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The Scientific Study of the Relationship Between Physicochemical and Microstructural Properties of Ultrafiltered Cheese: Protein Modification and Membrane Separation

Authors : Shahram Naghizadeh Raeisi, Ali Alghooneh

Abstract : The loss of curd cohesiveness and syneresis are two common problems in the ultrafiltered cheese industry. In this study, by using membrane technology and protein modification, a modified cheese was developed and its properties were compared with a control sample. In order to decrease the lactose content and adjust the protein, acidity, dry matter and milk minerals, a combination of ultrafiltration, nanofiltration and reverse osmosis technologies was employed. For protein modification, a two-stage chemical and enzymatic reaction was employed before and after ultrafiltration. The physicochemical and microstructural properties of the modified ultrafiltered cheese were compared with the control one. Results showed that the modified protein enhanced the functional properties of the final cheese significantly (pvalue< 0.05), even if the protein content was 50% lower than the control one. The modified cheese showed 21 ± 0.70, 18 ± 1.10 & 25±1.65% higher hardness, cohesiveness and water-holding capacity values, respectively, than the control sample. This behavior could be explained by the developed microstructure of the gel network. Furthermore, chemical-enzymatic modification of milk protein induced a significant change in the network parameter of the final cheese. In this way, the indices of network linkage strength, network linkage density, and time scale of junctions were 10.34 ± 0.52, 68.50 ± 2.10 & 82.21 ± 3.85% higher than the control sample, whereas the distance between adjacent linkages was 16.77 ± 1.10% lower than the control sample. These results were supported by the results of the textural analysis. A non-linear viscoelastic study showed a triangle waveform stress of the modified protein contained cheese, while the control sample showed rectangular waveform stress, which suggested a better sliceability of the modified cheese. Moreover, to study the shelf life of the products, the acidity, as well as molds and yeast population, were determined in 120 days. It's worth mentioning that the lactose content of modified cheese was adjusted at 2.5% before fermentation, while the lactose of the control one was at 4.5%. The control sample showed 8 weeks shelf life, while the shelf life of the modified cheese was 18 weeks in the refrigerator. During 18 weeks, the acidity of modified and control samples increased from 82 ± 1.50 to 94 ± 2.20 °D and 88 ± 1.64 to 194 ± 5.10 °D, respectively. The mold and yeast populations, with time, followed the semicircular shape model (R2 = 0.92, R2adj = 0.89, RMSE = 1.25). Furthermore, the mold and yeast counts and their growth rate in the modified cheese were lower than those for control one; Aforementioned result could be explained by the shortage of the source of energy for the microorganism in the modified cheese. The lactose content of the modified sample was less than 0.2 ± 0.05% at the end of fermentation, while this was 3.7 ± 0.68% in the control sample.

Keywords : non-linear viscoelastic, protein modification, semicircular shape model, ultrafiltered cheese
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