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## Drying as an unit operation in downstream processing

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Consumer demand has increased for processed products that keep more of their original characteristics. Downstream processing refers to the separation or purification of biological products, generally in marketable quantities especially in the manufacture of pharmaceuticals such as antibiotics, hormones, antibodies, vaccines, industrial enzymes, natural fragrance, flavor compound, etc. There have been various advances in the drying of foods with respect to quality, rehydration, and energy minimization. Freeze-drying is considered a suitable dehydration process for bacteria, with the ultimate goal of achieving a solid and stable final formulation. Spray drying allows preparation of stable and functional powder products and can be applied to stabilize heat sensitive ingredients, such as enzymes and probiotic bacteria. The choice of an appropriate drying medium is very important in the case of LAB, so as to increase their survival rates during dehydration itself and subsequent storage. This paper is a review of drying as a unit operation in downstream processing and discusses the innovative drying technologies, quality of dried foods and deteriorative reactions during drying, drying methods, stages in downstream processing, separation technology in downstream processing and drying of cell materials. The freeze-drying process, pretreatment prior to freeze drying, freeze drying of microorganisms, optimal spray drying of enzymes, eggs and probiotics, effect of droplet size in spray drying as well as single droplet drying methods were considered. The paper concluded that as drying technologies become more diverse and complex, dryer selection has become an increasingly difficult and demanding task as changes in operating conditions of the same dryer can affect the quality of the product.

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