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Food Technology and Biotechnology in the Development of the Republic of Croatia

Prehrambena tehnologija i biotehnologija u razvoju Hrvatske

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Summary

A number of fundamental guidelines are crucial in outlining the role of food technology and biotechnology in Croatia: general trends in the production and distribution of food, medicines, and biologically active substances in production, technological and natural environment, as well as specific requirements of the present situation and orientation in future development of Croatia. It is expected that food technology and biotechnology in particular, the development of which is gaining in importance worldwide, will occupy an appropriate place in development strategy of Croatia, since the priorities of that strategy include food production, bioprocesses and environment protection.

Processing of agricultural products is very important for overall efficiency of agricultural production, for increased valorization of those products, for ensuring supply of quality and inexpensive food and for export of specific food and biotechnological products. In order to achieve these goals strict production norms must be satisfied, which implies modern and rational technology in production and distribution.

By adopting, albeit belatedly in some segments, the technologies of production of food and biologically active substances used in the developed countries, Croatia is in the position to take advantage, to a considerably greater extent than before, of its geographic location, climatic and agroecological conditions, and the structure of economy which awards the agricultural and food system as well as tourism, a prominent place.

In Croatia, provided the interdisciplinary cooperation, there is a satisfactory intellectual basis for rapid development of the food system and its inclusion into modern trends. The role of scientific and educational institutions is very important, and in that context the Faculty of Food Technology and Biotechnology in Zagreb plays a particularly important role.

Sažetak

Neke su osnovne odrednice bile odlučujuće za shvaćanje uloge prehrambene tehnologije i biotehnologije u Hrvatskoj. To su: opće tendencije u proizvodnji i prometu hrane, lijekova i biološki aktivnih supstancija u proizvodno-tehnološkom i prirodnom okruženju, te specifični uvjeti trenutka i opredjeljenja na kojima se zasniva razvoj Hrvatske u budućem razdoblju. Naime, očekuje se da će prehrambena tehnologija, a posebice biotehnologija čije razvojne funkcije u svjetskim razmjerima postaju sve značajnije, naći odgovarajuće mjesto u strategiji razvoja Hrvatske.

Prerada poljoprivrednih proizvoda ima veliko značenje za cjelokupnu poljoprivrednu proizvodnju, za što veću valorizaciju tih proizvoda, za snabdijevanje pučanstva jeftinom hranom, ali bolje kakvoće te za izvoz specifičnih prehrambenih i biotehnoloških proizvoda.

Da bi se to postiglo, mora se proizvoditi po sve strožijim normama, tj. suvremenom i racionalnom tehnologijom u proizvodnji i distribuciji.

Usvojivši, iako u ponekim segmentima sa zakašnjenjem, tehnologije razvijenih zemalja u proizvodnji hrane i bioloških aktivnih pripravaka, Hrvatska ima priliku iskoristiti u znatno većoj mjeri nego prije prednosti koje joj daje geografski položaj, klimatski i agroekološki uvjeti, te struktura gospodarstva u kojima poljoprivredno-prehrambeni sustav i turizam zauzimaju vrlo istaknuto mjesto.

U Hrvatskoj, uz prijeko potrebnu interdisciplinarnu suradnju, postoji solidna intelektualna osnovica za ubrzani razvitak prehrambenog sustava i njegova uključivanja u suvremene tijekove. Prema tome, vrlo je važna uloga znanstveno-nastavnih institucija, a posebno značenje u tome ima Prehrambeno-biotehnološki fakultet Sveučilišta u Zagrebu, Zagreb.

