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Study of Ice Cream Freezing Process after Treatment with Ultrasound

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Abstract: Application of power ultrasound to Food freezing is a relatively new subject, cavitations is the most significant power which can not only lead to the production of gas bubbles in ice ream but also the occurrence of micro streaming, also it can promote ice nucleation to accelerate the heat and mass transfer process accompanying the freeze process. In this work ice cream freezing process time after treatment with ultrasound (20 KHZ) was studied. Results were shown that ultrasound is beneficial power to ice cream freezing process and it can be shorten the Freezing process time. Also be lead to product of better quality of ice cream e.g. reducing crystal size and preventing incrustation of freezing surface.

Key word: Ice cream · freezing process · ultrasound

INTRODUCTION

Ice cream can be considered as an aerated suspension of crystallized fat and water in highly concentrated sugar solution containing hydrocolloids, casein micelles and proteins. The control of the crystallization process is one of the major factors affecting the stability and sensory characteristics of these products. Power ultrasound is a relatively new technology which can be used to promote the nucleation of ice [1]. In the presence of an acoustic wave, ice can be initiated at a higher nucleation temperature, than under control conditions. The results from theoretical studies have indicated that the cavitations bubbles produced by the ultrasonic wave are responsible for the nucleation process [2]. Cavitations bubbles also benefit the freezing process by reducing both the heat and mass transfer resistance at the ice/liquid interface and thus increasing freezing rate [3, 4]. Ice crystal is another major component of the freezing system, of ice cream than will fracture when they are subjected to sound wave. Fragmentation of ice crystals leads to crystal size reduction [4]. Factors that affect the efficiency of power ultrasound can be classified in two categories. Product factors and sound factors, product factors involve, parameters such as product structure, moisture content and viscosity, initial gas content and bubble size, etc., Sound factors include power and duration or pulse time of ultrasound, ultrasound frequency, ultrasonic mode. Power ultrasound is used to initiate nucleation in ice cream, it is suggested that the power should be greater than 2 w cm^{-2} of liquid and the preferred frequency be 20 KHz. Further more, the duration should be as short as possible and preferably no more than 5 second [5]. In this study we have utilized from ultrasound power (20 KHz) for promoting of ice nucleation and accelerate the heat and mass transfer process and reduction time in freezing process. Also it be use to provement of sensory characteristics such as flavor, texture and mouth feel in ice cream.

MATERIALS AND METHODS

The first for the purpose of determining the effect of power ultrasound during ice cream freezing process. One horn ultrasonic with frequency 20KHz and 5 levels of time (1, 5, 20, 40, 60 min) model Dr Hielscher, was used. also for ice cream manufacture a pasteurized, homogenized and ripened standard ice cream mix were used and ice cream consisted of 8% milk fat, 10% milk solids nonfat, 18% sugar and 2.5% guar mixed were batch pasteurized at 75ºC for 15 min and homogenized at 17.2 mpa first stage, 3.4 mpa second stage. Cooled to 4°C and aged for 24h. Then mix place into, Ice cream maker and, Ice cream frozen time investigate by determining of the nucleation forming of ice crystals, Then determining of over run and characteristics properties in mix of ice cream. The statically analysis system was used an ANOVA to find out effects of different levels pulse ultrasonic on the

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freezing time and quality characteristics of ice cream. General linear model ($P<0.05$) was used to detect differences among treatment means. All measurements were performed in triplicate using three ice cream samples per treatment.

RESULTS AND DISCUSSION

Figure 1 shows by increasing pulse time in all of treatments, time freezing were decreased, observed acoustic treatment of 1 min did not cause any significant change in freezing rate. The control sample (non-ultrasound) had the highest time freezing 20 min and all the other treatments had lower time freezing. However noticeable increase of freezing was observed when acoustic exposure time was raised to 5, 20, 40, 60 minute, further more, during the pulse time, changing freezing period for ice cream with an acoustic exposure time of 60minute was found to be the faster. Also the samples prepared with 20, 40, 60 minute pulse time, had a significantly ($P = 0.05$) lower time freezing than the others power ultrasound proposed to increase the initial gas content so that the purporation of air lost due to the ultrasound irradiation can be compensated or to carry out the process under increase pressure or to in corporate air into the partially frozen ice cream rather than at the initial stage of the freezing process. Preventing incrustation on the cold surface is another possible benefit effect [6], Ultrasound can promote ice nucleation due to cavitations and enhance heat and mass transfer due to microstreming agitation [7].

