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THE EFFECT OF THE FREEZING PROCESS ON THE PROPERTIES OF FOOD PRODUCTS

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A R T I C L E I N F O.

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Annotation

This article will focus on the preservation of everyday products for consumption without compromising their technological characteristics by freezing them. The article will consist of a scientific and methodological study of the subject based on world experience in this field, a scientific study of its implementation in practice, providing their own suggestions and feedback, preventing negative situations in it.

Introduction

The basis of human health and efficiency is a sufficient and balanced intake of the necessary macro and micronutrients with food. Biological multicomponent systems, such as milk (or blood), freeze at temperatures below 0 °C. For normal cow's milk, the freezing temperature ranges from -0.54 to — 0.58 °C. Deviation from this temperature means that the milk has water impurities, i.e. it is diluted.

The cells of the native muscle tissue of the product and the intermuscular space are filled with a liquid in which proteins, minerals and other substances are in a different colloidal state.

When frozen, ice is formed from the water contained in the muscle fibers and the intermuscular space, which has a larger volume than water. Therefore, ice causes destruction and other changes in muscle tissue (fish, meat, etc.).

At a temperature from 0.5 to -5 ° C, the maximum number of ice crystals is formed, but not all water freezes; at — 18 ° C, 75% of water freezes; the solution freezes completely at -56 ° C. The size of ice crystals and the place of their formation depend on the freezing rate. With rapid freezing, crystals are formed mainly inside cells, with a decrease in the speed of the process — in the intercellular spaces. In this case, the fibers are dehydrated and cavities appear between them.

The size of ice crystals is inversely proportional to the freezing rate. With slow freezing, a relatively small number of crystals are formed, but they have large dimensions (width 5 • 10 ~ 4 cm and length

MO^{-2} cm) and significantly damage muscle tissue. With rapid freezing, on the contrary, a lot of small crystals are formed ($5\text{-}10^{-6}$ см wide and $1 \cdot 10^{-4}$ см long), which damage muscle tissue to a lesser extent. [7]

With an increase in the duration of freezing, structural changes in products increase. With a freezing duration of more than 5 minutes, the sarcolemma (cellular plasma) is damaged, and ice crystals form first inside the fibers, and then outside. With minor damage to the sarcolemma, the muscles can be thawed without loss of juice. At the same time, the water formed during the melting of ice is completely absorbed by proteins.

In industrial conditions, the freezing rate is much lower than that which leads to intracellular ice formation. At this rate, ice crystals appear first on the outside of the fibers, since the extracellular osmotic pressure is less than the intracellular one. During extracellular ice formation, the ionic strength of the unfrozen intracellular fluid increases and water is osmotically removed from the supercooled interior of muscle cells. The released water freezes on the existing ice crystals and increases them, as a result of which the fibers are deformed and destroyed. Moreover, at high ionic strength, some part of muscle proteins is denatured, which, regardless of the movement of water, can explain the loss of moisture-retaining ability by muscle proteins and the inability of fibers after thawing to absorb water removed during freezing.

In recent years, the production of frozen agricultural products, semi-finished products and finished products has been increasing every year in our country and other industrialized countries. Despite the higher costs of refrigeration and storage, they pay off due to a sharp reduction in product losses and smoothing the seasonality of their consumption, as well as obtaining higher quality products and semi-finished products before consumption compared to those subjected, for example, to heat treatment.

The expansion of the production of quick-frozen food products by the International Institute of Refrigeration is considered a promising direction in food preservation technology in the XXI century. However, most dairy products are aggregatively unstable to freezing. This, in particular, explains the limited use of refrigeration technology in the dairy industry (refrigeration storage of butter, cheese, cottage cheese, production and storage of ice cream). The problems of freezing and increasing the volume of frozen food are closely related to the development of resource-saving technology, as well as more complete use of secondary raw materials.

Freezing is the process of lowering the temperature of a product to a value below the cryoscopic, accompanied by the transition to ice of almost the entire amount of water contained in it. Freezing is usually carried out to prepare the product for long-term storage at subzero temperatures. Freezing is significantly different from cooling, as well as from freezing. Thus, most perishable products in the frozen state can be successfully stored for a year or more. The main differences between freezing and cooling are as follows: when freezing, water turns into ice, which prevents the nutrition of microorganisms, resulting in unfavorable osmotic conditions and dramatically reduces the rate of biochemical reactions in the product.

The decrease in temperature, which is more significant than during cooling and freezing, also creates unfavorable conditions not only for the vital activity of the microflora of the product and the environment in which they are located, but also for the flow of biochemical processes. [8]

The eutectic temperature of the tissue juices of food products is about -60^0C. Practically in the refrigeration technology of food products, as a rule, they do not resort to freezing tissue juices to the state of eutectic.

Water turned into ice in food products is called frozen. Its quantity is judged by the increase, which is the ratio of moisture converted into ice to its entire amount (in liquid and solid states) contained at a given temperature.

At cryoscopic temperature w = 0, and at eutectic temperature w = 1. For intermediate temperatures , the values of this value can be determined by the empirical formula:

$$\omega = \frac{1{,}105}{1 + \frac{0{,}31}{\lg\left[t + \left(1 - t_{кр}\right)\right]}},$$

where tcr is the cryoscopic temperature for this product, 0^0C.

The values of t and tcr are substituted into the formula in absolute numerical terms, i.e. if the temperature is negative, then it is taken without a minus sign. The initial cryoscopic temperature of many foods, such as meat, fish, milk, eggs and some others, is close to -1 ° C. Therefore, for them, the above formula can be applied without significant error in the following simplified form:

$$\omega = \frac{1{,}105}{1 + \frac{0{,}31}{\lg t}}.$$

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