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Milk Fermentation studied by Isothermal Calorimetry

Introduction

Microorganisms not only spoil food, they can also be used to preserve it. There are many examples of foods which are made with the help of microorganisms, for example wine or some types of sausages. Also there are many fermented milk products, such as yoghurt and the soft cheeses like camembert. Since all microbiological metabolism produces heat, it is convenient to study these fermentation processes by isothermal calorimetry.

The experiments described in this application note have been performed to illustrate the fermentation process in milk. Milk with 3% fat contains in addition approximately 88% water, 3% protein and 5% lactose [1]. During fermentation, the lactose in the milk is metabolized by bacteria to produce a final product with a sour taste and a shelf life longer than that of ordinary milk. The bacteria used are either mesophiles or thermophiles which have an optimal growth temperature of about 25 °C and 40°C, respectively. In the experiment described here, a Lactococcus culture was added to milk and fermented at 25°C to make the traditional Swedish cultured buttermilk called "filmjölk". Note that TAM Air can also be used to study yogurt production using thermophilic bacteria at 40-45°C.

Materials and Method

Ordinary pasteurized milk with 3% fat was used. This was mixed with a starter culture of 1% cultured buttermilk ("filmjölk"). Each 20 ml sample was held in a glass ampoule and loaded into a TAM Air calorimeter. The ampoule was sealed using an aluminum cap with a Teflon coated rubber seal. Firstly the fermentation process was studied at 19°C and again at 25°C. Secondly three further samples were run at 19°C with different substances added. The additives were 6% dextrose, 3% sodium chloride and 0.1% sodium benzoate, respectively.

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Fields of application
Food Science
Microbiology

Instrument configuration
314 TAM Air

Reference
[1] Penfield, M. P. and A. M. Campbell (1990), "Experimental food science", Academic Press.

Result and discussion

Figure 1 shows the fermentation process at the two different temperatures.

Figure 2 shows the result of the measurement when different substances were added. It can be seen that the fermentation is a faster process without additives. The sample with added sugar was somewhat less rapid than the normal sample, while the two other added substances made the fermentation process substantially slower. This clearly demonstrates that calorimetry can be used to study the course of the fermentation processes.

Figure 1. The result of two measurements of milk fermentation at 25 and 19°C . The higher temperature results in a more rapid process.

Figure 2. The result of four milk fermentation experiments at 19°C with the following samples: normal culture (solid line); with 6% dextrose (dotted line); with 3% sodium chloride (dash-dotted line); and with approx. 0.1% sodium benzoate (dashed line).

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