By increasing pulse time to 20 minutes, over run was increased and then decreased (Fig 2). Over run in all treatments was higher than control sample, 73%, except for produced sample with 1 minute pulse time, the results showed that, pulse time had significant effect ($P = 0.05$) on over run increasing (Fig. 3).

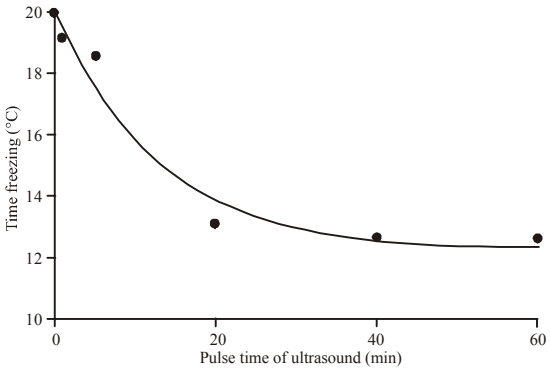

Fig. 1: Influence of pulse time on time freezing

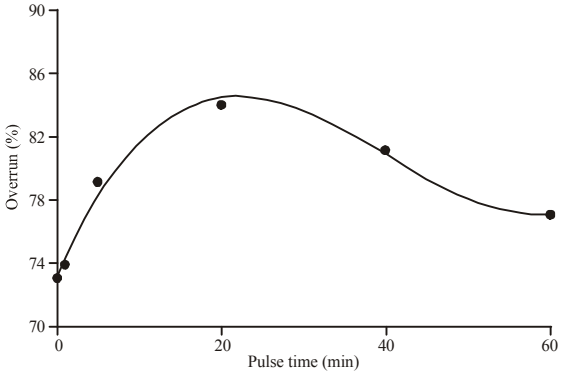

Fig. 2: Influence of pulse time on overrun

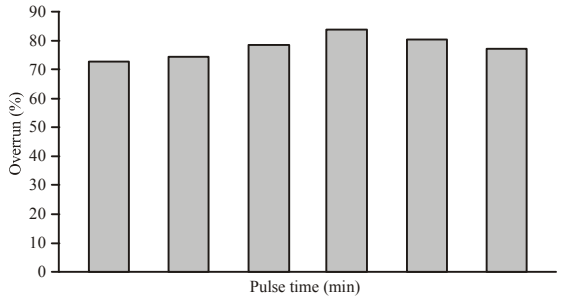

Fig. 3: Influence of pulse time on overrun

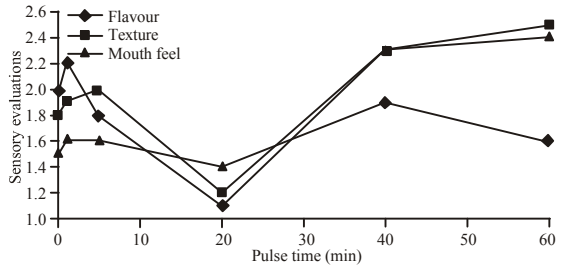

Fig. 4: Influence of pule time on sensory evaluations

The negative effect of time power ultrasound on the overrun can be minimized by applying 20 minuet of from time power ultrasound. The lowest over run a bout 77% observed for 60 min of pulse time, over run reduction for ice cream treated for 60 minute was faster than 40 and 20 min, This might be due to the accumulated thermal effect which is proportional to acoustic duration. Also might high time power ultrasound can promote crystal fragmentation in ice cream [8-12].

Between all treatments the sample prepared with 20 minutes pulse time had the best sensory flavor, texture and mouth feel evaluations (Fig. 4). Flavor and texture in control sample were better than the others but the

samples prepared with 5 and 20 minutes pulse time had better mouth feel than the control.

Power ultrasound is known as a commercial method for degassing some liquid frozen manufacturing processes and thus can modification of the ice cream sensory characteristics. Such as texture and mouth feel. In summary these results showed that pulse time had effective influence on decrease of time freezing and over run increasing and sensory properties according to these results the best treatment was the sample prepared with 20 minute, of pulse time. That decreased time freezing about 35% in ice cream processing [12].

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