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Effect of different production methods on quality parameters of Hatay Künefe cheese

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Research Article

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Abstract

We investigated four different production methods of Künefe cheese, emphasizing their industrial importance. The four methods used fresh Künefe cheese (FKC), salted Künefe cheese (SKC), Boru type Künefe cheese (BKC) and culture-added processed Künefe cheese (CPKC), all used in the production of Künefe, a syrupy dessert unique to the Middle East. FKC was produced as a result of curd formation from raw milk with rennet and then the fermentation of curd. SKC was manufactured using the salting method in addition to FKC production. BKC was obtained using the dry cooking process with emulsifying salts applied to cheese curd. CPKC was produced by applying heat treatment to raw milk and using starter culture before adding rennet that was different to Boru-type Künefe cheese. The composition, color, meltability, texture and sensory properties of the Künefe cheeses were examined. As a result of statistical analysis, it was determined that the effect of different production methods on the composition, meltability, texture (except springiness and cohesiveness) and sensory properties was significant in all cheeses ($P < 0.05$). CKPC was the most appropriate cheese in various properties.

Traditional dairy products, especially cheese, have an important place in the food culture of rural areas (Karaca and Kırdar, 2016; Güzeler *et al*., 2022). Traditional cheeses are among the most diverse dairy products. This diversity may result from using different types of milk as raw materials, the characteristics of the geographical region, technological applications, and the consumption of fresh or ripened cheese (Çayır *et al*., 2019). Hatay province is among the wealthiest cuisines in Türkiye. Künefe cheese, a dairy product, is used in the production of Künefe dessert, which is a special dessert produced by Tel Kadayıf (a sweet pastry with a texture like that of shredded phyllo dough) and one of the local tastes of Hatay province (Karaca and Ocak, 2016; Güzeler and Kılınçlı, 2018; Aslan Günay, 2019).

It has been reported that four different production methods are applied in the production of Künefe cheese in Hatay province (M. S. Çayır, personal communication). These are fresh Künefe cheese, salted Künefe cheese, Boru type Künefe cheese, and culture-added processed Künefe cheese (Güzeler *et al*., 2019). Fresh Künefe cheese (unsalted Antakya cheese for Künefe) does not contain salt, so its shelf life is limited to a few days depending on the storage temperature. Salted Künefe cheese (salted Antakya cheese for Künefe) is produced with a high salt content; its shelf life can be up to six months at room temperature and up to one year in refrigerated conditions. This cheese is used in Künefe dessert after it is kept in potable water for about 24 h by changing the water a few times, and the salt is completely removed. Both types of cheese are not consumed raw but are used only for preparing the Künefe dessert (TPE, 2018).

Boru-type Künefe cheese is dry-cooked by incorporating emulsifying salts into the curd (Esen and Güzeler, 2023). The primary purpose of using melting salts in the production of this cheese is to prevent the loss of curd (by simply flowing away) and allowing the cheese to creep better. Additionally, heat treatment (dry cooking) of the curd extends cheese storage by preventing the inclusion of pathogenic microorganisms (Esen, 2021). Another type is processed Künefe cheese with the addition of a starter. The heat treatment of raw milk and the use of the starter culture in the production of this cheese makes it different from other cheeses (M. S. Çayır & D. Taş, personal communication).

Recently, various studies have been carried out in many countries to transfer the production method of local traditional or artisan products to medium and small-scale enterprises. This is done to expand the product range, improve safety and contribute to the regional economy. However, the production of a wide range of local cheese varieties in various regions of Türkiye has not yet been realized at the commercial level, and the desired quality criteria has not been achieved (Karaca *et al*., 2008). We hypothesized that different production methods would affect the composition, color, meltability, texture and sensory attributes of Künefe cheeses. Accordingly, we examined four different production methods of Künefe cheese:

fresh Künefe cheese (FKC), salted Künefe cheese (SKC), Boru type Künefe cheese (BKC) and culture-added processed Künefe cheese (CPKC). All can be used in the production of Künefe, which has an important place among the traditional desserts of Türkiye. We investigated the physical, chemical, textural and sensory properties of the cheeses produced.

