats displays that milk from Kazakhstan (KCM) appears to be richer in fats (3.65 %) than the one from Australia (ACM). A similar scenario was with protein content; here the ACM protein content was lower than the KCM protein percentage (3.59 %). On the other hand, KCM is less in lactose content than ACM, and there are no significant differences between them. However, the total solids and ash content of KCM is about 11.49 % and 0.82 %, respectively, and, therefore, appears to be high in comparison with ACM. The technological processing applied to camel milk, including separation, pasteurization, fermentation, as well as yogurt making, was found to be largely influenced by the properties and composition of its proteins. The addition of FOS and AP also insignificantly affected the lactose content of the yogurts.

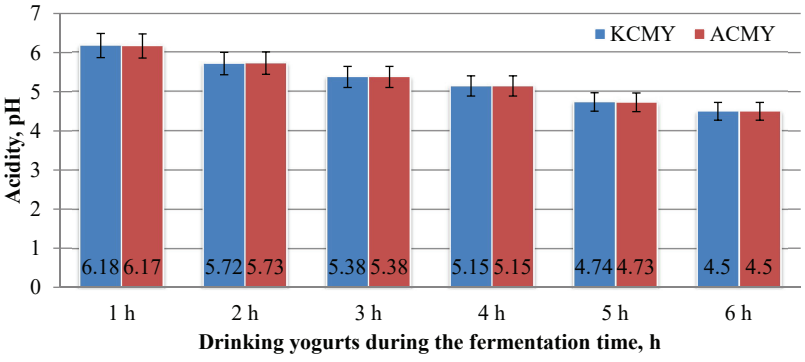

Fig. 2. pH of the samples during the incubation time at 43 °C. The samples were made in triplicate: KCMY – Kazakhstani camel milk yogurt with additives; ACMY – Australian camel milk yogurt with additives

Table 1

Chemical composition of the main components of Kazakhstan's and Australian camel milk (not separated) and its products (winter season's milk)

Parameters	Methods for identification	Kazakhstan		Australia		*P* value of between milks ≤0.05
		Camel milk	Drinking yogurt	Camel milk	Drinking yogurt	
Fat, % m/v	ISO 19662 |IDF 238:2018	3.65	1.508	2.53	1.505	0.00001
Protein, % m/m	ISO 8968-1|IDF 20-1:2014	3.59	3.05	2.97	2.52	0.000055
Lactose, % m/m	ISO 9622	4.21	4.43	4.31	4.42	0.035242
Total solids, % m/m	ISO 6731|IDF 21:2010	11.49	11.64	10.59	11.10	0.000013
Ash, % m/m	NMKL 173:2005	0.82	0.84	0.79	0.81	0.00001

5. 2. Identifying the chemical composition of yogurts

Camel milk casein contained most of the essential AA in high ratios. In our study, both non-essential and essential AA contents in Kazakhstani camel milk yogurt (KCMY) and Australian camel milk yogurt (ACMY) were comprehensively assayed. As a comparison, AA daily consumption requirements by FAO for elderly people of different ages were added. The results of AA identification in both yogurt products are shown in Tables 2, 3.

Our study results properly showed that the obtained amounts of essential and non-essential AA in native milk and yogurt products are different. Meth+Cys, Phe levels in KCM are higher than in KCMY by 9.5 and 5.1 % respectively. At the same time, the levels of Lys, Thr, Val, Iso+Leu, His in KCMY were higher by 60, 8, 4, 3.4 and 7.1 % accordingly compared to KCM. The total amount of essential AA in KCM and KCMY was identical. However, compared to ACMY, the levels of essential AA in KCMY were significantly higher, except for Tryptophan, which was not detected in ACM and ACMY products.

In the case of ACM, its essential AA content also resembled slight increasing levels of Meth+Cys and Iso+Leu in ACMY, the amount of which was higher by 12 and 70 % than in ACM. Nevertheless, other essential AA levels between ACM and ACMY were equal. The total amount of essential AA in ACMY registered were higher by 17 % compared to ACM.

The results of non-essential AA were also different in raw milk compared to the final product. One unusual fact remains that Aspartic and Glutamic acids were not identified in KCMY compared to KCM and ACMY. However, Lysine and Histidine were not found in ACMY in comparison to KCMY. Gly, Arg, Ala levels in KCMY increased to 25, 14.3, and 78.2 % respectively. On the other hand, its Ser, Tyr, Pro amounts decreased to 3, 46 and 1.5 % accordingly compared to the KCM results. The results of ACMY demonstrated that almost all non-essential AA in it were lower compared to KCMY.

Table 2

Content of essential amino acids in Kazakhstani and Australian yogurts in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

AA types	Kazakhstani raw camel milk, %/100 ml sample	KCMY, %/100 ml sample	Australian raw camel milk, %/100 ml sample	ACMY, %/100 ml sample	*P* value, between yogurt samples ≤0.05	Daily consumption requirement (%/100 g protein) by FAO	
						elderly people (6174 years old)	persons of advanced age (75 years and older)
1	2	3	5	4	7	8	9
Lysine	0.079±0.04	0.13±0.04^{a,b}	0.00	0.00	0.00	0	0
Threonine	0.23±0.12	0.25±0.10^{a}	0.14±0.063	0.14±0.036	>0.00001	0.4	0.4
Methionine +Cysteine	0.21±0.62	0.19±0.06^{a,c}	0.058±0.002	0.066±0.003^{d}	>0.001925	0.35	0.35
Valine	0.24±0.08	0.25±0,10^{a}	0.13±0.005	0.13±0.039	>0.021207	0.5	0.5
Isoleucine+Leucine	0.56±0.19	0.58±0.15^{a,b}	0.21±0.0057	0.39±0.0015^{d}	>0.004816	0.4	0.4
						0.7	0.7
Phenylalanine	0.39±0.04	0.37±0.11^{a,c}	0.31±0.05	0.30±0.09	<0.080784	0.6	0.6
Histidyn	0.26±0.017	0.28±0.14^{a,b}	0.00	0.00	0.00	0	0
Tryptophan	0.08±0.12	0.05^{c}	0.00	0.00	0.00	0	0
Total	2.049	2.05	0.848	1.026	–	2.95	2.95

