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The follow result showed that chemical composition and physical criteria discussions were similar to those showed in literature (Konuspayeva et al., 2009; Abdelgadir et al., 2013).

Table 1. Chemical composition and physical criteria for sampled individuals.

Variables	Nbre	Mean	Std Dev	Minimum	Maximum
Milk sample t°	145	20,524	1,919	15,000	30,000
Fat	145	26,735	16,432	2,100	84,700
Solids non Fat	145	83,908	8,467	58,200	100,900
Total solids	145	110,643	22,128	66,500	180,000
density	145	1029,850	2,878	1021,160	1035,450
Protein	145	32,567	3,829	20,600	52,000
Lactose	145	44,643	4,333	31,100	53,300
Added water	145	4,966	7,879	0,000	34,390
Ash	145	6,656	0,680	4,600	8,000
Freezing point	145	-0,513	0,059	-0,638	-0,341
Urea	145	251,886	113,896	94,250	584,201
pH	145	6,552	0,183	6,000	6,850
Acidity	145	15,859	2,167	9,000	25,000
Casein	65	25,955	2,577	19,628	31,326
PS	65	5,100	3,798	2,488	33,764
Pcsn	65	79,872	9,596	8,571	86,613
Non protein nitrogen	65	0,345	0,096	0,190	0,554

For used milk samples acidity, pH, density, freezing point, dry matter, fat, SNF, protein, casein, whey proteins, NPN, urea, lactose and ash were respectively16.3 ± 0.1; 6.65 ± 0.14; 1031 ± 2; -0.547±0.041; 122.65 ± 5.89 g/l; 33.98 ± 3.5 g/l; 88.68 ± 6.06 g/l; 34.45 ± 2.31 g/l; 28.72 ± 0.74 g/l; 4.61 ± 1.29 g/l, 493 ±123 mg/l, 375 ±76 mg/l , 47.05 ± 3.30 g/l and 6.98 ± 0.36 g/l for spring and 15.1 ± 1.5; 6.61 ± 0.11; 1029 ± 2; -0.481±0.034; 98.13 ±10.20 g/l; 18.46 ± 6.18 g/l; 79.66 ± 4.89 g/l; 30.71 ± 1.97 g/l; 25.33 ± 3.92 g/l; 4.90 ± 1.34 g/l, 361 ±150 mg/l, 188 ±18; 42.54 ± 2.54 g/l and 6.33 ± 0.4 g/l for summer. Regarding coagulation properties and cheese yield at mold release that is coagulation pH, Flocculation time, Clotting time, cheese dry matter , cheese fat; Fresh yield; Dry yield, Dry matter recovery ; Fat recovery, Whey solids and Whey fat were respectively 6.55 ± 0.15; 10 ± 2.2 mins; 34.0±4.1 mins; 45.2 ± 6.49 %; 56.5 ± 4.1 % DM; 10.32 ± 1.42 %; 4.60 ± 0.19 %; 37.54 ±1.93 %; 76.61 ± 3.45 %, 79.64 ±12.35 g/l, 9.00 ±1.83 g/l for spring milk and 6.37 ± 0.37; 7.1 ± 3.7 mins;29.4±5.8 mins; 38.4 ±5.9 %; 34.1 ± 8.0 % DM; 9.65 ± 1.84 %; 3.62 ± 0.38 %; 36.97 ± 1.93 %; 68.33 ± 4.25 %, 63.10±4.95 g/l, 6.63 ±2.33 g/l for summer milk. Produced cheese was significantly affected by season ($p<0.001$). The yield and properties of cheese made with camel milk varies significantly with milk properties ($p<0.05$). This study showed that the transformation of camel milk to cheese remainder sensitive. However, produce camel cheese along the year is possible with technological adaptations independently to environmental factors (locality and season). To do this processed milk should be fresh and harvested in good hygienic condition.