Materials and methods

Materials

Raw Holstein or Holstein/Friesian cow milk was supplied by Amik Milk Processing Plant (Hatay, Türkiye) for fresh (FKC) and salted (SKC) Künefe cheeses, by Eryılmaz Cheese Factory (Hatay, Türkiye) for Boru-type Künefe cheese (BKC) and by Çay Çiftlik Milk and Dairy Products Factory (Adana, Türkiye) for culture added processed Künefe cheese (CPKC). Cheese rennet (strength: 1/16.000 MCU/ml- 200 IMCU/ml, form: liquid, chymosin/pepsin ratio: ≥ 85/15) was obtained by Mysecoren (Maysa Gida, Istanbul, Türkiye). *Lactococcus lactis* subsp. *cremoris* and *Lactococcus lactis* subsp. *lactis* mesophilic cultures were used in the preparation of CPKC cheese (Chr. Hansen A/S, Hørsholm, Denmark). Refined rock salt was used only in the production of SKC (Zafer Salt, Adana, Türkiye). Dry cooking was accomplished using emulsifying salts that included different phosphate and citrate salt combinations (0.5% Kasomel 3112 and 0.5% Kasomel 2185, Maysa Gida, Istanbul, Türkiye). The packaging materials of the cheeses were obtained from Çekmez Plastik and Kağıtçılık Limited Company. The properties of packaging materials are provided in the online Supplementary File Table S1.

The manufacturing procedure of the cheeses and dessert

The production of each cheese was carried out at the dairy of milk origin as given above, all of which are located in the Çukurova region of South Anatolia, Türkiye. After the productions made with three replications, all cheeses were taken to the Dairy Technology Research Laboratory at Çukurova University, Faculty of Engineering, Department of Food Engineering (Adana, Türkiye) by cold chain and stored at 4 ± 1°C. A detailed account of the production methods is given in the online Supplementary File, materials and methods and flowchart Figures S1 and S2. In brief, the raw milk was first standardized for a fat content of 2.8% (FKC, SKC and CPKC) or 1.1% (BKC). Heat treatment to 33 ± 1 °C was applied to FKC, SKC, and BKC and each batch was then mixed with cheese rennet and left to curdle for around 40 min. The cheese curd was then cut and left to stand until the whey was drained. The pressed cheese curd was fermented for one to two hours to produce FKC. The pressed curd was separated into molds, packaged and stored at 4 ± 1 °C until analysis. For the production of SKC, the FKC curd was cut into 1 cm^3 dimensions and dry salted by adding approximately 3% of salt with resting for one day followed by ripening in 18% brine for one more day in cold storage. After removal from the brine the SKC was again dry salted at a rate of 0.3%, packaged and stored at + 4 °C. A portion of the FKC was put into the dry cooking machine for the BKC production, together with emulsifying salts, and the dry cooking process was carried out at 70 °C for 20 min followed by packaging and storage at + 4 °C. In CPKC production, milk was heat treated at 72 ± 1 °C for 20 s, cooled to 34 ± 1°C and 1 g/100 kg of starter culture was added followed by cheese rennet. After curdling for approximately 40 min the curd was cut into 2–3 cm^3 cubes and left to stand until the whey was drained. For 1–2 h, the cheese curd was fermented and when the pH reached 5.30–5.50, the curd was cut into blocks and cooked with the emulsifying salts in a dry cooking machine at 72–74°C for 20 min. The obtained cheese was shaped and weighed (500 g) after resting, then vacuum packed and stored at + 4°C. The production of Künefe desserts utilized the production method of Antakya Künefe, which received a Geographical Indication Registration Certificate from the Turkish Patent Institute (TPE, 2007). SKC was first de-salted, the other cheeses were used as prepared. 1 kg of Kadayıf dough was mixed with 300 g of butter and separated by hand and then pressed into oiled aluminum Künefe cups, to each of which 70 g of Künefe cheese was added. Then, 50 g of shredded phyllo dough was pressed to cover the Künefe cheese and cooked on low heat, inverted and cooked again. Finally, a hot syrup of water (60%), sugar (40%) and 3–4 drops of lemon juice was poured over the hot Künefe.

Sensory analysis

Since the raw milk used was processed into cheeses without heat treatment, sensory analysis was only done on the cooked Künefe desserts. Eleven trained panelists evaluated the cheeses in the prepared desserts according to the scoring method for texture (scale 0–5), appearance (scale 0–5), taste (scale 0–5), odor (scale 0–5), and overall acceptability (scale 0–20). The sensory assessment form used was modified from TS (1989) and Mutluer (2007).

