

# EFFECTS ON TEXTURE AND MICROSTRUCTURE FOLLOWING REPLACEMENT OF MANUAL BY MECHANICAL PROCESSING, IN *SERRA DA ESTRELA* CHEESEMAKING



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## INTRODUCTION

*SERRA DA ESTRELA* IS CONSIDERED THE MOST POPULAR TRADITIONAL CHEESE MANUFACTURED IN PORTUGAL. THIS CHEESE IS PRODUCED FOLLOWING ARTISANAL TECHNIQUES OF CHEESE MAKING FROM RAW EWE'S MILK, WITHOUT ADDITION OF A STARTER CULTURE; IT IS COAGULATED BY CRUDE AQUEOUS EXTRACTS OF FLOWERS OF THE WILD THISTLE (*CYNARA CARDUNCULUS* L.). THE AIM OF THIS STUDY WAS TO PRODUCE *SERRA DA ESTRELA* CHEESE IN A TAILOR-MADE MECHANIZED APPARATUS, AND TO COMPARE THE RESULTS WITH THOSE ASSOCIATED WITH TRADITIONAL MANUFACTURE, IN TERMS OF TEXTURAL AND MICROSTRUCTURAL FEATURES.

## METHODOLOGY

**CHEESE MANUFACTURE** RAW MILK FROM THE *SERRA DA ESTRELA* SHEEP WAS DIVIDED INTO TWO BATCHES: ONE BATCH WAS USED TO MANUFACTURE *SERRA DA ESTRELA* LIKE-CHEESE USING THE CHEESE MAKING APPARATUS, AND THE OTHER BATCH WAS USED TO MANUFACTURE *SERRA DA ESTRELA* CHEESE ACCORDING TO THE TRADITIONAL PROCEDURES. ALL CHEESES WERE ANALYSED UP TO 3 WK OF AGE, PERIOD THAT CORRESPONDS TO THE END OF THE FIRST STAGE OF RIPENING: RIPENING WAS AT 9 °C AND 99% HUMIDITY.

**ELECTRON MICROSCOPY** THE CHEESE CURD WAS CUT INTO APPROX. 4X4X1 MM PARALLELIPEDAL SAMPLES, WHICH WERE IMMEDIATELY IMMERSED IN 2.8% GLUTARALDEHYDE SOLUTION (AT 20 °C FOR 24 H), AND POSTFIXED WITH IMIDAZOLE-BUFFERED (pH 7.4) 2% OSMIUM TETROXIDE SOLUTION (AT 6 °C FOR 24 °C). THE SAMPLES WERE DEHYDRATED SUCCESSIVELY IN GRADED ETHANOL SOLUTIONS (10-100%). THE DEHYDRATED SAMPLES WERE NATURALLY DRIED AND MOUNTED ON ALUMINUM STUBS WITH DOUBLE CONDUCTIVE CARBON. ALL SAMPLES WERE STORED IN A DESICCATOR AT 20 °C, AND WERE EXAMINED IN A SCANNING ELECTRON MICROSCOPE (JSM-5600LV, JEOL, TOKYO, JAPAN) OPERATING AT 15 KV.

**CHEESE RHEOLOGY** FORCE DISPLACEMENT CURVES WERE DETERMINED IN PUNCTURE TESTS USING A PLUNGER OF 6 MM OF DIAMETER AT A CROSS HEAD SPEED OF 50 MM·MIN<sup>-1</sup> FOR A FIXED HEIGHT (30MM) WITH AN INSTRON MODEL 4501 (HIGH WYCOMBE, BUCKS, UK). FIVE DETERMINATIONS PER CHEESE WERE MADE AT 23 °C.

## RESULTS AND DISCUSSION

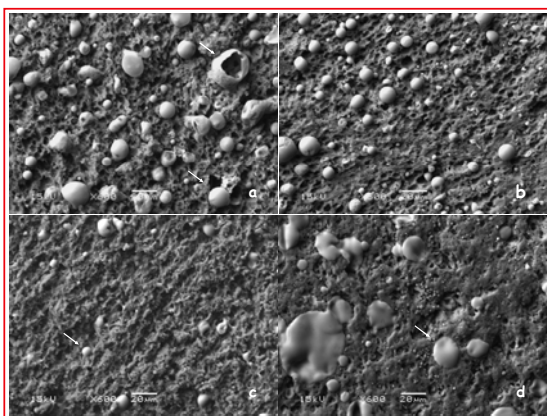


FIGURE 1. SCANNING ELECTRON MICROGRAPHS OF *SERRA DA ESTRELA* CHEESE MADE BY MECHANICAL (a, c) AND MANUAL PROCESSING (b, d) AT 3 D (a, b) AND 14 D (c, d) OF AGE. THE CURD MATRIX WAS EMBEDDED BY FAT GLOBULES (SMALL ARROWS), THAT WERE RETAINED BY FIXATION WITH IMIDAZOLE-BUFFERED  $OsO_4$ .



FIGURE 2. CHEESE RIPENED FOR 21 D. *SERRA DA ESTRELA* CHEESE MADE BY TRADITIONAL (LEFT) AND MECHANICAL (RIGHT) PROCESSING.