Food technology and biotechnology are applied sciences, crucial for the development of a society and improvement of living standard. They are closely related in the process of food production, particularly of fermented foodstuffs (wine, beer, vinegar, vegetable preservation, dairy products, bakery products, tea, coffee etc.). Their

common feature is that they deal with biological material which is subjected to various technological operations and processes in order to obtain products which have to be biologically valuable, stable and toxicologically sound. The development of food technology and biotechnology is necessarily linked with the development of agricultural production both quantitatively (because of balancing the raw materials) and qualitatively. It is well known that the relationship is reciprocal: just as the advancement of food capacities in many countries has affected considerably agricultural production, the agricultural production can in turn limit the successful development of food industry and biotechnology. Namely, agricultural production and food capacity development are not always fully coordinated. This disproportion of agricultural production and processing capacities hinders the development of food industry and biotechnology because it causes insufficient utilization of the existing capacities, which has unfavorable effects on export or import of food, agricultural and biotechnological products. This relationship is well illustrated by Croatian primary agricultural product: corn (Fig. 1.). The extent of corn production in Croatia warrants modern capacities for moist processing which are not available.

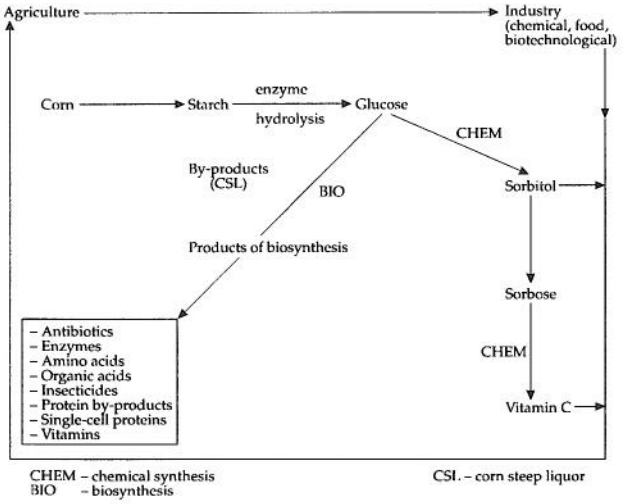

Fig. 1. Corn in the agriculture-industry cycle
Slika 1. Kukuruz u ciklusu povezivanja poljoprivrede i industrije

The qualitative aspect of this relationship is evident in orienting the selection process toward obtaining sorts (or breeds) of satisfactory technological characteristics, with respect to content (e.g. sugar content in beet, dry matter content in tomatoes, content and type of oil or proteins in oil plants or cereals etc.), or with respect to maturation dynamics (peas). It also underlies the modification of processing methods and development of process solutions for better exploitation of »classical« and »new« raw materials. It goes without saying that the goals of food technology and biotechnology at a particular stage may be of more global (general) or narrow (specific) significance, depending on the particular situation or needs of a country. Necessary substitutions providing better exploitation and improvement of particular raw materials must be considered. Biotechnology is a strong link between agricultural production and food industry. The improvement of genetic potential of plants (in favorable and unfavorable climatic and soil conditions) is an important factor in biotechnology application and establishing the relationship between agriculture and food industry. This above all implies practical implementation of genetic engineering by recombinant DNA, with the purpose of breeding new plant species of specific desired qualities (Table 1).

Table 1. Desirable properties of plants modified by rDNA technology

Tablica 1. Poželjna svojstva biljnih vrsta izmijenjenih tehnologijom rDNA

– Higher yield of fruits of desired chemical composition (dry matter, carbohydrates, proteins, amino acids etc.)
– Growth on the soil of higher salinity, in unfavorable climatic conditions (drought), and in general, on soils of inferior quality
– Binding gaseous nitrogen from air without mediation of nitrogen fixating microorganisms
– Resistance to herbicides, mycotoxins, viruses, insects etc.
– Biosynthesis and increased production of secondary metabolites for the purposes of food production by plant cells and tissue culture

On the other hand, active microbial biomasses have found increased application in primary food production (Table 2).

