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Bacteriological quality of on-farm manufactured goat cheese

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SUMMARY

The bacteriological quality of 198 ripened soft or semi-soft goat cheeses obtained from dairy farms and the retail trade was investigated. The cheeses were examined for total counts of aerobic bacteria, coliform bacteria (37 and 44 °C respectively), enterococci, coagulase positive staphylococci, *Bacillus cereus* and *Clostridium perfringens*. Cheeses obtained from dairy-farms were also determined for pH value. In terms of all tests performed, cheeses made of heat-treated milk with starter culture had the best prospects for fulfilling the criteria for 'fit for consumption'. Cheeses made of raw milk without starter culture made up the most unsatisfactory group from a food-hygiene point of view. Bacteriological guidelines for on-farm manufactured goat cheese are suggested.

INTRODUCTION

During the last few years there has been an increasing demand for goat milk and goat milk products in many countries (1–3). This increases the need for public health laboratories to include these products in their routine microbiological examination of food. Only a few surveys of the microbiological quality of commercial goat milk (1, 4, 5) and goat cheese (6, 7) have hitherto been published. The present study was conducted in order to obtain knowledge about the bacteriological quality of goat cheeses manufactured in different ways.

MATERIALS AND METHODS

Ripened soft or semi-soft goat cheeses, in all 198, obtained from dairy-farms and the retail trade were the subject of the present study. All cheese samples from the dairy-farms were packed in plastic bags and sent together with ice packs to the laboratory. These samples arrived at the laboratory within 24 h, while the samples bought in shops were transported by car and reached the laboratory within 4 h. All samples, each at least 300 g, were kept at 4 °C in the laboratory and the examinations were carried out within 3 days of arrival.

The samples were divided into four groups: dairy-farm cheeses made of milk heat-treated at 71–72 °C for 15–30 s or at 63–68 °C for 10–30 min (the lower the

Table 1. *Distributions of cheeses according to age*

	Cheeses made of					
	Heat-treated milk with starter culture (HS)		Raw milk with starter culture (RS)		Raw milk without starter culture (R)	
Age	No.	%	No.	%	No.	%
< 2 weeks	21	48	26	47	9	38
⩾ 2 weeks to < 2 months	15	34	19	35	12	50
⩾ 2 months to < 4 months	8	18	10	18	3	13
Total	44		55		24	

temperature the longer the time) and with starter culture (HS): 44 cheeses from 16 farms; dairy-farm cheeses made of raw milk with starter culture (RS): 55 cheeses from 16 farms; dairy-farm cheeses made of raw milk without starter culture (R): 24 cheeses from 8 farms; cheeses of unknown manufacturing process and date purchased in shops (P): 75 cheeses from 32 shops.

The starter culture used for all cheeses in HS and RS was 'filmjölk'. This is a product of fermented whole cow milk marketed in Sweden. For the samples obtained from dairy-farms, the day of manufacturing was noted (Table 1).

Preparation of sample

From each cheese a 10 g cube, consisting of material from both the surface and the interior, was cut. Using a stomacher, the sample was macerated and blended with 90 ml of sterile peptone water. Tenfold serial dilutions of 1 ml of macerate were made in peptone water. The macerate and the dilutions were then pour-plated in 1 ml portions into, or surface-plated in 0·1 ml portions onto, the media used.

pH

The pH of the macerate of each cheese sample obtained from the dairy-farms (groups HS, RS and R) was measured with a pH meter (Orion Research, model 701 A).

Confirmatory tests

The different confirmatory tests are described under each analysis. For these confirmatory tests 10 typical colonies or, when fewer were grown, all typical colonies, were examined.

Total counts of aerobic bacteria

Pour plates of Tryptone Glucose Extract Agar (Difco) were incubated at 30 °C for 72 h. The plates were then examined, using a hand lens in good illumination, and all colonies were counted.

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Coliform bacteria (37 and 44 °C)

Pour plates of Violet Red Bile Agar (VRB Agar, Oxoid) were allowed to solidify and were then overlaid with 3–4 ml of melted VRB Agar. The plates were incubated at 37 °C for 24 h and at 44 °C for 48 h respectively. All pink to red colonies, irrespective of diameter or presence/absence of zone of precipitation, were counted as being 'coliform bacteria 37 °C' and presumptive 'coliform bacteria 44 °C'.