Raw milk and whey analyses

Using a pH meter, the pH of whey and raw milk was measured (Model: WTW pH3110 Set 2 type; Weilheim, Germany). The alkali titration method was used to determine acidity, and the results were expressed as a percentage of lactic acid (TS, 2002). The gravimetric method (TS, 2002), the Gerber method (AOAC, 2005), and the Kjeldahl method (IDF, 2014) were used to calculate the total solid content, fat content, and protein content, respectively. The ash content of samples was determined according to the method specified in AOAC (1990).

Cheese analyses

Details of all of the analytical methods employed are given in the online Supplementary File. In brief, cheeses were analyzed for total solids and for contents of nitrogen, protein, fat, and salt, both on fresh samples and dry matter. According to Koçak (2007), cheese yield was measured as the amount of cheese (kg) manufactured from 100 kilograms of milk. The pH of the cheese was determined using a pH meter (Inolab pH 720, WTW GmbH, Weilheim, Germany) (Hannon *et al*., 2003). Colour properties were analyzed using a Chroma Meter (Minolta, model CR300, Minolta Camera Company, Osaka, Japan) and expressed in terms of L^*, a^*, and b^*. A TA.XTPlus Texture Analyser (Stable Micro Systems, Godalming, Surrey, UK) was used to examine the textural properties with data collection and calculation were done using the associated Stable Micro Systems software. Finally, the Poduval and Mistry (1999) method was used to determine meltability (Kahyaoğlu, 2002).

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Statistical analysis

SPSS statistics software's analysis of variance (ANOVA) was employed for the statistical analysis of the data in this study. Duncan's multiple range tests were used to evaluate differences among the treatments statistically. Significance was established at $P < 0.05$.

Results and discussion

The compositions of raw milk and whey are given in Table 1. The pH and titratable acidity levels did not differ significantly among treatments. When the fat content of raw milk and whey was examined, it was observed that FKC milk (FKC_m) as well as SKC_m, and $CPKC_m$ had higher fat content than BKC_m ($P < 0.05$). In BKC production, milk fat was standardized according to the information taken from manufacturers of Hatay province, and the fat ratio was reduced. For this reason, the fat contents differed, as did the dry matter contents. SKC_m had higher protein content than the other milks and there were also significant differences in the ash content of the whey samples.

Cheese yield is affected by many factors, including milk composition, milk quality, casein content and genetic variants, somatic cell count in milk, coagulant type, milk pasteurization, curd firmness at cutting, vat design, and manufacturing parameters (Abd El-Gawad and Ahmed, 2011). As shown in Table 2, the highest cheese yield value was found in SKC, while the lowest value was found in FKC. Procedures that may affect cheese yield were carried out during the production of the different Künefe cheeses, and there were indeed significant differences in yield. It was thought that the higher cheese yield of SKC was due to the higher fat, protein and total solid content of the milk, perhaps together with an effect of the salting process. CPKC, which was heat processed, had the next highest yield. This is to be expected: during heat treatment, denaturation occurs in the serum proteins, the milk fat is kept in the curd more and some of the mineral salts become insoluble (Yıldırım *et al.*, 2011).

Acidity is one of the most important features of Künefe cheese because, as in pasta filata type cheeses, the fluidity of the protein mass known as creep occurs in a narrow range, around pH 5.2–4.9 (Aslan Günay, 2019). The pH values of our Künefe cheeses varied between 4.96 and 5.24, and titration acidity values varied between 0.98 and 1.64% (Table 2). These pH values show that the creep properties are of good quality. Nevertheless, there was significant variation with the lowest pH value and highest TA in CPKC. This may be due to the pasteurization of milk in its production and the addition of starter culture before fermentation.