Note: Each value is the mean ±SD; abbreviations: KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05). a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (high range), c – KCMY compared to KCM (low range), d – ACMY compared to ACM (high range)

Table 3

Content of non-essential amino acids in Kazakhstani and Australian yogurts in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

AA types	Kazakhstani raw camel milk, %/100 ml sample	KCMY, %/100 ml sample	Australian raw camel milk, %/100 ml sample	*ACMY*, %/100 ml sample	*P* value, between yogurt samples ≤0.05
1	2	3	4	5	6
Aspartic acid	0.06±0.002	0^{b}	0.20±0.02	0.20±0.068	0.00
Glutamic acid	0.2±0.07	0^{b}	1.34±0.074	$1.44±0.065^{d}$	0.00
Glysine	0.21±0.06	$0.28±0.10^{a,b}$	0.04±0.07	$0.0379±0.05^{e}$	>0.036185
Serine	0.44±0.04	$0.43±0.11^{a}$	0.14±0.012	0.15±0.021	>0.001183
Tyrosine	0.52±0.02	$0.28±0.08^{a,b}$	0.039±0.002	$0.16±0.09^{d}$	>0.021207
Arginin	0.42±0.02	$0.49±0.20^{a,b}$	0.10±0.03	$0.13±0.06^{d}$	>0.000456
Alanine	0.12±0.02	$0.55±0.14^{a,c}$	0.073±0.008	$0.083±0.005^{d}$	>0.001183
Proline	0.87±0.07	$0.86±0.22^{a}$	0.32±0.094	0.32±0.094	>0,00001
Total	2.84	2.89	2.522	2.52	–

Note: Each value is the mean ±SD. Abbreviations: KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05); a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (high range), c – KCMY compared to KCM (low range), d – ACMY compared to ACM (high range), e – ACMY compared to ACM (low range)

The obtained data for ACM and ACMY presented differences between the amounts. All AA contents increased in ACMY relative to ACM, except Aspartic acid, Gly, Pro levels. The last three AA were identified in the same range as ACMY. In addition, the amino acid scoring difference coefficient between yogurt samples was defined (Fig. 3).

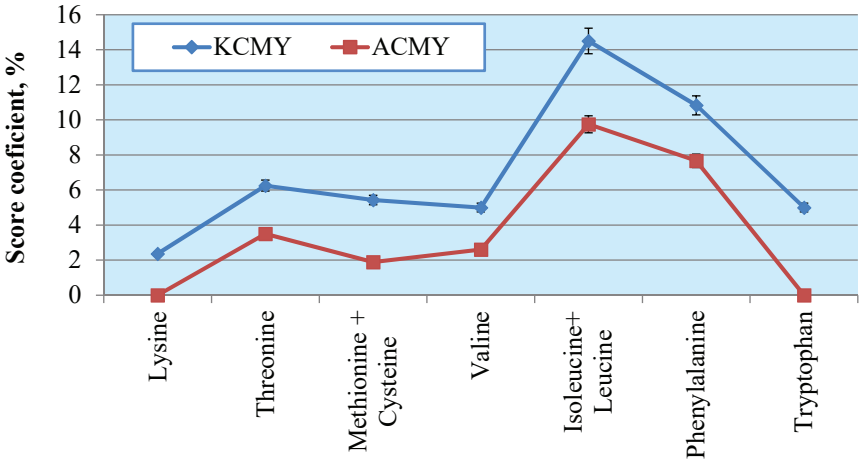

Fig. 3. Amino acid scoring difference coefficient of Kazakhstani and Australian yogurts, %

Amino acid scoring difference coefficient calculations presented that Lysine (score of 2.36 %) in KCMY receives a limited score compared to other AA scores. On the other hand, the score of Isoleucine+Leucine (score of 14.5 %) was on top compared to the other five AA. The ACMY was first-limiting in Methionine+Cysteine (score of 1.89 %), but the highest level was detected in Isoleucine+Leucine (score of 9.75 %). Once, Lysine and Tryptophan in ACMY were unidentified, the AA score did not present any results, which decreased the total value of the AA scoring difference coefficient. The comparison total percentage of AA score in KCMY was tower up to 57 % compared to the ACMY score.

Fatty acids (FA) are the major components of fats in the case of milk fats. The composition of FA in camel milk (CM) was investigated by many researchers nowadays. The general pattern of CM FA indicates that their short-chain fatty acids, C4-C14, are presented in minimal amounts in milk fat compared to other species. Still, the concentrations of C16.0–C20.0 are relatively high.

By the FAO requirements for functional foods, especially for gerodiet products, the fat content must be lower than 1.5 %, and FA intake per day must be 10 g/100 g. The results of the FA composition of our products are presented in Table 4.

The results of FA in native camel milk and yogurts were also with some distinction. The data presented that Lauric, Trideclyic, Mystric, and Pentadecylic acids were not identified in KCMY compared to KCM. The differences of FA by the volume per mL of sample were as follows. Compared to KCM, Linoleic, Linolenic, Arachidic FA increased in KCMY to 2, 11, and 33 % accordingly. Besides this, a geometric isomer of linoleic acid linoleaidic acids (C18:2–9,12) was identified in KCMY. Apart from this, three types of VLCFA in KCMY are also recognized. However, Margaric, Stearic, Oleic FA decreased in KCMY in contrast to KCM.

ACMY FA content was higher than in KCMY yogurt samples. The SCFA in both products was not determined. In the case of individual FA, Undecylic, Linoleaidic, Heneicosanoic, Lignoceric, and Nervonic acids were not identified in ACMY compared to KCMY, while Lauric, Trideclyic, Mystic, and Pentadecylic acids were also not determined in KCMY compared to ACMY. The highest amount of AA detected in KMCY belongs to Caprylic, Palmitic and Stearic acids, at the same time, the lowest degree is set for Margaric, Linoleaidic, and Arachidic acids. In the case of ACMY, Mystic, Palmitic, and Oleic acid contents were on top of results, but Caprylic, Trideclyic, Arachidic acid percentages were limited.