Colonies of presumptive 'coliform bacteria 44 °C' were transferred to tubes containing Brilliant Green Bile (2%) Broth (Oxoid). These tubes were incubated in a waterbath at 44 °C for 48 h. Strains growing with pink to red colonies on VRB Agar incubated at 44 °C for 48 h and producing gas in Brilliant Green Bile Broth were classified as 'coliform bacteria 44 °C' (8, 9).

Enterococci

Surface-inoculated plates of Slanetz and Bartley Medium (Oxoid) were incubated at 44 °C for 48 h. The plates were then examined using a hand lens in good illumination. All pink, red or maroon colonies, irrespective of diameter, were counted.

Coagulase positive staphylococci

Surface-inoculated plates of Baird-Parker medium (BBL) were incubated at 37 °C for 48 h. Typical colonies and also such black colonies which only had one of the two zones stipulated by Baird-Parker (10) were selected for the following confirmation tests: Gram reaction, oxidation and fermentation of glucose (O/F), production of catalase and coagulase (tube test).

The production of enterotoxins A, B and C_1 was tested for 63 strains of coagulase positive staphylococci recovered from 16 cheeses delivered by 16 dairy farms using antisera and reference enterotoxins from Serva Feinbiochemica, Heidelberg, Federal Republic of Germany. In order to obtain a concentrated enterotoxin solution, the 'cellophane sac culture technique' described by Donnelly and co-workers (11) was used. The enterotoxins were determined using a microslide gel double-diffusion technique. The test was performed as described by Zehren and Zehren (12).

Bacillus cereus

Surface-inoculated plates of blood agar (5 ml defibrinated horse blood and 95 ml Blood Agar Base, Difco) were incubated at 30 °C for 24 h. Bacteria from colonies with typical *B. cereus* morphology and showing haemolysis were surface-inoculated onto egg yolk agar (Tryptone Soya Agar and Egg Yolk Emulsion, Oxoid) and onto *B. cereus* selective agar (Cereus Selective Agar Base according to Mossel, Merck and Egg Yolk Emulsion, Oxoid). The plates were incubated at 30 °C for 24 h. Cells from presumptive *B. cereus* colonies were Gram-stained and microscopically examined.

Clostridium perfringens

C. perfringens was determined using Bacto SFP Agar Base (Difco) supplemented with 10 ml of 4% D-cycloserine (Sigma) per litre medium. Pour plates were prepared and then incubated at 37 °C for 24 h in anaerobic jars equipped with GasPak (BBL). Black colonies with a diameter > 1 mm were regarded as presumptive *C. perfringens* colonies. For confirmation, the isolated strains were tested in buffered motility/nitrate medium according to Nordic Committee on Food Analysis (13) and in nutrient gelatine. Non-motile strains which reduced nitrate to nitrite and hydrolysed gelatine were regarded as *C. perfringens*.

Salmonella

From each of 31 samples, belonging to group P, a 10 g cube, consisting of material from both the surface and the interior, was cut down into a vial containing 40 ml of Tetrathionate Broth (complete medium according to Oxoid). Incubation was performed at 37 °C for 24 h, whereupon material from the broth was streaked on plates with Brilliant Green Agar (Oxoid CM 329). The plates were incubated at 37 °C and examined after 24 and 48 h.

Listeria

For technical reasons, listeria were not sought in this study.

Statistical analyses

Bravais correlation coefficients were calculated pairwise between six parameters: total counts of aerobic bacteria, coliform bacteria (37 and 44 °C respectively), enterococci, pH and maturation time for each of the HS, RS and R groups (Tables 4–6). For group R (Table 6) coefficients are also given for coagulase positive staphylococci. The critical values with $P < 5\%$ are given for evaluation of Bravais correlation coefficients in the tables (Tables 4–6).

RESULTS

pH

Table 2 shows the distribution of the pH levels for the three groups HS, RS and R.