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MANUFACTURING CAMEL CHEESE: THE EXPERIENCE OF SAUDI ARABIA

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Abstract

Unlike other dairy products, camel cheese processing is recent. Thanks to recombinant camel chymosin, camel cheese making is easier. In Saudi Arabia, camel cheese making was developed for last 4 years in the Camel project (FAO project). Our cheeses are made with fresh milk strictly controlled for their microbiological quality (coliform, total flora). The milk composition is known, all samples being analyzed with Milkoscan-FOSS FT1 ©. Different starters are used from Coquard © (France) according to the type of cheese expected. All along the process, the pH is checked (draining, moulding, pressing, salting). The composition of the whey is also determined. At the end of the process, after salting, dry matter and final pH are measured as well as the total yield. Cheese of Haloumi type are pasteurized in their whey and packaged under vacuum. Some cheeses are ripening in special cave for few weeks (Mozzarella, Feta) or months (Camembert, Saint-Paulin). The cheese yield is depending of the cheese type but occurs between 8 and 12%. Sensory tests are performed. These cheeses are available on the market. Different experiments are performed in order to test the effect of different starters.

Key words: camel milk, cheese, starters, milk processing, milk composition

ТҮЙЕ ІРІМШІГІН ӨНДІРУ: САУД АРАБИЯСЫНЫҢ ТӘЖІРИБЕСІ

Басқа сүт тағамдарына қарағанда түйе сүтінен ірімшік алу жақында ғана басталды. Түйенің рекомбинантты химозині арқылы түйе сүтінен ірімшік алуды жеңілдетті. Сауд Арабиясында соңғы 4 жылда Camel жобасының аясында (ФАО жобасы) ірімшік алу технологиясы жасалды. Біз жасаған түйе сүтінің ірімшіктеріне микробиологиялық бақылдау жүргізілді. Сүт құрамы MilkoScan-FOSS FT1 © анализаторында анықталады. Әр түрлі ұйытқылар Coquard © (Франция) ірімшік түріне қарай қолданылады. Ірімшік дайындаудың барлық сатыларында (құю, престеу, тұздау) pH тексерілді. Сонымен қатар сарысу құрамы анықталынды. Тұздалғаннан кейін құрғақ зат және pH көрсеткіштері тексеріліп жалпы шығымы анықталды. Haloumi ірімшік түрі оның сарысуында пастерзацияланып вакуумда қапталынды. Кейбір ірімшіктер (Моцарелла, Фета) арнаулы үңгірлерде бірнеше аптада немесе айда (Камамбер, Санкт-Паулин) пісіп жетілді. Дайын ірімшіктің шығымы 8 және 12% аралығында болды. Сенсорлық тестер жүргізілді. Осы аталған ірімшіктер нарыққа ұсынылды. Ұйытқылар әсерін зерттеу үшін түрлі тәжірибелер жүргізілді.

Түйін сөздер: түйе сүті, ірімшік, тоқ басар, сүтті өңдеу, сүт құрамы

ПРОИЗВОДСТВО ВЕРБЛЮЖЬЕГО СЫРА: ОПЫТ САУДОВСКОЙ АРАВИИ

В отличие от других молочных продуктов, переработка верблюжьего сыра началась недавно. Благодаря рекомбинантному верблюжьему химозину, облегчилось производство сыра из верблюжего молока. В Саудовской Аравии в рамках проекта Camel (проект ФАО) за последние 4 года была разработана технология производства сыра из верблюжего молока№. Сыр готовится из сырого молока? Поэтому микробиологическое качество регулярно контролируется их микробиологическое качество. Молоко анализируется на физико-химический состав на приборе MilkoScan-FOSS FT1 © и снимаются микробиологические показатели.. Используются различные закваски фирмы Coquard © (Франция) для производства сыра,в зависимости от типа ожидаемого сыра. На каждом этапе проверяется pH (слив, литье, прессование, соление). Состав сыворотки также исследуется. По окончанию пресса после соления определяется общее сухое вещество, измеряют конечное значение pH , а также общий выход продукта. Сыр типа Haloumi пастеризуют в своей сыворотке и подвергают вакуумной упаковке. Некоторые сыры созревают в специальном подвале в течение нескольких недель (Моцарелла, Фета) или месяцев (Камамбер, Сан-Полен). Выход сыра зависит от типа сыра, для сыра из верблюжего молока выход составляет от 8 до 12%. Проводили дегустацию для определения органолептические свойств. Данныереализуются и пользуются спросом на рынке.

