**Innovative Romanian Food Biotechnology** *Vol. 7, Issue of September, 2010*

*Received August 15, 2010 / Accepted September 2, 2010*

***REVIEW ARTICLE***

# AN OVERVIEW ON THE CURRENT STATUS OF ROMANIAN BIOTECHNOLOGY IN EDUCATIONAL AND TRADE SECTOR

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**Abstract**

Biotechnology is one of the key enabling technologies of the 21st century with a potentially wide range of applications in many sectors, including health, food and agriculture and industrial processes. In Romania, the biotechnology industry is not very well developed at present. Prior to 2007, the development of the biotechnology sector was of low priority for the government. In 2007 the National Plan for Research, Development and Innovation was launched in Romania and aims to develop science and technology for economic competitiveness, improving quality and increasing social awareness of potential recovery and broaden action. This paper syntheses the relevant information about applied biotechnology in our country from educational and trade perspectives development. This study is part of activities of project the postdoctoral schools of national interest Applied Biotechnology with impact in Romanian bio-economy, acronym PDS-BIOTECH.

This project is co-financed by European Social Fund through Operational Programme Human Resources Development 2007- 2013, priority axis no. 1 Education and professional training to support the growth and development of knowledge-based society, area of intervention 1.5 Doctoral and postdoctoral programs to assistance the research.

**Key words:** biotechnology, attitudes, bio-economic, high levels education programmes

## General aspects

Biotechnology is *the application of integrated biological sciences and engineering technology for the use of living organisms, biologically active acellular structures and their molecular analogues in order to produce goods and services* (Bahrim, 2004).

This definition includes traditional biotechnology processes that have been used for a very long time in the food and drinks industry (as fermentation, bioconversion etc) as well as modern biotechnological processes (such as nucleic acid DNA/RNA technology, proteomics, metabolomics and related omics technologies and supporting tools).

Biotechnology is one of the key enabling technologies of the 21st century with a potentially



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wide range of applications in many sectors, including health (red biotechnology), food and agriculture (yellow and green biotechnology), industrial processes (white biotechnology), marine and aquaculture (blue biotechnology) and for environmental protection (green biotechnology). Biotechnology can contribute to the achievement of major European Union policy goals, such as economic growth and job creation, public health, environmental protection and sustainable development (Zika *et al*., 2007).

Nowadays, biotechnology has a global dimension, the expansion of the knowledge base being accompanied by an unprecedented speed through transformation of scientific inventions into practical use and products (COM 2002-27).

The European Council in Stockholm in March 2001 confirmed the role of biotechnology and life sciences and invited the Commission, together with the Council, to: *examine measures required to utilise the full potential of biotechnology and strengthen the European biotechnology sector's competitiveness in order to match leading competitors while ensuring that those developments occur in a manner which is healthy and safe for consumers and the environment, and consistent with common fundamental values and ethical principles*.

In Europe and elsewhere, intensive public debate has emerged. Although a majority of people remain optimistic about biotechnology and its uses, a growing number of people feel that the risks associated with agricultural applications, and even environmental and health applications, are increasingly unacceptable (Macer and Chen Ng, 2000).

## A short review of Public Attitudes towards Biotechnology in the world

The extension of biotechnology is currently a matter of widespread concern in most European Union (EU) countries.

Several studies have been released with a focus on public understanding, perception, and acceptance of biotechnology (Vanderschure *et al*, 2010). The series of Eurobarometer surveys chart the public's views of biotechnology. Previous studies have evaluated awareness of the public regarding facts connected to biology and biotechnology (Hossain *et al*., 2003). Most studies investigating social aspects of biotechnology used non-restricted samples (Harrison *et al.* 2004, Gaskell *et al*., 2006) giving an overall public acceptance and concern about biotechnology.

The most extensive international study on consumer attitudes towards biotechnology was conducted by Environics International (2000). More than 35 000 respondents from 35 countries were asked whether they agreed that the benefits of biotechnology outweighed the risks. There clearly are differences in public acceptance of different biotechnological products. Survey respondents were asked whether they would support or oppose the use of biotechnology to develop different applications of biotechnology. Almost all respondents (85%) indicated that they would support the use of biotechnology to develop new human medicines. However, 15% would oppose the use of biotechnology even for such a clearly beneficial use.

Almost 75% of people will support the application of biotechnology for environmental clean-up, 55% were agree with genetically animal feed and 42% supported the use of modern biotechnology to clone animals for medical purpose.

Pardo *et al.* (2002) suggested that in Europe, about one in five adults qualify as well-informed about biotechnology while a third of Europeans display a middle-level awareness and understanding. The necessity to raise knowledge about biotechnology has been debated in several European documents and research articles.

Studies using Eurobarometer surveys highlight significant heterogeneity within biotechnology applications where there is opposition to genetically modified foods, whereas the public remains supportive towards healthcare and environmental applications (Gaskell *et al.* 2000, 2003).