While SKC had the highest total solid content, BKC had the lowest value. Significant differences ($P < 0.05$) were observed in the total solid content of the cheeses (Table 2), probably related to the different dry matter and fat contents of the milks (Table 1), and the processes such as dry salting and brining in the production of SKC. The official designation (TPE, 2018) specifies total solids between 41.4% and 54.3%, or between 56.2% and 69.8% for SKC. With the exception of BKC our values were consistent with this. The lower fat standardization of the BKC_m probably explains this lack of compliance and it is essential for future research studies to use milk with a higher fat content in BKC sample. For the same reason the fat and fat in dry matter contents of FKC, SKC, and CPKC were significantly higher than BKC (Table 2). Milk with a fat content of 1.1% is generally used in the production of Boru-type Künefe cheese in Hatay (M. S. Çayır, personal communication). The reason is uncertain but might be related to production costs.

CPKC had the highest nitrogen and protein content, while FKC had the lowest ($P < 0.05$). However, there were some similarities, namely between FKC and BKC and also between SKC and CPKC. The reason for this is not clear, but it is thought that this similarity occurred due to the similar steps at the start of production. Both FKC and BKC were made without ripening in the brine, whereas ripening and adding of starter culture followed by dry cooking were applied to SKC and CKPC. It was reported that the protein contents varied between 17.10% and 24.24% in fresh Künefe cheeses offered for sale in Hatay (Karaca *et al.*, 2008), and the protein contents in salted Künefe cheeses varied between 18.26% and 21.40% (Say *et al.*, 2016). The protein content of all Künefe cheeses produced in this study was at the top end of these ranges, and higher than the values specified as a minimum certification requirement (TPE, 2018). Since the milk fat was reduced in the production of BKC and the total solid contents

Table 1. Composition of the raw cow milk and whey of the cheeses

Treatments[1]						
Raw milk	pH	TA, %	DM, %	Fat, %	Protein, %	Ash, %
FKC_m	6.73 ± 0.06^{a}	0.13 ± 0.01^{a}	11.28 ± 0.20^{ab}	2.77 ± 0.15^{a}	2.92 ± 0.01^{b}	0.59 ± 0.21^{a}
BKC_m	6.70 ± 0.05^{a}	0.14 ± 0.02^{a}	10.84 ± 0.32^{b}	1.13 ± 0.15^{b}	2.95 ± 0.02^{b}	0.69 ± 0.15^{a}
SKC_m	6.69 ± 0.07^{a}	0.13 ± 0.01^{a}	11.71 ± 0.18^{a}	2.83 ± 0.38^{a}	3.04 ± 0.03^{a}	0.63 ± 0.03^{a}
$CPKC_m$	6.76 ± 0.07^{a}	0.13 ± 0.02^{a}	11.04 ± 0.34^{b}	2.80 ± 0.10^{a}	2.96 ± 0.02^{b}	0.57 ± 0.26^{a}
Whey						
FKC_w	6.50 ± 0.03^{a}	0.10 ± 0.01^{a}	6.52 ± 0.17^{a}	0.40 ± 0.01^{b}	1.02 ± 0.01^{b}	0.45 ± 0.02^{ab}
BKC_w	6.53 ± 0.04^{a}	0.09 ± 0.01^{a}	5.61 ± 0.27^{b}	0.15 ± 0.05^{c}	1.02 ± 0.01^{b}	0.36 ± 0.03^{b}
SKC_w	6.48 ± 0.03^{a}	0.11 ± 0.01^{a}	6.58 ± 0.06^{a}	0.50 ± 0.04^{a}	1.07 ± 0.02^{a}	0.46 ± 0.04^{a}
$CPKC_w$	6.53 ± 0.03^{a}	0.09 ± 0.01^{a}	6.37 ± 0.15^{a}	0.45 ± 0.05^{ab}	1.02 ± 0.02^{b}	0.39 ± 0.07^{ab}

[1]Treatments: FKC_m, raw cow milk of fresh Künefe cheese; BKC_m, raw cow milk of Boru type Künefe cheese; SKC_m, raw cow milk of salted Künefe cheese; $CPKC_m$, raw cow milk of culture-added processed Künefe cheese; FKC_w, whey of fresh Künefe cheese; BKC_w, whey of Boru type Künefe cheese; SKC_w, whey of salted Künefe cheese; $CPKC_w$, whey of culture-added processed Künefe cheese.
[2]DM, dry matter; TA, titratable acidity in terms of % lactic acid; NFDM, non-fat dry matter.
a–d Means in the same column followed by different letters were significantly different $P < 0.05$

Table 2. Compositional, color, textural, meltability, and sensory properties of Künefe cheeses

