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A SCANNING ELECTRON MICROSCOPICAL STUDY ON THE MICROSTRUCTURE OF DOMIATI CHEESE

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Domiati cheese made by the conventional method, and from recombined cow's and buffalo's milk concentrated by ultrafiltration were examined by scanning electron microscopy at different periods of storage in pickle. Fresh cheese showed an open loose network of aggregated micelles, that changed to a network with considerable fusion of casein micelles. The cheese from UF recombined milk showed a matrix of small particle size which grew larger during pickling. The pickled Domiati cheese from UF buffalo's milk showed crystal shaped materials at the junctions of protein particles probably made of calcium lactate.

Key words: Domiati cheese, UF, Microstructure.

INTRODUCTION

Domiati cheese is unique as salt is added to milk before renneting which retards coagulation and weaken the formed curd. The high salt content used (7-10%), would greatly affect the structure of cheese. Chemicals such as $CaCl_2$ which increased the firmness of milk gels also caused casein micelles to fuse [1]. The use of milk concentrated by ultrafiltration in making Domiati cheese has been recently described by Abd El-Salam *et al.* [2]; and El-Shibiny *et al.* [3]. This would also bring additional changes in the microstructure of cheese.

Considerable research has been done on Domiati cheese that has been reviewed by Fahmi and Sharara [4] and Abd El-Salam *et al.* [5]. However, little has been done on the microstructure of this type of cheese [6-8] especially from ultrafiltered milk [9] and further studies along this line are needed.

The present paper describes the use of scanning electron microscope to study the microstructure of Domiati cheese with particular reference to cheese from milk concentrated by ultrafiltration.

MATERIALS AND METHODS

Domiati cheese samples were prepared from buffalo's milk and recombined cow's milk concentrated by ultrafiltration using a DDS Lab-20 ultrafiltration unit (Pasilac A/S silkeborg, Denmark) as described by Abd El-Salam *et al.* [2] and El-Shibiny *et al.* [3] respectively. Samples of Domiati cheese made by the conventional method of Fahmi and Sharara [4] were obtained from commercial cheese factories.

A rectangular block 3x3x1 mm was cut from the cheese sample with a sharp razor, fixed in 2% glutaraldehyde solution for 2 hrs at room temperature (20-25°). The block was removed from the fixation bath and dehdyrated in a graded series of ethyl alcohol (30-96%). Critical point drying was achieved using a critical point drying apparatus (Balzers Union, W. Germany). The dried sample was mounted on aluminium stub with the aid of silver cement, and then coated with gold at 10 mA for 2 min. using Edwards sputter coater (Edwards, England). Samples were then examined in a scanning electron microscope (Neolab 7, Canada) operated at 10 KV, and photomicrographs were taken with a Zeiss Camera.

RESULTS AND DISCUSSION

Scanning electronmicrographs of fresh domiati cheese made by the conventional method (Figs. 1 and 2) showed an open, loose network of aggregated casein micelles. The casein micelles retain their globular structure with limited fusion and formation of fibrous structure, a typical feature of rennet induced gels [1]. No special morphological features were observed in the scanning electronmicrographs that can be attributed to the high salt content in accordance with other reports [7].

The scanning electronmicrographs of pickled (4 months) Domiati cheese made by the conventional method (Fig. 3 and 4) showed extensive internal microstructural modifications. Although the cheese retained the open structure, there had been a transition to casein micelle fusion and the formation of fibrous network. This may be attributed to the considerable depletion of Ca^{++} from the

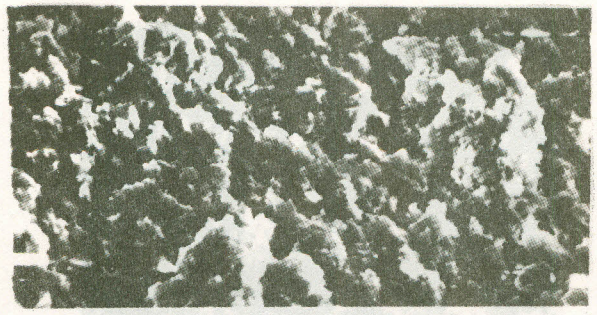

Fig. 1. Scanning electron micrograph of fresh Domiati cheese. Magnification 2500x.

