Physicochemical profiling of traditional Kyrgyz Chobogo

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Abstract. *This study aims to perform the first comprehensive physicochemical and nutritional characterisation of chobogo, a traditional dairy byproduct with nomadic roots in Kyrgyz food culture. Although it is increasingly popular and commonly consumed in Kyrgyz households, chobogo has remained scientifically undocumented and unregulated in terms of food safety and composition. Validated analytical methods were used to assess its acidity, macronutrient content, and fatty acid and amino acid profiles. The results indicate that chobogo is an energy-rich product with a balanced nutritional composition, containing essential and conditionally essential amino acids, as well as a favourable profile of dietary fats. Its overall characteristics suggest potential health benefits when consumed in moderation, particularly for individuals with high energy needs. These findings provide a scientific foundation for the standardisation and safe use of chobogo in modern food systems. The data also support its potential for industrial production as a culturally significant and functionally valuable dairy ingredient, contributing to the sustainable valorisation of traditional dairy byproducts.*

Introduction and objective

Dairy products have long served as a fundamental source of nutrition for many cultures worldwide, offering essential macro- and micronutrients that support human health (Mehwish et al., 2023). In Central Asian countries with hot and dry climates, milk fat was traditionally preserved in the form of clarified butter; in Kyrgyzstan, this product is known as Sary-Mai. It is valued for storage and transport, especially during summer migrations to highland pastures, where herding families spend months without access to industrial foods or refrigeration. In recent years, renewed interest in national cuisine has increased and Sary-Mai has regained popularity as a culturally significant and energy-rich food.

As Sary-Mai production increases, so does the quantity of its byproduct – chobogo. This dense, mildly sweet dairy residue is formed during the melting of cream. Although official data on its production are lacking, household use of chobogo is expanding. Other dairy byproducts, such as buttermilk and whey, are well-recognised for their nutritional value and have been increasingly valorised through their incorporation into food, pharmaceutical, cosmetic, and veterinary applications (Hameed et al., 2023). chobogo, composed primarily of coagulated milk solids, also holds nutritional potential as a traditional byproduct. Its valorisation aligns with modern sustainability trends in agri-food systems (Khalid et al., 2024; Tahir et al., 2023).

In Kyrgyz nomadic tradition, chobogo is consumed on its own, particularly by children and herders, due to its high energy content. However, despite its growing consumption, no food safety standards currently regulate its production. This study aims to investigate the composition of chobogo to support future standardisation, safety evaluation, and exploration of its potential health benefits for diverse consumer groups.

Materials and methods

Materials

For the study, 100 litres of raw milk supplied to the Alaiku Organics dairy plant in Osh, Kyrgyzstan, were used. The milk from stall-fed cows had the following characteristics: fat content 3.6%, protein content 3.1%, lactose content 4.5%, SNF (solids-not-fat) 8.5%, total solids 12.1%, pH 6.7, and density 1.028 g/cm³. The milk had a yellowish straw hue and a characteristic milky taste without any extraneous odours. The temperature of the milk was 5°C, and it was delivered for processing on February 12, 2024.

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Production of Kyrgyz Chobogo

The raw milk was pre-cleaned of mechanical impurities using a nylon filter (UVMilk, Kyrgyzstan) with a pore size of 50 microns. The filtered raw milk was then pasteurised in a food-grade stainless steel vessel at a temperature of 65–70°C for 30 minutes to eliminate potential pathogenic microorganisms. The pasteurised milk was cooled to 45°C (Chebotarev et al., 2018) and sent to a separator (GEA MSE-500-01-777, Italy) for the extraction of high-fat cream. The freshly separated cream (3.42 kg) with a fat content of 68% was cooled to 5–7°C and left for 12 hours for cream ripening and fat crystallisation.

The ripened cream (3000 g) was slowly heated to 110–120°C with constant stirring. The subsequent stages of the process are shown in Fig. 1. These include melting the cream, evaporating residual water, coagulating proteins, and caramelising milk sugar. When the milk residue reached a light brown colour, heating was stopped. The melted liquid fat was strained through a fine sieve. The filtered milk fat is called Sary-Mai, and the light brown residue left on the filter is referred to as Kyrgyz chobogo. The final yield was 1820 g of Sary-Mai and 270 g of chobogo.