The results regarding ACM and ACMY were also different. The level of Linoleic and Linolenic FA in ACMY increased to 20 and 42 % accordingly compared to KCM. However, there was a slight decrease in the amount of the

rest FA in ACMY. The quantity of Mystric, Myristoleic, Pentadecylic FA in ACM was lower to 45, 61, and 50 % respectively compared to ACMY. The identical scenario was with Palmitoleic, Margaric, Stearic, Oleic, and Arachidic FA in KCM. Their level in KCMY reduced between 52–62 %. According to the results in Table 4, the IA, MCFA, LCFA, VLCGA, Ω 6/Ω 3 ratio, and OI of both camel milk and yogurts were identified, the results of which are presented in Fig. 4.

The AI was calculated based on the obtained values for the lauric (C12:0), myristic (C14:0), and palmitic (C16:0) acids, and unsaturated fatty acids for all the sample products. The obtained data for KCMY have a relatively low AI of ACMY. However, the AI of raw milk was also higher as opposed to yogurt products. The total MCFA for KCMY was 0.162, while for ACMY it indicates 0.2288, which is higher than in KCMY by 70 %. Nevertheless, the LCFA in KCMY was set at 0.139, in ACMY reached 0.4903, which is higher than in KCMY by 71 %. Still, this level also demonstrated that the level of LCFA compared to KCM decreased in KCMY by 65 %. However, the VLCFA in KCMY was set at a high value. The LCFA in ACM dropped in ACMY to 79 %.

The omega 6 and omega 3 ratios in KCMY were greater up to 16 % than in ACMY. The comparison of KCM with KCMY in Ω6/Ω3 presented that camel milk is low at this ratio to 13 % than the yogurts results. The same matter let out with ACM and ACMY, where the Ω6/Ω3 ratio appeared more than 7 % in ACMY compared to ACM.

The OI of both yogurt products was also with different values. The OI of ACMY presented less amount (8 % lower) than KCMY data. Differentiation between Kazakhstani milk and yogurt was by 15 % lower in KCMY than in KCM. Regarding ACM and ACMY, the OI decreased in ACMY by 45 % compared to ACM.

The vitamin content of camel milk and its products is rarely illustrated in the studies. Researchers are mostly trying to focus on changes in the Ascorbic acids (vit. C) content. In our study, the main possible vitamins content in KCMY and ACMY products compared to native camel milk samples were assayed, and the results presented us some differences between them (Table 5).

Table 4

Identified results of the fatty acid content of Kazakhstani and Australian yogurts in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

Carbon number	FA name	Kazakhstani raw camel milk, mg/mL sample	KCMY, mg/mL sample	Australian raw camel milk, mg/mL sample	*ACMY*, mg/mL sample	*P* value, between yogurt samples ≤0.05	Daily consumption requirement for FA (%/100 g) by FAO	
							elderly people (61–74 years old)	persons of advanced age (75 years and older)
1	2	3	4	5	6	7	8	9
C8:0	Caprylic	0.023±0.09	0.090±0.009^{b}	0.0085±0.004^{e}	0.0010±08	>0.047851	10	10
C10:0	Capric	0.033±0.02^{c}	0.031±0.005	0.0084±0.006^{e}	0.00042±0.001	>0.000908		
C11:0	Undecylic acid	0	0.041±0.003	0	0	0		
C12:0	Lauric	0.076±0.03	0	0.061±0.09^{e}	0.0292±0.002	0		
C13:0	Trideclyic	0.005±0.002	0	0.003±0.001^{e}	0.0013±0.002	0		
C14:0	Mystric	1.105±0.010	0	0.545±0.01^{e}	0.30±0.004	0		
C14:1n-5	Myristoleic	0.07±0.002	0.024±0.002^{a,b}	0.055±0.004^{e}	0.021±0.002	<0.308488		
C15:0	Pentadecylic	0.13±0.001	0	0.05±0.001^{e} 0.025±0.002				
C16:0	Palmitic	0.036±0.006	0.057±0.003^{b}	0.063±0.007	0.071±0.002^{d}	<0.380594		
C16:1n-7	Palmitoleic	0.07±0.001	0.024±0.01^{b}	0.375±0.013^{e}	0.180±0.004	<0.360944		
C17:0	Margaric	0.091±0.004^{c}	0.0023±0.006^{a}	0.018±0.0012^{e}	0.0087±0.001	<0.486803		
C18:0	Stearic	0.76±0.008^{c}	0.0559±0.001^{a}	0.404±0.011^{e}	0.25±0.002	<0.249782		
C18:1n-9 cis	Oleic	1.196±0.013^{c}	1.192±0.002	0.743±0.014^{e}	0.452±0.001	<0.190195		
C18:2n-6 all cis	Linoleic	0.0165±0.009	0.0167±0.002^{a}	0.087±0.009	0.109±0.002^{d}	<0.446935		
C18:2-9, 12	Linoleaidic acid	0	0.0024±0.004	0	0	0		
C18:3n-3	Linolenic	0.011±0.005	0.0124±0.003^{a}	0.014±0.009	0.024±0.004^{d}	<0.395895		
C20:0	Arachidic	0.001±0.003	0.0015±0.005^{a}	0.011±0.002^{e}	0.08±0.003	<0.49385		
C21:0	Heneicosa noic acid	0	0.018±0.007	0	0	0		
C24:0	Lignoceric acid	0	3.21±0.003	0	0	0		
C24:1	Nervonic acid	0	3.11±0.004	0	0	0		

Note: Each value is the mean ±SD. Abbreviations: KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05); a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (high range), c – KCMY compared to KCM (low range), d – ACMY compared to ACM (high range), e – ACMY compared to ACM (low range)

In our results, the vitamin content of pure milk relative to yogurt samples was different. The Thiamine and Nicotinamide volume in KCMY dropped to 25 and 93 % compared to KCM. However, other vitamins in KCMY rise up from 35 to 70 % compared to KCM.

