Effect of ripening conditions on the properties of Blue cheese produced from cow's and goat's milk

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Abstract: Blue cheese (style Roquefort) was made from cow's and goat's milk. Fresh cheese was ripened at room conditions for 30 days, then resulted cheese were divided into two portions, one was complete ripened at room conditions and the other was complete ripened at refrigerator for another 30 days. Cheese samples were analyzed at 1, 30 and 60 days of ripening period, for moisture, fat, pH, total nitrogen and free amino acids. Tyrosine & Tryptophan and total volatile fatty acids contents as well as their organoleptic properties. No clear differences were observed between both goat's and cow's cheese in their gross composition. Goat's blue cheese ripened for 60 days at room temperature had a higher total free amino acids contents than that in cow's cheese, while their values were higher when cheese ripened at refrigerator than that ripened at room temperature. Blue cheese from goat's milk showed the highest total volatile fatty acids and Tyrosine & Tryptophan contents during ripening, at the end of ripening, the cheese ripened at room temperature gave the higher values than that ripened at refrigerator. Blue cheese from goat's milk ranked a higher score for organoleptic properties during ripening conditions compare with that made from cow's milk. It can be concluded that goat's milk can be successfully used in the manufacture of blue cheese and ripened at room temperature with high quality over than that from cow's milk.
[EL-Sheikh, M.M.; M.H. EL-Senaity; Y.B. Youssef and Nadia M. Shahein and N.S. Abd Rabou. **Effect of ripening conditions on the properties of Blue cheese produced from cow's and goat's milk**. Journal of American Science 2011;7(1):485-490]. (ISSN: 1545-1003). http://www.americanscience.org.

Keywords: Blue cheese, Cow's Goat's milk.

1. Introduction

The three classic "old-world" varieties of blue cheese are Roquefort (sheep's milk blue from southern France), Gorgonzola (northern Italian cow's milk blue), and Stilton (cow's milk blue from central England). The three cheeses vary quite a bit both in texture and taste. Roquefort is sweet, moist and crumbly; Stilton is firmer and spicier; and Gorgonzola (especially the variety known as *dolce*) is sweet and creamy (Deetae et al., 2007).

Blue cheese (Style Roquefort) is the main blue mould cheese produced in Egypt; this type is initially made from full cream sheep milk. During ripening of blue-veined cheese, desirable changes occur as a result of limited degradations of the carbohydrates, protein and fat of milk, (Ali, 1993). This is brought about by the combined action of milk enzymes, rennet. Starter cultures (mainly the mould) and other microbial flora, many chemical and biological interactions are involved. At the end of ripening, a complex mixture of compounds which give the nature cheese, the required balance of flavour and aroma are formed, (Varnam and Sutherland, 2001).

Proteolysis is more extensive in blue cheese than in most other varieties. Blue cheeses are characterized by the growth of Pencillium requeforti in openings within the cheese body. In addition to proteolytic enzymes originating from the milk, coagulant and starter microorganisms. The biochemistry of ripening of blue cheese is far more complex than that of internal bacterial-ripened varieties such as Cheddar or Gouda. Despite this and the international importance of a number of blue cheeses (e.g. Roquefort, Stilton and Gorgonzola) there have been relatively few studies on proteolysis in blue cheese during ripening (Zarmpoutis et al., 1996).

Proteolysis is the most important phenomenon to take place during cheese ripening. The peptides and amino acids freed by the action of proteolytic enzymes, moulds, etc. are related both to flavour intensity (McGugar et al., 1979) and to cheese age, (Ramos, et al., 1987 and Ali, 1993).

The fat and protein contents of cow's and goat's milk are generally fairly similar. However, that does not mean cow's and goat's milk are the same? Goat's milk has a more easily digestible fat and protein content than cow milk. The increased digestibility of protein is of importance to infant diets. Goat milk can successfully replace cow milk in diets of those who are allergic to cow milk. In under-developed countries, where meat consumption is low, goat milk is an important daily food source of protein, phosphate and calcium not available otherwise because of a lack of cow milk (Paul

kindstedt, 2005), so goat's milk is more suitable for producing blue cheese.

Science a long time, a great interest had been arisen to the goats all over the globe. They were considered ideal milk animals, which can convert feed of poor nutritional quality to milk. In Egypt, the total population of goats amounted to 3.4 millions. Annual goat's milk production of 376.500 tons was estimated, however only 20% was used for human consumption (EL-Abd et al., 1992).