Total counts of aerobic bacteria

Fig. 1 shows the distribution of the total counts of aerobic bacteria for each group of cheeses. Among the 198 cheeses there were 34 samples having $\geqslant 10^9$ in total counts of aerobic bacteria per g.

Coliform bacteria (37 and 44 °C respectively)

The distributions of the numbers of coliform bacteria (37 and 44 °C) respectively are illustrated for each group of cheeses in Fig. 2 and Fig. 3. Thirty of the 34 samples having $\geqslant 10^9$ in total counts of aerobic bacteria per g had $\geqslant 10^4$ coliform bacteria 37 °C per g.

Table 2. *Distributions of cheeses according to pH*

	Distributions					
	HS		RS		R	
pH level	No.	%	No.	%	No.	%
⩾ 5·0 – < 5·5	17	39	19	35	3	13
⩾ 5·5 – < 6·0	16	36	22	40	10	42
⩾ 6·0 – < 6·5	7	16	8	15	8	33
⩾ 6·5 – < 7·0	3	7	3	6	3	13
⩾ 7·0 – < 7·5	1	2	2	4	—	—
⩾ 7·5	—	—	1	2	—	—
Total	44	—	55		24	

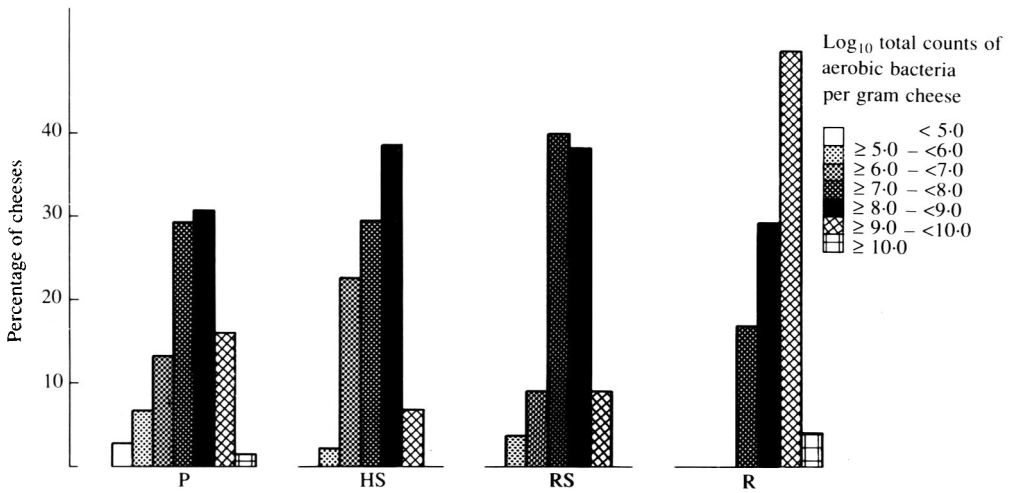

Fig. 1. Distribution of the total counts of aerobic bacteria in each group of cheeses. P, of unknown manufacturing process; HS, of heat-treated milk with starter culture; RS, of raw milk with starter culture; R, of raw milk without starter culture.

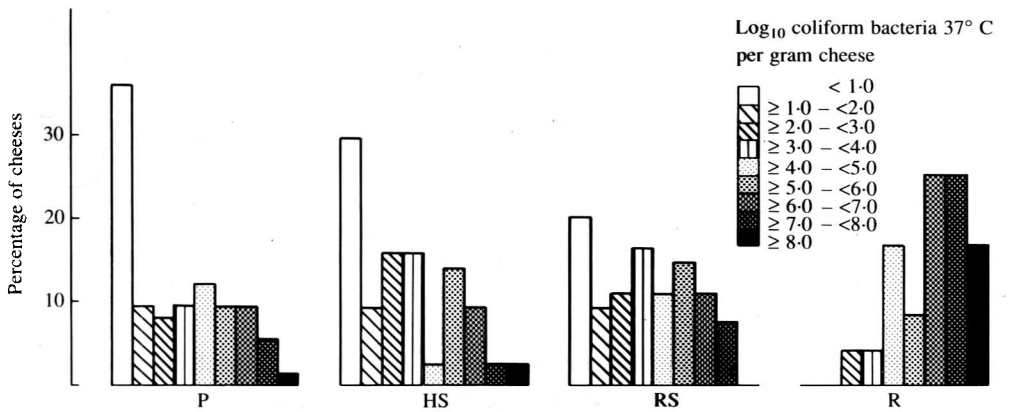

Fig. 2. Distribution of the coliform bacteria 37 °C in each group of cheeses. P, of unknown manufacturing process; HS, of heat-treated milk with starter culture; RS, of raw milk with starter culture; R, of raw milk without starter culture.

