Development of Stable Flavored Whey Protein Beverages

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TABLE OF CONTENTS

Abstract

An ongoing project funded by DMI is examining an innovative concentrated high intensity electric field (CHIEF) process that kills microbes in milk non-thermally. Our very preliminary trial on cheese whey treatment using CHIEF technology demonstrated a 4 log reduction of E. Coli at 22°C. In this study, CHIEF technology will be evaluated for pasteurization of an acidic whey protein beverage. This technology allows the processing of protein-rich whey beverage without thermal treatment, hopefully to avoid undesirable protein precipitation.

Introduction

Whey is a protein-rich liquid component of milk that is produced as a by-product of cheese making. The health benefits of consuming whey have been recognized, and the use of whey has been expanded to many functional foods.

High protein beverages containing whey are anticipated to be a welcome healthy product. Whey protein is unstable when subjected to heat. High heat (above 72°C) denatures whey proteins and destroys some bioactive compounds, which results in instability and reduced health and nutritional values. Therefore, thermal processing such as thermal pasteurization of whey-containing beverages should be avoided.

An ongoing project funded by DMI is examining an innovative concentrated high intensity electric field (CHIEF) process that kills microbes in milk non- thermally. Our very preliminary trial on cheese whey treatment using CHIEF technology demonstrated a 4 log reduction of E. Coli at 22°C. We hypothesize that the CHIEF process could be optimized to provide a solution to the heat-instability problems in whey beverages.

We further hypothesize that the stability and sensory acceptance of whey protein beverages would be affected by the source and form of whey, and the addition of acids and natural components such as fruit juice. Therefore, the performance of CHIEF will be optimized by testing different formulations.

Objectives

1. Explore the feasibility of using CHIEF technology for pasteurization of whey
2. Study the physical and chemical stability of whey beverages processed by CHIEF.
3. Study the effects of formulation on the performance of CHIEF process.

Materials and Methods

Whey beverages and microbe inoculation

Formulated whey beverages will be used as liquid samples to study the effects of CHIEF treatments on bacterial reduction, quality, and shelf stability. The microbiological, flavor, and other properties of whey beverages will be determined prior to and after CHIEF treatment. The microbial study will determine the most resistant microorganisms as the process target in order to set the minimum processing requirement.

Table 1. Bacterial count of *E. coli* 25922 inoculated into model whey beverage before and after treatment with CHIEF.

Model whey beverages	Bacteria initial count (log CFU/mL)	One pass count (log CFU/mL)	Two pass count (log CFU/mL)
100% whey	7.6	5.0	3.2
75% whey/ 25% orange juice	7.4	4.6	2.7
50% whey/ 50% orange juice	7.3	4.0	2.5
25% whey/ 75% orange juice	7.4	3.8	2.1
75% whey/ 25% grape juice	7.4	4.5	2.3
75% whey/ 25% apple juice	7.5	4.3	2.2

Small lab-scale CHIEF system

The small lab scale CHIEF system that was developed for a separate study will be slightly modified with safety and operation improvements for the proposed project. The flow rate, electrical field strength, and power supply frequency are adjustable.

Treatments and process variables

The prepared whey beverage samples will be treated using the CHIEF system under different processing conditions individually or in combinations of following variables:

- Sample variables (juice and protein content, temperature, level of inoculation)
- Voltages (electric field strength)
- Frequency
- Treatment duration
- Flow rate
- Post-treatment storage (temperature)

Physical, chemical and microbiological analyses

The color, rheological properties, temperature, pH, and enzymatic activities of whey beverages will be measured before and after treatments. Standard Plate Count (SPC), preliminary incubation Count (PIC, shelf life), coliform count will be carried out.

Results and Discussion

A new mobile continuous pilot prototype CHIEF system with a capacity of 2L/min has been designed and fabricated for this project. The key process parameters include electrical field strength from10 kV/cm to 70 kV/cm, flow rate from 500 to 2000 ml per minutes, and working pressure from 150 to1500 psi.

Model whey beverages containing whey and orange juice, grape juice and apple juice were formulated. The following blends of whey and fruit juice were prepared: 100% whey, 75% whey/25% fruit juice, 50% whey/50% fruit juice, 25% whey/75% fruit juice. The model beverages were subjected to CHIEF treatments at an applied voltage of 30kV. The experimental results show that 2-3 and 4-6 log E. coli vegetative cell reduction was achieved with one pass and two passes CHIEF treatment, respectively. Shelf life study shows that the CHIEF treated whey beverage have the same shelf life of 2weeks as those treated with traditional thermal process.

We designed and built up a new mobile pilot CHIEF system with improved reactors and system efficiency. Our investigation shows that the bacterial reduction is governed by the electric field strength, pressure, flow rate and the formulation. The results clearly suggested that a CHIEF treatment has the potential to deliver similar microbial inactivation effectiveness as a standard HTST pasteurization system, and should provide a solution for whey beverage process.

Additional research is needed to evaluate the quality changes of whey beverages processed by CHIEF, and to perform process optimization and a cost assessment on the system.