Innovative methods of processing liquid food media

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Abstract. Cheese is a staple in Uzbekistan, with high demand and widespread consumption. Milk is the primary source of cheese production, and various factors influence the final product. Not only cow's milk but also goat's, sheep's, and other types can be used. Despite the numerous types of cheese, a unified classification remains elusive. Additionally, different countries may use the same name for distinct cheeses, resulting from varying technological processes. Conversely, the same cheese name can be associated with different production methods. This study aims to address these complexities and explore the diversity of cheese products in Uzbekistan.

1 Introduction

There are known methods of selective impact on milk components that ensure its safety of use while preserving its nutritional and biological value. methods of selective impact on milk components that ensure its safety of use while preserving its nutritional and biological value. Such methods include: ultraviolet light, ionising radiation, infrared radiation, ultrasonic and cavitation effects, avalanche-streamer discharge, etc [1].

It is known that ultraviolet light is a strong bactericidal agent and has a mutagenic effect, which causes changes in DNA and ribonucleic acids in the structure of a microbiological cell. Vegetative forms of pathogenic microorganisms are the most sensitive to UV rays; however, spore forms, in turn, are more resistant to this type of radiation [2].

Given the ability of UV light to penetrate poorly into the depth of the product, it is used to treat its surface; this may catalyse oxidative changes that lead to the process of lipolysis and, as a consequence, the appearance of rancidity and discolouration. When UV light is used, small amounts of ozone may be observed on the product surface [2,3].

Artificial ionising radiation (α-, β- and γ-particles) is a treatment using radioactive radiation, which is caused by ionisation of intracellular substances, leading to a bactericidal effect [4,5,9]. Yeasts, moulds and fungi are known to die when exposed to 0.1-0.5 Mrad radiation; microorganisms are more resistant to radiation and, therefore, their death occurs at 4-6 Mrad [6, 11].

The method described above is relatively cost-effective because it reduces the amount of food additives (preservatives and antioxidants) used to prolong the life cycle of the product [8].

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It is established that under this type of radiation, excited and ionised water molecules form free radicals and molecular products [9,13]. Due to the use of this type of irradiation with the formation of peroxide compounds, the flavour and nutritional value of the product may change for the worse.

Currently, one of the innovative methods that is widely used in domestic and foreign practice is ultrasound.

Ultrasound exposure is usually either high or low frequency.

Ultrasonic high frequency vibrations (frequency above 20 kHz) have bactericidal properties [10,15].

2 Materials and methods

Bactericidal effect is achieved with the help of ultrasonic wave (Fig. 1), which promotes compression and rarefaction when propagating in an elastic medium. When the wave passes through the liquid, it forms submicroscopic and microscopic cavities, which in turn, increasing in size, "pull" gas molecules and vapour-like liquid into themselves. This effect creates high pressure in the cavities, which causes disintegration of cytoplasmic structures and leads to the death of the microbial cell [15]. The formation and rupture of cavities occurring in the medium is called cavitation.

Ultrasound emitters (electroacoustic transducers) are characterised by sensitivity, electroacoustic efficiency and intrinsic electrical impedance.

The transducer sound field is divided into two zones: the near zone and the far zone. The near zone is the area directly in front of the transducer where the echo amplitude passes through a series of maxima and minima. The near zone ends at the last maximum, which is located at a distance N from the transducer. The location of the last maximum is known to be the natural focus of the transducer. The far zone is the area beyond N where the sound field pressure gradually decreases to zero [10,12,13].

The position of the last maximum N on the acoustic axis in turn depends on the diameter and wavelength and for a circular disc radiator is expressed by the formula

$$N = \frac{D^2 - \lambda^2}{4\lambda}$$

where N is the length of the near zone, m,

D - diameter of the transmitter, m,

λ - wavelength, m

However, since D is usually much larger than λ, the equation can be simplified to the form

$$N = \frac{D^2}{4\lambda}$$

The characteristics of the sound field are determined by the design of the ultrasonic transducer. Consequently, its shape determines the sound propagation in the investigated area and the sensitivity of the transducer.

Cavitation causes ionisation of liquid vapour by the formation of a cavitation bubble. When the bubble bursts, an electrical discharge occurs, raising the temperature and generating a high voltage electric field. In this case, liquid vapours of high-molecular compounds in the cavitation cavity are split into hydrogen and hydroxyl group with the formation of active oxygen, hydrogen peroxide, which inactivates microbial enzymes, while protein coagulation occurs, which causes the death of the microbiological cell [8,14].

