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Application of the lactoperoxidase system to improve the quality of goat milk cheese

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Abstract

Gouda cheese was made from goat milk preserved by the lactoperoxidase (LP) system and the effect of the LP system on the biochemical, microbiological and sensory properties of cheese over a ripening period of 90 days was investigated. Cheese made from LP-activated goat milk had significantly lower coliform and coagulase positive staphylococci counts as compared to cheese made from the untreated control goat milk. The LP treatment did not affect the overall chemical composition of the cheese. The level of proteolysis in both the control and the LP-treated goat milk cheeses was similar. However, the level of lipolysis of cheese made from LP-activated goat milk was significantly lower (9.7 milliequivalent/100 g fat) than that made from the control goat milk (12.3 milliequivalent/100 g fat) at the end of the ripening period. The lower lipolytic activity of cheese made from LP-activated goat milk might be of importance in reducing the strong flavour associated with goat milk cheeses. Significant differences in the overall sensory attributes were observed between cheeses made from the untreated control and LP-activated goat milk. Gouda cheese made from LP-activated goat milk had a milder flavour than the control. Thus, it can be concluded that preservation of goat cheese milk by the LP system can be used to improve the microbiological quality and flavour of Gouda cheese without any detrimental effect on the gross chemical composition of the cheese.

Keywords: Lactoperoxidase system, gouda cheese, goat milk
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Introduction

Goat milk and milk products are important sources of protein for humans in many developing countries (Klinger & Rosenthal, 1997). However, its production and handling presents a major problem limiting its consumption. Most goat milk cheeses are manufactured from raw goat milk with or without thermal treatment (Klinger & Rosenthal, 1997). Cheeses made under these conditions may not have the minimum hygiene and sanitary guarantee necessary to obtain constant product quality. The naturally occurring antimicrobial system in milk, the lactoperoxidase (LP) system, can be used to improve the quality of goat milk cheeses. The objective of this study was therefore to assess the effect of the lactoperoxidase (LP) system on the quality of goat milk cheese.

Materials and Methods

Milk samples obtained from a herd of Saanen goats kept at the Faculty of Veterinary Science, University of Pretoria, were used for the cheesemaking experiment. The milk samples were divided into two portions of 10 litres each. One portion was LP-activated as recommended by the International Dairy Federation (IDF, 1988) and the other portion was used as a control. Gouda cheese was made from the treated and the control milk samples according to Scott *et al*. (1998). A mesophilic cheese starter culture LL 50C (Anchor Biotechnologies, Johannesburg) which has previously been tested for its resistance to the LP system (Seifu *et al*., 2003) was used for the cheesemaking experiment. The parameters measured were: fat content of milk and cheese samples; salt and moisture content of cheese samples; total solids content of milk samples; protein content of milk and cheese samples using a Leco FP-528 Nitrogen/Protein Analyser (Leco Corporation, Michigan, USA); proteolysis in cheese samples by measuring the water soluble nitrogen, trichloroacetic acid soluble nitrogen and phosphotungstic acid soluble nitrogen at 30, 60 and 90 days of ripening; lipolysis in cheese samples by measuring the total free fatty acids; microbiological analysis of cheese samples and sensory analysis of cheese samples using the triangle test. All these were determined following standard methods as described by Seifu *et al*. (2004). The pH of cheese samples was measured

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using a penetration electrode (Sentron Inc., USA). The Wilcoxon Mann Whitney test was used to statistically analyse the data (SAS, 1999). The experiment was repeated four times.

Results and Discussion

The Saanen goat milk used for the cheesemaking experiment had a fat content of 38.3 g/kg, a protein content of 27.3 g/kg, a total solids content of 119.7 g/kg and a solids-not-fat content of 81.5 g/kg. These values are consistent with the values reported previously by Habteyohannes (2001).

Activation of the LP system did not affect the gross chemical composition and yield of Gouda cheese made from Saanen goat milk (Table 1). This finding is in line with an earlier report by Santos *et al*. (1995). No difference ($P > 0.05$) in pH was observed between the control and the experimental cheeses (Table 1). This can be attributed to the use of the LP-resistant starter culture (LL 50C) during the cheesemaking experiment.

Table 1 Yield and chemical composition of Gouda cheese made from lactoperoxidase activated and control Saanen goat milk during a ripening period of 90 days (n = 4 ± s.d.)

