Effect of Starch Addition on Rheological Properties of Processed Cheese

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Abstract

The main objective of this study was to determine the effect of starches on the rheological and functional properties of processed cheese. The key challenge of this project was to succeed in developing a reduced protein processed cheese. To do so, a fundamental understanding was needed of the textural and functional contributions of the starches in a dynamic processed cheese environment. A collection of different techniques, namely rheology, confocal microscopy, particle size measurement and functionality tests (firmness, stress and strain, melt) were used. The effects of various starches were studied in two formulations: model rennet casein-based processed cheese spread and an Individual Wrapped Slice (IWS) processed cheese.

A range of experimental cheeses was produced by addition of starches at different rates. Samples were prepared on three different pieces of equipment: a Paar-Physica Rheometer (starch cell), a Rapid Visco Analyzer (RVA), and a Blentech cooker (pilot-plant). Ten different starches (Cornstarch, Waxy cornstarch, High amylose cornstarch (HACS), Rice starch, Waxy rice starch, Potato starch, Wheat starch, Resistant starch, Acid converted starch and Perfectamyl (Di-starch phosphate of potato starch) were used for the study. These showed differences in rheological, microstructural and functional properties of the final products. The differences arising in the samples prepared on the various equipment might be due to the physio-chemical properties of the food components and/or to differences in processing conditions.

The rennet casein-based processed cheese spreads were prepared on the Paar-Physica and the RVA with 9.7% protein level. Addition of starch (ten starches) to processed cheese spread increases the rheological attributes, such as complex modulus (G^*), strain and viscosity. However the extent of this increase is totally dependent on the type and physio-chemical properties of the starch. For better understanding of the effect of starch addition, microstructural evaluation and particle size distribution were required in addition to rheological behaviour. The microstructure showed marked differences, which were attributed to different processing conditions and also the physio-chemical properties of the food components (protein, fat and starch). This was also observed in the particle size distribution, where the RVA tended to produce smaller fat droplets than the Paar-Physica.

The protein level in the rennet casein-based processed cheese spread was decreased from 9.7% to 8.5% and 7.5%. Six different starches (Waxy cornstarch, HACS, Rice starch, Potato starch, Wheat starch and Acid converted starch) were investigated in

these reduced protein systems. It was found that reducing the level of protein in the processed cheese influenced the rheological properties, the mean particle size and the microstructural properties of model processed cheese spreads. The emulsifying properties and gel strength of the gel network decrease with reduction in the protein level, thereby decreasing the elasticity of the processed cheese.

Validation of the effects of starch on rennet casein-based processed cheese spreads was carried out in an IWS processed cheese system using the RVA. The impact of four different starches on the meltability and textural properties of IWS processed cheese was dependent on the type of starch. Potato starch, wheat starch and rice starch increased the firmness and viscosity of the processed cheese. However, as the firmness increased the melt decreased. HACS contributed slightly to the firmness and viscosity of the IWS processed cheese. Strain values were largely unaffected by starch addition suggesting that the processed cheese structure remained a continuous protein network. Among all the starches, potato starch gave the best results in terms of textural properties of the processed cheese, especially firmness. Protein substitution of 1 and 2 wt% was achieved by replacement with 1 and 2 wt% potato starch respectively. The low protein and high starch levels introduced some stickiness into the product.

On a pilot-plant scale, when potato starch was used to replace protein at 1 and 2 wt% levels, the firmness of the control was retained in the resulting reduced protein processed cheeses and the flavour of the starch containing products was found to be satisfactory. Although the melt characteristics decreased, they remain within the commercially acceptable limits. However stickiness was again an issue that needs to be addressed before commercialisation.

Processed cheese is a very complex system involving protein-protein, protein-fat and protein-water interactions. Addition of starch increases the number of different interactions. Differences in the processing conditions along with physio-chemical properties of the food components lead to differences in the rheological and functional behaviour of the processed cheese. Despite all these complexities, this work provides useful information on the effects of adding starch on the rheological, microstructural and functional properties of processed cheese. This work demonstrates reduced protein IWS processed cheese manufacture is possible although some further work is needed on the stickiness issue.

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