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Emerging technologies for improving the chemical, technological and nutritional properties of starch

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Starch is a natural polymer widely found in various plant species and represents one of the main sources of energy in human nutrition. Its granular structure is mainly composed of amylose and amylopectin, organized in amorphous and crystalline regions, whose molecular structure influences its chemical, technological, and nutritional properties. Among these properties, solubility, water retention capacity, viscosity, gel formation, and stabilizing action stand out, determining its functionality in different food systems. Nutritionally, starch is classified into three fractions according to its digestion rate: rapidly digestible starch, slowly digestible starch, associated with the gradual release of glucose and glycemic control, and resistant starch, which is a type of dietary fiber. Despite its wide application in the food industry, native starch has limitations, such as low solubility in cold water and instability in the face of variations in temperature, pH, and processing conditions. In this context, emerging technologies arise as alternatives to conventional modification methods, showing potential to promote more sustainable, versatile processes with less waste generation. Ultrasound, cold plasma, high hydrostatic pressure, pulsed electric fields, irradiation, high-pressure homogenization, microwave heating, and ohmic heating, modify starch through different mechanisms. These may induce physical changes, such as granule fragmentation, surface pore formation, and component leaching, as well as chemical modifications, such as cross-linking. Ultrasound promotes acoustic cavitation, which can modify starch granules, increase water absorption through pore formation, and enhance the non-digestible starch fraction through chain cleavage and molecular reorganization. Ohmic heating generates heat through the passage of electric current, inducing molecular changes that may affect the technological properties and digestibility of starch. The nature and intensity of these changes depend on the starch source, processing parameters, and intended application. Thus, emerging technologies can improve the technological properties of starch, expand its industrial applications, and modulate its digestibility.

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