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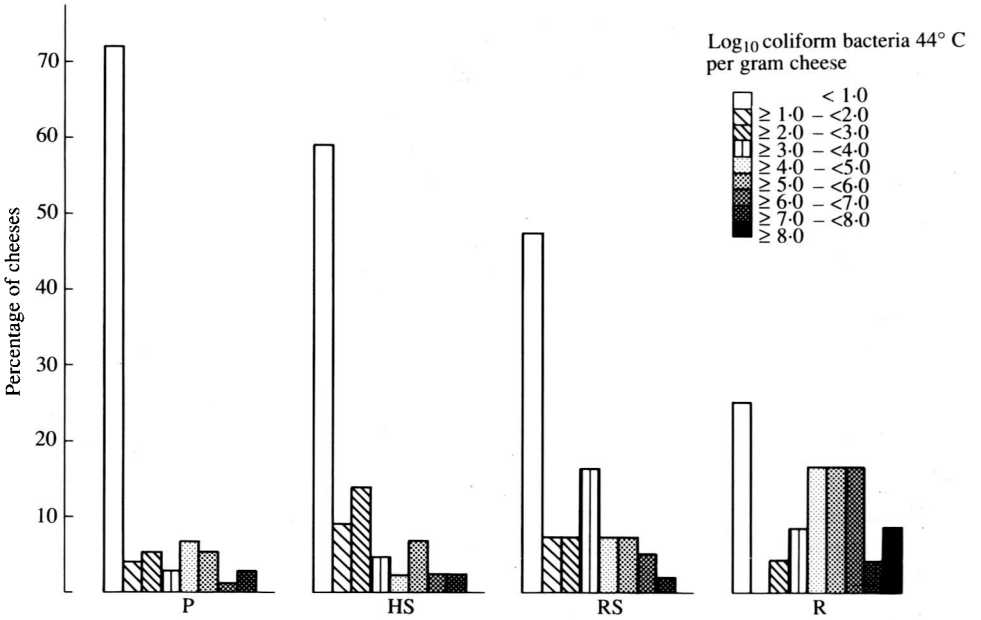

Fig. 3. Distribution of the coliform bacteria 44 °C in each group of cheeses. P, of unknown manufacturing process; HS, of heat-treated milk with starter culture; RS, of raw milk with starter culture; R, of raw milk without starter culture.

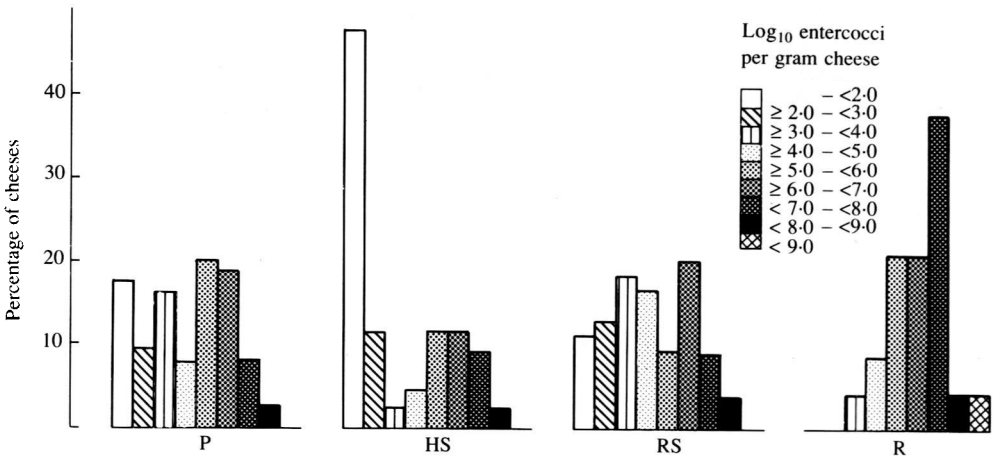

Fig. 4. Distribution of the enterococci in each group of cheeses. P, of unknown manufacturing process; HS, of heat-treated milk with starter culture; RS, of raw milk with starter culture; R, of raw milk without starter culture.