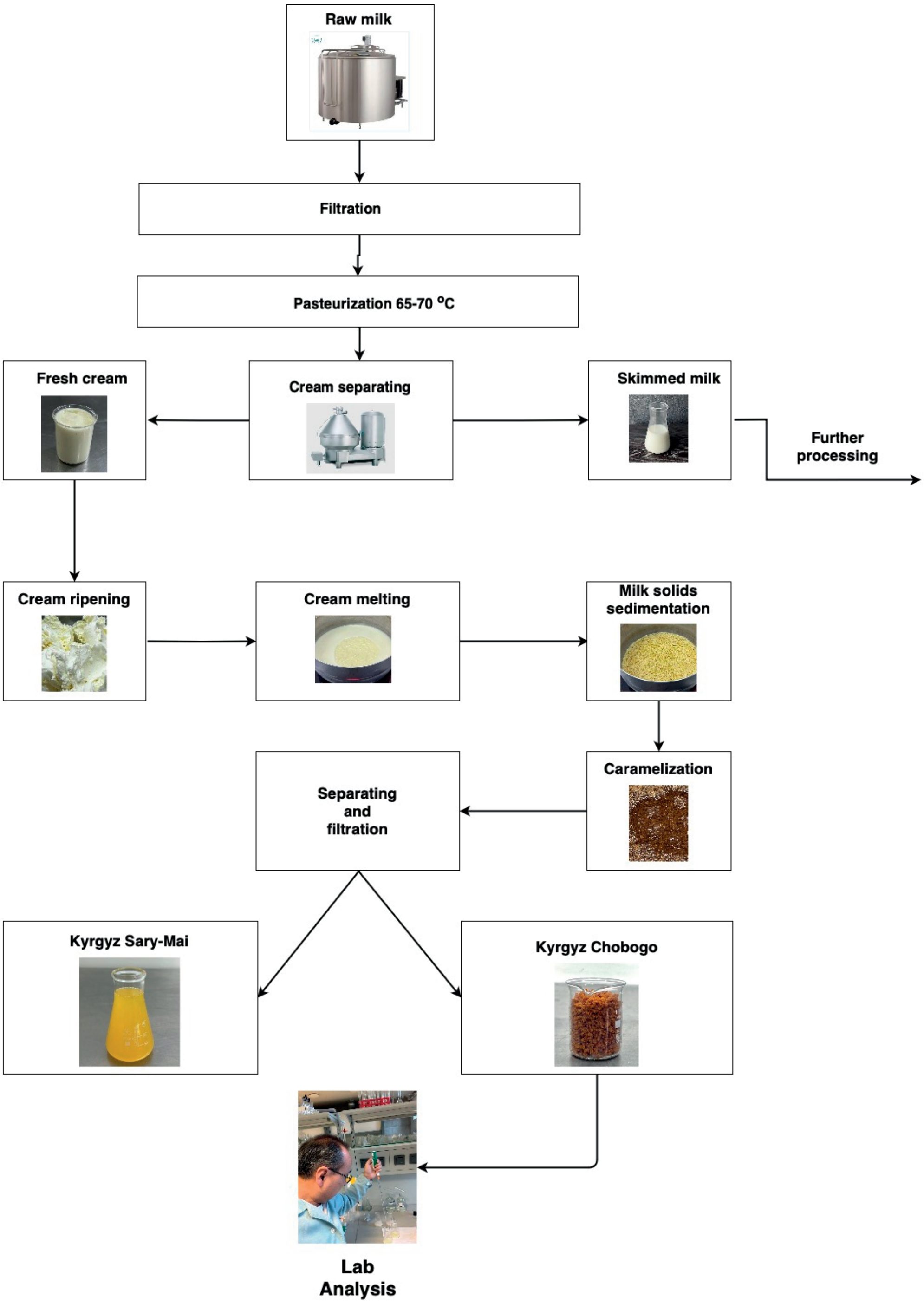

Fig. 1. Production scheme

Determination of physicochemical properties

Chobogo samples were analysed in triplicate for physicochemical and sensory parameters. pH measurements were conducted directly using a pH meter (Sartorius Professional meter for pH Measurement, Germany). Titratable acidity, expressed as a percentage of lactic acid (g/100 g chobogo), was determined according to ISO 11869:2012 standard method (*ISO/TS 11869:2012 – Fermented Milks — Determination of Titratable Acidity — Potentiometric Method*, 2012). Dry matter, moisture, acidity, ash, fat, and protein determinations were performed following prescribed methods: dry matter and moisture ISO 5534:2004c (*ISO 5534:2004 – Cheese and Processed Cheese — Determination of the Total Solids Content (Reference Method)*, 2004), ash AOAC, 2005 (*AOAC (2005) Official Method of Analysis. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24. – References – Scientific Research Publishing*, 2005), fat ISO 23319:2022 (*ISO 23319:2022 - Cheese and Processed Cheese Products, Caseins and Caseinates — Determination of Fat Content — Gravimetric Method*, 2022), lactose ISO 22662:2024 (*ISO 22662:2024 – Milk and Milk Products — Determination of Lactose Content by High-Performance Liquid Chromatography (Reference Method)*, 2024), and protein ISO 8968-3:2004b (*ISO 8968-3:2004 – Milk — Determination of Nitrogen Content — Part 3: Block-Digestion Method (Semi-Micro Rapid Routine Method)*, 2004).

