Small Ruminant Research 101 (2011) 17–32

Contents lists available at SciVerse ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Microbiological characteristics of Greek traditional cheeses☆

Evanthia Litopoulou-Tzanetaki*, Nikolaos Tzanetakis

Laboratory of Food Microbiology and Hygiene, Department of Food Science and Technology, Faculty of Agriculture, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

ARTICLE INFO

Article history:
Available online 2 October 2011

Keywords:
Greek traditional cheeses
Microflora
Biochemical activities
NSLAB

ABSTRACT

Cheesemaking in Greece has a centuries-old tradition and ancient Greeks considered the cheese as a divine invention and gift. Numerous traditional cheeses are made throughout Greece today and twenty of them were recognized as PDO. As a total, Greek traditional cheeses are grouped, according to their technology of manufacture, as: cheeses in brine, soft cheeses, semi-hard cheeses, hard cheeses and whey cheeses. Their predominant microflora throughout ripening is consisted of NSLAB that proliferate and contribute by their biochemical activities to cheese ripening and the development of flavor characteristics. Microorganisms indicative of their hygienic quality, *Enterobacteriaceae* and coliforms, decline during ripening and are usually found at negligible levels in the mature products.

1. Introduction

Cheese making in Greece has a centuries old tradition. Homer in 8th century BC in his Odyssey describes well the shepherd and cheese maker Polyphemus of the 12th century BC, as well as his cheeses. Diodorus (Diodorus Siculus, 1st century B.C), the Greek historian from Sicily, wrote that Aristeus, son of Apollo and grandson of Zeus, who had learned the art of cheese making from his nannies, the nymphs, was sent by the Gods at Olympus mountain to teach the Greeks how to make cheese. Given the value of cheese as a food, it is not surprising that ancient Greeks considered the cheese as a divine invention and gift. The cheese that Homer described seems possible to be the ancestor of Feta and it is the main cheese manufactured in Greece from the ancient times till today. Meanwhile, various cheese types evolved through the centuries, so that nowadays each area, almost every island has its individual unique tradition in cheese manufacture.

Lately, the EU supports the local products and the traditional technologies. "Typical" foods are considered as safer and healthier by the consumer and "typicality" has been established as a recent way to understand the quality of a product (Rubino et al., 1999). There is also the Council Regulation (EEC) no. – 2087/92 (1992), which attempts to unify different concepts of typicity and lays down rules on the protection of agricultural products intended for human consumption. The PDO/PGI labels guarantee specific sensory properties and imply that particular characteristics are present in the product.

Numerous traditional cheeses are made throughout Greece today. Some of them are in fact types of the same cheese variety, have somewhat different steps in technology or possibly the same technology, but known with different local names. Twenty of them were recognized as PDO (Protected Designation of Origin) cheeses and there are others, waiting for their recognition. As a total, Greek traditional cheeses could be grouped, according to their technology of manufacture, as: cheeses in brine; soft cheeses; semi-hard cheeses; hard cheeses; whey cheeses.

2. Cheeses in brine (Pickled cheeses)

2.1. Batzos cheese, PDO

Batzos is a low-fat, semi-hard, white brined cheese with a sourish and lightly piquant taste and a large number of

☆ This paper is part of the special issue entitled Products from Small Ruminants, Guest Edited by A. Govaris and G. Moatsou.

* Corresponding author. Tel.: +30 2310991727; fax: +30 2310991674.
E-mail address: ganet@agro.auth.gr (E. Litopoulou-Tzanetaki).

0921-4488/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.smallrumres.2011.09.022

"holes" in the body. It is made from either caprine milk, or ovine milk or mixtures of both milks. The cheese is made at home by the traditional method as well as at creameries of Western Macedonia and the nearby Thessaly, using modifications of the traditional method and technological innovations.

The milk is not heat-treated and coagulation takes place within 50 min at 28–30 °C. When the milk just begin to gel, the manufacturer "hits" the milk with a thick wooden stick about 150–200 times; the milk is then left to curdle for 35–40 min before being hit again for 300–350 times. During these hitting stages, a large proportion of fat is transferred to the whey. The curd is then left to settle, but some cheese makers would apply mild heat before placing the curd, cut in appropriate pieces, in cheese cloths and hanging them to drain and ripen for 24 h. The next day, the ripened curd is cut into slices, salted with coarse salt, placed in tins and covered with brine (Anifantakis, 1991; Zygouris, 1956). Cheese is either consumed fresh or stored in cool rooms.

The microbial counts in the curds of Batzos cheese from ovine milk in summer (Fig. 2) were higher than in curds of spring cheeses (Fig. 1) for all microbial groups except staphylococci (Nikolaou et al., 2002). Lactic acid bacteria (LAB), *Enterobacteriaceae* and coliforms are the major components of the microflora during ripening; LAB grown on M17 agar was the most abundant microbial group in the curd and cheese during storage for one month at 4 °C. *Enterobacteriaceae* and coliforms, declined faster in cheeses made in the summer. This was possibly related to the lower pH values of cheeses made in the summer and the higher number of LAB present in curds of summer cheeses.