The objective of this study was using of goat's milk in making blue cheese (style Roquefort) in comparison with cow's milk and studying the effect of ripening temperature on the properties of the resultant cheese.

2. Materials and Methods

Milk: Whole cow's milk was obtained from the herd of the Ministry of Agriculture, (Dokki, Giza, Egypt), while goat's milk was obtained from a herd of private farm in Giza district.

Starter:*Streptococcus Lactis* ssp *Lactis* (1106) was obtained from MIRCEN, Faculty of Agriculture, Ain Shams University.

Moulds:A strain of *Pencillium roqueforti* was obtained from Chr-Hansen's A/S, Horsholm, Denmark.

Rennet: Rennet powder was obtained from Chr-Hansen's, Denmark with a commercial name HA-LA.

Salt: Pure sodium chloride (NaCl) was obtained from the local market.

Table 1: Gross composition of goat's milk compared with that o cow's milk

	Cow's milk	Goat's milk
Total solids %	12.0	12.50
Fat %	3.40	3.60
Total protein %	3.45	3.20
Lactose %	4.40	4.70
Ash %	0.72	0.75
Acidity %	0.16	0.17
pH value	6.40	6.52

Average of three replicates

Data of milk composition Table(1) indicated that averages of milk TS, fat, total protein lactose, ash, acidity and pH values showed of both goat's and cow's milk.

Blue-veined cheese making:

The method of (Kosikowski, 1982) was applied. Fresh milk was heated to 73°C for 10 min., and then cooled immediately to 35°C. 1% of active *S. Lactis* was added. When the acidity of milk reached 0.22%, rennet was added (0.3g/10kg milk). The milk was left to curdle, after complete coagulation, the curd was cut into cubes (½ inch) which were settled for 5 min. and temperature was raised to 40°C. Curd was stirred occasionally during the next 30 to 60 min., until acidity reached 0.19%. 1% of salt was added and whey was drained. The curd was hooped and each layer sprinkled with *P. roqueforti* spores containing powder. The cheese was turned at intervals for several hours. Cheese was salted in 20% brine for 24 hrs. then punched. The hoops were stored in curing refrigerator at (8-10°C, 90% relative humidity). Cheese samples were taken for analysis at1, 30 and 60 days of ripening at (refrigerator and room temperature).

Methods of analysis:

The total solids, total protein, fat pH and acidity of both cow's and goat's mil were determined as given by (A.O.A.C., 1990).

The total solids, total nitrogen, fat and acidity of blue cheese were estimated according to (A.O.A.C., 1990). pH values were measured using pH-meter with a glass electrode (MV 870-Digital-pH meter). Tyrosine and tryptophan of cheese samples were measured as Vakaleries and Price (1959). Total volatile fatty acids (TVFA) of cheese samples were estimated as described by (Kosikowski, 1982).

Amino acids analysis:

Amino acids composition of cheese samples were determined according to method of Millipore Cooperative (1987) using high pressure liquid chromatographic analysis (HPLC).

Organoleptic assessment:

Blue cheese (style Roquefort) samples were scored for organoleptic properties by a taste panel of 11 persons for National Research Centre staff as described by EL-Shazly et al., (1994). The panelists scored the cheese flavour (out of 40 points) texture (out of 20 points) and colour (out of 40 points).

3. Results and Discussion

The mean values for moisture, fat, fat/DM, nitrogen and pH in blue cheese (style Roquefort) during ripening are summarized in Table (2). Moisture content decreased gradually during ripening. Its content, of goat's blue cheese was less than that of cow's cheese at fresh and during ripening

period, this may be due to the differences in initial total solids contents of both cheeses, which related to the variation of water holding capacity of both curds during cheese making. This observation may be explained by that casein micelles of goat's milk are smaller than that of cow's milk (Juarez and Ramos, 1980 and Riel, 1985). However, moisture content of cheese ripened at refrigerator was less than that ripened at room temperature at the end of ripening period. The pH of fresh blue goat's cheese was 5.20 but increased to 5.40 for cheese ripened at room temperature and 5.50 for that ripened at refrigerator, while pH value of fresh blue cow's milk was 5.30 increased to 5.60 for cheese ripened at room temperature and 5.65 for that ripened at refrigerator. The increase in the pH of blue cheese during ripening is due to the deamination of amino acids with the production of NH3 and the metabolism of lactic acid to CO2. Similar results have been reported by (Zarmpoutis et al., 1996). Also, these results were agreed with (Abd-EL-Salam et al., 1988 and EL-Dairouty et al., 1990).