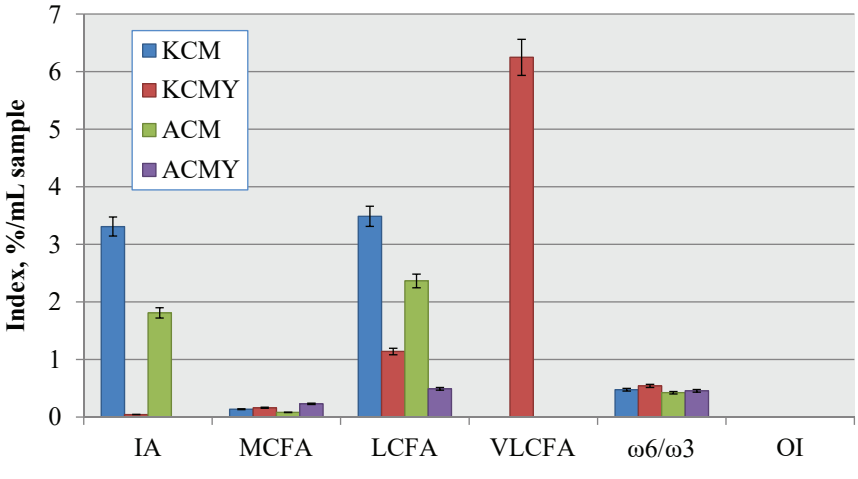

Fig. 4. Quality characteristics of KCMY and ACMY fatty acids content: AI — atherogenic index. MCFA — medium-chain fatty acids, LCFA — long-chain fatty acids, VLCGA — very-long-chain fatty acids. Ω 3 — omega 3 fatty acids, Ω 6 — omega 6 fatty acids, OI — oxidative index

Thiamine level in KCMY was lower than in ACMY up to 57 %. However, Riboflavin results in both samples were identical. The Nicotinamide content in ACMY dropped to 59 % compared to KCMY. The Pyridoxine level in ACMY was not detected. The Folic acid content results illustrated that it was in the same amount, with slight changes towards KCMY. In the case of Cyanocobalamin, it is not detected in KCMY, while in ACMY it received visible results. The ascorbic acid content in ACMY was higher up to 25 % than in KCMY. The same scenario was regarding the Nicotinic acid, where its amount increased in KCMY up to 23 %.

The comparison between ACM and ACMY demonstrated that still ACM vitamin contents were higher than in ACMY.

In the case of fat-soluble vitamins, their content level depends on the product's fat content. Unfortunately, this information is often lacking in the published references. Our case identified fat-soluble vitamin content in KCMY and ACMY presented in Table 6.

According to our results (Table 6), Retinol content in KCMY was higher than 85 % than in ACMY and 90 % than in KCM.

The Tocopherol amount in ACM and ACMY was not detected; however, its weight in KCMY was 0.1 mg/100 g. Compared to KCM, its volume in KCMY up to 30 %.

Considering the important role of minerals in human body health, especially for older adults, we also determined the mineral content of our fermented products from different origins. Our identified results presented the number of minerals and their values with RDI covering (Table 7).

As can be seen in Table 6, KCM surpasses KCMY in all identified results, still the percentage of differences varies between 5 to 18 %. However, the Magnesium level in KCMY up to 12 % compared to KCM.

All elements in ACM and ACMY were identified, however, in KCM and KCMY, the Zinc and Selenium were not taken to determine. The level of Ca, Mg, P, Zn, and Se grow up in ACMY compared to ACM to 4, 3.5, 1.3, 1.7, and 95 % accordingly. As a counterpart, K and Fe amount dropped in ACMY to 3 and 48 % respectively compared to ACM. The changes in the Na level were insignificant.

Table 5

Water-soluble vitamin content of Kazakhstani and Australian yogurts in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

Water-soluble vitamin name	Kazakhstani raw camel milk, mg/100 g sample	KCMY, mg/100 g	Australian raw camel milk, mg/100 g sample	ACMY, mg/100 g	P value, between yogurt samples ≤0.05	RDI values mg/day [36]	
						male	female
1	2	3	4	5	6	7	8
Thiamine/B1	0.24±0.05^{c}	0.18±0.036	0.191±0.002^{e}	0.42±0.006	>0.002092	1.2	1.1
Riboflavin/B2	0.36±0.03	0.95±0.040^{b}	0.018±0.004^{e}	0.010±0.006	<0.052886	1.3	1.1
Nicotinamide/B3	0.62±0.03	0.039±0.008^{a}	0.150±0.08^{e}	0.016±0.006	<0.301624	16	14
Pyridoxine/B6	0.021±0.01	0.072±0.014^{b}	ND	ND	0	1.7	1.5
Folic acid/B9	0.30±0.01	0.74±0.0015^{b}	0.357±0.06^{e}	0.076±0.0032	<0.498163	600	600
Cyanocobalamin/B12/ μg	0.16±0.005	ND	ND	0.03±0.0018	0	0.002	0.002
Ascorbic acid/C	2.2±0.09	3.4±0.022^{b}	0.196±0.011^{e}	0.085±0.033	<0.317044	90	75
Nicotinic acid	0.018±0.04	0.026±0.005^{a,b}	0.241±0.015^{e}	0.020±0.0014	<0.445122	92	5

Note: Each value is the mean ±SD. Abbreviations: RDI – Recommended Dietary Index. ND – not detected. KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05); a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (high range), c – KCMY compared to KCM (low range), d – ACMY compared to ACM (high range), e – ACMY compared to ACM (low range)

ACMY results presented increasing amounts of Calcium up to 5 %, Potassium 34 %, Sodium 34 %, and Phosphorus 30 %, compared to KCMY. On the other hand, Magnesium and Iron level was low in ACMY to 47 % and 60 % respectively compared to KCMY.

5. 3. Analysis of results significance

According to our results, the total amount of essential and non-essential AA in KCMY was equally higher than in ACMY up to 50 % and 12 % respectively.

The calculated significance value (p<0.05) demonstrated that results in KCMY count are statistically significant than in ACMY count. However, there was one case with Phenylalanine, which presented there is no significant difference (0.08>0.05) between the results of both yogurts with diverse origins.

