The Renneting Properties of Skim Milk Solutions Supplemented with Milk Protein Concentrate: The Effect of Hydration and Storage of the Milk Protein Concentrate.

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Abstract

The purpose of this study was to examine the effect of storage and hydration of milk protein concentrate with 85% protein (MPC85) on the renneting properties of skim milk solutions supplemented with MPC85. The following techniques were used in this investigation: solubility testing, rheology, polyacrylamide gel electrophoresis (PAGE), and mass spectrometry.

The solubility of MPC85 samples which had been stored for different periods at temperatures ranging from 30°C to 50°C was found to decrease as storage time increased. In addition, as the storage temperature increased, so did the rate at which solubility decreased. This decrease in solubility dropped to approximately 22% of its original amount. Similar experiments were also performed on samples stored at 20°C (ie approximate room temperature), but showed no change over the time frame of the experiment.

Rheology experiments were performed on 10% (w/w) skim milk supplemented with 2.5% MPC85 (w/w). The experimental conditions, such as temperature (30°C), reconstitution time frame, and rennet concentration (100 μL per 50 g sample), remained constant throughout testing.

The rheological properties of the samples showed a large decrease in the formed gel strength of the renneted samples, and an increase in gelation time, as storage time and/or temperature were increased. Additionally, the viscoelastic moduli (G' and G'') and fracture stress also decreased as storage time and/or temperature were increased. This again excludes samples prepared from MPC85 stored at 20°C which showed no change.

The rheological properties of skim milk solutions supplemented with MPC85, with respect to hydration time was studied using three MPC85 powders of low, medium, and high solubility. Hydration time was varied between 1 and 24 hours, and results showed that samples made from high and medium solubility MPC85 increased gel strength with hydration, with high solubility MPC85 producing the stronger gels. Samples prepared with low solubility MPC85, produced

very weak gels which only changed minimally with hydration time. Aggregation and gelation times for each set of samples were different, but did not change with hydration time.

PAGE was used to analyse the composition of MPC85 to attempt to gain an understanding of what caused the change in properties with storage time and temperature. Experiments revealed that a large decrease in the solubility of caseins, and whey proteins decreased in solubility only minimally.

Mass spectrometry was used to analyse samples stored at 50°C, and it was found that the casein proteins suffered glycation. Whey proteins were also analysed, but data proved too noisy for any conclusions.

In general this thesis aims to provide useful information on the effects of storage and hydration of MPC85, especially with regard to the production of skim milk solutions supplemented with MPC85.

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1 Introduction

1.1 Background Information

The food industry produces many products to supply an ever changing market. In most countries dairy goods are an important component of the human diet, but milk is a perishable substance due to its high water content and near neutral pH. So if it is not intended for immediate consumption, it requires processing into other products such as milk powder or cheese to prolong shelf life.

Traditionally conversion of milk into cheese was a way of preserving milk and the nutrients it contained. Cheese can be made by many methods, one of which is through the addition of rennet to milk, which in turn causes aggregation to the point where it becomes a gel. The gel (often referred to as the curd) is separated from the whey, and the curd is the basis of the cheese. Cheese is a very important product to the New Zealand dairy industry, it is the second highest export product after milk powder. The cheese making process that is the topic of research for this thesis involves the fortification of milk with milk protein concentrates (MPC's).

MPC's are ultrafiltered/diafiltered concentrates of skim milk with high protein content (dry basis ranging from ~37% (skim milk powder) to 85% (MPC85)). These MPC powders, particularly MPC85, are often used as milk protein sources in cheese applications (eg as a cheese extender to improve the yield of cheese during each production run). As such, MPC, when added to milk must provide adequate properties during rennet treatment (gelation time and strength).

There has been extensive research carried out on cheese making, the goals of which were a better understanding of the physical interactions and chemistry of milk gelation. There has been a lot of work carried out in the recent past to collect information on the effects of milk renneting conditions such as pH, temperature, ionic strength, calcium concentration, casein concentration,

and the temperature history of milk on the final property of the cheese product. In contrast, there have been few literature reports on the renneting properties of reconstituted MPC either alone, or on its addition to skim milk, although this remains an area of commercial interest.

The aim of this study is to systematically investigate the effect of hydration time and storage conditions of MPC on the renneting properties of skim milk supplemented with MPC. MPC85 is used in preference to other MPC products as it is a key product for cheese milk extension due to its high protein content which reduces the level of whey by-products.

1.2 Thesis Outline

The goal of this thesis is to provide an understanding of the effects of variation of storage conditions, and variation in hydration times, on the properties of rennet induced skim milk gels fortified with MPC85.

Chapter 2 is a review of the literature relevant to this work. This includes skim milk, MPC, and the effects of rennet on skim milk.

Chapter 3 is a description of the experimental procedures used to collect information, and gives brief background information on the methods employed throughout the research.

Chapter 4 is an investigation of the solubility properties of MPC85 that have been stored under a variety of storage temperatures for varying amounts of time.

Chapter 5 is a description of the rheological study of the renneting properties of skim milk gels supplemented with MPC85. The MPC has also been stored at different storage times and temperatures.

Chapter 6 examines the effects of hydration time on samples using three different MPC85 powders which have high, medium, or low solubility.

Chapter 7 is a study of the composition of MPC85 powders that have been stored for different storage times at different temperatures, to gain insight into the changing properties of samples made with the MPC85.

Chapter 8 explains the use of mass spectrometry to study MPC85 stored at 50°C and covers the full decrease of MPC85 solubility found during this study. Mass spectrometry can identify the changes to individual proteins with storage time.

Chapter 9 is an overall discussion, and examines the relationship between different testing methods.

Chapter 10 is a presentation of the conclusions and lists recommendations for further work.

The appendix gives an overview of the preliminary work performed before the commencement of the full study. The preliminary experiments were initially presented separately as a progress report, and remain in this form.