Colour characteristics were assessed using a CIE Lab* system (1996) with a Chromameter CR-400 (Konica Minolta, Tokyo, Japan), calibrated with a standard white plate. Total colour difference (ΔE) was calculated using the formula (Mileriene et al., 2021):

$$\Delta E = \sqrt{(L - L_0)^2 + (a - a_0)^2 + (b - b_0)^2},$$

where L_0, a_0, and b_0 were values of day 1 and L, a, b were the values measured throughout the storage period. Texture properties were evaluated using a texture analyser CT3 (Brookfield, USA) with TA4/1000 cylinder. The samples were compressed using a TA4/1000 cylindrical probe with a diameter of 38.1 mm (D), length of 20 mm (L), a penetration speed of 1 mm/s, and a penetration depth of 10 mm.

Determination of amino acid profile

The amino acid (AA) compositions of the samples were analysed via ultrafast liquid chromatography (UFLC) with automated o-phthalaldehyde (OPA)/9--fluorenylmethyl chloroformate (FMOC)/Mercapto-propionic Acid (MERC) derivatisation. Standard solutions of the amino acids including alanine, aspartic acid, arginine, cystine, glycine, valine, leucine, isoleucine, threonine, serine, proline, methionine, glutamic acid, phenylalanine, lysine, histidine, tyrosine, asparagine, and tryptophan were used for this analysis (A9781 Sigma-Aldrich, Germany).

To commence the analysis, each sample (approx. 0.4 g) underwent hydrolysis with 25 mL of 6 M HCl for 24 hours at 103°C. The resultant contents were quantitatively transferred into a 250 mL beaker using a 150–200 mL solution of 0.2 mol Na+/L, pH 2.20 trisodium citrate dihydrate. The resulting hydrolysate was partially neutralised by the gradual addition of 17 mL of 7.5 N sodium hydroxide solution while stirring continuously, ensuring the temperature remained below 40°C (in a cold-water bath). The pH was adjusted to 2.20 at room temperature using sodium hydroxide solution (7.5 N).

Before injection, all samples were filtered through 0.45-µm filters. The amino acids were separated using a UHPLC column YMC-Triart C18 (1.9 µm, YMC co. ltd.) on a UFLC instrument (Shimadzu, Japan), which was equipped with a fluorescence detector RF-20Axs and a pre-treatment function equipped automatic injector SIL-30AC (Shimadzu, Japan). The analytical conditions were as follows: mobile phase consisting of solvent A (20 mmol/L potassium phosphate buffer, pH 6.5) and solvent B (45/40/15 acetonitrile/methanol/water); flow rate set at 0.5 mL/min; column temperature maintained at 45°C; detection wavelengths: RF-20Axs Ex. at 350 nm, Em. at 450 nm to Ex. at 266 nm, Em. at 305 nm (9.0 min). A calibration set comprising five levels was utilised, covering a concentration range of 9.375–150.00 µmol/L, except for cysteine covering a concentration range of 8.08–75.00 µmol/L.

Fatty acid profile

The analysis for the identification and quantification of fatty acids (FA) was conducted via gas chromatography utilising a capillary column and flame-ionisation detection. Initially, FA were extracted from a 2 g sample using 15 mL of n-hexane (Chempur, Poland), followed by methylation with anhydrous KOH methanol solution to yield methyl esters, following the protocol outlined in ISO 12966–2:2017 (*ISO 12966-2:2017 – Animal and Vegetable Fats and Oils — Gas Chromatography of Fatty Acid Methyl Esters — Part 2: Preparation of Methyl Esters of Fatty Acids*, 2017).

The analysis of FA methyl esters was carried out using a Shimadzu GC-2010 gas chromatograph (Shimadzu Kyoto, Japan) equipped with a flame ionisation detector (FID) and a 100 m column Restek Rt-2560, with a diameter of 0.25 µm and thickness of 0.20 µm, as specified in 12966-4:2015 (*ISO 12966-4:2015 – Animal and Vegetable Fats and Oils — Gas Chromatography of Fatty Acid Methyl Esters — Part 4: Determination by Capillary Gas Chromatography*, 2015). Chromatographic peaks were identified by comparing retention times with a mixture of Supelco 37 Component FAME Mix reagent kit (Supelco Analytical Bellefonte, PA, USA).