	Day 1		Day 90	
Parameter[a]	LP cheese	Control cheese	LP cheese	Control cheese
Moisture (g/100 g)	40.8 ± 1.03	41.2 ± 0.31	40.3 ± 0.57	40.7 ± 0.32
pH	5.16 ± 0.11	5.11 ± 0.06	5.14 ± 0.07	5.09 ± 0.08
Protein (g/100 g)	23.8 ± 1.06	24.1 ± 1.11	2 4.2 ± 0.63	24.1 ± 1.14
Fat (g/100 g)	32.4 ± 2.3	32.5 ± 2.7	34.1 ± 2.2	34.2 ± 2.1
Fat in dry matter (g/100g)	56.7 ± 5.4	55.1 ± 4.2	57.1 ± 2.95	57.8 ± 3.7
Salt (g/100 g)	2.1 ± 0.29	2.0 ± 0.09	2.5 ± 0.58	2.6 ± 0.20
Salt in moisture (g/100 g)	5.3 ± 0. 61	5.1 ± 0.14	5.0 ± 1.62	5.1 ± 1.67
Yield[b]	9.9 ± 0.74	10.1 ± 0.55		

[a]No difference ($P > 0.05$) was observed between the experimental and the control cheeses for all the parameters
[b]Yield expressed as kg dry matter per 100 litre of milk ; LP - lactoperoxidase; s.d. - standard deviation

Table 2 Proteolytic and lipolytic changes during ripening of Gouda cheese made from lactoperoxidase activated and control Saanen goat milk (n = 4 ± s.d.)

Parameter	Cheese	Ripening time (days)		
	Type	30	60	90
WSN[c]	LP	7.31 ± 0.07[a]	7.69 ± 0.03[a]	9.56 ± 0.03 [a]
	Control	7.51 ± 0.07[a]	8.02 ± 0.02[a]	10.01 ± 0.03[a]
TCASN[c]	LP	0.92 ± 0.02[a]	1.52 ± 0.02[a]	2.12 ± 0.01[a]
	Control	0.99 ± 0.03[a]	1.80 ± 0.01[a]	2.24 ± 0.01[a]
PTASN[c]	LP	-0.84 ± 0.03[a]	-0.26 ± 0.02[a]	0.28 ± 0.01[a]
	Control	-0.75 ± 0.03[a]	-0.21 ± 0.01[a]	0.23 ± 0.01[a]
FFA[d]	LP	6.98 ± 1.12[a]	8.62 ± 1.61[a]	10.19 ± 1.03[a]
	Control	8.21 ± 0.62[a]	9.70 ± 0.95[a]	12.27 ± 1.06[b]

[a,b] Superscripts in the same column within a parameter with different letters were different ($P < 0.05$)
[c] The soluble nitrogen fractions were expressed as percent of total nitrogen
[d] Free fatty acids expressed as milliequivalent/100 g fat
TN - Total nitrogen; WSN – Water-soluble nitrogen; TCASN - Trichloroacetic acid soluble nitrogen
PTASN - Phosphotungstic acid soluble nitrogen; LP - Lactoperoxidase; s.d. - Standard deviation

The level of proteolysis in the experimental cheese was comparable to that of the control cheese (Table 2). Since proteolysis in Dutch-type cheeses such as Gouda, is brought about mainly by the action of starter

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enzymes (Venema *et al*., 1987), the absence of significant differences (P > 0.05) in proteolysis between the experimental and the control cheeses might have been attributed to the use of the LP-resistant starter culture.