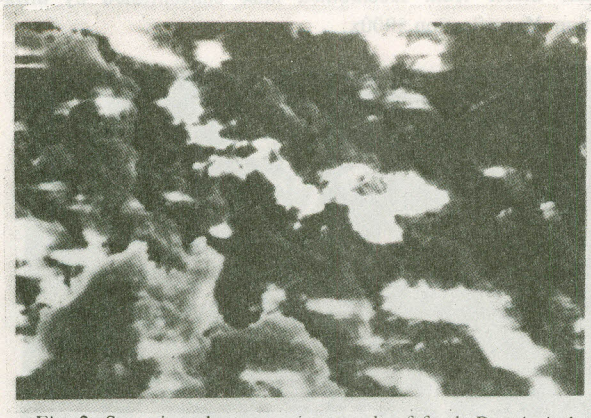

Fig. 2. Scanning electron micrograph of fresh Domiati cheese. Magnification 5000x.

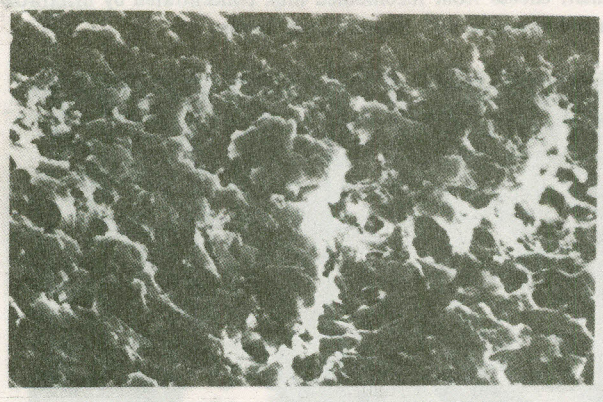

Fig. 3. Scanning electron micrograph of pickled (4 months) Domiati cheese. Magnification 2500x.

cheese matrix [10] and to continuous proteolysis. The same conclusion was arrived at for Telemea (pickled) cheese using transmission electron microscopy [11]. The large openings in fresh and pickled cheese probably reflect the location of whey pockets.

Scanning electronmicrograph of fresh Domiati cheese from recombined milk concentrated by ultrafiltration (Fig 5) showed an open loose protein network. The size of the particles formed by fusion of casein micelles was much less smaller than that observed with conventional Domiati

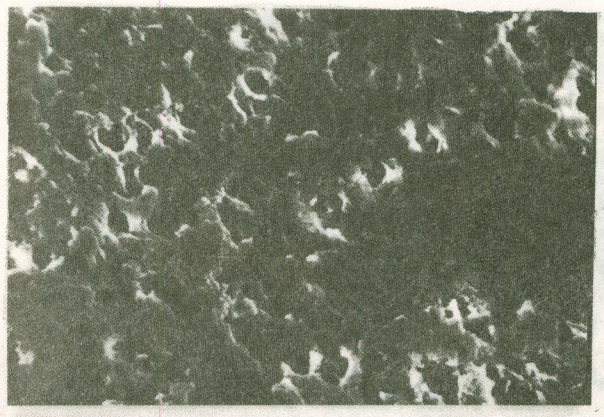

Fig. 4. Scanning electron micrograph of pickled (4 months) Domiati cheese. Magnification 5000x.