The analytical conditions were as follows: a volume of 1 µL was injected, the column temperature was initially set at 100°C for 4 minutes, then ramped up to 240°C at a rate of 13°C/min and maintained for 63 minutes. The injector temperature was set at 250°C and the detector temperature at 300°C. Nitrogen was employed as the carrier gas.

Each fatty acid was expressed in g/100 g of total fatty acid content. Fatty acids were categorised according to their degree of saturation and the number of double bonds into saturated fatty acids (SFA), unsaturated fatty acids (UFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), omega-3 fatty acids (n3PUFA) and omega-6 fatty acids (n6PUFA). Health lipid indices indicating the quality for pro-atherogenicity, pro-thrombogenicity, and risk of cardiovascular issues were assessed as follows (Pilarczyk et al., 2015):

Index of atherogenicity $(AI) = \frac{C12{:}0+(4*C14{:}0)+C16{:}0}{PUFA+MUFA}$;

Index of thrombogenicity $(TI) =$

$$= \frac{C12{:}0+C16{:}0+C18{:}0}{0.5*MUFA+0.5*n6PUFA+3*n3PUFA+\frac{n3PUFA}{n6PUFA}};$$

Hypocholesterolemic and hypercholesterolemic ratio $(h/H) = \frac{C18{:}1+PUFA}{C14{:}0+C16{:}0}$;

Desirable fatty acids $= UFA + C18{:}0$.

Determination of sensory profile

Sensory analysis was conducted by a trained panel of 7 members, following ISO 8586:2023 guidelines (*ISO 8586:2023 – Sensory Analysis — Selection and Training of Sensory Assessors*, 2023), using a scorecard designed according to the specific attributes of the product being evaluated. The scorecard included criteria such as appearance, aroma, texture, flavour, and overall acceptability, with each attribute rated on a structured scale ranging from 1 (poor) to 10 (excellent) (*ISO 4121:2003(En), Sensory Analysis — Guidelines for the Use of Quantitative Response Scales*, 2003). Panelists were provided with detailed definitions for each sensory attributes to ensure consistency and minimise bias. Evaluations were conducted under controlled conditions, including standardised lighting, temperature, and serving procedures, to ensure reliable and reproducible results. Statistical analysis was performed on the collected data to determine significant differences between samples, employing ANOVA and post-hoc tests as appropriate.

Determination of microstructure by scanning electron microscopy (SEM)

The morphology of the coating and film was analysed using a "Mira3" scanning electron microscope (SEM) manufactured by Tescan Orsay Holding, a.s. (Brno-Kohoutovice, Czech Republic). Samples were manually cut into pieces measuring 0.4 × 0.4 cm with a surgical-grade knife and mounted onto a 51 mm diameter silicon wafer (MicrotoNano, Haarlem, The Netherlands) without the use of double-sided adhesive carbon discs. Silicon was chosen as the substrate because of its high prevalence of CHON elements in organic samples, which helps minimise potential bias in the results and improves the signal-to-noise ratio. The SEM was operated in high vacuum mode with backscattered electron (BSE) and secondary electron (SE) detectors. Magnification was increased to 1.0 kx to ensure precise dimensional measurements and analysis of element composition, using a 5 kV acceleration voltage.

Statistical analysis

All analytical measurements (physicochemical parameters, composition indicators, amino acid and fatty acid profiles, as well as sensory scores) were performed in triplicate (n = 3). Results are expressed as mean values with standard deviation (mean ± SD). Data processing was carried out using the SPSS statistical package (SPSS Inc., version 24, Chicago, IL, USA).

Since the present study investigates a single production batch of chobogo without comparative treatment groups, statistical analysis was limited to descriptive statistics aimed at evaluating measurement repeatability and within-sample variation. Inferential statistical tests were not applied. A significance level of α = 0.05 is reported for reference in future comparative studies.

Results

Physicochemical profile

Titratable acidity and pH

The acidity and pH of the chobogo sample are presented in Table 1. The titratable acidity was measured at 0.15 ± 0.01 g/100 g, while the product exhibited a pH of 5.49 ± 0.02, indicating a slightly acidic environment. These acid-base properties are typical for high-fat dairy matrices obtained through heat clarification. A low variation between replicates demonstrates good measurement repeatability.

The relatively low pH, combined with a modest titratable acidity value, suggests that the product retains a mild acidic profile characteristic of concentrated dairy systems. Such acidity may influence flavour perception, colour formation, and overall shelf stability — aspects relevant for traditional products like chobogo.