Plant types modified by rDNA and active microbial biomass increase agricultural food production and make it cheaper. Apart from that, satisfying basic human nutritional needs require the conversion of some agricultural raw materials (primarily carbohydrates) into animal proteins. The major drawbacks of this conversion are a relatively low yield and a relatively long fattening cycle. Therefore, biotechnology is applied as auxiliary or rival technology, which enables carbohydrates, and vari-

Table 2. Areas of application of biologically active microbial biomasses

Tablica 2. Područja primjene biološki aktivnih mikrobnih biomasa

– Soil inoculation (increased number of saprophytic microorganisms)
– Microbiological treatment of seeds or seedlings with the purpose of biological binding of nitrogen (nitrogen fixatives)
– Improvement of fruit seedlings by mycorrhizal fungi
– Preservation and improvement of feed (lactic acid bacteria and yeasts)
– Biological insecticides (e.g. *B. thuringiensis*)
– Anti-frost protection of plants (e.g. *P. syringe*)
– Other microbiological fertilizers (mixed microbial cultures)

ous carbohydrate and lignocellulose materials to quickly and efficiently convert to protein-rich microbial biomass (40–80 % of dry matter). This biomass is used in livestock fattening as biological additive (2–4 %) or as substitute for fish meal (up to 10 % of dry inactive biomass). Particularly interesting is the use of microbial biomasses in human food, as partial or complete substitution for plant and animal proteins. Besides, the use of microbial biomass enriched with vitamins and minerals for pharmaceutical purposes, instead of standard medicines (biomass enriched with vitamins B and E, zinc, chromium, selenium etc.) is steadily increasing.

The Development of Food Technology

The development of modern food technology must provide quality nutrition. Ensuring sufficient quantities of relatively inexpensive food of biological and organoleptic quality satisfying the criteria of modern food science is a long-term and permanent objective in any society. In countries with developed agriculture and food industry the consumer is offered a selection of foods varying in quality, purpose and preparation requirements (dietetic, convenience, special-purpose food). Obviously, an essential feature of modern food industry is continuous improvement of the existing and introduction of new products, in keeping with the changes in consumption structure and the standard of living. In a word, it is desirable to produce food of high nutritive value, having a wide range of organoleptic properties, and keeping in mind regional specificities, which is of particular importance in the Republic of Croatia.

It is, therefore, important that modern processing methods enable the production of foods which maximally keep their natural nutritive-physiological and organoleptic characteristics, by abandoning chemical preservation methods (preservatives, additives).

At present, the advancements in food quality are unimaginable without the development of all infrastructural elements which comprise production, distribution and consumption. This has resulted in the introduction of the »quality assurance« (QA) concept, and more recently, of the »total quality management« (TQM) concept. Underlying these concepts is the dynamic approach to quality assurance, which is of particular importance in the production of biologically more valuable food. Besides the choice of the technological method, a very important role is played by the modern process control, including on-line measurements for complete monitoring of food properties during technological processes.

Current progress in technological processes and processing equipment in food industry is manifested along several lines:

- increase of unit capacity of installations, accompanied by the best possible energy effects;
- further advancement and increasing implementation of automatic process management and control;
- introduction of alternative processes and materials (e.g. in concentration, pasteurization, sterilization, extraction, and packaging materials);
- ever increasing application of biotechnology in food manufacture, and processing and preservation of food products;
- better yield of raw materials and waste disposal.

The starting points of future developments lie in numerous new or improved techniques. Here are some of the most characteristic ones:

1. Processing techniques (within individual food technologies) such as extrusion, vacuum technique, industrial microwave technique, membrane processes (microfiltration, ultrafiltration and reverse osmosis) including membrane reactors, high-pressure extraction with super critical gases, continuous fermentation technique, and aseptic HTST procedures.

2. Application of microbial and enzyme methods in food preservation and production or modification of basic raw materials, such as fats, starches and proteins.

3. Development of integrated on-line process measuring systems (sensors), such as biosensors, NIR (near infra red) and NMR (nuclear magnetic resonance) measuring systems, process chromatography and rheometry, laser technique etc.

4. Introduction of the so-called »production on time« by computer integrated manufacture (CIM), and transition to continuous process management.