Enterococci

Fig. 4 shows the distribution of enterococci for each group of cheeses. Among the 198 cheeses there were 31 samples having $\geqslant 10^7$ enterococci per g. All these 31 samples had $\geqslant 10^4$ coliform bacteria 37 °C and/or $\geqslant 10^3$ coliform bacteria 44 °C per g.

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Table 3. *Distributions of cheeses according to coagulase positive staphylococci*

	Distributions							
	P		HS		RS		R	
Log c.p.s. per g	No.	%	No.	%	No.	%	No.	%
< 2·0	68	91	38	86	37	67	12	50
⩾ 2·0 – < 3.0	3		2		4		—	
⩾ 3·0 – < 4·0	2		2		6		6	
⩾ 4·0 – < 5·0	1	9	—	14	2	33	2	50
⩾ 5·0 – < 6·0	1		2		3		1	
⩾ 6·0 – < 7·0	—		—		3		2	
⩾ 7·0	—		—		—		1	
Total	75		44		55		24	

Coagulase positive staphylococci (c.p.s.)

The distributions of c.p.s. for the four groups of cheeses are given in Table 3. Among all the 198 cheeses there were 43 samples having $\geqslant 10^2$ c.p.s. per g. Of these 43 samples 34 had $\geqslant 10^4$ coliform bacteria 37 °C and/or $\geqslant 10^3$ coliform bacteria 44 °C per g.

Of the 63 strains tested for enterotoxin production, enterotoxin A was produced by 14 (22 %), C_1 by 20 (32 %) and both A and C_1 by 3 (5 %) strains. The majority (41 strains) of the 63 strains did not show all the four criteria on BP agar (10). Of these 41 'atypical' strains two produced enterotoxin A, 20 enterotoxin C_1, 1 both enterotoxin A and C_1.

Clostridium perfringens

Seven of the 198 cheese samples studied, with all four cheese groups represented, exceeded 10^2 *C. perfringens* per g. Of these 7 samples, 4 also contained $\geqslant 10^5$ coliform bacteria 37 °C and $\geqslant 10^4$ coliform bacteria 44 °C per g. The largest number of *C. perfringens* isolated was 3×10^4 per g (one cheese).

Bacillus cereus

Eight of the 198 cheese samples, with all four cheese groups represented, contained $\geqslant 10^2$ *B. cereus* per g. Four of these eight cheeses also contained $\geqslant 10^5$ coliform bacteria 37 °C and $\geqslant 10^4$ coliform bacteria 44 °C per g. The largest number of *B. cereus* isolated was 2×10^5 per g (one cheese). In no case was *C. perfringens* and *B. cereus* isolated from the same sample.

Salmonella

Salmonella was not detected in any of the 31 cheeses (P) investigated.

DISCUSSION

pH

In the present study about 75 % of the sample macerates from the HS and the RS groups respectively had pH < 6·0 (Table 2). A low pH is desirable since this gives good protection against pathogens (14–17). For the cheeses belonging to

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Table 4. *Bravais correlation coefficients for 44 cheeses made of heat-treated milk with starter culture (HS). Critical r = 0·29 (P < 0·05). All table values higher than critical r are significant*

Parameters	Total counts	Coliform 37 °C	Coliform 44 °C	Enterococci	pH	Maturation
Total counts of aerobic bacteria	—	0·47	0·32	0·40	0·24	0·07
Coliform bacteria 37 °C	—	—	0·61	0·73	0·51	0·36
Coliform bacteria 44 °C	—	—	—	0·42	0·25	0·27
Enterococci	—	—	—	—	0·48	0·36
pH	—	—	—	—	—	0·42
Maturation	—	—	—	—	—	—

group HS and RS, there is a positively significant correlation between pH and maturation time, i.e. lower pH level was foremost found in the younger cheeses and higher pH level in the older cheeses (Tables 4 & 5).