Ключевые слова: верблюжье молоко, сыр, закуски, переработка молока, состав молока

Introduction

From the studies of Kappeler et al. (2006), recombinant specific camel rennet was elaborated and marketed under the name of Chymax-M1000®, Ch. Hansen©. Thus, since the recent availability of this recombinant coagulant, camel milk coagulation is no longer a constraint. Nowadays, the challenge for dairy scientists and cheese makers is to adapt the different known types of cheese technology to camel milk. Different technological parameters for camel cheese making have been tested, and mozzarella, white cheese or gruyere was produced, (Konuspayeva et al. 2012; Camier et al. 2014; Konuspayeva et al. 2014). The present communication aims to present preliminary results regarding the role of the factor “starter” in the organoleptic quality and physic-chemical composition of the final cheese produced.

Material and methods

Milk origin and control

The camel milk was collected from the farm at the Conservation and Genetic Improvement Centre (CGIC), Al-Kharj, Saudi Arabia. In the centre, the lactating camels (n=17) were milked twice a day by a milking machine (Boumatic©) at 7 am and 4 pm. The good hygienic practices were checked at each milking. Daily milk was pooled and stored at 4°C in cans before processing into cheese. Before starting cheese production, one mixed milk sample was collected for microbiological and physico-chemical analysis.

Materials

Eight starters from Coquard© (France) were used, namely Beta 3, Beta 4, Beta 4, Beta 6, Beta 8 (mesophiles strains of *Lactococcus lactis* and *L.cremoris*), Omega1, Omega2 and Omega3 (mixed of *Lactococcus cremoris*; *L. lactis* -80%, and *L. diacetilactis, Leuconostoc cremoris and Streptococcus thermophilus* -20%). In all trials (5 repetitions for each starters), the milk was renneted by recombinant camel chymosin, Chy-Max M1000 (Ch. Hansen©, Denmark) as the coagulating agent at 50 µl/lL L-1 concentration. The following equipment was used: fabric bag as the mould; one cylinder press (8 bar max) for cheese pressing (Coquard©, France).

Cheese technology

The technology used was same to Halloumi making (Lteif et al., 2009). All along the process, the pH is checked (draining, moulding, pressing, salting). The composition of the whey is also determined. At the end of the process, after salting, dry matter and final pH were measured as well as the total yield.

Results and discussion

The eight starters were tested by using the same technology applied on raw camel milk (table 1) and the final product gave different pH values at the end of the processing (Figure 1)

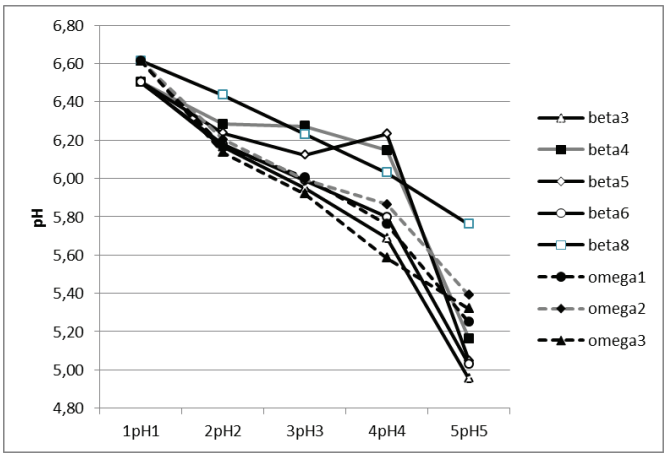

Figure 1. Kinetic of pH during processing according to the different starters used

Table 1. Physico-chemical composition of the raw camel milk used for the different Starters (mean and SD)

Parameter	mean ± SD
pH	6.51 ± 0.04
DryMatter, %	10.81 ± 1.17
Freezing point, °C	0.322 ± 0.004
Fat, %	3.13 ± 0.29
Protein, %	2.75 ± 0.13
Lactose, %	4.55 ± 0.18

During the cheese processing, the impact of the different starters appeared not significant on physico-chemical parameters of the whey (table 2).