	Treatments[1]			
Properties[2]	FKC	BKC	SKC	CPKC
Cheese yield, %	8.27 ± 0.12^{d}	9.23 ± 0.04^{c}	11.25 ± 0.12^{a}	10.27 ± 0.18^{b}
pH	5.06 ± 0.06^{b}	5.24 ± 0.05^{a}	5.10 ± 0.03^{b}	4.96 ± 0.05^{c}
TA, %	1.49 ± 0.13^{ab}	0.98 ± 0.06^{c}	1.37 ± 0.09^{b}	1.64 ± 0.05^{a}
TSC, %	47.46 ± 1.63^{c}	34.13 ± 1.27^{d}	61.50 ± 0.77^{a}	53.96 ± 1.10^{b}
Fat, %	22.17 ± 1.44^{b}	7.00 ± 0.05^{c}	23.67 ± 0.76^{ab}	24.67 ± 1.04^{a}
Fat in DM, %	46.67 ± 1.71^{a}	20.53 ± 0.85^{c}	38.49 ± 1.61^{b}	45.70 ± 1.07^{a}
TN	3.51 ± 0.11^{b}	3.57 ± 0.22^{b}	3.84 ± 0.14^{a}	3.91 ± 0.03^{a}
Protein, %	22.38 ± 0.74^{b}	22.75 ± 1.39^{b}	24.48 ± 0.90^{a}	24.96 ± 0.20^{a}
Protein in DM, %	47.19 ± 1.39^{b}	66.61 ± 1.71^{a}	39.83 ± 1.95^{c}	46.27 ± 1.29^{b}
Salt, %	0.23 ± 0.00^{b}	0.23 ± 0.00^{b}	8.81 ± 0.13^{a}	0.23 ± 0.00^{b}
Salt in DM, %	0.49 ± 0.02^{b}	0.69 ± 0.03^{b}	14.33 ± 0.28^{a}	0.43 ± 0.01^{b}
Color at external surface				
L^*	89.82 ± 1.66^{a}	81.36 ± 3.02^{b}	89.76 ± 0.74^{a}	86.31 ± 1.98^{a}
a^*	−2.83 ± 0.14^{a}	−4.34 ± 0.14^{b}	−2.99 ± 0.11^{a}	−5.31 ± 0.55^{c}
b^*	11.36 ± 0.77^{c}	11.70 ± 0.34^{c}	13.18 ± 0.62^{b}	18.85 ± 1.02^{a}
Textural Properties				
Hardness (g)	2541.30 ± 423.23^{b}	1337.44 ± 208.19^{c}	6151.65 ± 614.11^{a}	2997.64 ± 647.61^{b}
Springiness	0.88 ± 0.02^{a}	0.88 ± 0.02^{a}	0.91 ± 0.06^{a}	0.88 ± 0.02^{a}
Cohesiveness	0.80 ± 0.03^{a}	0.83 ± 0.01^{a}	0.82 ± 0.02^{a}	0.81 ± 0.01^{a}
Chewiness (g)	2024.20 ± 288.10^{b}	1097.72 ± 182.34^{c}	5026.92 ± 588.87^{a}	2442.04 ± 536.12^{b}
Meltability (mm)	20.16 ± 6.93^{c}	54.33 ± 4.16^{b}	36.33 ± 5.13^{cb}	78.33 ± 20.59^{a}
Sensory Properties				
Appearance	5.00 ± 0.00^{a}	3.60 ± 0.54^{b}	3.40 ± 0.89^{b}	5.00 ± 0.00^{a}
Texture	4.60 ± 0.54^{a}	4.00 ± 0.70^{a}	2.80 ± 1.09^{b}	4.20 ± 1.30^{a}
Odor	4.60 ± 0.89^{a}	4.80 ± 0.44^{a}	2.60 ± 1.67^{b}	4.80 ± 0.44^{a}
Taste	4.40 ± 0.89^{ab}	3.60 ± 0.89^{b}	3.80 ± 0.44^{b}	5.00 ± 0.00^{a}
Overall acceptance	18.60 ± 2.32^{ab}	16.00 ± 2.57^{ab}	12.60 ± 4.09^{b}	19.00 ± 1.74^{ab}

