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SUBSTANTIATION OF THE MECHANISM OF INTERACTION BETWEEN BIOPOLYMERS OF FLOUR AND THE NANOPARTICLES OF THE "MAGNETOFOOD" FOOD ADDITIVE

Interaction of the "Magnetofood" with biopolymers (proteins, proteids, carbohydrates, lipids) is a system of complex chemical reactions. Nucleation of a new, stable phase from an initial metastable phase occurs in this process. An important role is played by supramolecular organization of the "Magnetofood" nanoparticles and the structure of the organic matrix. This results in formation of spatial nanostructures which significantly affect functional and technological properties of raw materials and semi-finished products. To explain the mechanism of moisture-retaining power of the "Magnetofood" food additive nanoparticles and the mechanism of interaction of the "Magnetofood" nanoparticles with polymers of dough systems, it is necessary to, understand the nature and strength of the interaction of the "Magnetofood" nanoparticles with water and corresponding substrates.

The mechanism of influence of the "Magnetofood" additive on retaining moisture in rye-and-wheat dough with various medium pH was established. In a neutral medium of polarized "Magnetofood" nanoparticles, solvated "Magnetofood" nanoparticles are formed. Their surface acquires hydrophily and ability to interact with ionogenic groups of biopolymers and water dipoles. Interaction of solvated "Magnetofood" nanoparticles with water molecules results in solvate complexes. In an acidic medium, the protonated "Magnetofood" nanoparticles contacting with water form solvated "Magnetofood" nanoparticles whose interaction bonds with water dipoles through hydrogen bonds results in formation of solvate complexes. In an alkaline medium, hydroxylated "Magnetofood" nanoparticles interact with water dipoles by ion-dipole mechanism forming solvated "Magnetofood" nanoparticles which interact with water dipoles through hydrogen bonds. This results in formation of solvate complexes [1].

The mechanism of interaction of the "Magnetofood" nanoparticles with ionogenic groups of biopolymers of dough systems was established. The "Magnetofood" nanoparticles enter ionic interaction which arises between: – negatively charged hydroxyl OH^- groups of hydroxylated Fe_3O_4 nanoparticles and positively charged NH_3^+ groups of side radicals of amino acid residues; – positively charged H^+ cations of protonated Fe_3O_4 nanoparticles and negatively charged COO^- groups of side radicals of amino acid residues. The "Magnetofood" nanoparticles enter ion-dipole and dipole-dipole interactions, which result from: – ion-dipole interaction between the protonated "Magnetofood" nanoparticles and the carbohydroxylated residues of amino acid, lipid, carbohydrate; – dipole-dipole interaction between polarized "Magnetofood" nanoparticles and a dipole of the peptide bond.

Due to coordination interactions, the "Magnetofood" nanoparticles form electrostatic intra- and intermolecular complexes ("clathrates" and "cavitates", respectively). Solvated "Magnetofood" nanoparticles form hydrogen bonds with water dipoles. Hydrogen bonds arise in the interaction of solvated "Magnetofood" nanoparticles with molecules of biopolymers (proteins, carbohydrates) containing hydrophilic groups, the groups having polar bonds: C–O, C–N, O–H, S–H [1].

A "cluster-loop-chain" model of interaction of biopolymers of rye-and-wheat dough with the "Magnetofood" additive was proposed. The ability of the "Magnetofood" nanoparticles to enter electrostatic and coordination interactions with protein biomolecules determines a more branched structure and interweaving of protein macromolecules. Formations of "cluster", "clathrate", "cavitate" and "loop" types arise. In these "clusters", "clathrates", "cavitates" and "loops", intermicellar and intramicellar water bound by hydrogen, dipole-ion and dipole-dipole bonds with polarized "Magnetofood" nanoparticles and hydrophilic groups of amino acids may be retained. According to this theory, elasticity of gluten proteins, in particular glutenin is determined by the equilibrium relations between hydrated "loops" and hydrogen-bound zones of "chains" that depend on the degree of hydration. Stretchability of the semi-finished dough products will ultimately consist in stretching of the "loops" and "divergences" of the "chains"[1].

References

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