Table 2: Gross composition of blue cheese (style Roquefort) made from goat's milk compared with that o cow's milk

Chemical Composition	Ripening period (days)							
	Goat milk				Cow milk			
	1	30	60		1	30	60	
			A	B			A	B
Moisture	55.70	54.20	52.90	52.70	57.70	56.15	54.50	54.20
Fat	16.20	16.70	17.50	17.55	15.40	16.50	17.10	17.20
Fat/DM	36.57	36.46	37.15	37.10	36.41	37.62	37.15	37.10
Total nitrogen	2.65	2.95	3.20	3.40	2.80	2.95	3.15	3.45
pH value	5.20	5.30	5.40	5.50	5.30	5.50	5.60	5.65

Average of three replicates
A= at room temperature B= at refrigerator temperature

Table (2) represented that total nitrogen of goat's and cow's blue cheese. Total nitrogen content of cow's cheese was similar to goat's cheese at fresh and during ripening, total nitrogen were gradually increased in both cheeses as the ripening progressed, which due to the continuous protein hydrolysis of cheese during ripening. These results were agreed with those of (Abd-EL-Salam et al., 1988, EL-Dairouty et al., 1990 and Farahat et al., 1982).

From Table (2) it can observed that fat% and fat/DM percentage of goat's blue cheese was similar to cow's blue cheese at fresh and during ripening, fat contents were gradually increased in both cheeses as the ripening progressed, which due to the decrease in moisture content of cheese during ripening. These results were agreed with those of (Abd-EL-Salam et al., 1988, EL-Dairouty et al., 1990 and Farahat et al., 1982).

Amino acids content in blue cheese (style Roquefort):

Proteolysis of blue cheese in particularly extensive as a result to the activity of proteinase from the action of exo- and endo peptidases of *Penicillium roqueforti* (Le-Pars and Gryion, 1981). The relative proportions of free amino acids in Blue cheese made from goat's milk compared with that made from cow's milk at fresh and during ripening period, Table (3).

In fresh cheese it can be observed that Aspartic, Glutamic, Proline and Cystine were higher in both cheeses while Aspartic, Glutamine, Glycine, Proline, Leucine and Lysine were higher in cheese made from goat's milk than that made from cow's milk. This trend may be due to the variation of milk protein in both goat's and cow's milk (Juarez and Ramos, 1984). After 30 days of ripening it can be showed that the concentration of Arginine, Valine, Methionine, Cystine, Leucine, Phenylalanine and Lysine amino acids were increased with the same trend in both cheeses, while Therionine amino acid decreased in cow's cheese and increased in goat's cheese. On the other hand amino acid Proline decreased in both cheeses. In the other hand, it observed that Glutamic, Histidine, Therionine and Tyrosine amino acids were decreased in cow's cheese while, goat's cheese were increased except Proline amino acid which decreased. These variations may be

due to the breakdown of protein in Blue cheese (Fernandez-Salguero, et al., 1989).

At the end of ripening (60 days) both cheeses ripened at refrigerator or at room temperature Table

Lysine decreased in goat's cheese and increased in cow's cheese. The remain amino acids increased in goat's cheese, while decreased in cow's cheese during ripening. This decreasing in some amino acids concentration may be attributed to their degradation to another minor components and free fatty acids throughout the decarboxylation and deamination of amino acids (Nakae and Eliott, 1965 and Ali, 1993).

(3), the results evaluated that Aspartic and Glutamic were decreased in both cheeses while, Proline and

Total amino acids in both blue cheese (Style Roquefort) increased during ripening period especially, after 30 days. On the other hand cheese ripened for 60 days at room temperature had a higher total amino acids contents in goat's cheese than that in cow's cheese. Total amino acids were higher when cheese ripened at refrigerator than that ripened at room temperature. These results were agreed with that obtaining by Dolores Gonzales de Liano et al., 1991.

Table 3: Mean values of free amino acids content of Roquefort style cheese made from goat's milk compared with that o cow's milk during ripening.

