THE INVESTIGATION OF THE QUALITY OF MILK PRE-CONCENTRATED BY AN ON-FARM EVAPORATION SYSTEM

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XINJUN XU

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ABSTRACT

Pre-concentrating milk on-farm is likely to become an economical operation in the milk processing as the volume of milk processed in a dairy plant is steadily increasing, which means that the milk collection area is becoming larger and larger. A major concern of introducing the on-farm concentration system is the quality of pre-concentrated milk.

The objectives of this study were to find out the most suitable evaporating temperature and the optimum concentration of milk to be done in an on-farm evaporator system.

A Centritherm evaporator, which will be similar to the evaporator used in the on-farm evaporator system, was mainly employed to concentrate milk and a single tube falling film evaporator was also used for comparison in the experimental work.

The effect of evaporation conditions on the changes in quality of pre-concentrated milk during the storage on farm, transportation from farm to processing factory, and the storage at factory were investigated. This consisted of two aspects: microbiological and chemical/physical.

The microbiological study concentrated on the microbial growth rate and microbial numbers in the concentrated milk, including total bacteria, psychrotrophic bacteria, coliform bacteria, thermophilic bacteria.

It was found that in general the numbers of total bacteria were reduced as both the evaporating temperature and the concentration of milk were increased. When the evaporating temperature was 50°C, the total bacteria was decreased gradually as the concentration of milk rose. But when the evaporating temperature was above 60°C, the numbers of total bacteria were decreased significantly with the increase of the concentration of milk.

When storage time on farm (at 5°C) was increased, the standard plate counts of raw milk and the samples of milk evaporated at 50°C increased. However, the standard plate counts of the samples of milk evaporated at 60°C and 70°C were nearly kept constant.

An important finding is that there were no psychrotrophic bacteria detected in the samples of milk evaporated at 60°C and 70°C. Whereas a large numbers of psychrotrophic bacteria were found in the raw milk and the samples of milk evaporated at 50°C.

It was also found that the numbers of coliform bacteria were greatly reduced in the milks evaporated at 50°C and the population was totally killed when the milk was concentrated at evaporating temperature over 60°C.

During the transportation to and storage at the processing factory, the concentrated milk is likely to be recontaminated. An experiment to imitate the transportation process was designed to check the growth of bacteria in the raw milk and the 40% and 50% total solids (TS) milks concentrated at 60°C without contamination or with contamination, by adding 5% raw milk into the concentrated milk. It was found that the numbers of total bacteria in the concentrated milk without contamination did not change during the simulated transportation to and storage at the factory for two days, whereas the numbers of total bacteria in the concentrated milk with contamination were increased during the simulated transportation and storage. The increased bacteria were mainly the psychrotrophic bacteria, but the higher the concentration of milk, the lower the rate of bacterial growth.

The investigation of the chemical and physical properties of the pre-concentrated milk was to examine the apparent viscosity, fat globule size distribution, the content of free fatty acids and denatured whey proteins.

The apparent viscosity of concentrated milk increased gradually as the concentration was raised up to 50% TS, but only slightly increased with the storage time. However, a

great increase in the viscosity with concentration and storage time occurred in the samples of about 54% TS concentration.

The fat globule size distribution in the samples of concentrated milk was examined and it was found that as the milk concentration increases, the volume (%) of the large size globules (around 4 μm) was reduced rapidly before the concentration reached about 30% TS, but for the greater increase in concentration the distributions of fat globules size were nearly kept constant.

The contents of free fatty acids in the raw milk and milks concentrated at 60°C and 70°C were nearly the same (less than 2 m.Mols/l milk), whereas the content of free fatty acids in the milk concentrated at 50°C was higher and increasing with storage time (4.5-7.0 m.Mols/l milk). This was ascribed to both the damage of natural fat protection due to the fracture of the globule membrane during evaporation, and the increase of lipases from the high population of psychrotrophic bacteria in the samples of milk evaporated at 50°C.

No obvious denaturation of whey protein was found in the samples of milk (30-40% TS) concentrated at 60°C for 40 to 90 minutes. However when the evaporation temperature was 70°C, about 50% the bovine serum albumin (BSA) was denatured as concentration of milk was increased beyond 40% TS.

Based on these experimental results, suitable conditions were determined to be an evaporating temperature of 60°C, and the concentration of milk could be 40% to 50% TS. The storage time of three days at farm and two days at factory could be acceptable if the temperature of concentrated milk is kept at 5°C, and concentrated milk can be stored at a dairy factory longer than raw milk when they are under the same transportation and storage conditions.

The results obtained from the falling film evaporator showed that the reduction of the numbers of total bacteria and the numbers of psychrotrophic bacteria with the increasing of concentration and evaporating temperature was quicker than that in the Centritherm

evaporator. The fat globule size distribution is nearly the same in both evaporators under the similar experimental conditions.

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