

Mechanochemical Technologies of Plant Materials Treatment

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The plant raw materials are multiphase multicomponent systems having ordered cellular structure. Intercellular substances are presented mainly by cellulose, hemicellulose, lignin. Lipids, soluble oligosaccharides, polyphenols and other products of living plant organism as alkaloids, active acids, glycosides are among the most deliverable.

Mechanochemistry is the perspective approach for the production of powdered cellulose-, polyphenol-containing products that are necessary for different branches of industries. The mechanochemical cellulose etherification with carboxymethylcellulose-containing powdered product for application in oil and gas industry gives the illustration. Mechanical and mechanochemical damage of intercellular components facilitates the extraction of cellular substances.

Cellular components - bioactive substances may be presented in plant raw materials in different chemical forms. For example, alkaloids and bioactive triterpenoid acids have free, salt, complex, molecular complex forms. Aglicons are presented in free, glycoside with soluble saccharides, glycoside with insoluble saccharides, molecular complex forms. Different chemical forms have different solubility and efficiency of extraction. Sometimes it is possible to enhance the yield of extraction by previous chemical treatment of raw material. Solid state mechanochemical reactions can be used for the transformation of chemical forms existing in plant material into more soluble form. Alkaloids and acids salts are more soluble in water than free alkaloids and acids. Glycosides with mono- and disaccharides are more soluble in comparison with other aglicon chemical forms. The choice of solid mechanochemical reagent is defined by chemical reaction leading to soluble forms.

Mechanochemically assisted extraction in plant raw materials treatment consists of previous mechanochemical treatment of mixture of raw material with suitable solid reagent to transform bioactive substances into more soluble form in solvent used in subsequent extraction operation. The chemical solid state reaction of bioactive substances and reagent takes place during mechanical treatment of mixtures.

The yield of extraction of bioactive substances rises as a result of formation of new portions of soluble bioactive substances. The selectivity of extraction is also different in technologies with organic solvent percolation and in ones with use of mechanochemical reaction. The selectivity of organic extraction is defined by the solubility of bioactive and ballast substances. The selectivity of extraction with use of previous mechanochemical transformation depends on the chemical affinities of bioactive and ballast substances. So, the selectivity of extraction can be improved via mechanochemical approach.

Mechanochemical treatment of plant materials with reagents leading to the formation of water-soluble bioactive forms gives rise to new commercial products – powders of plant materials containing bioactive substances in bioavailable forms. These powders can be used as food additives, veterinary medicines, growth regulated matter for agriculture and biotechnology.

The mechanochemical approach advances are illustrated by examples of some alkaloids, triterpenoid acids, sterols and ecdysteroids. In some cases it is possible to increase the yield of bioactive substance to more than 50%, to elevate the selectivity of green product and to facilitate the following purification, to exclude the organic solvents from technology.