Comparison of FA results of both products and its significance degree calculation demonstrated that Caprylic and Capric acids percentage difference among products was not significant, and it is lower than the p-value 0.05. However, significant differences between KCMY and ACMY results were identified. The difference of Linoleic acid in KCMY was significantly higher than in ACMY, as a counterpart, Linolenic acid in ACMY was detected in a significantly higher amount than in KCMY. Myristoleic, Margaric, Stearic, Arachidic acids amounts were higher in KCMY in comparison with ACMY results and their significance level was more than the p-value (>0.05). At the same point, Palmitic, Palmitoleic, and Oleic acids contents in ACMY were higher than in KCMY, as well as the significance level was higher than the p-value (>0.05).

The Thiamin difference level in KCMY and ACMY was less than the p-value (<0.05), which means the values are significant. The Nicotinamide content differences between KCMY and ACMY were not significant. The Folic acid content results were determined as significant. The research results presented sufficient significant differences in results. The ascorbic acid content in ACMY and KCMY was significant (>0.05).

Table 6

Fat-soluble vitamin content of Kazakhstani and Australian yogurts in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

Fat-soluble vitamin name	Kazakhstani raw camel milk, mg/100 g sample	KCMY, mg/100 g	Australian raw camel milk, mg/100 g sample	ACMY, mg/100 g	P value, between yogurt samples ≤0.05	RDI values, mg/day [36]	
						male	female
Retinol/A	0.04±0.002	$0.021\pm0.002^{a, b}$	0	0.0031±0.008	<0.341833	0.9	0.7
Tocopherol/E	0.03±0.52	0.1 ± 0.005^{b}	0	ND	0	15	15

Note: Each value is the mean ±SD. Abbreviations: RDI – Recommended Dietary Index. ND – not detected. KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05); a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (high range)

Table 7

Mineral content of KCMY and ACMY products in comparison with Kazakhstani and Australian raw camel milk (1.5 % fat)

Minerals	Kazakhstani raw camel milk, mg/100 g sample	KCMY, mg/100 g	Australian raw camel milk, mg/100 g sample	ACMY, mg/100 g	P value, between yogurt samples ≤0.05	RDI values, mg/day	
						male	female
1	2	3	4	5	6	7	8
Macroelements							
Calcium/Ca	120 ± 0.12^{b}	114.24 ± 1.56^{a}	105.3±0.28	109.35 ± 0.14^{c}	>0.00001	1300	1300
Potassium/K	130 ± 1.23^{b}	121.47±1.44	172.15 ± 1.2^{d}	167.1±0.21	>0.00001	NG	NG
Sodium/Na	37 ± 0.21^{b}	31.18±0.34	47.4±0.18	47.6±0.012	>0.00001	NG	NG
Magnesium/Mg	15±0.19	17.14 ± 0.26^{a}	7.76±0.11	8.04 ± 0.18^{c}	>0.00001	230	190
Phosphorus/P	84 ± 0.14^{b}	74.18±0.96	89.95±0.17	91.1 ± 0.046^{c}	>0.00001	NG	NG
Microelements							
Zinc/Zn	**	**	0.398±0.24	0.405 ± 0.05^{c}	0	7	4.9
Iron/Fe	100 ± 1.17^{b}	93 ± 0.001^{a}	0.026 ± 0.04^{d}	0.05±0.002	<0.232124	14	11
Selenium/Se	**	**	0.017±0.02	0.033 ± 0.005^{c}	0	34	26

*Note: Each value is the mean ±SD. ** – were not taken to determine. Abbreviations: RDI – Recommended Dietary Index. NG – not given by requirements. KCMY – Kazakhstani camel milk yogurt, ACMY – Australian camel milk yogurt, KCM – Kazakhstani camel milk, ACM – Australian camel milk. Means with different letters in each row are significantly different (P<0.05); a – KCMY compared to ACMY (high range), b – KCMY compared to KCM (low range), c – ACMY compared to ACM (high range), d – ACMY compared to ACM (low range)*

The results differences between KCMY and ACMY in macroelements did not show significance. In the case of microelements, the Iron content difference between the two products was identified as significant (>0.05).

6. Discussion of the results of studying the effect of the developed technology of drinking yogurt on its chemical composition

Camel milk is difficult to process into diverse dairy products, and its initial chemical composition and the way of its processing play a vital role in this process. It was observed that at pH 5, significant changes occurred in the dromedary casein micelle structure from milk to coagulum [37]. Some studies [38, 39] stated that the pasteurization of camel milk could change its chemical composition.

According to our experimental design, it was possible to produce drinking yogurt by our developed technology, even if camel milk was from different origin and its chemical composition was with some differences.

By the gerodiet claim, the fat matter of products must range between 1.3–1.5 %, based on the initial fat results of camel milk we were able to normalize the fat content of fluid milk to 1.5 %. However, during the milk separation process, the fatty acid composition of milk could be changed because of the low fat content. Therefore, we added flaxseed oil to the normalized milk as a source of ALA and good cholesterol, which are crucial for elderly people's diet. The differences in FA between unprocessed camel milk and yogurts are presented in Table 4. Moreover, because of FO addition, we are forced to homogenize camel milk. Adding FO, AP, FOS, TGSe sharply decreased the pH of the yogurts during the incubation time, which means it reduced incubation time for 2 hours compared to normal yogurt fermentation time. During the fermentation period, a highly significant decrease of pH of yogurts with mean values of 5.07 after 4 h and 4.51 after 6 h of fermentation was recorded (Fig. 2). Besides this technological impact, the additives have other nutritional and structural influence on the final products quality. The AP was added as an antioxidant additive and also it helps to reduce saturated fats in the organism, enhance the amino acid composition [40]. Pectin is known to exhibit antioxidant activity [41, 42]. In addition to its own antioxidant effect, one of the pectin functions is to transport dietary antioxidants (vitamin C, carotenoids, and phenolic compounds) in the gastrointestinal tract and protect them from degradation in the acidic environment of the stomach [43–46]. MTGse is an enzyme that helps to bond and easily digest proteins, and FOS is a probiotic, which will work in tandem with LAB and stomach cultures actively work in the intestinal phase. Nevertheless, these supplements did not affect the organoleptic characteristics of yogurts.

The above proposed technology of processing camel milk into drinking yogurt for a gerodiet has not been previously suggested by scientists. Therefore, scientific information regarding its technological characteristics, physico-chemical composition, and structure is limited.

