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New trials to make camel mozzarella

Mozzarella, one of the most consumed cheeses in the world was traditionally done with cow milk. The use of camel milk was tried in the present study. All technological production chain is presented in this work. For clotting camel milk,Chy-Max M1000 (Chr Hansen ® Denmark) was used. For lactic culture,mesophilic starters (Coquard^{TM}, France) were used. On average, camel mozzarella yield was 7,05% and the global composition on fat, protein, lactose, ash, total solids was 18,78±1,58, 30,02±1,72, 0, 3,36±0,45, 53,79±2,34% respectively. Microbiological control showed absence of *Salmonella*, *Listeria*, *Staphylococcus* in all studied cheeses. Globally composition is closed to buffalo or cow mozzarella, but the texture of camel mozzarella is quite different. Further studies are needed to describe rheological properties of camel mozzarella.

***Key words**:* camel milk, mozzarella, cheese making, technology.

The camel milk is traditionally never processedinto cheese because the difficulties of clotting. Nevertheless, since the years 80's some researcheswere done to get camel cheese [1]. Since Chr Hansen company delivered camel chymosin on the large market, production of camel cheese became easier [2,3]. After solving this mostly important problem in camel cheese making, new lands are open to produce different types of camel cheeses. One of the most consumed cheeses in the world is mozzarella, used notably in pizza. Many works weredone to produce mozzarella type with all types of milk [4], even if traditionally it was only with buffalo milk [5]. Now, mozzarella from cow milk is common [6]. The present work is focused on the making of mozzarella cheese from camel milk.

Materials and methods

Materials: camel milk was obtained from camel farm of FAO Camel Project at Al-Kharj, Saudi Arabia. Bulk milk from 7 lactating camels of 6-20 years old milked by machine milking was used. Milk was cooled up to 4^0C and the same day used for cheese making. The camel milk coagulantChy-MAX M1000 (ChyMax Hansen©, Denmark) was used. To get specific cheese test, mesophilic lactic culture (Coquard ™, France) was introduced in the milk.

Processing.Mesophilic ferments were added in whole camel milk at 40^0C temperature, and then incubated for 1-1,5 hours. Camel chymosin was added for clotting (for 1 h) and then the clot was cut in cube of 1 cm^3. Then hand-filling was proceeding into cloths for a first draining within 15 minutes, and a second one in moulds for 4-24 h. After draining, the cheese was pressed under 2 bars pressure during 2-3 h. Then, cheese was cooked at 80^0C for 20 minutes in whey, which was collected at draining step. In the next step, heated cheese was massaged and transformed in ball, then put in brine (saturated solution) for 5-10 minutes according to the size of balls. Ripening of cheese was achieved for 24 hours at 10-14^{o}C and then packaged individually.

*Microbiological contro*l analysis was achieved according to the standards: 9225-84. «Milk and milk products.Microbiological method of analysis», 30347-97 «Milk and milk products.Method of determination of *Staphylococcus aureus*», 10444.11-91 "Food products.Method of detection of lactic microorganisms". By using those standards, mesophilic aerobic and facultative anaerobic bacteria, coliforms, pathogen *Staphylococcus aureus* and lactic bacteria were quantified.

Results and discussion

Finally, eleven cheeses with agreeable taste were obtained. The average yield was at 7.05±0.95%, with max value at 8.75%, min at 5.56% and median at 6.94%.The global composition (total protein, fat, lactose, ash and total solids) forcamel mozzarella cheese was determined (Table 1).

Table 1 – Global composition of 11 samples of camel mozzarella

№	Code of sample	Cheese yields	Protein	Fat	Lactose	Ash	Total solids
1	M0207	7,55	31,12	18,39	0,00	4,24	56,00
2	M0308	7,14	34,30	18,10	0,00	2,96	57,00
3	M0309	6,43	28,40	19,41	0,00	3,18	52,50
4	M0809	6,25	29,60	18,93	0,00	3,68	53,10
5	M0907Z	7,50	30,92	20,00	0,00	3,83	56,00
6	M1709	6,82	28,84	14,80	0,00	3,52	48,60
7	M2207	8,33	29,00	18,00	0,00	3,01	52,00
8	M2409	6,25	31,00	19,00	0,00	2,77	54,50
9	M2506	5,56	29,11	20,29	0,00	3,65	55,00
10	M2909	8,75	29,00	20,65	0,00	3,01	54,00
11	M3007	6,94	28,95	19,00	0,00	3,15	53,00
	Average and SD	7,05±0,95	30,02±1,72	18,78±1,58	0	3,36±0,45	53,79±2,34

