

BIOTECHNOLOGICAL PROCESSES IN THE FOOD INDUSTRY



The most important branches of the bio-industry (Fig. 1.1) include some branches of the food industry (large-scale cultivation of yeast, algae and bacteria to produce proteins, amino acids, vitamins, enzymes); agriculture (cloning and selection of plant varieties, production of bioinsecticides, breeding of transgenic animals and plants); pharmaceutical industry (vaccine development, synthesis of hormones, antibiotics, interferons, new drugs); ecology - environmental protection and elimination of pollution (wastewater treatment, household waste processing, composting, etc.).



- ▶ Biotechnology is designed not only to improve the traditional methods widely used in the food industry in the production of lactic acid products, cheese, food acids, alcoholic beverages, but also to create modern technologies for the synthesis of polymers, artificial seasonings, raw materials (textile industry), for the production of methanol, ethanol, biogas and hydrogen to extract some metals from ores.

▶ Milk products

▶ In the food industry for the production of dairy products, mainly fermentation is used [4]. Streptococci and lactic acid bacteria are usually involved in the fermentation of milk; lactose is then converted into lactic acid. By using other reactions that accompany the main process or occur during subsequent processing, other milk processing products are also obtained. Among them, buttermilk, sour cream, yogurt and cheese.

▶ Six main reactions can occur in milk during fermentation, and as a result, lactic ($\text{CH}_3\text{CH}(\text{OH})\text{COOH}$), propionic ($\text{CH}_3\text{CH}_2\text{CHOOH}$) or citric acid ($(\text{HOOCCH}_2)_2\text{C}(\text{OH})\text{COOH}$), alcohol ($\text{C}_2\text{H}_5\text{OH}$), butyric acid ($\text{C}_3\text{H}_7\text{COOH}$) are formed) or coliform gas formation occurs. The main of these reactions is the formation of lactic acid. All methods of fermentation (fermentation) of milk are based on it. In this case, milk lactose is hydrolyzed with the formation of galactose and glucose. Typically, galactose is converted to glucose even before ripening. The bacteria present in milk convert glucose to lactic acid (Embden-Meyerhof-Parnassus pathway). The formation of a casein clot occurs at the isoelectric point of this protein (pH 4.6) under the action of lactic acid. This process underlies cheese making.

- ▶ In the production of Swiss cheese, oily fermentation with the formation of carbon dioxide plays a key role.
- ▶ $C_6H_{12}O_6 = CH_3CH_2CH_2COO + 2CO_2 + 2H_2$
- ▶ This is what determines the peculiar taste (bouquet) of these cheeses and the formation of eyes. The characteristic taste of buttermilk, sour cream and butter is formed as a result of fermentation of citric acid. It consists of the constituent flavors of diacetyl ($CH_3C(O)C(O)CH_3$), propionic and acetic acids, and related compounds. Various processes of milk fermentation are carried out today under controlled conditions. For many past millennia, they have been carried out with the participation of bacteria originally present in milk. Nowadays, various starter cultures are used for this, allowing you to get dairy products of the desired quality and type. The cultures of living bacteria used in this case can be either a single strain of a certain type, or several strains and / or species.

- ▶ Although the properties of cheeses are extremely diverse, there is much in common in the process of making all of them. The first stage is the preparation of a culture of lactic acid bacteria and the sowing of milk with it. Then the milk is curdled, for which the rennin enzyme is usually used. After separation of the aqueous liquid (serum), the resulting curd mass is subjected to heat treatment and pressed into molds. Next, the clot is salted and set to ripen. In the next step, the cheeses are sent for ripening or aging.

- ▶ Ripening occurs in special rooms with controlled temperature and lasts up to four years. Microorganisms and enzymes during this process hydrolyze fats, proteins and some other substances of young cheese. As a result of their decay, substances are formed that give the cheese a characteristic taste. It is easiest to get butter from dairy products. Depending on the type of oil produced, cream is used with a concentration of 30-32 to 30-40%. When they are knocked down, the emulsion of oil in water turns into an emulsion of water in oil. In the production of oil, special bacteria cultures are used to improve the taste and better preservation.
- ▶ In the manufacture of sour cream, 0.5-1% of the starter culture used in the production of oil is added to cream. Next, the product is kept until the acid concentration reaches 0.6%.
- ▶ It is known that some people do not tolerate lactose. They can produce milk treated with β -Galactosidase, an enzyme that reduces lactose. For this purpose, it is necessary to develop an inexpensive industrial method for the production of such milk. β -Galactosidase is obtained from yeast, molds and bacteria.

- ▶ Bakery products

- ▶ *Saccharomyces cerevisiae* yeast is still mainly used for bread production. Usually they are grown in batch fermenters on molasses (beet or sugarcane). In the simplest case, the dough is prepared by mixing flour, water, yeast and salt. When kneading, the layers of the dough move, conditions are created for the formation of gas bubbles and the rise of the dough. The mixed dough is given the opportunity to "fit", and then cut into pieces of the desired weight, molded and aged in a humid atmosphere. During exposure and at the first subsequent baking stage, the "nuclei" of gas bubbles formed during kneading and molding are filled with carbon dioxide. It is released during the anaerobic fermentation of glucose and maltose flour. The risen dough is baked. During this thermal process, starch gelatinizes, the yeast dies, and the dough is partially dehydrated. In addition to carbon dioxide, anaerobic fermentation produces organic acids, alcohols and ethers. All of them significantly affect the formation of the taste of bread.

- ▶ In addition to baking, starch is used to produce low molecular weight carbohydrates. Hydrolysis of starch on an industrial scale is carried out in different ways: only acid, acid and enzymes and only enzymes. In the mid-60s, the acid and acid-enzymatic processes were replaced by an enzymatic method for the processing of starch, based on the sequential use of α -Amylase *B.subtilis* and amyloglucosidase *A.oryzae* or *A.niger*. In addition to glucose production, the most notable success in this industry has been the production of mixtures of glucose and fructose. This product is known as high fructose isoglucose or corn syrup. Isoglucose can replace sucrose in most foods. Isomerization is carried out by enzymes from various organisms. Their choice is determined by how easy it is to work with them, whether they need cofactors and whether they are stable (see "Fundamentals of Engineering Enzymology").