The results of the AA content of KCMY and ACMY demonstrated that there are no significant differences between the products, except Phenylalanine. Generally, the identified amount of non-essential amino acids matched the daily requirements of FAO (2001) for older adults. By the diet menu, camel drinking yogurts can be served once per day (100–120 ml), where non-essential AA in KCMY and ACMY will cover 55.6 % and 34.8 % per 100 ml respectively. These changes could also be due to apple pectin, which also has a visible amount of AA. However, it must be noticed that its addition amount by the recipe was identical for both products.

The percentage of energy from fat is similar in the elderly and younger adults (35 to 40 %). It must not be smaller than this amount, because it is necessary to maintain recommended essential FA allowances per day. Adding flaxseed oil (FO) helped us to keep the main FA amount, which is very beneficial for older adults. By scientific papers, flaxseed oil is a rich source of ALA and lignans, and it keeps potential benefits of lowering blood's total cholesterol and can improve immune response [34]. Meanwhile, we would like to note that the percentage of adding FO does not exceed 0.5 %/1 L of milk, and this amount also does not exceed its usage requirements. Nevertheless, because of the presence of other FA in the yogurts, it is important to compare and quantify the SCFA and certain PUFA into an index of atherogenicity, which is a very critical index used as a stand-alone index for cardiac risk estimation. The consumption of yogurt products by elderly people with lower atherogenic index can help to decrease the total cholesterol, LDL-cholesterol level in the organism. Thus, according to the results and calculations, we can state that KCMY and ACMY provide the full daily FA requirement for elderly females and males. Moreover, their AI and OI are very low compared to other mammalian species of milk. These merits increase their nutritional and therapeutic value.

In the case of nutrients, the water-soluble vitamin content of both products was significantly different. The absence of Cyanocobalamin in KCMY and Pyridoxine in ACMY opens up new challenges for us, to deeply study the vitamin content of our products. By the water-soluble vitamins, KCMY can cover 2 % for elderly males and 2.5 % for elderly females RDI. At the same time, ACMY can cover RDI for elderly males for 2.3 %, females for 2.9 % if they will consume 100 ml of drinking yogurt per day. In the case of fat-soluble vitamin content, both products can cover RID for males and females between 0.5–1.5 %. It should be noted that some fat-soluble vitamins were not identified in the products. Because fat-soluble vitamins are concentrated in the fatty part of the milk, their content level obviously depends on the fat content in the product [47]. However, two main vitamins were detected in KCMY, while in ACMY it was only Retinol. In addition, FA content and fat-soluble vitamin content are closely related to each other, and the need for Tocopherol is directly related to the content of PUFAs in the diet. When the content of PUFAs in the diet is low, the need for Tocopherol decreases, and when the amount of PUFAs in the diet increases, the need for the vitamin Tocopherol increases.

For elderly people, it is necessary to keep in balance not only vitamins but minerals too. The deficiency of minerals leads to an increase in various dysfunctions of the human organism. During the product development, we also intended to define what mineral content of our product will be. As can be seen in Table 7, 100 ml of KCMY can cover 20.5 % for males, 21.23 % for females, and ACMY can cover 26.73 % for males, 27.66 % for females' daily consumption requirements index of minerals.

During the camel milk processing, issues appeared related to the precipitation in yogurt after the first day of storage. We assumed that these might be due to the equipment calibration and this problem is solved using a brand new water bath with an automatic timer and temperature program. Besides, there was another issue with standard preparation for identification on UHPLC. Since most standards were created for cow milk, we purchased a new standard for camel milk, which makes identification easy.

However, these facts do not diminish the nutritional and biological value of our developed yogurt products. Regardless, it expands the scientific evidence for raw camel milk and opens a new page of fermented camel milk products for the gerodiet as our researchers are the pioneers in the field.

In a further study, it is necessary to identify the structural-physical characteristics of products such as viscosity, particle size, texture, syneresis, etc. It is also necessary to analyze and identify the digestibility of products on the simulated elderly in-vitro model. As a final step, we are planning to conduct an organoleptic evaluation of our products, since camel milk has unique special flavor and taste characteristics, which are not always can be accepted by elderly people.

7. Conclusions

1. In this study, camel milk from Kazakhstan and Australia was processed to drinking yogurt for gerodiet according to the newly developed recipe and technology. On this basis, the effect of the developed technology on yogurts' nutritional composition such as amino acid scores, oxidative index, atherogenic index, omega6/omega3 ratios, the percentage of covering RDI requirements was determined.

2. The yogurts main chemical constituents such as amino acid, fatty acid, vitamins, and minerals were identified. The calculations of RDI presented that Kazakhstani camel milk yogurt can provide for 20 % more amino acids, 54 % fatty acids per day than Australian camel milk yogurt. A total of 9 vitamins in KCMY and 8 vitamins in ACMY were identified. The mineral content in KCMY is 12.65 % less than in ACMY. Nevertheless, it must be noted that the Zinc and Selenium content in KCMY was not taken into determination. Comparison of the results of yogurts with native camel milk from different origin also demonstrated that the additives used for yogurt production helped to save the main nutritional characteristics of milk during the processing.

3. The calculated significance value (p<0.05) of AA demonstrated that results in KCMY count are statistically significant than in ACMY count. FA differences between the yogurts were insignificant among individual FA content. The significance of vitamin results differences was more than the p-value (0.05), which allows us to assume that ACM can keep more vitamins during the processing. The macro elements did not show significance. According to our study results, it allows us to suggest that even if the milk from a different region, the technology developed by our scientific group can help keep the main nutritional value, even more; it will enrich the products chemical composition.

Acknowledgments

We are grateful to Nabiyeva Zhanar (director of the Scientific research institute of Food Safety) from the Almaty Technological University for giving a hand in preparing samples for analysis and to a staff of the School of Agriculture and Food Sciences, the University of Queensland, for their effort during the preparation of data and results of this manuscript. Special thanks to the Ministry of Economy and Ministry of Agriculture and Food of the Republic of Bulgaria for support during the product development at Lb-Bulgaricum.

