PROCESS DEVELOPMENT FOR A SHEEP WHEY BEVERAGE

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Maheeka Isurinie Weerawarna N. R. P.

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ABSTRACT

The potential of New Zealand sheep whey as a stable base ingredient in beverage manufacturing was studied using 4 model whey and 7 commercial whey streams. In order for sheep whey containing beverages to have a commercially adequate shelf life they are required to undergo a heat treatment. Due to the artisan small scale nature of sheep cheese manufacture in New Zealand heat treatment using continuous processing was not deemed feasible. The most likely form of heat treatment would be in package batch heating to 90°C with the pH of the beverage less than pH 4.6. Thus this study investigated the variations in the physicochemical composition of sheep whey as a function of cheese manufacturing on heat treatment (90ºC/ 5min) under varying acidic pH conditions (pH 4.5 and pH 3.5).

The composition of sheep whey varied primarily based on the pH of the cheese curd formation and separation method. Additionally, the whey composition also differed with the type of cheese produced and quality control of the process by each manufacturer. Of particular importance is the curd separation technique as this can result in casein contamination of the whey. A model study containing 5% w/v of contaminating curd in whey showed that significant Ca and Mg migrated from the curd into the whey during overnight cold storage (5ºC) at pH 3.5 resulting in an overall increase in ionic strength of the whey.

The stability of sheep whey during heat treatment (90ºC for 5 min) at pH 4.5 and pH 3.5 was studied via sedimentation and colour (L, a, b) measurement. The L value of whey samples heated at pH 4.5 increased and the samples produced 13 – 40% (v/v) sedimentation after overnight storage at 5ºC. Comparatively, whey heated at pH 3.5 was generally stable with less than 1% (v/v) sedimentation and no significant changes in the L value. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) revealed comparatively high loss of monomeric whey proteins in whey heated at pH 4.5 than at pH 3.5 and further confirmed the above results. However, a commercial whey with high ionic strength (conductivity 193.6 mS cm-1) was unstable at pH 3.5 heat treatment and produced about 40% (v/v) sedimentation and a prominent increase in the L value.

Consequently, an extended study on the effect of ionic strength, varied by the addition of NaCl, on heat stability (90ºC for 5 min at pH 3.5) of sheep whey was performed. Whey was stable with up to 0.1 mol L^{-1} added NaCl (conductivity 102.1 mS cm^{-1}) and produced 6% (v/v) sedimentation after the heat treatment followed by the overnight storage. In contrast, a dramatic

increase in sedimentation (about 60%, v/v) was evident at 0.15 mol L^{-1} NaCl with gradual reduction of sedimentation upon subsequent addition of NaCl. Transmission electron microscopy (TEM) images of the sediments showed hairy like aggregates at 0.15 mol L^{-1} NaCl which became dense with further increases in NaCl concentration and perhaps explain the sedimentation behaviour. Further, conductivity of whey increased linearly with increasing NaCl concentration (R^2 = 0.98 at a 95% level of confidence) and thus conductivity measurement could be used to predict the stability of whey during thermal processing.

Moreover, a prototype whey beverage was produced using the above established conditions (90^{o}C for 5 min heat treatment at pH 3.5 and conductivity below 102.1 mS cm^{-1}). However, the product, which was heated in 450 mL bottles (at 1.94°C/ min) rather than the test tubes (at 28°C/ min) of the earlier work, were found to be unstable. Further a rapid heat treatment (at 4.7°C/ min) of the beverage only produced floating aggregates. It was thought that the instability was due to extended heating and cooling rates. A subsequent study showed that holding time at the heat treatment affected the properties of whey protein aggregates and consequently produced either floating aggregates or sediments. Therefore, minimizing heating and cooling rates would be a significant consideration in commercial scale sheep whey processing.

Additionally, the research outcomes would assist on-site decision making for individual cheese manufacturers on the utilisation of different sheep whey streams as a stable base ingredient in beverage processing.

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TABLE OF CONTENTS