Table 1. Physicochemical parameters and colour values

Parameter	Mean ± St. Deviation
Titratable acidity, g/100 g	0.15 ± 0.01
pH	5.49 ± 0.02
CIELAB colour results:	
L*	36.5 ± 0.8
a*	10.2 ± 0.3
b*	22.4 ± 0.5
c*	24.4 ± 0.6
h*	65.3 ± 1.2

Colour profile

The spectrophotometric CIELAB analysis (Table 1) revealed that chobogo had a moderately dark brown colour typical for heat-treated dairy solids. The L* value of 36.5 ± 0.8 indicates low lightness, a* of 10.2 ± 0.3 reflects a reddish tone, and b* of 22.4 ± 0.5 confirms a strong yellow component. Together with c* (24.4 ± 0.6) and h* (65.3 ± 1.2), this profile corresponds to a saturated warm brown hue. Low standard deviations across colour metrics indicate high visual uniformity within the batch.

Microstructure

The SEM micrographs obtained at 1000× magnification (Fig. 2) reveal a heterogeneous microstructure characteristic of sediments formed during Sary-Mai clarification. The surface appears uneven, consisting of alternating depressions and elevations, while the internal morphology demonstrates a porous network with micropores of varying size and shape. Peak-like crystalline formations and dense clusters are observed, along with occasional microcracks and ruptures, indicating structural heterogeneity.

The presence of pores, aggregated clusters, and fractured regions suggests a complex spatial organisation of proteins, lipids, and mineral residues within the sediment matrix.

Sensory profile

A descriptive sensory evaluation was conducted by trained panelists using standardised methodology to assess the organoleptic properties outlined by (Lawless & Heymann, 2010). The outcomes are summarized in Table 2.

Panelists described chobogo as having a dense, rich texture and oily mouthfeel, with noticeable sour and roasted aroma nuances. The taste was perceived as balanced, combining mild sweetness, sourness, and a lasting aftertaste. Low to moderate standard deviations across parameters indicate consistent perception among assessors and reproducibility of results within this batch.

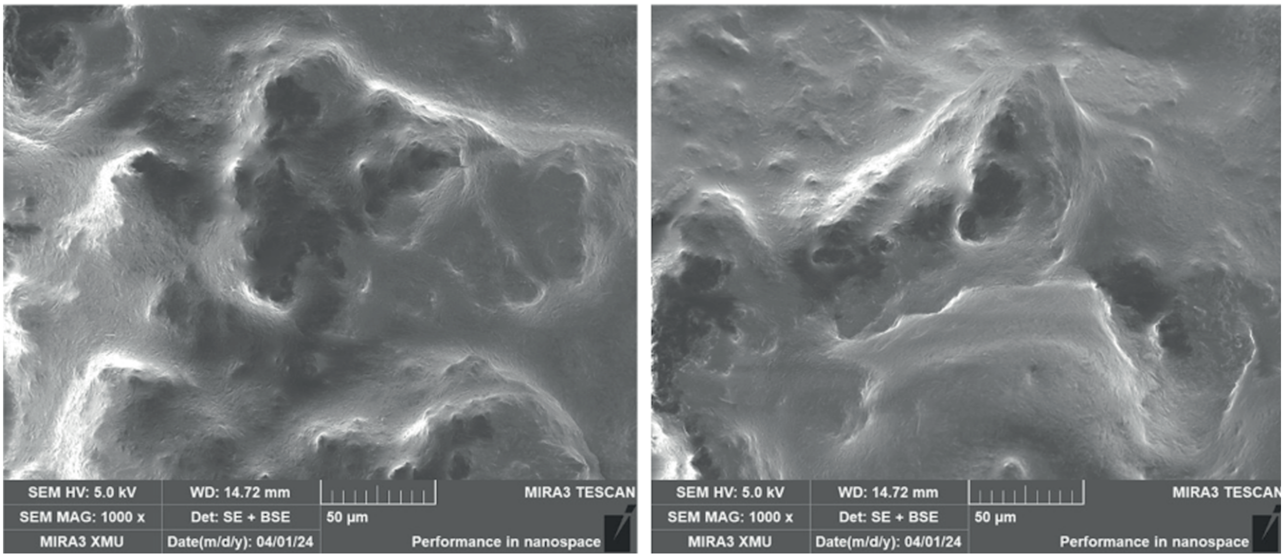

Fig. 2. SEM pictures

Table 2. Sensory profile of chobogo

Descriptive	Mean ± St. Deviation, units
Colour	7.30 ± 1.72
Texture	7.70 ± 1.41
Overall smell	7.30 ± 1.36
Roasted smell	7.10 ± 1.57
Sour smell	8.20 ± 1.72
Overall taste	6.90 ± 0.75
Consistency	7.86 ± 1.87
Oiliness	8.10 ± 0.84
Sweetness	7.20 ± 1.09
Aftertaste	7.10 ± 1.20
Acceptability	8.50 ± 0.84