Amino acids concentration g/100 g cheese protein	Ripening period (days)							
	Goat milk				Cow milk			
	Fresh	30	60		Fresh	30	60	
			A	B			A	B
Aspartic	3.56	1.08	0.12	0.99	1.96	0.98	0.48	1.97
Glutamic	4.37	6.97	0.87	0.02	2.23	1.24	0.95	1.99
Serine	0.19	0.35	0.22	0.22	0.29	0.21	0.09	0.14
Glycine	0.28	0.37	0.19	0.27	0.24	0.23	0.12	0.23
Histidene	0.63	1.30	0.91	0.90	1.29	0.96	0.44	0.53
Argininr	0.64	1.26	0.82	0.72	0.41	0.61	0.30	0.90
Therionine	0.36	3.09	0.60	2.54	1.84	1.62	0.82	0.41
Alanine	0.52	0.59	0.24	0.22	0.38	0.35	0.15	0.28
Proline	3.19	1.72	2.35	1.29	1.39	1.17	0.34	2.76
Tyrosine	0.46	1.19	0.99	1.00	0.72	0.58	0.12	0.88
Valine	0.16	1.61	3.77	1.17	0.99	1.25	0.22	0.51
Methionine	0.01	1.68	0.28	1.47	0.78	1.17	0.13	0.18
Cystine	2.50	27.77	13.44	20.65	4.33	16.51	1.41	0.96
Iso leucine	0.29	0.54	0.63	1.61	0.18	0.37	0.08	0.01
Leucine	0.62	1.58	0.67	1.11	0.20	0.54	0.03	0.10
Phenylalanine	0.66	1.80	0.28	1.68	0.19	0.54	0.20	0.24
Lysine	2.98	3.76	1.16	1.45	0.65	3.08	1.58	0.13
Total	**21.52**	**56.66**	**27.54**	**37.22**	**18.07**	**31.42**	**7.46**	**12.22**

Average of three replicates

A= at room temperature B= at refrigerator temperature

Ripening indices:

Table (4) reflected total volatile fatty acids in both blue cheese (Style Roquefort) increased during ripening period. On the other hand cheese ripened 60 days at room temperature had higher total volatile fatty acids contents in goat's cheese than that in cow's cheese. Total volatile fatty acids content were higher when cheese ripened at room temperature than that ripened at refrigerator. These results were agreed with that obtaining by (Dolores Gonzales de Liano et al., 1991).

Tyrosine and Tryptophan contents were gradually increased in the two treatments with progressive ripening (Table 4). However, at the end of ripening period Tyrosine & Tryptophan contents of goat's cheese were higher than that in cow's cheese. Also, their content was higher of cheese ripened at room temperature than that ripened at refrigerator.

Table 4: Mean values of total volatile fatty acids, Tyrosine and Tryptophan blue cheese made from goat's milk compared with that of cow's milk during ripening.

Ripening Period	TVFA		Tyrosine		Tryptophan	
	Cow	Goat	Cow	Goat	Cow	Goat
1	3.8	3.4	10.6	13.8	19.8	23.8
30	10.6	12.6	29.9	38.6	24.6	36.5
60 room temperature	31.2	35.2	88.3	110.3	56.5	60.9
60 refrigerator	22.8	20.0	54.1	63.2	36.8	43.3

Average of three replicates

Table 5: The sensory evaluation of blue cheese made from goat's milk compared with that of cow's milk during ripening.

	One month		Two months			
			Room temperature		Refrigerator	
	Cow	Goat	Cow	Goat	Cow	Goat
Colour (40)	22	24	36	38	26	28
Flavour (40)	32	36	32	38	34	36
Texture(20)	16	16	16	18	18	18
Total (100)	70	76	84	94	78	82

Average of three replicates

Organoleptic properties:

Table (5), shows the sensory evaluation of blue cheese (Style Roquefort) during ripening. Blue goat's cheese was ranked the highest total score (76/100) when one month old. Also, the same cheese ranked the highest total score (94/100) at the end of ripening period (60 days) when cheeses were ripened at room temperature. Blue cheese made from goat's was ranked higher flavour score than that made from cow's milk during ripening period. The cheese ripened at room temperature had higher total score than that ripened at refrigerator.

4. Conclusion

It can be concluded that blue cheese (Style Roquefort) can be successfully made from goat's milk, the resultant cheese had a similar properties compared with that made from cow's milk. Also, this cheese had acceptability over than that made from cow's cheese and was also, ranked the highest total score during ripening.

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12/21/2010