Total counts of aerobic bacteria

Only two samples exceeded 10^{10} in total counts of aerobic bacteria per g, one from group R and one from group P. Samples with $\geqslant 10^9$ but $< 10^{10}$ per g were found in all four groups of cheeses but most in group R (Fig. 1). This may be because no starter culture was present to inhibit the natural flora. Kosikowski (15) states that 10^9 in total counts of aerobic bacteria per g are realistic numbers in 'natural ripened cheese'. Our opinion, however, is that total counts of $\geqslant 10^9$ are not satisfactory from a food-hygiene point of view.

Coliform bacteria 37 °C

Hunter (18) reported coliforms to be rare in the goat udder. Coliforms were only isolated from one among 483 aseptically drawn milk samples from 250 goats. This sample came from a goat showing clinical signs of mastistis. In samples of commercial raw goat milk obtained from both producers and retailers, Jensen and Hughes (4) found 24%, Roberts (1) 19% and Espie and Mullan (5) 34% with counts of $> 10^3$ coliforms per ml. These results indicate that the milk easily gets contaminated after leaving the udder. Since coliforms are killed by pasteurization (15, 19), the coliforms isolated from cheeses made of pasteurized or milk sufficiently heat-treated in other ways, probably emanate from contamination during the cheese-making procedure (20, 21).

The correlations between maturation time and coliform bacteria 37 °C are positively significant for the HS and negatively significant for the R, whereas no correlation was found for the RS group (Tables 4–6). It is difficult to draw conclusions from these results. The influence of the maturation time on coliforms might be dependent on, for example, the storage temperature for the cheeses and the spectrum of coliform species contained by the cheeses (22–24). There is a positive significant correlation between the pH level and the number of coliform bacteria 37 °C in the two groups with starter culture (Tables 4, 5). These results are in agreement with the statement that an active starter culture rapidly lowers the

Table 5. *Bravais correlation coefficients for 55 cheeses made of raw milk with starter culture (RS). Critical r = 0·26* ($P < 0·5$). *All table values higher than critical r are significant*

Parameters	Total counts	Coliform 37 °C	Coliform 44 °C	Enterococci	pH	Maturation
Total counts of aerobic bacteria	—	0·30	0·23	0·36	0·16	0·003
Coliform bacteria 37 °C	—	—	0·61	0·45	0·29	0·04
Coliform bacteria 44 °C	—	—	—	0·36	0·03	0·10
Enterococci	—	—	—	—	0·47	0·42
pH	—	—	—	—	—	0·51
Maturation	—	—	—	—	—	—

pH level, thus causing an environment unfavourable for the coliforms (15, 25). Yale and Marquardt (26) showed that the lower the pH in cheddar cheese, the slower the growth of coliform bacteria 37 °C.

Coliform bacteria 44 °C

Determination of coliform bacteria 44 °C is used by the food industry and health authorities as a test to indicate poor manufacturing practice. These bacteria are not normal in the udder of milking animals, and if present they may cause mastitis (18). The normal habitat of coliform bacteria 44 °C, mainly *Escherichia coli*, is the intestinal canal of warm blooded animals. Consequently, these organisms should not be present in cheeses or other ready-to-eat food. From commercial raw goat milk, Jensen and Hughes (4) isolated *E. coli* in 61%, Roberts (1) in 9% and Espie and Mullan (5) in none of the samples tested. In group R, as many as 75% of the cheeses contained $\geqslant 10^2$ coliform bacteria 44 °C per g (Fig. 3). If large numbers of *E. coli* and other pathogenic *Enterobacteriaceae* occur in a dairy product, it could constitute a health hazard (21, 27).

