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Arunee Srichantra

**STUDIES OF UHT-PLANT FOULING BY
FRESH, RECOMBINED AND
RECONSTITUTED WHOLE MILK
EFFECTS OF PREHEAT TREATMENTS**

**A THESIS PRESENTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
FOOD ENGINEERING**

BY

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Abstract

The objective of this study was to investigate the effects of preheat treatments on fouling by fresh whole milk (FWM), recombined whole milk (RCB) and reconstituted whole milk (Recon) in the high-temperature heater of indirect UHT plants.

Various preheat treatments prior to evaporation during milk powder manufacture were applied to skim milk powder (SMP, 75 °C 2 s, 85 °C, 155 s and 95 °C, 155 s) and whole milk powder (WMP, 95 °C, 33 s). These preheat treatments were so-called “evaporator preheat treatments”. Skim milk powder (SMP) and whole milk powder (WMP) were derived from the same original batch of pasteurised FWM to remove the effects of the variation in milk composition between different milk batches. These SMPs were recombined with anhydrous milk fat and water to prepare RCB, and WMPs were reconstituted with water to prepare Recon. Then, (homogenized) FWM, RCB and Recon were subjected to various preheat treatments (75 °C, 11 s, 85 °C, 147 s and 95 °C, 147 s) prior to UHT processing. These preheat treatments were so-called “UHT preheat treatments”. Temperature difference (hot water inlet temperature – milk outlet temperature) was taken as a measure of the extent of fouling in the high-temperature heater. The slope of the linear regression of temperature difference versus time (for two hours of UHT processing) was taken as fouling rate (°C/h).

Increasing both evaporator and UHT preheat treatments resulted in increasing fouling rate and total deposit weight for all three whole milk types for several milk batches. In the case of FWM, there was no reduction in fouling rate with increasing UHT preheat treatment whether FWM was homogenized then preheated, preheated then homogenized or not homogenized at all. These findings, which are wholly consistent and well replicated, are in apparent conflict with the results of most previous comparable studies. Possible reasons for this are explained.

Further investigations of the effects of homogenization relating to the role of whey protein on the surface of the fat globules showed that whey protein associated with the membrane covering the surface of fat globules for homogenized then preheated FWM, RCB and Recon and that association increased with increasing heating process stage. The increasing association of whey protein with the milk fat globules membrane with increasing severity

of heating process stage became faster when preheat treatment was more severe: the association of whey protein plateaued on intermediate temperature heating when the milks were preheated at 75°C, 11 s and on preheating when the milks were preheated at 95°C, 147 s.

In the case of FWM, the thickness of the membrane covering the surface of fat globules for homogenized then preheated FWM, which increased with the severity of heating process stage, was greater than the thickness of the membrane in preheated then homogenized FWM. Preheating then homogenization resulted in the greater interfacial spreading of small molecules on the surface of fat globules, i.e. whey protein or small molecules from the disintegration of casein micelles during preheating.

Possible basic mechanisms for UHT fouling in the high-temperature heater include: the reduction in the solubility of calcium phosphate and the deposition of protein as fat-bound protein and non-fat-bound protein. When non-fat-bound protein in milk plasma deposited, it could be a carrier for the deposition of mineral, such as, the precipitate of calcium phosphate in the casein micelles or the deposition of complexes between whey protein and casein micelles.

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