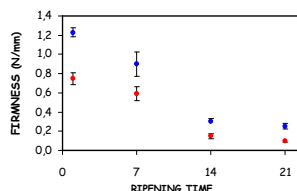


FIGURE 3. DIAGRAM OF FIRMNESS (IN N/MM OF PLUNGER) OF *SERRA DA ESTRELA* CHEESE BY TRADITIONAL PROCESSING (●) AND BY MECHANICAL PROCESSING (■), DURING RIPENING. VERTICAL BARS INDICATE THE STANDARD DEVIATIONS.

SCANNING ELECTRON MICROGRAPHS (FIGURE 1 AND 4) SHOW THE MICROSTRUCTURE OF *SERRA DA ESTRELA* CHEESE MADE BY MECHANICAL AND MANUAL PROCESSING.

IN FIGURE 1 (MICROGRAPHS b AND d), CHEESES MADE BY MANUAL PROCESSING REVEAL A PROTEIN MATRIX THAT IS MORE UNIFORM AND COMPACT THAN THAT EXHIBITED BY CHEESES MADE BY MECHANICAL PROCESSING. FURTHERMORE, DURING THE EXAMINATION BY SEM, THE CURD JUNCTIONS WERE OBSERVED MORE FREQUENTLY IN CHEESES MADE BY MANUAL PROCEDURES (FIGURE 1b, d).

SCANNING ELECTRON MICROGRAPHS AT HIGHER MAGNIFICATIONS (FIGURE 4) UNFOLD THE LARGE COLONIES OF LACTIC ACID BACTERIA PRESENT IN THE INTERIOR OF THE CURD OF *SERRA DA ESTRELA* CHEESE. ALTHOUGH SAID COLONIES WERE PRESENT IN ALL CHEESES AT DIFFERENT TIMES OF RIPENING, THE COLONIES OF BACTERIA SEEM TO BE MORE DISPersed IN THE PROTEIN MATRIX AND NOT ONLY RESTRICTED TO CURD JUNCTIONS WHERE THESE MICROORGANISMS ARE MORE FREQUENTLY FOUND IN *SERRA DA ESTRELA* CHEESE MADE BY MANUAL PROCESSING.

STRUCTURAL DIFFERENCES CAN BE DEPICTED ALSO IN FIGURE 2. SINCE THE FIRST DAY THAT CHEESES MADE BY MECHANICAL PROCESSING POSSESS MORE WHOLE IN THE INTERIOR OF THE CHEESE, WHERE THE WHEY WAS RETAINED.

ALTHOUGH ALL CHEESES REVEALED SIMILAR CONTENTS OF TOTAL SOLIDS AND FAT (DATA NOT SHOWN), *SERRA DA ESTRELA* CHEESES MADE BY TRADITIONAL PROCESS WERE CONSIDERABLY FIRMER THAN THOSE MADE BY MECHANICAL PROCEDURES (FIGURE 3). THIS FACT IS IN AGREEMENT WITH THE MICROSTRUCTURAL RESULTS REVEALED BY SCANNING ELECTRON MICROSCOPY (FIGURE 1), AND THE STRUCTURE OF THE CURD CHEESE SHOWN IN FIGURE 2.

IN SUMMARY, ALTHOUGH THE RESULTS PRESENTED HERE WERE OBTAINED ONLY DURING THE FIRST STAGE OF RIPENING, THE STRUCTURE AND THE MICROSTRUCTURE OF THE CHEESE ARE INFLUENCED BY THE WAY THAT THE CURD IS PROCESSED AFTER COAGULATION.

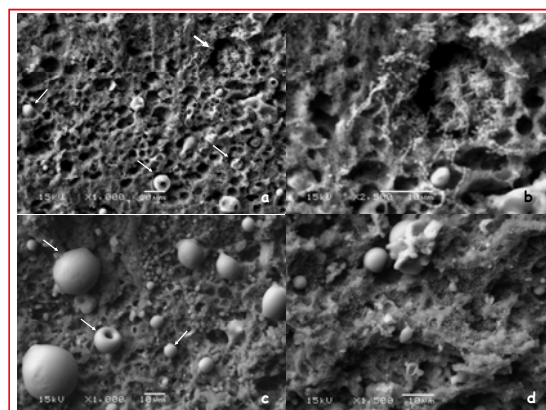


FIGURE 4. SCANNING ELECTRON MICROGRAPHS OF *SERRA DA ESTRELA* CHEESE MADE BY MECHANICAL (a-c) AND MANUAL PROCESSING (d). (a) SECTION ACROSS CURD JUNCTION SHOWING FAT GLOBULES RETAINED BY FIXATION WITH IMIDAZOLE-BUFFERED  $OsO_4$  (SMALL ARROWS) AND A COLONY OF LACTIC ACID BACTERIA (LARGE ARROW). (b) DETAIL OF THE LARGE COLONY OF ELONGATED CHAINS OF LACTIC ACID BACTERIA REFERRED TO IN THE MICROGRAPH a. MICROGRAPH (c) BACILLI-SHAPED BACTERIA DISPersed IN THE CASEIN MATRIX, WITH FAT GLOBULES (SMALL ARROWS). (d) SECTION ACROSS THE CURD JUNCTION, SHOWING A MIXED POPULATION OF BACILLI AND COCCI.

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