One of the important characteristics of futre development of processes and equipment for food industry is resorting to flexible unit- and complex procedures and installations, resulting from the transition from the »economics-of-scale« concept to the »economics-of-scope« concept. In other words, the rigid long-term production programs, highly specialized and dependent on raw material are replaced by easily adjustable processes coordinated with the changes in product assortment.

It also needs to be stressed that the basic technological processes are strongly affected by the application of biological factors. Biotechnology may be directly or indirectly included in the food industry. With respect to direct application of biotechnology (microorganisms) in food industry, it has to be noted that microorganisms may be used in a number of ways:

- in production of a chemical compound, such as organic acid or an enzyme;
- for enhancement of organoleptic properties of a product;
- as an integral part of a product;
- microorganism itself may be the final product, and therefore needs to be separated from the substrate in which it has been cultivated.

This is especially true of new raw materials, additives and enhancers of nutritive value of food, produced by biotechnological procedures (food acids, amino acids, vitamins, flavoring substances, antibiotics, gelling agents, enzymes), but also of important biotechnological products such as baker's and fresh yeast, commercial microbial starter cultures (wine yeast, lactic acid bacteria etc), proteins and modified soya proteins. Various meat analogs based on microbial biomass can be included among such products as well. One such product appears on the market under the name of »mycoprotein«, and it is produced by using mycelia of *Fusarium* molds.

Development of Biotechnology

Before analyzing Croatian needs and developmental trends, a survey of biotechnological developments in the world will be presented (Table 3).

Table 3. Areas of biotechnology application
Tablica 3. Područja primjene biotehnologije

Activity	Contribution of biotechnology
Pharmaceutical production	Lowering the expenditures in production of very expensive preparations (insulin, interferon, immuno-preparations)
Chemical industry	Chemical products obtained by biotechnological procedures (reagents, biopesticides, enzymes, etc.)
Fermentation industry	Yield increase and introduction of new products and production microorganisms (amino acids, proteins, alcohol and baker's yeast)
Food industry	Application of enzymes, bio-additives and starter cultures
Agriculture	Development of new plant varieties resistant to various meteorological conditions, introduction of new sorts with special chemical characteristics and application of biopesticides and biofertilizers
Cattle and poultry raising	Microbial feed production (transformation of carbohydrates and proteins). Raising superior and high-yield breeds
Environment protection	Treatment of solid wastes and waste waters, detoxification, deodorization
Mining	Bacterial ore leaching and metal refinement
Energetics	Application of new energy sources (renewable biomass), electronics and bioelectronics (biosensors, biochips)

Although the data in Table 3 suggest that biotechnology is very important in various areas of industrial production and enables more successful and cheaper output of a great number of different products, present interest in biotechnology has been instigated by emerging new products obtained with the help of organisms modified or constructed by rDNA. Genetic engineering is used in the manufacture of all pharmaceutical products: polypeptide hormones, blood plasma products, enzymes, interferons, lymphokynes, regulatory factor II, bacterial and viral vaccines etc. In other words, the development of rDNA technology deserves credit for biotechnology being in the center of media attention. However, many media have created and propagate the illusion that this technology is omnipotent and will solve all the problems of the world. Reality, of course, is different, and it requires coordinated development of all fundamental and applied disciplines which may ensure development of biotechnology for practical purposes. Practical developmental trends of industrial biotechnology may be grouped into four groups:

1. development of biocatalysts (production of microorganisms and enzymes, using gene technology);
2. development of processes and equipment;
3. providing renewable and inexpensive raw materials for the production of basic chemicals; and
4. education of individuals for efficient performance of all activities.

Survey of Food Industry and Biotechnological Production in Croatia

Any concept of developmental policy requires an analysis of the present state and needs of food industry and biotechnological production in Croatia. Essential data for such analysis are presented in Tables 4 and 5.