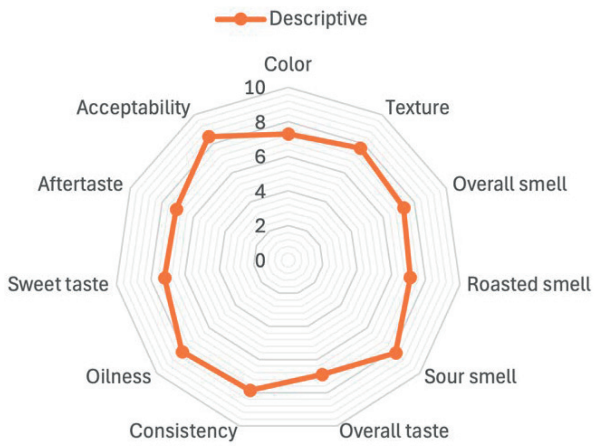

Fig. 3. Sensory profile visualisation of chobogo

Table 3. Composition and energy value of Kyrgyz chobogo

	Dry matter, g/100g	Fats, g/100g	Proteins, g/100g	Ash, g/100g	Carbohydrates, g/100g	Energy value, kCal
Chobogo	90.99 ± 0.10	53.10 ± 0.06	11.93 ± 0.01	2.36 ± 0.05	23.60 ± 0.10	620.0 ± 1.0

Fig. 3 illustrates the distribution of sensory intensities, demonstrating a relatively uniform profile across most evaluated attributes, with high acceptance scores.

Nutritional composition

Composition and energy value

The composition of chobogo is summarised in Table 3. The product contains 90.99 ± 0.10 g/100 g of dry matter, with fats accounting for 53.10 ± 0.06 g/100 g, proteins 11.93 ± 0.01 g/100 g, carbohydrates 23.60 ± 0.10 g/100 g, and ash 2.36 ± 0.05 g/100 g. The resulting energy value is 620.0 ± 1.0 kCal/100 g, indicating a highly concentrated nutritional profile. Low SD values confirm consistency of analytical measurements and stable composition within this batch.

The macronutrient distribution suggests that chobogo is a dense dairy product with high fat and moderate protein content, accompanied by residual carbohydrates and minerals originating from cream.

Amino acid profile

The amino acid composition of chobogo is shown in Table 4. The product contains a broad spectrum of amino acids, including non-essential, conditionally essential, and essential groups.

Among non-essential amino acids, glutamic acid (2.10 ± 0.14 µmol/L) and aspartic acid (0.95 ± 0.07 µmol/L) were predominant, while serine and alanine were present in smaller amounts. Conditionally essential amino acids such as glycine, arginine, tyrosine, cysteine, and proline were detected in moderate concentrations. Chobogo also contained all essential amino acids, with leucine being the most abundant.

Low variation across triplicates indicates reliable quantification and analytical precision.

Fatty acid profile

The fatty acid composition of chobogo is shown in Table 5. Saturated fatty acids (SFAs) were predominant, accounting for 68.85 ± 0.10%, with C16:0 (29.74 ± 0.02%), C18:0 (11.29 ± 0.01%), and C14:0 (11.07 ± 0.01%) being the major contributors. Short-chain SFAs such as C4:0 (3.77 ± 0.11%) and C6:0 (2.24 ± 0.02%) were also present.

Unsaturated fatty acids made up 31.13%, primarily MUFAs (25.50 ± 0.07%), dominated by oleic acid C18:1 (22.39 ± 0.04%), while PUFAs contributed 2.92 ± 0.03%, including C18:2 ω6 (2.23 ± 0.01%) and C18:3 ω3 (0.31 ± 0.00%). Natural trans fatty acids were detected at 2.71 ± 0.01%, mainly C18:1 trans and C18:2 trans.

Health-related lipid indices were calculated as AI = 2.71, TI = 2.86, h/H = 0.35, DFA = 42.41, and the omega-6/omega-3 ratio was 5.94 ± 0.06. Low standard deviations across most fatty acids indicate good analytical repeatability.

Discussion

This study provides the first detailed characterisation of traditional Kyrgyz chobogo, revealing how thermal clarification and concentration processes shape its physicochemical, microstructural, sensory, and nutritional properties.

