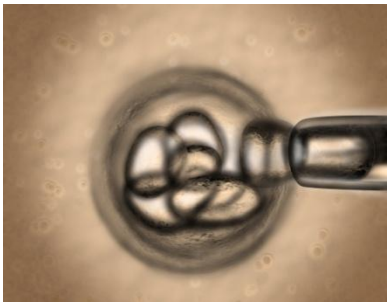
Biotechnology's Impact on Food Ingredients

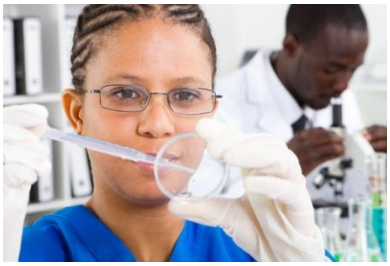
Natural biological processes have been employed for food production for more than 8,000 years. Bread, cheese, yogurt, beer and wine, vinegar, and many other foods are produced through microbial fermentation or enzymatic activity. Biotechnology offers many ways to improve the production of our food: natural flavors and colors; new vitamins, improved enzymes and emulsifiers; more options for assessing food safety; more waste treatment options; "greener" manufacturing processes; and even biodegradable plastic wrap that kills bacteria.

Cell Culture: A Biotech Tool



Cell cultures are groups of cells grown under controlled conditions, usually outside their normal environment. We have known for decades the basic requirements for keeping small numbers of plant, microorganism and mammalian cells in culture. Cell cultures can come from plants, viruses, insects, microorganisms, algae, or mammals, including human stem cells, human embryonic kidney (HEK) cells, tissue cells, or cultures of gut flora. We maintain these cultures primarily to collect the protein products that cells produce naturally. These cell cultures have been used for many purposes in general medicine, animal husbandry, agriculture, food research and industry.

Cell Cultures for Research



Understanding what controls the cell cycle – it's path from replication to differentiation to eventual cell death – is essential to understanding the underpinnings of human and animal health and many diseases, the basis of increasing crop plant yields, and numerous other biological processes. These scientific tools are also a means for quickly increasing the cell colonies used to manufacture products as diverse as fermented foods and medicines. For example, plant-cell culture gives us flavors, colors, thickeners and emulsifiers for food processing.

Understanding the molecular basis of a natural biological process allows many products to be tested in cells saving companies time and money while also leading to better products. Human, animal, plant and microbial cell cultures are important in identifying environmental hazards, in establishing safety for consumers, and in testing the efficacy of any compound that will be used in foods, drugs or vaccines.

Cell Cultures for Production

Once a chemical or protein is optimized for safety and efficacy in cell culture, scientists will recreate its production in a well-described and tested safe microorganism for production. This allows more efficient, cost-effective production of the chemical or protein along with more precise improvements to their functionality.

Typical production microorganisms are yeasts, aspergillus, E.coli, various bacilli, and Trichoderma reesei, due to their high productivity and tolerance to the production environment at commercial scale. Algae also could become a production platform for proteins, enzymes and other molecules. Algae are also composed of polysaccharides, starches and proteins and they produce pigments and antioxidants, such as the carotenoids lutein and beta carotene. Because some microalgae are high in Omega-3 fatty acids, they are used as health foods or supplements and as animal and fish feeds.

Examples in Food Production

Food ingredients are substances used to increase nutritional value, change consistency and enhance flavor. The compounds are substances nature has provided and are usually of plant or microbial origin – the common food and personal care ingredients xanthan gum and guar gum are produced by microbes. Many of the amino acid supplements, flavors, flavor enhancers and vitamins added to breakfast cereals are produced by microbial fermentation. Specialized high-purification systems remove all microbes prior to final food production.

Enzymes are used as processing aids to enhance the efficiency of food manufacture. For example, chymosin, used to make cheese, is an enzyme that occurs naturally in the stomachs of animals. Biotechnology scientists years ago created a way for yeasts, molds and bacteria to produce chymosin, eliminating reliance on livestock for this enzyme.

New Areas of Food Research

Biotechnology is using the biology of taste to create healthier foods. Tasting begins with taste receptors on our tongues and ends with our brains telling us a substance either tastes good or bad. Taste receptors can distinguish five different categories: sweet, salty, sour, bitter and umami (savory). Components like sugar, salt or MSG give foods their signature sweet, salty or savory flavor. These taste receptors develop to allow humans to identify foods with carbohydrates, proteins and other essential minerals and nutrients.

Researchers now use human taste receptors to automatically analyze numerous compounds and the reaction of taste receptors to these compounds. A goal of the research is to identify new ingredients that enhance the sweet, salty or savory taste of foods so that we could produce foods with less sugar, salt or MSG without sacrificing the pleasing taste. The receptors and cells used in these analyses are for research only and are never in the final food products.

Regulatory Structure

Biotech foods are regulated under the same U.S. laws that govern the health, safety, efficacy, and environmental impacts of all food products. A federal policy first adopted in 1986 in the Coordinated Framework for Regulation of Biotechnology set the precedent that a commercial product, regardless of its manner of production, should be regulated based on the product's composition and its intended use. The policy was clarified in the 1992 Statement of Policy: Foods Derived from New Plant Varieties, which recommended that developers voluntarily consult with FDA about new foods under development.

In the United States, responsibility for regulating food falls to three federal agencies: the Food and Drug Administration (FDA), the United States Department of Agriculture (USDA) and the Environmental Protection Agency (EPA). The FDA regulates novel substances in foods and feeds on the basis of dietary risk evaluating foods for safety, allergenicity, and toxicity. The FDA has the right to ban any food product, whether produced through biotechnology or other methods, if it is determined that there is a reasonable possibility that it is unsafe. Many food ingredients, either through long use by industry or through validation using scientific procedures, have been designated Generally Recognized As Safe (GRAS) under regulations established by the FDA. The USDA regulates bioengineered plants under the Animal and Plant Health Inspection Service (APHIS), assessing whether the plant may impact the agriculture industry or the meat processing industry. The EPA evaluates genetically engineered plants for environmental safety, conducting risk assessments on pesticides that could potentially cause harm to human health and the environment and establishing tolerance and residue levels for pesticides.