Table 4. Structure of industrial and other processing and service plants based on food technology
Tablica 4. Struktura industrijskih i drugih prerađivačkih i uslužnih pogona baziranih na prehrambenoj tehnologiji

Basic (»large-scale«) food industry	Standard industrial plants	Medium-sized and small plants (semi-industrial plants)
Mills	Manufacture of bread, pastry and similar products	Processing
Sugar refineries	Manufacture of confectionery products	
	Preservation and processing of: – meat	Packaging
Oil plants	– fish – milk	
	– fruit – vegetables – oils and fats	Preservation
Starch and starch-derivative industry (missing)		Catering
	Manufacture of convenience food	
Large slaughterhouses and meat processing facilities		Snacks
	Production of: alcoholic and non-alcoholic beverages	
	Cold storage, distribution centers (auctions and stock exchange centers of agricultural and food products)	Region-specific products

Table 5. Biotechnological production in Croatia
Tablica 5. Biotehnološka proizvodnja u Hrvatskoj

Product	Number of plants	Assortment
Beer	8	Light, dark, alcohol-free
Alcohol	4	Molasses, grain
Vinegar	6	Alcoholic, grape, apple, flavored
Baker's yeast	2	Fresh, compressed, active dried
Enzymes	1	Amylases, proteases, glucanases
Antibiotics	1	OTC, synthetic antibiotics
Vitamin C	1	Powder, tablets
Vaccines and immuno--preparations	2	For human and animal use
Insulin	1	Human

Croatian Needs, Potentials and Directions

The need to rebuild agricultural processing capacities partly or totally destroyed during aggression on the Republic of Croatia adds a new dimension to developmental strategy, perhaps not so much in the concept itself, as in its implementation. In order to define the strategy of development of food and biotechnological processing capacities it is essential to determine the basic starting points and reach consensus of relevant factors. Government and other institutions (competent departments, chambers and associations) must play an important role, especially since market mechanisms have not yet started acting as dominant developmental factors.

During reconstruction of individual facilities care must be taken to eliminate the existing »vertical and horizontal« disproportions. Therefore, conditions for normal coordination among primary production, processing, and markets for food and biotechnological products must be secured. Elimination of »vertical« reproduction disproportions must be coordinated with the elimination of »horizontal« ones, i.e. with appropriate location of production plants based on the following two criteria:

1. raw materials, and
2. markets.

Tradition in particular production may be added as a third criterion. Whereas in large-scale or basic industry (sugar refineries, oil plants, mills, large meat-packaging plants, breweries, malt, ethanol, yeast and vitamin C plants) the raw material criterion has been generally adopted, the location criteria for plants with higher degrees of product finalization (e.g. convenience foods) are more complex, with greater emphasis on the markets. These issues must be dealt with in the context of regional requirements as well, both with respect to assortment structure of processing plants and the distribution chain (wholesale markets, auction-exchange centers, various cold storage facilities etc.). This new situation in designing the agricultural and food system emphasizes complex corn processing (above all the so-called moist processing), and starch products and derivatives as irreplaceable primary materials for many industries or as finished products for immediate consumption.

In considering these issues and dilemmas it is important to evaluate the potentials of individual regions, especially those which had previously been neglected with respect to their possible contribution to the agricultural and food system (Medjimurje, Gorski Kotar, Lika, Hrvatsko zagorje, Istra, parts of Dalmatia and the islands) but which have recently, largely owing to the war, drawn attention to their insufficient exploitation.

Food industry and biotechnological production as well as the entire agricultural processing sector must follow the trends in Europe and, in general, in the developed countries, with respect to assortment, technology and processing solutions. The assortment based particularly on minimally processed, as »natural« as possible (including organically grown food), convenience and functional foods requires:

1. standard biological value,
2. constant quality,
3. hygienic quality, wholesomeness and
4. modern packaging and marketing procedures.

The development of new products also plays a very important part.

Technology should be in tune with the achievements of modern process techniques, biotechnology, computerization and marketing.