Physicochemical properties: acidity and pH

The titratable acidity of 0.15 g/100 g (as lactic acid) falls within the expected range for non-fermented high-fat dairy products (typically 0.14–0.18 g/100 g),

Table 4. Amino acid composition in chobogo

	Non-essential				
Amino acids	Aspartic acid	Glutamic acid	Serine	Alanine	
µmol/L	0.95 ± 0.07	2.10 ± 0.14	0.58 ± 0.04	0.35 ± 0.02	
	Cond. Essential				
Amino acids	Glycine	Arginine	Tyrosine	Cysteine	Proline
µmol/L	0.4 ± 0.01	0.38 ± 0.02	0.44 ± 0.03	0.28 ± 0.04	0.22 ± 0.01
	Essential				
Amino acids	Histidine	Threonine	Valine	Methionine	Phenylalanine
µmol/L	0.23 ± 0.02	0.56 ± 0.04	0.48 ± 0.02	0.31 ± 0.05	0.49 ± 0.02
		Isoleucine	Leucine	Lysine	
		0.47 ± 0.01	0.96 ± 0.03	0.39 ± 0.08	

Table 5. Composition of fatty acids

Group	Fatty acid	Content (Mean ± SD)
Short-chain (SCFA)	C4:0	3.77 ± 0.11
	C6:0	2.24 ± 0.02
	C8:0	1.25 ± 0.01
Medium-chain (MCFA)	C10:0	2.71 ± 0.01
	C12:0	3.10 ± 0.01
Long-chain (LCFA)	C14:0	11.07 ± 0.01
	C15:0	1.30 ± 0.00
	C16:0	29.74 ± 0.02
	C17:0	0.86 ± 0.00
	C18:0	11.29 ± 0.01
MUFA	C14:1	0.89 ± 0.00
	C16:1	1.81 ± 0.01
	C18:1	22.39 ± 0.04
	Other MUFA	0.14 – 0.26*
PUFA ω6	C18:2	2.23 ± 0.01
	Other ω6	0.01 – 0.15*
PUFA ω3	C18:3 α	0.31 ± 0.00
	Other ω3	0.03 – 0.08*
Trans fatty acids	C18:1 tr.	2.57 ± 0.01
	C18:2 tr.	0.14 ± 0.00
	Total TFA	2.71 ± 0.01
Total groups	SFA	68.85 ± 0.10
	MUFA	25.50 ± 0.07
	PUFA	2.92 ± 0.03
	Omega-6/Omega-3	5.94 ± 0.06
	AI	2.71 ± 0.01
	TI	2.86 ± 0.01
	h/H	0.35 ± 0.00
	DFA	42.41 ± 0.12

*Minor fatty acids (< 1%) are grouped and presented as summary values.

indicating the absence of fermentation. The acidity likely reflects the intrinsic properties of the raw cream and minor acid development during heat treatment (Schmidt et al., 1996).

The pH value of 5.49 is lower than that of typical cream (pH 6.4–6.7), which may be attributed to partial disruption of milk buffering systems during heating (Aydogdu et al., 2023), the presence of lactic acid and its salts (Rafiee Tari et al., 2021), and concentration of acidic compounds. Lower pH despite similar acidity suggests redistribution of components during clarification, influencing acid-base balance. These properties correspond to thermal concentration behaviour of dairy systems. However, as only one batch was examined, generalisation requires additional replication.

Colour development during heating

Colour development was consistent with controlled thermal processing. Heating below 130°C induces Maillard reactions and lactose caramelisation, forming a brown hue without burning. This explains the moderate L* value and the shift toward red-yellow tones (a* and b*), similar to thermally-treated dairy residues reported by (Chudy et al., 2020). Concentration of solids during clarification enhances chroma and hue saturation.

Microstructure evolution under heat treatment

The porous morphology observed (SEM) may result from protein denaturation and coagulation during heating (El-Bakry et al., 2018), accompanied by whey-protein release and casein micelle disruption (Kamigaki, 2020). Peak-like aggregates are likely linked to crystallisation of calcium phosphate and residual fats, while microcracks suggest dehydration and structural breakdown under thermal stress. The combination of smooth and irregular regions reflects redistribution of proteins, fats, and minerals. These microstructural traits align with previously described heat-treated dairy matrices (Rovira et al., 2011) and explain functional behaviour during processing. The observed structure supports potential applications in reprocessing, ingredient development, and culinary uses.

Nutritional composition and energy density

Chobogo presented a highly concentrated energy profile dominated by fat (53.10 g/100 g), resulting in 620 kcal/100 g. Similar concentration-based nutrient enhancement has been reported in processed dairy systems (Rinaldi et al., 2023). While high saturated fat intake requires moderation, such energy-dense foods historically served nomadic communities with high physical demands. Fat also transports vitamins A, D, E, and K, improving micronutrient delivery (Palacios and Gonzalez, 2014). Proteins (11.93 g/100 g) may support metabolic and structural functions, and heat treatment may enhance digestibility (Wada and Lönnerdal, 2014). Residual lactose provides short-chain energy, while minerals present in the ash fraction contribute to dietary mineral intake (Górska-Warsewicz et al., 2019).