Enterococci

There are two main opinions about the presence of enterococci in cheese. One is that enterococci constitute a part of the ripening flora in cheese, and thus have no hygienic significance (7, 15, 28–30). Among the HS and RS cheeses, there is a positively significant correlation between enterococci and maturation time (Tables 4 & 5). The other opinion is that the enterococci should be considered as indicators of deficient hygiene (31), faecal contamination (32–34) or even constitute a risk of food poisoning (34, 35). In the present study also the number of enterococci and the number of coliform bacteria (37 and 44 °C) are positively significantly correlated in the HS and RS groups (Tables 4, 5). Brandl and co-workers (30), however, who examined cheeses of different types (presumably cow milk cheese), found no correlation between counts of coliform bacteria and enterococci and concluded that enterococci in cheese had neither the function of indicator organisms for good manufacturing practice nor that they provided evidence of health risks. Norberg (6) reported that 25 of 35 goat cheeses from the retail trade

had enterococci counts of $> 10^5$ to $\leqslant 10^7$ and six cheeses $> 10^7$ per g. He is of the opinion that if the number of enterococci in cheese is very large this indicates deficient treatment. Our opinion is that not only the numbers of enterococci may be judged but also their potential for production of histamine (36) and other toxigenic substances (37).

Coagulase positive staphylococci (c.p.s.)

Staphylococcal toxin is probably the most common food poisoning agent associated with cheeses (38). The staphylococci may originate from a primary contamination, i.e. being excreted with the milk, or from a secondary contamination, mainly from persons manufacturing the food.

In a Swedish survey, c.p.s. were isolated from aseptically drawn goat milk in 1% of 371 samples (7). The share of samples with c.p.s. in two corresponding investigations – one Scottish (18) (483 samples) and one Californian (39) (4662 samples) – was 3%. An explanation of the lower incidence in the Swedish investigation might be that, in the area studied, goats with clinical signs of mastitis were slaughtered. Buyser and co-workers (2) analysed 52 c.p.s. strains isolated from individual goat milk samples and found that 39 (75%) of the strains produced enterotoxin C. One strain produced enterotoxin D.

In commercial raw goat milk obtained both from producers and retailers, c.p.s. were isolated from 16 (6%) of 291 samples (4) and 107 (4%) of 2474 samples (1). Up to 50% of the R cheeses studied contained more than 10^2 c.p.s. per g. For P, HS and RS cheeses the corresponding figures were 9%, 14% and 33% (Table 3). Many of the strains isolated were also enterotoxin-producing. Norberg (6) found 8 (38%) of 21 goat cheeses from the retail trade with $> 10^2$ c.p.s. per g.

Discussing cheese in general, some authors state that c.p.s. decline after a couple of weeks' ripening (17, 40–42). However, in the present study there is no significant correlation between maturation time and the number of c.p.s. per g in the R group (Table 6). It is also essential to note that an investigation showing the absence of c.p.s. does not guarantee that the cheese is free of enterotoxin (42–44).

In a goat cheese involved in a food poisoning event, Hole (45) found 900 million c.p.s. per g. Two lactating goats on the dairy farm had mastitis. C.p.s. isolated from newly made cheeses and the mastitis milk produced both enterotoxin A and D. In another case of poisoning involving goat cheese, Kvellestad and co-workers (46) found 6000 to 9 million c.p.s. per g of cheeses. The presence of both C and D staphylococcal enterotoxin in the cheeses was proven.

In, our opinion the presence of c.p.s. must be seriously considered.

Bacillus cereus *and* Clostridium perfringens

C. perfringens or *B. cereus* was isolated from only 4% of the cheeses in the present study. Norberg (6) did not find *C. perfringens* at all when investigating 35 goat cheeses. However, in a study by Seligman (47) including 83 home-made goat cheeses, 9 had 10^1–10^2 *C. perfringens* per g. There appear to be no reports in the literature concerning the frequency of *B. cereus* in goat cheese. However, from commercial raw goat milk, Jensen and Hughes (4) isolated *B. cereus* from 7% (20 of 291) and Roberts (1) from < 1% of samples (3 of 1348).