In the course of the development and restructuring of these activities a special place belongs to small and medium-sized semiplants and businesses (»mini factories«), whose role will be primarily to complement the assortment of industrially manufactured products and/or act as alternatives for some of them. Namely, in the technological, economic and ownership restructuring of the agricultural and food system, small- and medium-scale agricultural processing is becoming one of the key factors in the development of the entire system. Related to this is the need for permanent expansion of assortment of food and biotechnological products, which can be, with respect to quality, variety and manner of presentation by suitable technology, readily adjusted to specific market requirements. Small plants are, by their very nature, more practical and flexible, which makes them less risk-prone. It can realistically be expected that smaller, with respect to technology and market requirements more flexible processing plants will rapidly contribute to progress in all aspects of primary agricultural production and improve market supply with a rich assortment of quality goods.

Why is it important to draw attention to biotechnological trends in the development of Croatia? It is estimated that the value of new biotechnological products in the world (not counting traditional fermented foods) will reach almost 65 billion US$ by the year 2000 (Table 6). About 19.4 % of that amount will be contributed by new food products, and about 13.2 % by new agricultural products.

Some of the pharmaceutical industry output, fine chemicals and the largest portion of the presently unforeseeable development will also be directed toward food industry, agriculture and cattle-raising.

Table 6. Estimated value of biotechnological products in the world by year 2000

Tablica 6. Procjena vrijednosti biotehnoloških proizvoda u svijetu do 2000. godine

Area of application	Value/millions of US$
Energy	16 350
Food products	12 655
Chemicals	10 550
Pharmaceutical products	9 080
Agriculture	8 546
Leaching of metals	4 570
Environment protection	100
Other (unforeseeable development)	3 000
TOTAL	64 851

Income-oriented Development of Food Technology and Biotechnology

In keeping with the long-term orientation of the entire national economy toward market economy and market-based evaluation of products and services, the goal of long-term development and research in the area of food technology and biotechnology has to be the manufacture of:

1. expensive and high-quality products, which yield high profits although turned out in small series;

2. non-capital-intensive products (majority of basic agricultural raw materials, foodstuffs and beverages) which yield adequate profit through mass production of large quantities of relatively inexpensive goods.

It has to be kept in mind, however, that biotechnological research and development of new products and procedures for food and pharmaceutical industry are very expensive, time-consuming and risky. Any new product must first be approved and then introduced on the market. The license to market a product may be revoked even after a period of well established mass consumption. An example of such practices is the ban on the use of saccharin and cyclamates which was issued after additional tests had been carried out.

Because of scarce resources allotted to research and development in this country, developmental potentials of our food technology and biotechnology are limited. Therefore, it cannot be expected that in the following period all goals of biotechnology, agriculture, food industry or other areas will be realized in full. Due to that, investments into research must be carefully considered and planned.

To assess profitability of investments into long-term development of biotechnology in food production, hypothetical models of research into new sugar beet hybrids, citric acid and natural fruit flavors production may be used as examples. The high price of domestic sugar, as a limiting factor of Croatia's competitiveness on the world market (confectionery and fruit products), can be compensated for by long-term investment into development of new varieties, with the mass fraction of sucrose 4–6 % higher than in the existing sorts. If, for example, the average mass fraction of sucrose in sugar beet increased by only 1 %, about 1 500 hectares (3 706.5 acres) of the best soil would be available for other crops. That would increase sugar production by 10 000 tons. It must also be mentioned that this would greatly decrease transportation costs and save energy, which would in turn affect the price of sugar, and accordingly, of confectionery and fruit products as well.

The advantages of biotechnological manufacture of fine chemicals and food additives can be illustrated by citric acid production. The annual world production of citric acid, by biotechnological processes alone, is about 350 000 tons. The equivalent amount from »natural raw materials« would require over 7 million tons of lemons or a corresponding quantity of other citrus fruits, which would be considerably more expensive.