Table 2 – Microbiological quality of 11 samples camel mozzarella

№	Code of sample	Coliform	Salmonella	Listeria	Staphylococcus
1	M0207	4,30E+04	0,00E+00	0,00E+00	0,00E+00
2	M0308	1,00E+01	0,00E+00	0,00E+00	0,00E+00
3	M0309	8,60E+04	0,00E+00	0,00E+00	0,00E+00
4	M0809	1,10E+06	0,00E+00	0,00E+00	0,00E+00
5	M0907Z	6,80E+03	0,00E+00	0,00E+00	0,00E+00
6	M1709	4,60E+06	0,00E+00	0,00E+00	0,00E+00
7	M2207	5,80E+03	0,00E+00	0,00E+00	0,00E+00
8	M2409	1,10E+05	0,00E+00	0,00E+00	0,00E+00
9	M2506	1,00E+01	0,00E+00	0,00E+00	0,00E+00
10	M2909	1,50E+04	0,00E+00	0,00E+00	0,00E+00
11	M3007	1,00E+01	0,00E+00	0,00E+00	0,00E+00

Camel cheese contained more proteins than fat matter. In comparison to buffalo mozzarella, fat matter wasalmost in the same quantity (around 17%), but camel mozzarella had more protein (around 18% of protein in buffalo mozzarella) [7]. It's mean that the global composition of camel mozzarella is close to the other types of mozzarella, but the rheological properties and the melting capacity are not comparable.

The lactose was not found in camel mozzarella contrary to buffalo mozzarella.

Regarding the microbiological safety, all cheeses were analyzed for family of pathogenic bacteria *Coliform, Salmonella, Listeria* and *Staphylococcus*(Table 2). *Salmonella*, *Listeria* and *Staphyloccocus*were not present.At reverse, the presence of coliform was common (8 samples among 11) which is probably linked to the hygiene atmilking and during the cheese making process. Further studies are in course to improve the hygiene by HACCP method.

Conclusion. Camel mozzarella makingisnow possible. The acceptability of this new cheese has to be tested with a panel of consumers. The marketing of this product in camel countries could be a good opportunity for the camel producers.

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Modelling lactic acid fermentation of gowé a sorghum-based fermented beverage

Gowé is a sour and sweet sorghum based traditional Beninese beverage. The traditional manufacturing of Gowé includes malting, fermentation and cooking. A Gowé of high quality relies on a sufficient acidification during fermentation and sorghum starch hydrolysis which produces fermentable substrates and imparts a sugary taste. The kinetics of the lactic fermentation thus depends on malt amylasic activities that are in return inhibited by the acidification due to the production of lactic acid. The final objective of this study is to propose a global model allowing predicting the good making of Gowé.

Two selected lactobacilli known to have different potentialities of acidification: *L. plantarum* and *L. brevis* were cultivated on MRS liquid medium. We firstly modeled the growth of the two strains at constant pH according to the logistic primary model of Rosso (1996) which determines lag time and growth rate. Secondly, a cardinal model (CPM) was used to model the effect of pH on growth rate. Lactic acid production is linked to bacterial growth rate through a sigmoid type model. A double linear model was fitted with the variation of α amylasic activity with pH. A global fermentation simulator was thus built, and the comparison of measured and predicted data in MRS medium showed that the model gives a good prediction of growth rate and lactic acid production for the two strains. The simulator in addition predicts that after 15 hours of fermentation conducted by *L. plantarum*, all α amylase activity is lost while a third of the activity remained after 24 hours with the *L brevis* strain. This result shows that the *L. brevis* strain is potentially well suited for the lactic fermentation of Gowé.