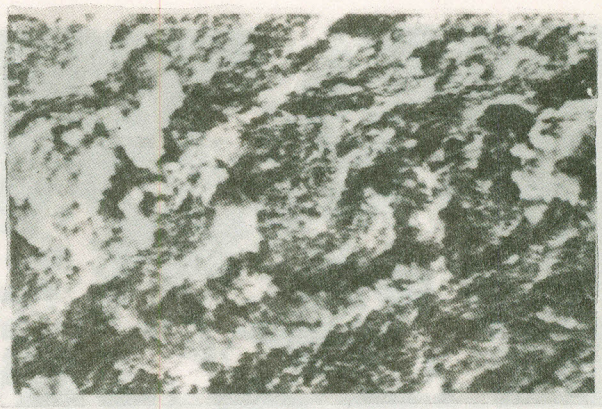

Fig. 5. Scanning electron micrograph of fresh Domiati cheese from recombined milk concentrated by ultrafiltration. Magnification 2500x.

cheese. This could be attributed to two factors, the whey proteins present in ultrafiltrated milk may interfere with the formation of large micellar aggregates, and to homogenization.

During storage in the pickle, Domiati cheese from recombined ultrafiltrated milk exhibited transition changes in its microstructure (Figs, 6,7,8,9) it is apparent from these results that cheese structure became more loose with increase in the size of protein particles in the cheese matrix. Also the large opening in the cheese matrix became more apparent. In general, the microstructure of pickled cheese from recombined ultrafiltrated milk compared favourably with that of conventional pickled Domiati cheese.

Figure 10 shows the scanning electronmicrographs of pickeld UF Domiati cheese made from retentate that received heat treatment to 80^{o} before processing, while Figure 11 reveals the same for unheated cheeses. No obvious differences could be traced to the effect of heat treatment on the cheese microstructure.

Fig. 6. Scanning electron micrograph of pickled (2 months) Domiati cheese from recombined milk concentrated by ultrafiltration. Magnification 5000x.

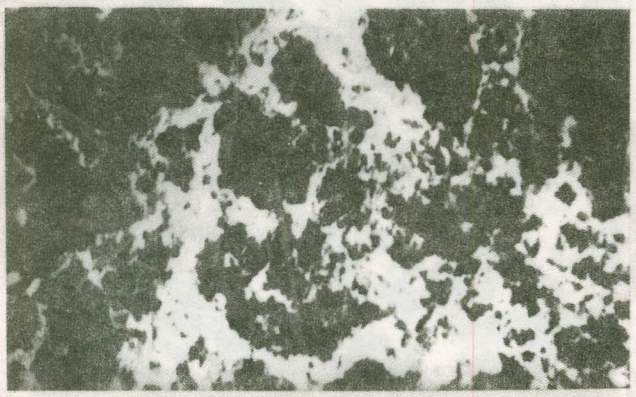

Fig. 7. Scanning electron micrograph of pickled (3 months) Domiati cheese from recombined milk concentrated by ultrafiltration. Magnification 5000x.

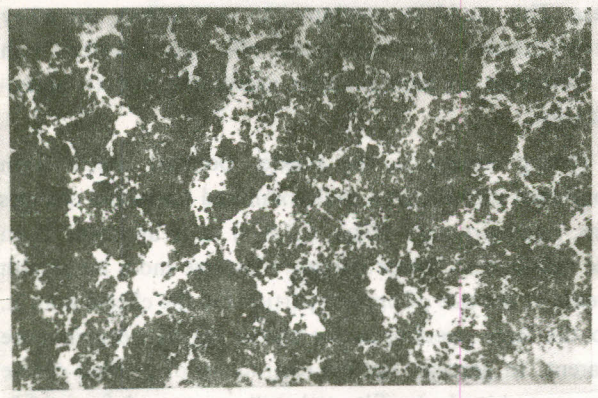

Fig. 8. Scanning electron micrograph of pickled (4 months) Domiati cheese from recombined milk concentrated by ultrafiltratin. Magnification 2500x.