Among LAB lactobacilli predominated in cheeses made in summer; in spring enterococci were the most abundant bacteria (Table 1). *Lactobacillus paracasei* subsp. *paracasei* and *Lb. paraplantarum* were isolated frequently from the ripened curds of Batzos cheese in summer, while *Enterococcus faecium* was the most frequently isolated LAB species in spring. *Lactococcus lactis* subsp. *lactis* was found only in the curds of spring cheeses.

Table 1
Species of lactic acid bacteria isolated from ripened curd of Batzos cheese from raw ovine milk, made in spring and summer. Isolates from two batches of cheese in each season.

Species	% of isolates from cheese made in Spring	Summer
Lactococci		
Lc. lactis subsp. *lactis*	22.22	–
Lactobacilli		
Lb. paracasei subsp. *paracasei*	–	32.98
Lb. paraplantarum	14.82	30.85
Lb. pentosus	7.41	–
Enterococci		
E. faecalis	7.41	13.83
E. faecium	40.74	21.28
E. durans	3.70	–
E. pseudoavium	–	1.06
Pediococcus spp.	3.70	–
Total	100.00	100.00

Hydrolysis of both α_s- and β-casein (CN) proceeded more rapidly in spring than in summer; α_s-CN is also degraded faster than β-CN. Lipolysis products increased gradually with storage and accumulated at higher levels in cheese made in the summer.

For the cheese from caprine milk no significant differences were observed in the counts related to the season, but significant changes in the microbial counts throughout

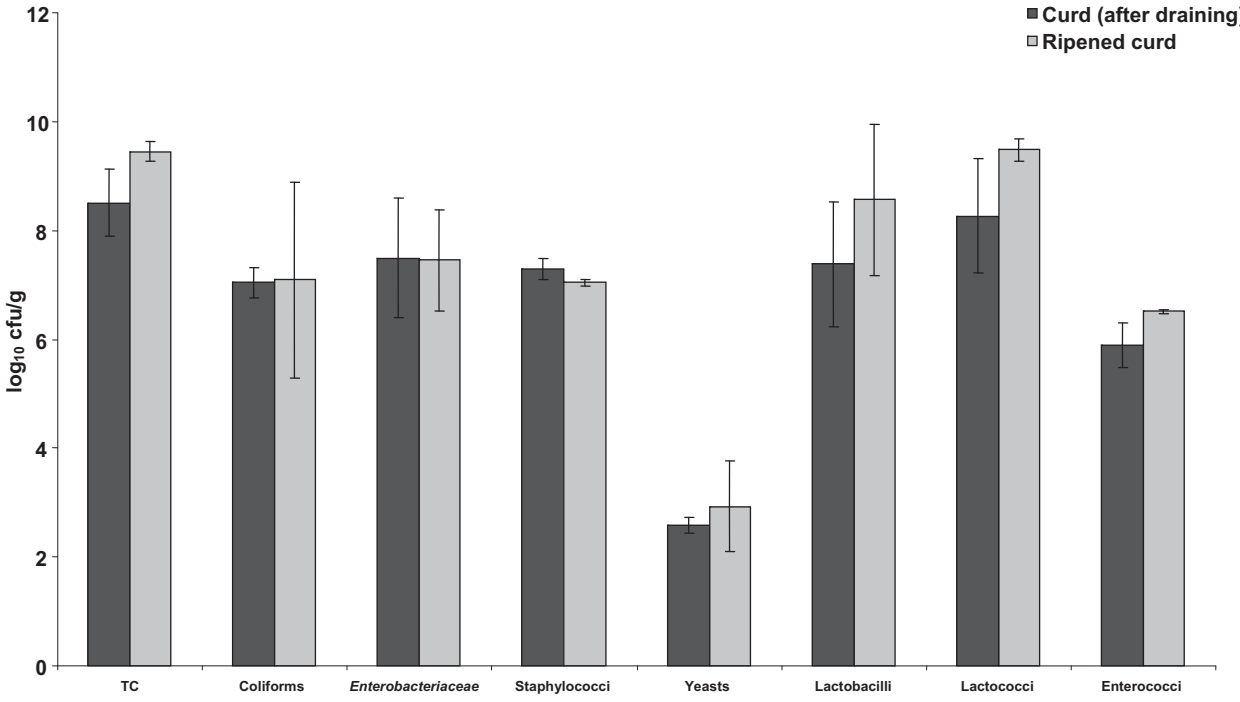

Fig. 1. Log counts ($x \pm$ SD) of microbial groups in the curd of Batzos cheese from raw ovine milk, made in summer. Mean of two cheesemaking trials.