References

1. Farah, Z. (1993). Composition and characteristics of camel milk. Journal of Dairy Research, 60 (4), 603–626. doi: https://doi.org/10.1017/s0022029900027953
2. Elagamy, E. I. (2000). Effect of heat treatment on camel milk proteins with respect to antimicrobial factors: a comparison with cows' and buffalo milk proteins. Food Chemistry, 68 (2), 227–232. doi: https://doi.org/10.1016/s0308-8146(99)00199-5
3. Abbas, S., Hifsa, A., Aalia, N., Lubna, S. (2013). Physico-chemical analysis and composition of camel milk. International Research, 2 (2), 84–98.
4. Yadav, A. K., Kumar, R., Priyadarshini, L., Singh, J. (2015). Composition and medicinal properties of camel milk: A Review. Asian Journal of Dairy and Food Research, 34 (2), 83. doi: https://doi.org/10.5958/0976-0563.2015.00018.4
5. Gul, W., Farooq, N., Anees, D., Khan, U., Rehan, F. (2015). Camel Milk: A Boon to Mankind. International Journal of Research Studies in Biosciences (IJRSB), 3 (11), 23–29.
6. Konuspayeva, G., Faye, B., Loiseau, G. (2009). The composition of camel milk: A meta-analysis of the literature data. Journal of Food Composition and Analysis, 22 (2), 95–101. doi: https://doi.org/10.1016/j.jfca.2008.09.008
7. Tasturganova, E., Dikhanbaeva, F., Prosekov, A., Zhunusova, G., Dzhetpisbaeva, B., Matibaeva, A. (2018). Research of Fatty Acid Composition of Samples of Bio-Drink Made of Camel Milk. Current Research in Nutrition and Food Science Journal, 6 (2), 491–499. doi: https://doi.org/10.12944/crnfsj.6.2.23
8. Gran, S. O., Mohammed, M. O., Shareha, A. M., Lgwegba, A. O. L. (1991). A comparative study on fermentability of camel and cow milk by lactic acid culture. Proceedings of the International Conference On Camel Production and Improvement. Libya, 183–188.
9. Kaskous, S. (2016). Importance of camel milk for human health. Emirates Journal of Food and Agriculture, 28 (3), 158. doi: https://doi.org/10.9755/ejfa.2015-05-296
10. Khan, A. A., Alzohairy, M. A. (2011). Hepatoprotective Effects of Camel Milk against CCl4-induced Hepatotoxicity in Rats. Asian Journal of Biochemistry, 6 (2), 171–180. doi: https://doi.org/10.3923/ajb.2011.171.180

11. El-Agamy, E. I., Nawar, M., Shamsia, S. M., Awad, S., Haenlein, G. F. W. (2009). Are camel milk proteins convenient to the nutrition of cow milk allergic children? Small Ruminant Research, 82 (1), 1–6. doi: https://doi.org/10.1016/j.smallrumres.2008.12.016
12. Kamal, M., Foukani, M., Karoui, R. (2017). Rheological and physical properties of camel and cow milk gels enriched with phosphate and calcium during acid-induced gelation. Journal of Food Science and Technology, 54 (2), 439–446. doi: https://doi.org/10.1007/s13197-016-2480-9
13. Al haj Omar A., Al Kanhal, H. A. (2010). Compositional, technological and nutritional aspects of dromedary camel milk. International Dairy Journal, 20 (12), 811–821. doi: https://doi.org/10.1016/j.idairyj.2010.04.003
14. Yagil, R. (1982). Camels and Camel Milk. FAO Animal Production and Health Paper. Available at: http://www.fao.org/3/x6528e/X6528E00.htm
15. Farrell, H. M., Qi, P. X., Uversky, V. N. (2006). New Views of Protein Structure: Applications to the Caseins: Protein Structure and Functionality. Advances in Biopolymers, 52–70. doi: https://doi.org/10.1021/bk-2006-0935.ch004
16. Holt, C. (1998). Casein Micelle Substructure and Calcium Phosphate Interactions Studied by Sephacryl Column Chromatography. Journal of Dairy Science, 81 (11), 2994–3003. doi: https://doi.org/10.3168/jds.s0022-0302(98)75863-1
17. Redwan, E. M., Tabll, A. (2007). Camel Lactoferrin Markedly Inhibits Hepatitis C Virus Genotype 4 Infection of Human Peripheral Blood Leukocytes. Journal of Immunoassay and Immunochemistry, 28 (3), 267–277. doi: https://doi.org/10.1080/15321810701454839
18. Inayat, S., Arain, M. A., Khaskheli, M., Mali, A. H. (2003). Study of the effect of processing on the chemical quality of soft unripened cheese made from camel milk. Pakistan Journal of Nutrition, 2 (2), 102–105. doi: https://doi.org/10.3923/pjn.2003.102.105
19. Mehaia, M. A. (2006). Manufacture of fresh soft white cheese (Domiati-type) from dromedary camels milk using ultrafiltration process. Journal of Food Technology, 4 (3), 206–212.
20. Elayan, A. A., Suliema, A. E., Saleh, F. A. (2008). The hypo-cholesterolemic effect of Gariss and Gariss containing Bifidobacteria in rats fed on a cholesterol-enriched diet. Asian Journal of Biochemistry, 3 (1), 43–47. doi: https://doi.org/10.3923/ajb.2008.43.47
21. Hashim, I. B., Khalil, A. H., Habib, H. (2009). Quality and acceptability of a set-type yogurt made from camel milk. Journal of Dairy Science, 92 (3), 857–862. doi: https://doi.org/10.3168/jds.2008-1408
22. Abu-Lehia, I. H., Al-Mohizea, I. S., El-Behry, M. (1989). Studies on the production of ice cream from camel milk products. Aust J Dairy Technol., 44 (1), 31–34.
23. Farah, Z., Streiff, T., Bachmann, M. R. (1989). Manufacture and characterization of camel milk butter. Milchwissenschaft, 44, 412–415.
24. Wang, N., Wang, K. Y., Li, G., Guo, W., Liu, D. (2015). Expression and characterization of camel chymosin in Pichia pastoris. Protein Expression and Purification, 111, 75–81. doi: https://doi.org/10.1016/j.pep.2015.03.012
25. Abu-Lehia, I. H. (1989). Physical and chemical characteristics of camel milkfat and its fractions. Food Chemistry, 34 (4), 261–271. doi: https://doi.org/10.1016/0308-8146(89)90103-9
26. Farah, Z., Mollet, M., Younan, M., Dahir, R. (2007). Camel dairy in Somalia: Limiting factors and development potential. Livestock Science, 110 (1-2), 187–191. doi: https://doi.org/10.1016/j.livsci.2006.12.010
27. Raghvendar, S., Sahani, M. S. (2005). Value added camel milk products. National seminar on value added dairy products. Available at: http://www.dairysociety.org/pdf/Souvenir_Seminar.pdf
28. Buchilina, A., Aryana, K. (2021). Physicochemical and microbiological characteristics of camel milk yogurt as influenced by monk fruit sweetener. Journal of Dairy Science, 104 (2), 1484–1493. doi: https://doi.org/10.3168/jds.2020-18842
29. Atwaa, E., Hassan, M. A. A., Ramadan, M. (2020). Production of Probiotic Stirred Yoghurt from Camel Milk and Oat Milk. Journal of Food and Dairy Sciences, 11 (9), 259–264. doi: https://doi.org/10.21608/jfds.2020.118366
30. Kamal-Eldin, A., Alhammadi, A., Gharsallaoui, A., Hamed, F., Ghnimi, S. (2020). Physicochemical, rheological, and micro-structural properties of yogurts produced from mixtures of camel and bovine milks. NFS Journal, 19, 26–33. doi: https://doi.org/10.1016/j.nfs.2020.05.001
31. Chen, C., Wang, P., Zhang, N., Zhang, W., Ren, F. (2019). Improving the textural properties of camel milk acid gel by treatment with trisodium citrate and transglutaminase. LWT, 103, 53–59. doi: https://doi.org/10.1016/j.lwt.2018.12.063
32. Raghvendar, S., Sahani, M. S., Tuteja, F. C., Aminnudeen, Ghorui S. K. (2006). Camel milk Skin cream. Technical Bulletin. Publisher National Research Center on Camel, Bikaner, India, 9–14.
33. Nanda, D. K., Tomar, S. K., Singh, R., Mal, G., Singh, P., Arora, D. K. et. al. (2011). Phenotypic and genotypic characterisation of Lactobacilli isolated from camel cheese produced in India. International Journal of Dairy Technology, 64 (3), 437–443. doi: https://doi.org/10.1111/j.1471-0307.2011.00695.x
34. Nantapo, C. T. W., Muchenje, V., Hugo, A. (2014). Atherogenicity index and health-related fatty acids in different stages of lactation from Friesian, Jersey and Friesian×Jersey cross cow milk under a pasture-based dairy system. Food Chemistry, 146, 127–133. doi: https://doi.org/10.1016/j.foodchem.2013.09.009
35. Martinie, G. D., Schilt, A. A. (1976). Wet oxidation efficiencies of perchloric acid mixtures for various organic substances and the identities of residual matter. Analytical Chemistry, 48 (1), 70–74. doi: https://doi.org/10.1021/ac60365a032
36. Csapó, J., Albert, C., Prokisch, J. (2017). The role of vitamins in the diet of the elderly I. Fat-soluble vitamins. Acta Universitatis Sapientiae, Alimentaria, 10 (1), 127–145. doi: https://doi.org/10.1515/ausal-2017-0009

