

Powder and Bulk-Solids Processing

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Introduction. The inherent safety, convenience, availability, nutritional content, aesthetic appeal, and variety that typify our food supplies are a hallmark of modern life, but this was not always the case. For the last 100 years we have been witnessing dramatic advances in the scientific understanding and engineering techniques that increase agricultural production and allow for the commercial-scale production of countless processed foods. Through the concerted efforts of chemical engineers and others, the yields and quality of farm crops have increased exponentially, and the industry producing and packaging foods and beverages has evolved to a business worth many hundreds of billions of dollars. Modern-day consumers love “convenience foods,” for which chemical engineers invented the many automated processes needed to concentrate, freeze, dehydrate, and otherwise process such foods.

Fast-cooking foods. Fast-cooking, or “instant,” foods, such as quick-cooking rice, canned soups, packaged bake mixes, and canned and frozen vegetables are often prepared by hydrating and then precooking the foodstuff, after which the treated products are dried to reduce the moisture content and prolong shelf life.

Early efforts to produce fast-cooking rice, beans, and other legumes, however, often made trade-offs in terms of nutrition. Such processing typically required nutrient-rich outer bran layers to be removed (because they tend to absorb water slowly and thus slow the cooking process). To avoid this trade-off, chemical engineers developed food processing techniques allowing highly nutritious brown rice, wild rice, beans, and various crop seeds to be cooked quickly without sacrificing their nutrient-rich outer layers. For example, whole grain, brown, or white milled rice is heated to create cracks in the outer layers and then hydrated with water, cooked to partially gelatinize the starch content, and then cooled and dried for packaging.

Chemical engineers also have helped devise the processes to produce frozen foods retaining their appearance, texture, taste, and nutritional content when thawed and cooked. For instance, investigators found that quick-freezing processes could keep large ice crystals from forming in the foods and help thawed foods retain fresh taste and texture. Similarly, when vegetables are first blanched (swift cooking in boiling water) and then frozen quickly, the combined process suppresses certain enzymes causing discoloration and “off” flavors. In freeze-drying processes, food material is introduced to a vacuum chamber where it is frozen, and then most of the water is removed by sublimation by reducing the chamber pressure to a few millibars, which is finally subjected to controlled heating to remove any remaining water. Freeze-dried foods have a long shelf life and quickly regain their original flavor, aroma, size, shape, and texture, once water is added back to them, which reduces spoilage and the weight of the food, making it easier and cheaper to transport.

Conclusion. In recent years, powder and bulk-solids processing has become more technically sophisticated, with advances in the areas of weighing and feeding bulk solids, separating and classifying powders, characterizing particles, pneumatic conveying, drying, mixing and blending, and managing both dust emissions and the electrostatic hazards that can arise when dusts are present in enclosed areas. These advances have had a tremendous impact on food processing and have enabled the commercial-scale production of foods powdered form, such as cake mixes, powdered pancake mixes, and cocoa.