The use of buffalo's milk concentrated by ultrafiltration in Domiati cheese making resulted in cheese of accepted texture when fresh and after short storage period, that tend to be fragile with advanced storage. Scanning

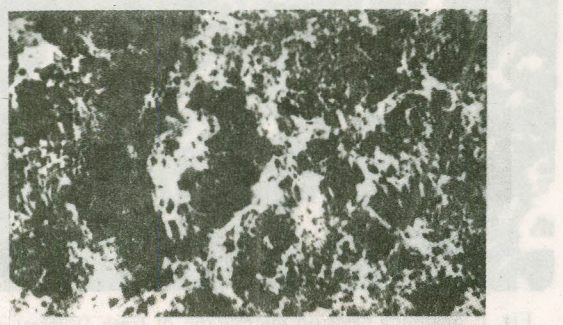

Fig. 9. Scanning electron micrograph of pickled (4 months) Domiati cheese from recombined milk concentrated by ultrafiltration. Magnification 5000x.

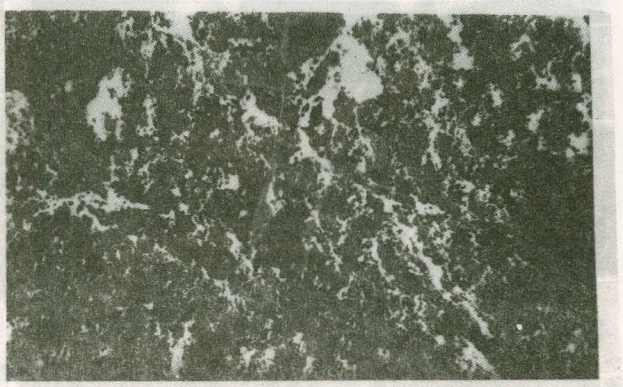

Fig. 10. Scanning electron micrograph of pickled (4 months) Domiati cheese from recombined milk concentrated by ultrafiltration and heated to 80°. Magnification 2500x.

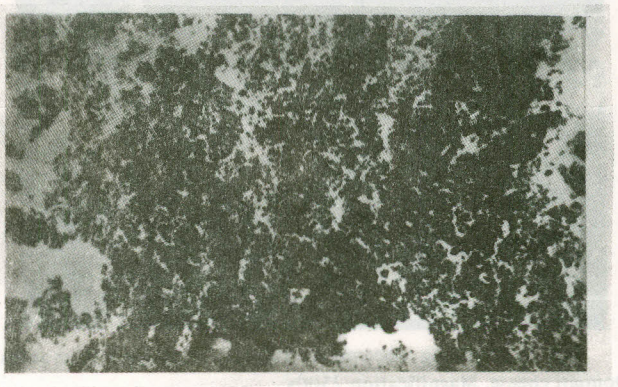

Fig. 11. Scanning electron micrograph if pickled (4 months) Domiati cheese from recombined milk concentrated by ultrafiltration. Magnification 2500x.

electron micrographs (Fig. 12, 13 and 14) reveal an unusual structure for pickled (4 months) Domiati cheese from UF buffalo's milk. The presence of crystal shaped materials at the junctions between protein particles are apparent which represent weak points in the protein network. This may explain the fragile texture observed. Buffalo's milk is characterized by high colloidal calcium content [12]. Therefore, buffalo's milk concentrated by ultrafiltration

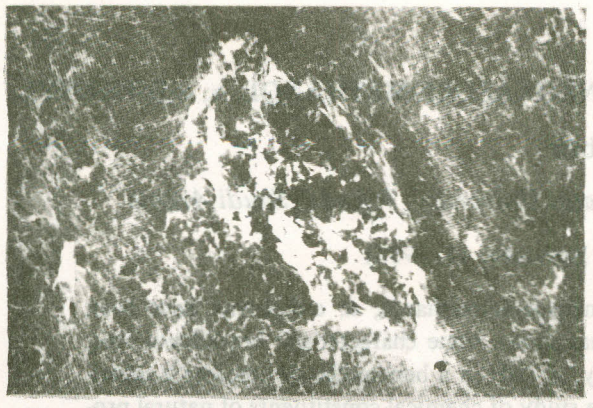

Fig. 12. Scanning electron micrograph of pickled (4 months) Domiati cheese from bufalo's milk concentrated by ultrafiltration. Magnification 1000x.