Some studies point out that moral beliefs do exert an important influence on risk benefit evaluations

(Macer, 1994, 1996). Protests from key social reference groups, e.g., environmentalists on GMO products, or moral resistance from religious groups to certain medical applications (Bauer *et al*., 2002), do play a key role in the risk learning process of some individuals. In fact, decision-making in biotechnology seems to be the result of a trade-off between two conflicting decision-making models, the first grounded on core values and moral acceptability and an alternative model based on standard cost-benefit analysis where risk beliefs are weighted against benefit perceptions (Costa-Font and Mossialos, 2005). Some studies have shown that risk perceptions are less influential than moral acceptability in shaping public perceptions in each EU country across all applications examined by the Eurobarometer 1999 Survey (Gaskell *et al.*, 2000).

Council for Biotechnology (2001) tracking attitudes from March 2000 to July 2002 and found that the consumer awareness for biotechnology could be used for various applications increased. Agreement that biotechnology allowed farmers to grow more food to feed the world's population increased from 61% to 70%. Also, agreement that biotechnology could be used to develop hardier crops able to grow in difficult conditions, such as drought, increased from 58% to 65%. Similarly, recognition that biotechnology could be used to develop healthier foods, such as foods with lower fats content or higher in nutrients increased from 45% to 54%. Recognition that biotechnology could be used to reduce the need for chemical pesticides increased from 42% to 48%.

Costa-Font and Mossialos (2005) suggested that attitude on biotechnology may have two or more dimensions. These authors used the ambivalent hypothesis (both positive and negative at the same time), and concluded that ambivalence is a significant feature to take into consideration when examining attitudes even though it has a heterogeneous effect among different applications. Their findings support the hypothesis that perceptions of the benefits and risks of biotechnology might be strongly influenced by the way in which individuals evaluate new information.

Gaskell *et al.* (2003) suggested that public may differ in their perceptions of benefits and risks, as follows:

- the *relaxed group* think that a particular application is useful (has benefits) and has no associated risks.
- the *sceptical group* think that a particular application carries risks but no benefits.
- the *trade-off group* think that a particular application has both benefits and carries risks.
- the *uninterested group* see the application as having neither benefits nor risks.

The current socio-economic issues of managing some human diseases, starvation, environmental contamination, as well as maintaining the sustainability of the food supply have global significance and need creative, effective solutions. Biotechnology has an important role to play in addressing them, but whether or not an innovation actually represents a solution frequently depends further on its acceptability to consumers. An innovation is not a solution if nobody uses it (Mohr and Topping, 2010).

## The current status of biotech field in Romania

Romanian legislation is opposing the true sense and finality of research due to excessive centralization and high level of bureaucracy, inflexibility and lack of adaptation to research needs, administrative and financial inadvertencies. The unwanted consequence is waste of funds, time, and capabilities.

In Romania, the biotechnology industry is not very well developed. Prior to 2007, the development of the biotechnology sector was of low priority for the government. Very few funding programmes existed and there were no specific policies for development and support of this field.

The main fields of biotechnology companies in our country are shown in Figure 1. As regards their size there is an equal distribution of companies depending on the number of employees.

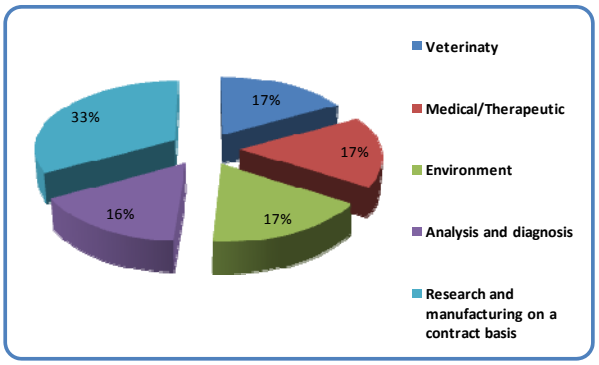


***Figure 1.*** *Romanian companies with biotech profile (Source:www.romanianbiotech.com)*

Although it is universally acknowledged the importance of biotechnology, as at the European levels are developed numerous platforms and associations, this area has not received over time significant financial support from the local executive power, both in terms of academic research in the field as in transfer of know-how from universities to the economic environment. Before 2007, the biotech sector development has been of low priority for the government. There were very few funding programs in this area without being defined an overall strategy and specific government policies to develop and support a European and international key emergency field.

In 2007, were developed two strategic documents:

- **National Strategic Reference Framework** (CSNR) which aims principally strategic focus on economic, social and regional cohesion of Romania and to establish appropriate and correct relationship with the European Commission policies, to develop policies for economic development and create new jobs.
- **National Plan for Research, Development and Innovation** (PNCDI) which is the main instrument through which the National Authority for Scientific Research (ANCS) is implementing the National Strategy for RDI. The aims of this programme are to develop science and technology for economic competitiveness, improving quality and increasing social awareness of potential recovery and broaden action.

