FEATURES OF TEMPERATURE CONTROL AND MANAGEMENT IN BREAD BIOTECHNOLOGY

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The yeast *Saccharomyces cerevisiae* is a key microorganism in bread production, responsible for the dough fermentation process [1]. This biotechnological process requires precise control of temperature parameters, as they directly affect yeast activity, fermentation rate, and the quality of the final product. Optimal temperature management at different stages of bread production is critical to ensuring consistent product quality and energy efficiency.

Modern bakeries utilize various types of temperature sensors (resistance thermometers, thermocouples, infrared sensors) to enable continuous monitoring of dough temperature and air temperature in proofing and baking chambers. The most effective approach is a multi-level control system that involves placing sensors in different zones: inside the dough mass (to monitor fermentation), in the proofing chamber air (to regulate dough rising conditions), and in different zones of the oven (to ensure uniform baking). Automated control systems (ACS) based on programmable logic controllers (PLCs) allow dynamic regulation of temperature regimes at different production stages [2]. Special attention is given to pulse control systems, which prevent temperature fluctuations during intense heat generation in the fermentation process. A key challenge in bread production is the non-uniform temperature field within the dough mass and baking chamber, which can lead to uneven fermentation and baking. To address this issue, situational control systems (SCS) are recommended. These systems integrate data from temperature sensors, humidity sensors, pH meters, and carbon dioxide concentration sensors [1]. Such systems employ machine learning algorithms to predict temperature field dynamics and automatically adjust baking parameters. An important design consideration is the placement of backup temperature sensors and emergency temperature regulation systems. The implementation of computer-integrated monitoring systems with remote control functionality significantly enhances process reliability and efficiency.

Research has shown that optimal temperature control combined with modern ACS improves the quality of bakery products by 20 – 25 % and reduces energy consumption by 15 – 18 %. Further advancements in these technologies, particularly the application of artificial intelligence for temperature dynamics prediction, open new prospects for improving bread biotechnology.

References:

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