Table 6. *Bravais correlation coefficients for 24 cheeses made of raw milk without starter culture (R). Critical r = 0·40 (P < 0·05). All table values higher than critical r are significant*

Parameters	Total counts	Coliform 37 °C	Coliform 44 °C	Entero-cocci	C.p.s.	pH	Matura-tion
Total counts of aerobic bacteria	—	0·41	0·02	0·44	−0·06	−0·31	−0·06
Coliform bacteria 37 °C	—	—	0·29	0·51	0·35	−0·03	−0·49
Coliform bacteria 44 °C	—	—	—	0·39	−0·08	−0·48	−0·30
Enterococci	—	—	—	—	0·18	−0·31	−0·02
Coagulase positive staphylococci	—	—	—	—	—	0·43	−0·38
pH	—	—	—	—	—	—	−0·07
Maturation	—	—	—	—	—	—	—

Salmonella

Salmonella could not be detected in any of the 31 investigated samples. Neither Roberts (1) nor Norberg (6) could find salmonella bacteria in commercial raw goat milk (2462 samples) or in goat cheese (35 samples), respectively. Jensen and Hughes (4) isolated salmonella from 1 of 291 samples of commercial raw goat milk. Moreover few outbreaks of salmonella infections due to cheese have been reported (38).

General comments

On the basis of the present results and discussion it is suggested that the most suitable parameters for examining the hygienic condition of on-farm manufactured ripened soft or semi-soft goat cheese are coliform bacteria 37 °C, coliform bacteria 44 °C and coagulase positive staphylococci. The coliform bacteria were selected because they provide good measurements of hygiene and the c.p.s. because they are the pathogens most often connected with outbreaks of cheese poisoning (38).

Since cheeses which have large numbers of total counts of aerobic bacteria and/or enterococci also show, in almost all cases, such high figures of coliform bacteria that they will be judged as unfit for consumption (see guidelines below), the parameters 'total counts of aerobic bacteria' and 'enterococci' may be excluded. The pathogenic species *C. perfringens* and *B. cereus* seem to be rather unusual in this type of cheese and when appearing they may be accompanied by rather large counts of coliform bacteria. Concerning the analysis of salmonella, consideration must be taken to the current salmonella situation, i.e. in countries which have no problems with salmonella in farm animals the analysis may be omitted. Furthermore, the fewer the parameters the less costly the investigation. On the basis of the results of the present study we suggest the following guidelines:

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Table 7. *Hygienic classification of the 198 cheeses according to the bacteriological guidelines given under general comments*

	Hygienic classification (%)			
Group of cheeses	Fit for consumption	Fit for consumption with reservation	Unfit for consumption	Total
P	51	9	40	100
HS	41	25	34	100
RS	29	9	62	100
R	0	0	100	100

Analysis	Fit for consumption	Fit for consumption with reservation	Unfit for consumption
Coliform bacteria 37 °C	< 1000	1000 – < 10000	⩾ 10000
Coliform bacteria 44 °C	< 100	100 – < 1000	⩾ 1000
Coagulase positive staphylococci	< 100	100 – < 1000	⩾ 1000

If these guidelines were used for judgement of the cheeses involved in the present investigation, the results obtained would be as presented in Table 7. The most common reason for the judgement 'unfit for consumption' was coliform bacteria 37 °C (group P) or the combination of coliform bacteria 37 °C and coliform bacteria 44 °C (HS, RS and R). The most common reason for the judgement 'fit for consumption with reservation' was coliform bacteria 37 °C (P and RS) or coliform bacteria 44 °C (HS).

None of the cheeses constituting the R group fulfilled the criteria for 'fit for consumption'. Thus it seems to be difficult to make a cheese of acceptable hygienic quality out of raw milk, especially when no starter culture is added.

CONCLUSION

The investigation of the bacteriologic quality of on-farm manufactured goat cheese indicates that the manufacturing of cheese from raw milk presents public health risks. Adequate heat-treatment of the milk and use of starter culture is recommended as the best means of preventing cheese-borne diseases. However, heat-treatment and starter culture may be insufficient unless completed by good hygiene throughout cheese production. Coliform bacteria (37 and 44 °C) and coagulase positive staphylococci might be the most useful parameters when examining the hygienic quality of on-farm manufactured goat cheeses.

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