37. Protein and amino acid requirements in human nutrition: report of a joint FAO/WHO/UNU expert consultation (2002). WHO. Available at: https://apps.who.int/iris/handle/10665/43411
38. Attia, H., Kherouatou, N., Nasri, M., Khorchani, T. (2000). Characterization of the dromedary milk casein micelle and study of its changes during acidification. Lait, 80 (5), 503–515. doi: https://doi.org/10.1051/lait:2000141
39. Hassan, R. A., El Zube, I. E. M., Babiker, S. A. (2007). Effect of pasteurization of raw camel milk and storage temperature on the chemical composition of fermented camel milk. International Journal of Dairy Science, 2 (2), 166–171. doi: https://doi.org/10.3923/ijds.2007.166.171
40. Hattem, H. E., Manal, A. N., Hanna, S. S., Elham, A. A. (2011). A study on the effect of thermal treatment on composition and some properties of camel milk. Slovak Journal of Animal Science, 44, 97–102.
41. Samout, N., Bouzenna, H., Dhibi, S., Ncib, S., ElFeki, A., Hfaiedh, N. (2016). Therapeutic effect of apple pectin in obese rats. Biomedicine & Pharmacotherapy, 83, 1233–1238. doi: https://doi.org/10.1016/j.biopha.2016.08.038
42. Nara, K., Yamaguchi, A., Maeda, N., Koga, H. (2009). Antioxidative Activity of Water Soluble Polysaccharide in Pumpkin Fruits (Cucurbita maximaDuchesne). Bioscience, Biotechnology, and Biochemistry, 73 (6), 1416–1418. doi: https://doi.org/10.1271/bbb.80529
43. Wang, J., Hu, S., Nie, S., Yu, Q., Xie, M. (2016). Reviews on Mechanisms of In Vitro Antioxidant Activity of Polysaccharides. Oxidative Medicine and Cellular Longevity. 2016, 1–13. doi: https://doi.org/10.1155/2016/5692852
44. Saura-Calixto, F. (2011). Dietary Fiber as a Carrier of Dietary Antioxidants: An Essential Physiological Function. Journal of Agricultural and Food Chemistry, 59 (1), 43–49. doi: https://doi.org/10.1021/jf1036596
45. Cencič, A., Langerholc, T. (2010). Functional cell models of the gut and their applications in food microbiology — A review. International Journal of Food Microbiology, 141, S4–S14. doi: https://doi.org/10.1016/j.ijfoodmicro.2010.03.026
46. Faye, B., Konuspayeva, G., Bengoum, M. (2019). Vitamins of camel milk: a comprehensive review. Journal of Camelid Science, 12, 17–32. Available at: https://agritrop.cirad.fr/595190/1/595190.pdf