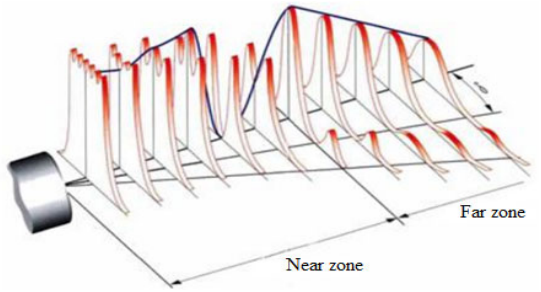

Fig. 1. Ultrasonic wave generated by acoustic vibrations.

The bactericidal effect of ultrasound depends on the presence of lipids, proteins, and the concentration of microbial cells. Vegetative cells are more sensitive than spore cells, cocci are killed more slowly than bacilli. Depending on the size of the microorganism, large cells die faster than small cells.

When using electromagnetic radiation, it was found that the bacterial contamination of milk decreases when exposed to electromagnetic radiation with the following electric current parameters: pulse duration - 19.82 ms, pause duration- 19.64 ms, pulse voltage- 22 V and exposure time - 20 min [6,8,14]. According to [15], with such exposure, the organoleptic parameters of fermented milk products were slightly better than control samples (without treatment). The results of microbiological studies of the quality of fermented dairy products showed that products made from milk processed using an electromagnetic pulse generator had a slightly higher number of lactic acid microorganisms contained in the introduced starter cultures compared with control samples. The number of yeasts and molds in the sample after electromagnetic radiation decreased compared to the control sample [2,4,6].

It is reliably known that under the action of electromagnetic radiation on water containing E. Coli bacteria, their growth was suppressed, as well as yeast-like fungi from the genus Candidaalbicans and microscopic mold fungi from the genera Penicillium and Aspergillus [4].

3 Results and discussion

The method of treatment of liquid food media using electrodischarge plasma is known. Evaluation of the effect of electrodischarge plasma in water containing conditionally pathogenic microorganisms showed that treatment of lactic acid bacteria suspension at a concentration of $2.0 \cdot 10^2$ CFU/ml by spark discharge reduces the number of viable cells (Fig. 2). After the first treatment cycle 50% of the total microorganism content was inactivated, the third and fifth cycles contributed to water disinfection to values of $1.5 \cdot 10^3$.

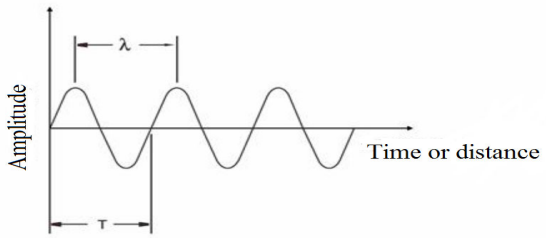

Fig. 2. Basic parameters of the ultrasonic wave.

According to the results, it was observed that the number of cells of the spore-forming bacterium Bacillussubtilis decreased significantly; in a short interval of treatment from one, two minutes of exposure, the contamination was reduced by 3 times, and it was shown that ten-fold treatment reduced the concentration of cells by more than 99%.

At manufacture of briny cheese-brynza it is expedient to exclude process of pasteurisation of raw milk and to replace it by high-frequency acoustic cavitation treatment with the subsequent thermisation that will allow to reduce level of bacterial contamination of raw milk and to keep biologically important components promoting increase of food and biological value of cheese-brynza with application of high-frequency cavitation treatment of milk developed for the first time.

4 Conclusion

The possibility of application of acoustic cavitation and lavinostreamer discharge methods in raw milk processing to achieve pasteurisation effect has been studied. The feasibility of using a dual approach to achieve the pasteurisation effect has been proved: the technological effect of acoustic cavitation is appropriate for inactivation of microbial biota, and the application of lavinostreamer discharge - to reduce the contamination of spore bacteria. Ultrasound emitters (electroacoustic transducers) are characterized by sensitivity, electroacoustic efficiency and intrinsic electrical impedance.

Being in a denatured state and having hydrophilic and hydrophobic sites on its surface, protein particles have high stability and are able to perform the functions of a dispersed phase in any system, regardless of pH and temperature. BCH is easily dispersed and quickly reconstituted without special equipment or technology.

One of the most effective ways to use dairy components obtained by the membrane method from whey is the production of whole milk products.

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