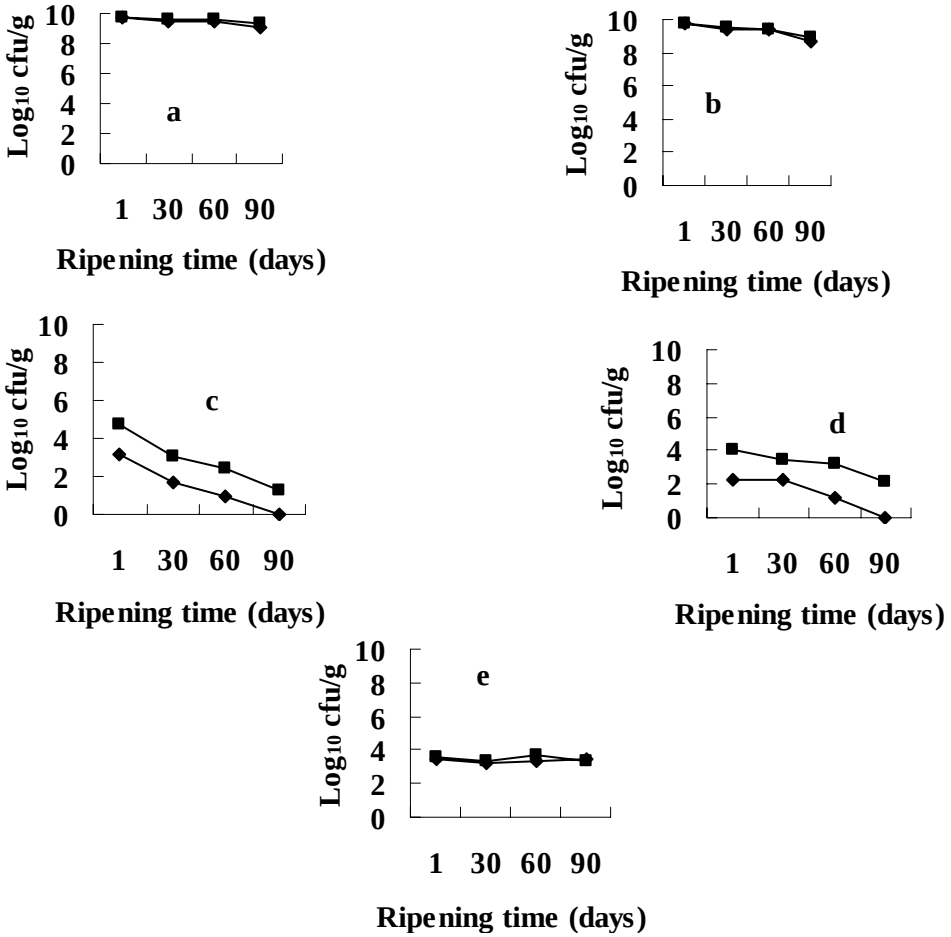

Figure 1 Changes in the aerobic plate (a), lactic acid bacteria (b), coliform (c), coagulase positive staphylococci (d) and mould (e) counts in Gouda cheese made from lactoperoxidase activated (◆) and control (■) Saanen goat milk during a ripening period of 90 days. (n = 4)

A difference (P < 0.05) in the level of total free fatty acids (FFA) was observed between the experimental and the control cheeses at 90 days of ripening (Table 2). Free fatty acid generation and resulting characteristic flavour of goat milk products is due to the distribution of lipoprotein lipase in various components of the milk system (Chilliard *et al*., 1984). Ahrné & Björck (1985) reported that activation of the LP system in cow milk inhibited the activity of lipoprotein lipase and reduced the FFA levels in the milk. The lower FFA level (therefore, lower lipolysis) observed in Gouda cheese made from LP-activated goat milk can be attributed to the inhibition of lipoprotein lipase by the oxidation products of the LP system. Thus, activation of the LP system in goat cheese milk might be of significant importance in reducing the strong flavour associated with goat milk cheeses.

Out of the 120 panelists who participated in the sensory session, 52 assessors detected differences between the experimental and the control cheeses (P = 0.014). This can be attributed to the difference between the level of lipolysis (FFA level) in the two cheese types. The panelists who participated in the sensory session also commented that Gouda cheese made from LP-activated goat milk had a milder flavour than Gouda cheese made from the control. Thus, activation of the LP system in goat milk may be used to improve the flavour of goat milk cheeses by lowering the extent of lipolysis during ripening of the cheese.

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The microbiological counts of Gouda cheese over the ripening period of 90 days showed absence of differences ($P > 0.05$) in aerobic plate count (APC) (Figure 1a), lactic acid bacteria (LAB) count (Figure 1b) and mould counts (Figure 1e) between the control and the experimental cheeses. However, differences ($P < 0.05$) were observed in coliform (Figure 1c) and coagulase positive staphylococci (CPS) counts (Figure 1d) between the experimental and the control cheeses throughout the ripening period. Since large numbers of coliforms and CPS in cheese milk can cause early blowing and enterotoxin production in cheese (Chapman & Sharpe, 1990), respectively, the decrease in coliform and CPS in cheeses made from goat milk preserved by activation of the LP system suggests that activation of the LP system in goat milk prior to cheesemaking could be of practical importance especially for small-scale cheese producers who in most instances produce cheese from unpasteurised milk.

Conclusions

From the results of the current study, it can be concluded that preservation of goat cheese milk by the LP system can be used to improve the microbiological quality and flavour of goat milk Gouda cheese without any detrimental effect to the chemical composition of the cheese if an appropriate starter culture is used. Since most goat milk cheeses are manufactured from raw milk without heat treatment, preservation of goat milk by the LP system may be used to increase the safety margin of cheeses made from raw goat milk.

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