Amino acid availability and functional relevance

Chobogo retained a broad spectrum of essential, conditionally essential, and non-essential amino acids, indicating preserved protein value (Asif et al., 2022). Glutamic and aspartic acids dominated the non-essential group, contributing to umami characteristics and nitrogen metabolism (Alencar et al., 2024). Conditionally essential amino acids – including arginine, tyrosine, cysteine, proline – support immune function and tissue repair (Arribas-López et al., 2021). Leucine was the most abundant essential amino acid, relevant for protein synthesis and energy regulation (Rahman et al., 2022). Thermal processes can retain digestibility depending on conditions (Wang et al., 2024), supporting the nutritional potential of Chobogo.

Fatty acid balance and lipid indices

The fatty acid profile was dominated by SFAs (68.85%), notably palmitic, stearic, and myristic acids. Despite associations between high SFA intake and cardiovascular risk, these lipids support membrane structure and energy metabolism (Mensink, 2016). Short-chain fatty acids like butyric and caproic may aid gut health and immunity. MUFAs (25.50%), primarily oleic acid, contribute to cardioprotective effects (Micha et al., 2017), while PUFAs (2.92%) regulate inflammation. The ω6/ω3 ratio (5.94) falls within recommended limits (Calder and Development, 2020). Natural trans fatty acids (2.71%) align with traditional dairy profiles (Taormina et al., 2024). Lipid indices (AI = 2.71; TI = 2.86; h/H = 0.35; DFA = 42.41) reflect moderate metabolic impact.

Integrated interpretation

Together, the results demonstrate that Chobogo is a high-energy traditional dairy product with preserved amino acid diversity, a structured lipid profile, and a characteristic microstructure developed through thermal treatment. The balance of saturated and unsaturated fatty acids, presence of functional short-chain lipids, and nutrient-dense composition highlight its potential as a culturally relevant food with both historical and modern dietary significance.

Limitations and future perspectives

As analysis was conducted on a single production batch, variation related to seasonality, raw material quality, and processing conditions remains to be evaluated. Future research should incorporate multiple batches, shelf-life evaluation, digestibility studies, and consumer acceptance trials to validate broader applicability.

Conclusion

Chobogo is a culturally significant yet scientifically understudied byproduct of cream clarification. Despite its traditional relevance and increasing consumption, it has lacked regulatory standards, safety documentation, and analytical characterisation. This study provides the first comprehensive dataset describing its physicochemical properties, amino acid and fatty acid composition, sensory attributes, and microstructure, thereby addressing a notable research gap in dairy byproduct valorisation.

Chobogo demonstrated a high dry matter (90.99 g/100 g), elevated energy value (620 kcal/100 g), and substantial fat content (53.10 g/100 g), with proteins (11.93 g/100 g) contributing a complete spectrum of essential and conditionally essential amino acids. The lipid fraction was dominated by saturated and monounsaturated fatty acids, accompanied by a balanced ω6/ω3 ratio (5.94), moderate AI (2.71) and TI (2.86), and low natural trans-fat levels. Sensory evaluation indicated positive acceptability, while SEM analysis revealed a porous crystalline microstructure shaped by thermal concentration.

These findings indicate that chobogo is not only a traditional high-energy food but also a promising candidate for functional and value-added dairy applications, particularly within sustainable and zero-waste processing frameworks. To advance its utilisation, future work should focus on multi-batch variability, shelf-life behaviour, consumer perception across different demographic groups, and nutritional functionality in vivo. Establishing standardised processing guidelines and quality parameters could facilitate its integration into modern dairy production without compromising its cultural authenticity.

Declarations and acknowledgements

Ethics approval and consent to participate

The study was carried out in compliance with the European Union and Lithuanian legal acts regulating scientific research.

This study was approved by the Technological Institute of the Kyrgyz State Technical University Named after I. Razzakov (Approval No. 2024-CCO-EBC-V-017). All participants provided informed consent before participation.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare no conflict of interest.

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Credit authorship contribution statement

Askarbek Mametjanov: Investigation, Conceptualization, Formal analysis, Data curation, Writing – Original draft. **Mukarama Musulmanova:** Conceptualization, Funding acquisition. **Lina Lauciene:** Formal analysis, Data curation, Writing. **Kristina Kondrotiene:** Formal analysis, Data curation, Writing. **Vitalijs Radenkovs:** Formal analysis, Data curation, Writing. **Sandra Kiselioviene:** Formal analysis, Data curation, Writing. **Alvija Šalaševičienė:** Formal analysis, Data curation, Writing. **Adele Askarbekova:** Writing – review and editing. **Loreta Serniene:** Investigation, Conceptualization, Formal analysis, Data curation, Writing – review and editing. All authors read and approved the final manuscript.

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