Comparison of two ultrafiltration membrane systems for whole milk feta cheese production.

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Abstract

Cheese is one of the most well known food products in the world dating back to the 8th century B.C. There are more than 2000 varieties of cheese that are manufactured all over the world. Feta cheese is a soft white cheese with a salty and slightly acidic taste, which has originated from Greece. Most of the feta cheese manufactured in Greece is consumed locally, the migration of greeks to other parts of the world led to a demand for feta cheese outside of Greece. The spreading of the popularity of feta cheese to other ethnic groups in different parts of the world resulted in the high demand for feta cheese worldwide.

The modern and most efficient method of feta cheese production involves a membrane filtration method, known as ultrafiltration. The ultrafiltration process utilises pressure as a driving force to concentrate milk by removal of water and small dissolved molecules. Hollow fibre and spiral wound ultrafiltration membranes are the two types of membranes that are commonly used for cheese production. An extensive amount of research exists on the implementation of ultrafiltration to improve the efficiency of the cheese making process and the performance of the membranes. However, limited research has been conducted on the comparison of the hollow fibre and spiral wound membrane performance in the cheese making process.

The objective of the research was to determine if the hollow fibre membranes used at Puhoi Valley Cheese can be replaced with spiral wound membranes without compromising the quality of cheese produced. In order to achieve the objective, feta cheese was produced using hollow fibre and spiral wound ultrafiltration pilot plants. The operating performances of the hollow fibre and spiral wound membrane units were compared. To ensure that the quality of cheese is maintained, the cheese manufactured on the pilot plant units was analysed in terms of composition, microbiology, texture and sensory properties.

The cheese made using the hollow fibre membrane pilot plant was compared with the reference sample from Puhoi Valley Cheese as they use hollow fibre membranes to produce feta cheese. The cheese made from the spiral wound membrane unit was also compared to that made by the hollow fibre membrane pilot plant unit. The operating parameters such as the inlet and outlet pressure, pressure difference along the membrane, transmembrane pressure, flow rate, recycle rate (bleed off rate),

temperature and the run time were recorded. The operating parameters of the hollow fibre and spiral wound runs were compared with the data from Puhoi Valley Cheese.

The quality of cheese made on the hollow fibre and spiral wound pilot plant units were evaluated in terms of composition, texture, microbiology and sensory properties. The composition was defined by the fat, protein, total solids and salt contents. The fat content was determined by utilising the modified Schmid-Bondzynski-Ratzlaff method, protein by the Kjeldahl method, total solids by using the air drying oven and salt percentage by the volhard method. The texture of the cheese was determined by the fracturability and hardness from the compression curve generated using the single bite compression test. The microbiological testing was performed according to New Zealand testing methods for *E.Coli*, *Staphylococcus aureus*, coliforms and yeast and mould. The difference from the control method was utilised for sensory evaluation. The acid degree value method was used to determine the lipase activity in feta cheese.

It was found from the composition, texture and sensory analysis that the cheese from the hollow fibre pilot plant was different from the cheese manufactured at Puhoi Valley Cheeses (PVC). The spiral wound cheeses were also found to be different to PVC cheese, however the spiral wound cheeses and the pilot plant hollow fibre cheese were the same. The differences between both the pilot plant cheeses and PVC cheese were in terms of the fat, salt, moisture contents and the lipase activity in the cheeses. The fat content in the hollow fibre and spiral wound pilot plant cheeses are lower in comparison to the PVC cheese. This difference in fat content is considered to be due to the difference in the fat to protein ratio of the milk concentrated on the pilot plant and the PVC ultrafiltration system. The lower fat content resulted in firmer cheese than PVC due to more cross linking between the protein strands in cheese.

The salt content in the cheeses made using the hollow fibre and spiral wound pilot plants was lower than Puhoi Valley Cheese. This is considered to be due to the low ratio of brine volume to cheese volume used for salting the cheese. The salt content of brine decreases during brining; hence a low ratio of brine volume to cheese volume causes a significant decrease in brine concentration. The decrease in brine concentration decreases the salt intake of the cheese. As salt diffuses in the moisture diffuses out, lower salt content results in higher moisture content in the cheese. As mentioned, the moisture content of the hollow fibre pilot plant cheese was higher than

the PVC cheese. The moisture content is inversely proportional to the total solids, hence higher moisture in pilot plant cheeses implies lower total solids than the PVC cheese.

The lipase activity results showed that the hollow fibre and spiral wound pilot plant cheeses had higher lipase activity than the Puhoi valley cheese. The differences in lipase activity of the pilot plant cheeses and Puhoi Valley cheese were considered to be due to the incomplete inactivation of lipase present in milk during pasteurisation. The results from texture and sensory evaluation support the above mentioned differences. The microbiology results for all pilot plant cheeses were within the trigger limits set by Puhoi valley cheeses.

The results from monitoring the operating parameters of both the pilot plant data show that the permeate flux decreases while the total solids in milk increase with time, which was also observed from the Puhoi Valley Cheese data. However, the rate of decrease of the permeate flux and the increase of the total solids in milk are dependent on the membrane area, feed volume, transmembrane pressure, pressure drop across the membrane and the flow characteristics.

The rate of decrease in permeate flux and the rate of increase in the total solids of the hollow fibre runs and spiral wound runs are slightly different. The difference is due to the availability of larger membrane surface area and processing of larger feed volume of milk in the spiral wound runs. The transmembrane pressure and the pressure drop across the membrane were maintained as close as possible to Puhoi Valley Cheese.

In conclusion, spiral wound membranes can be used to achieve the desired total solids concentration and successfully make the same feta cheese as the hollow fibre pilot plant. In order to make the same quality of feta cheese as Puhoi Valley Cheese using the spiral wound membrane pilot plant, the same composition of milk used for concentration at Puhoi Valley Cheese needs to be used on the spiral wound pilot plant unit. It is recommended that Puhoi Valley Cheeses should be replaced with spiral wound membranes if they are more economical in terms of cost than the hollow fibre membranes.

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