[1]Treatments: FKC, fresh Künefe cheese; BKC, Boru type Künefe cheese; SKC, salted Künefe cheese; CPKC, culture-added processed Künefe cheese.
[2]TSC, Total solid content; TA, Titratable acidity in terms of % lactic acid; TN, Total nitrogen; DM, Dry matter.
a–d Means in the same row followed by different letters were significantly different $P < 0.05$.

of the cheeses differed, the protein contents in the dry matter also differed ($P < 0.05$). Since the salting method was used in the production of SKC, the salt content and salt in the dry matter of SKC were found to be significantly higher than other cheeses ($P < 0.05$). The salt content and salt in the dry matter of all the cheeses comply with the values specified in the Antakya Künefe cheese Geographical Indication Certificate (TPE, 2018).

The color of Antakya Künefe cheese varies from porcelain white to cream, depending on feeding and seasonal conditions (TPE, 2018). Our color analysis data are shown in Table 2. The lowest L^* value was determined in BKC, and this difference was statistically significant ($P < 0.05$). The main determinant of cheese's lightness is the light emitted by the fat globules (Felix da Silva *et al.*, 2016), so this is to be expected due to the lower fat content of BKC_m. There was a statistically significant ($P < 0.05$) difference between cheeses in terms of a^* values, again probably due to different fat contents. The highest b^* value, in other words, yellow color, was detected mainly in CPKC, followed by SKC, BKC and FKC, respectively. BKC and SKC had more blue color than other cheeses. The effect of different production methods on the b^* values of Künefe cheese was statistically significant ($P < 0.05$). A study on processed cheeses stated that the b^* values of cheeses with low-fat content were lower than those with high-fat content (Felix da Silva *et al.*, 2016), and full-fat Cheddar cheeses were more yellow than low-fat cheeses (Drake *et al.*, 1996).

The textural properties of the Künefe cheeses are given in Table 2. The hardness and chewiness values of Künefe cheeses produced using different methods were statistically different ($P < 0.05$) although the difference between FKC and CPKC cheeses was not statistically significant ($P > 0.05$). Especially, SKC produced by adding salt had the highest hardness and chewiness value among all cheeses. Cheese structure may also be impacted by salt content. A higher cheese salt content would promote casein solubilization, causing the protein matrix to become more hydrated and swell (Pastorino *et al.*, 2003). In addition, it was thought that the total solid and protein contents of the cheeses affected the hardness and chewiness values, meaning that SKC with high total solid and protein content had high values. The effect of different production methods on the springiness and cohesiveness values of Künefe cheese was not significant ($P > 0.05$).

Since Künefe cheese is an ingredient of Künefe desserts in Türkiye, its melting property is important (Esen and Güzeler, 2023). The different production techniques had a significant impact ($P < 0.05$) on the meltability parameters. Although proteins do not melt, their interactions with one another can alter and create an effect that we call melt (Lucey *et al.*, 2003; Esen and Güzeler, 2023). While CPKC had the highest meltability value, it was followed by BKC, SKC and FKC, respectively. It was thought that the addition of emulsifying salts during the dry cooking stage was the cause of the higher meltability values of CPKC and BKC. Monovalent cations and polyvalent anions make up the ionic compounds known as emulsifying salts. 'Calcium sequestering' (which helps disrupt the calcium-phosphate linked protein network present in natural cheese during processed cheese production) and 'pH adjustment' are the two primary purposes of emulsifying salts in processed cheese. These two purposes help in hydrating the caseins found in natural cheese so that they can easily interact with the water and fat phases, thereby creating a homogeneous process cheese emulsion (Kapoor and Metzger, 2008).

The sensory properties of the Künefe cheeses in the prepared desserts are presented in Table 2. The different production techniques did have an effect on the appearance, odor, texture, taste, and overall acceptance of the cheeses. CPKC received the highest scores in terms of consumer preference. In general, the composition, color, textural and meltability properties of CPKC positively affected consumer preferences.

In conclusion, the composition, color, meltability, texture, and sensory attributes of Künefe cheeses were affected by the use of different production techniques. When all the findings were evaluated, it was seen that the most suitable cheese among the Künefe cheeses is CPKC, produced by heating raw milk and using starter culture before adding rennet and applying dry cooking with emulsifying salts.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0022029923000298

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