SOME FACTORS INFLUENCING THE CHOICE OF LACTIC STREPTOCOCCI FOR USE AS STARTERS IN CHEESEMAKING

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ABSTRACT

Strains of lactic streptococci characterized as bitter cheese starters multiplied rapidly during normal cheesemaking and reached high populations in the curd before salting. The multiplication of starter strains which are typically non-bitter was inhibited by the cooking temperatures used in normal Cheddar cheesemaking, even though acid production continued. The populations reached were substantially lower than with bitter starters. If manufacturing conditions were altered so that non-bitter strains reached high numbers in the curd, cheeses were bitter. Conversely, bitterness was absent, or of reduced intensity, when growth of conventionally bitter starters was restricted during cheese manufacture, either by the use of raised cooking temperatures, or by bacteriophage attack. The results of 60 cheesemaking trials with 10 starter strains confirmed this association between the size of starter population reached during cheesemaking and the presence or absence of bitterness.

A new model is proposed to account for the development of bitterness in Cheddar cheese. Unlike other schemes where the production of bitter peptides is attributed directly to rennet action on casein, the new hypothesis considers that the starter strain is responsible for the formation of bitter-flavoured peptides and does not merely act to remove them. All starters are potentially able to produce either bitter or non-bitter cheese, depending upon the conditions of manufacture (including bacteriophage development) and, hence, the population reached. The response to selected manufacturing conditions rather than any single difference between particular starter strains determines the likelihood of bitterness development.

The key cheesemaking trials were repeated using aseptic techniques under controlled bacteriological conditions. Previous studies of aseptically manufactured cheese utilized starters which gave little Cheddar flavour or exhibited pronounced flavour defects. In this investigation, cheeses

made aseptically with Streptococcus cremoris AM_2 alone, possessed full Cheddar flavour and no off-flavours provided that normal manufacturing procedures were followed. Cheeses made with AM_2 at a low cooking temperature (33°C) and ML_8 cheeses made at the normal cooking temperature (38°C) were extremely bitter and lacking in Cheddar flavour. When appropriate levels of bacteriophage were present during manufacture, bitterness was abolished entirely from both the ML_8 and low-cook AM_2 cheeses. There were accompanying increases in Cheddar flavour scores.

A search for temperate bacteriophages and lysogenic strains in the lactic streptococci used as starters in cheesemaking showed that the occurrence of lysogeny or defective lysogeny could be relatively widespread. A temperate bacteriophage was inducible from Str.cremoris R_1 by ultraviolet irradiation or mitomycin C treatment. Induced lysates produced plaques on lawns of 3 closely related Str.cremoris strains, AM_1, SK_{11} and US_3. Strain SK_{11} was readily lysogenised. Str.cremoris AM_1 was the most reliable indicator strain, although the age of the culture used for seeding plates was critical. Zones of lysis, but no plaque formation were observed on lawns of 9 additional Str.cremoris strains. Several other strains of both Str.cremoris and Str.lactis were inducible by either treatment but no indicator strains for the induced phages were found. The significance of lysogeny in cheesemaking cannot yet be assessed.

PREFACE

These studies were undertaken to investigate the role of the starter streptococci in the development of bitterness and cheese flavour in Cheddar cheese. Because of the seasonal nature of the work and long periods required to observe the outcome of cheesemaking experiments a second project, the incidence of lysogeny amongst the strains of starter streptococci, was undertaken concurrently with the cheese investigations. Most previous studies had considered only virulent bacteriophages whereas temperate bacteriophages had been virtually ignored. There was no confirmed report of lysogeny in group N streptococci when this investigation was commenced. It was possible that some cheesemaking characteristics of particular starter strains were due to their lysogenic nature.

The results of conventional cheesemaking trials carried out to investigate bitterness development are reported in Section I. Section II describes experiments based on cheesemaking using aseptic techniques under controlled bacteriological conditions. The investigations of temperate bacteriophages and lysogeny in the starter streptococci are contained in Section III.

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The Electron Microscopy Unit, Applied Biochemistry Division, D.S.I.R., Palmerston North carried out the electron microscopy.

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