The general tendency to eliminate artificial flavorings from food production draws much closer attention to the manufacture of natural ones. In spite of the state-of-the-art facilities and »aroma recovery« plants, 1 kg of fruit flavor, requires the processing of tons of fruit. Special biotechnological methods allow the raw materials to be directly enriched by the appropriate aroma. Fermentation processes and new separation techniques enable the production of expensive and quality flavors at much lower costs and with higher gain.

Biotechnological production of human insulin proves that such reasoning is not just a hypothetical model. Whereas the classical technique of insulin extraction requires about 9 kg of bovine or porcine pancreas for 1 g of product, microbial production with *E. coli* gives the same results in 20 liters of microbial culture.

Similarly, aerobic and anaerobic treatments of waste water used at present have, with the help of modern biochemical engineering methods, spatially and temporally condensed the natural, but very slow self-purification process.

In any case, the new or improved biotechnological procedures in food industry are expected to satisfy health standards, ensured by adequate testing, and output finished products which are cheaper than the comparable natural or synthetic products of equal quality. In order to achieve this, during long-term development of food industry and biotechnology in Croatia particular importance must be attached to:

1. experiences acquired in traditional biotechnology, possibilities of development and revitalization of the existing and new capacities of fermentation industry in Croatia;

2. original research, with the purpose of faster development and better implementation of starter cultures, enzyme technology and biochemical engineering in food industry and production;

3. application of improved control and regulation methods for new biotechnological processes, and product quality control with respect to technological, economical, ecological and health requirements.

The Role of Scientific Research and Education

The establishment of the Food Technology Department of the Zagreb University in 1956, and of the Biotechnological Department in 1960, which have subsequently merged into the Food Technology and Biotechnology

Faculty, laid the foundations of the first undergraduate and graduate studies of food technologies and biotechnologies in this part of Europe, and created the nucleus of scientific research in the fields of food science, and food technology and biotechnology, expanded recently by food and biochemical engineering, and nutrition science. Every effort has been made to keep up with the current trends in those areas. The result of such approach is the considerable influence of the Faculty of Food Technology and Biotechnology on the development of food and pharmaceutical industry in Croatia, primarily through education of a large number of graduated food technology and biotechnology engineers (2340), and holders of master's (274) and PhD (163) degrees. Based on the experiences of the Faculty of Food Technology and Biotechnology and with its help, a number of related institutions has been founded, such as the Food Technology Faculty of the Osijek University, and several institutes, research centers, and divisions within large industrial plants.

The advancement of food technology and biotechnology in Croatia was greatly aided by international scientific cooperation, i.e. joint projects and exchanges of researchers, particularly with leading countries in relevant scientific disciplines.

All this indicates that in Croatia, given the necessary interdisciplinary cooperation, there exists a solid intellectual basis for rapid development of the food system and its inclusion into modern trends. Scientific and educational institutions play a very important role in that process. This can be illustrated with the results of the Zagreb Faculty of Food Technology and Biotechnology, and the Osijek Faculty of Food Technology. In spite of all difficulties burdening the development of science in Croatia (lasting financial restrictions, lack of consistent policies and compartmentalization of curricula) successful cooperation between faculties and factories has been established, the consequence of which has been the application of research results in the improvement of the existing technological processes and the introduction of new technologies into food industry, and biochemical and pharmaceutical production. Our scientists have been the principal investigators on a number of scientific projects at regional, national and international level.

However, in spite of the successful start and achieved results in scientific research and their application in technological processes, not all potentials of food technology and biotechnology have been used to the full, particularly with regard to manpower. The reasons for that lie in insufficient research coordination, but also in the brain-drain of top experts who have earned international reputation. Unfortunately, that trend continues and should, therefore, be stopped. Coordination of scientific research at the Faculty of Food Technology and Biotechnology with economic developmental programs is one of the possible ways of keeping the young researchers in the country and at academic institutions, after completing graduate studies and obtaining master's and doctor's degrees.