Table 2. Physico-chemical characteristics of the cheese-whey obtained during draining according to the different tested starters (mean and SD)

Parameters	Beta3	Beta4	Beta5	Beta6	Beta8	Omega1	Omega2	Omega3
pH	6.05 ± 0.35	6.27 ± 0.08	6.27 ± 0.40	5.87 ± 0.35	6.23 ± 0.13	6.09 ± 0.06	6.06 ± 0.08	5.95 ± 0.10
Dry matter,%	6.97 ± 0.85	6.96 ± 0.60	6.91 ± 0.63	7.16 ± 0.42	5.97 ± 2.58	7.12 ± 0.24	7.30 ± 0.12	6.15 ± 1.54
Freezing point, °C	0.315 ± 0.035	0.325 ± 0.003	0.328 ± 0.008	0.345 ± 0.018	0.333 ± 0.007	0.340 ± 0.001	0.338 ± 0.005	0.342 ± 0.008
Fat, %	1.27 ± 0.34	1.15 ± 0.58	1.17 ± 0.44	1.28 ± 0.36	1.51 ± 0.37	1.18 ± 0.25	1.25 ± 0.11	1.20 ± 0.09
Protein, %	0.66 ± 0.03	0.67 ± 0.04	0.67 ± 0.06	0.66 ± 0.05	0.57 ± 0.09	0.58 ± 0.08	0.58 ± 0.07	0.59 ± 0.06
Lactose, %	4.43 ± 0.21	4.48 ± 0.23	4.51 ± 0.13	4.43 ± 0.20	4.77 ± 0.04	4.70 ± 0.02	4.71 ± 0.00	4.69 ± 0.01

There was no significant difference in mean pH and mean dry matter of the final cheese according to the different starters used. However, the starters Beta tend to acidify more than Omega starters except Beta8. The dry matter of cheese varied from 36,3 to 50.4%. The yield (weight of cheese/weight of milk *100) varied from 6.53% (Beta 6 starter) to 8.75% (Omega2 starter), i.e. 12 to 14 liters of milk are required to get one kg of cheese (table 3).

Table 3. pH value, dry matter and yield of camel cheese obtained with different starters

Starter	pH	Dry Matter (%)	Yield (%)
Beta 3	4.95 ± 0.41	44.70 ± 4.16	7.07± 0.84
Beta 4	5.16 ± 0.47	50.41 ± 8.70	6.93 ± 1.10
Beta 5	5.05 ± 0.35	44.22 ± 5.85	6.93 ± 1.23
Beta 6	5.03 ± 0.29	47.21 ± 1.78	6.53 ± 1.73
Beta 8	5.76 ± 0.16	36.29 ± 1.53	7.08 ± 1.18
Omega 1	5.25 ± 0.17	42.93 ± 7.68	7.71 ± 0.29
Omega 2	5.39 ± 0.08	41.14 ± 5.71	8.75 ± 1.77
Omega 3	5.32 ± 0.07	42.18 ± 5.35	6.83 ± 0.82

As we used a small quantity of milk (13.5 l) for each trial, the apparent yield given in the table 3 was probably underestimated because a loss of matter during the process ‘(residues in fabric bag at cheese release, loss of whey at cooling, loss of matter at cooking and brining). According to the dry matter of whey, cheese and milk at origin, these losses are estimated to 30%. It’s mean that the true yield was around 9 to 10% which is comparable to cow cheese making (Goudedranche et al., 2001).

There preliminary results require supplementary analysis (calcium-phosphorus balance, total nitrogen) to assess the effect of the different starters. Organoleptic tests have to be achieved for completing this comparative study.

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