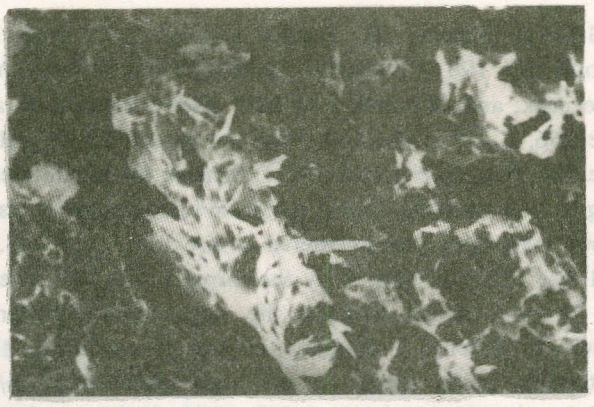

Fig. 13. Scanning electron micrograph of pickled (4 months) Domiati cheese from buffalo's milk concentrated by ultrafiltration. Magnification 5000x.

Fig. 14. Scanning electron micrograph of two different sections (4 months) Domiati cheese from buffalo's milk concentrated by ultrafiltration. Magnification 5000x.

and Domiati cheese made from this concentrate would retain high calcium content. During pickling, the formed lactic acid is continuously transformed into calcium lactate. In the absence of sufficient pickling solution as followed in the present procedure for cheese making [2] to dissolve the formed lactate, crystals of this substance would grow in the cheese matrix. This may explain the observed structure of pickled Domiati cheese from UF buffalo's milk. However, this does not exclude the possiblity of forming calcium phosphate crystals similar to that observed in the seaminess defect in Cheddar cheese [13].

Scanning electron microscopy, in the present study, offered a powerfull tool to follow the microstructure of Domiati cheese made under different conditions of processing and storage.

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REFERENCES

1. M. Kalab and V.R. Harawalker, J. Dairy Sci., **56**, 835 (1973).
2. M.H. Abd El-Salam, S. El-Shibiny, N.S. Ahmed and A.A. Ismail, Egyptian J. Dairy Sci., **9**, 151 (1981).
3. S. El-Shibiny, H. Haggag, N.S. Ahmed and M.H. Abd El-Salam, Asian J. Dairy Res., **1**, 1 (1982).
4. A.H. Fahmi and H.A. Sharara, J. Dairy Res., **17**, 312 (1950).
5. M.H. Abd El-Salam, S. El-Shibiny and A.H. Fahmi, New Zealand J. Dairy Sci. Tech., **11**, 57 (1976).
6. M.H. Abd El-Salam and S. El-Shibiny, J. Dairy Res., **40**, 113 (1973).
7. T.J. Keer, C.J. Washam, A.L. Evans and R.L. Todd, J. Food Prot., **44**, 496 (1981).
8. M.M. Omar and S. El-Shibiny, Egyptian J. Dairy Sci., **13**, 33 (1985).
9. M.M. Omar, Egyptian J. Diary Sci., **15**, 123 (1987).
10. N. S. Ahmed, M.H. Abd El-Salam and S. El-Shibiny, Indian J. Diary Sci., **25**, 246 (1972).
11. M. Caloianu, S.I. Farag and I. M. Buruiana, Egyptian J. Dairy Sci., **8**, 151 (1980).
12. M.H. Abd El-Salam and S. El-Shibiny, Indian J. Dairy Sci., **19**, 151 (1966).
13. J. Conochie, and B.J. Sutherland, J. Dairy, Res., **32**, 35 (1965).