The strategy of PNCDI is to promote high quality research and innovation at the national level, to establish related infrastructure, to improve human resources and visibility by increasing national and international partnerships and cooperation. The priority areas include, among others bio and eco-technology, industry, agriculture, food engineering and safety, health, energy, environment and transportation. It is important to mention the EU strategy for biotechnology sector and its applications in health, food and agriculture, environment protection etc. Substantial funding from the European Union (almost 20 billion) is not exploited optimally, although these can be a successful key resource for developing in short, medium and long terms for Romanian economy and society, and a key element of the budget in terms of sustainability strategy and investment.

Although absorption of structural funds and cohesion has become first priority of the Romanian Government, unfortunately, only 1.15 billion Euros have been accessed by projects, which represent only about 6% of EU funds. The main reasons for this are poor representation of national companies in European projects, authorities inertia, poor information of potential beneficiaries and lack of capital, because accessing these funds involves co-financing.

## Brain-drain phenomenon

At this stage of development, Romanian bioscience is paradoxically confronted with either asset-less hyper-competence or competence-less lay-off nearby high-tech assets (Vidulescu, 2003). Coherent plans for development should match the right level of trained competence with adequate material and technical resources. Bilateral recognition of diplomas by Romania and countries with prestigious educational systems would help the Romanian young researchers to find their way back home. Ways should be found to stimulate young researchers, by setting rules and criteria for promotion based on the true merit and capabilities.

## Higher Educational offer

Among Romanian universities, a number of 21 of them organize educational programmes in biotechnology and related fields. The sample

structure for the exploratory research is shown in Figure 2.

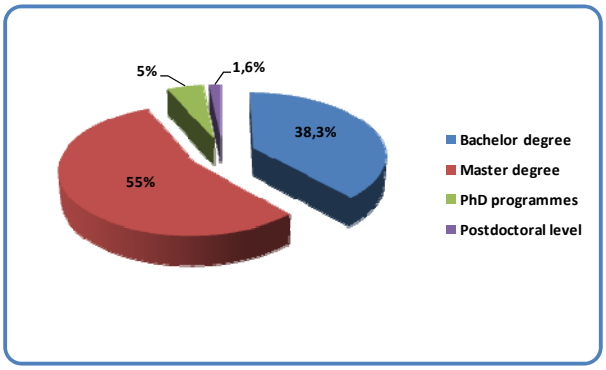


***Figure 2.*** *Educational programmes in biotechnology field in Romanian universities*

The radiography of fundamental areas in which Romanian universities organize educational programmes in biotechnology and related areas is shown in Figure 3.

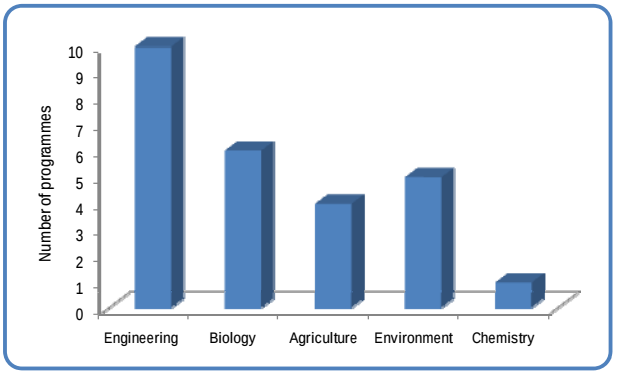


***Figure 3.*** *Fundamental fields with higher educational programmes for applied biotechnology in Romanian universities*

It can be seen from table 1 the expansion of training programs for the first (bachelor) and second cycle (MA) and a low supply level of doctoral and post-doctoral programmes in biotechnology. These data justify the appropriateness of training specialists at advanced levels through doctoral and post-doctoral levels for the progress of biotechnology in our country.

## Modern research infrastructures

In 2006 was launched by NURC/UEFISCU the program "platforms/laboratories for interdisciplinary research training" addressed to public universities in Romania, capable to provide co-financing up to 50% of the total project.

The main objectives of this program were:

- to increase the capacity of national universities to integrate at the European level;
- to increase the scientific performance and matching the higher education system to the needs of Romanian society;
- to provide highly qualified human resources for education and research by organizing training system master and doctoral programs in a new configuration;
- to develop interdisciplinary and transdisciplinary training programs.

In the biotechnology field have been created the following research and educational platforms:

❑ **Integrated Research and Training Centre for Applied Biotechnology in Food Industry – BIOALIMENT (**http://www.bioaliment.ugal.ro/index_en.html**)**
BIOALIMENT aims to create a pole of higher education and research for biotechnology applied in health, food industry and environment aligned to European and national strategies. BIOALIMENT work for and contributes to the implementation of the principles of modern biotechnology relating to raw material processing, increase of nutritional value and functional roles of food, in order to ensure food quality and safety. At the same time, the platform BIOALIMENT develops research and educational programs in the fields of food bioadditives and bioingredients obtaining, bioprocesses modeling and engineering, waste bioconversion and environment protection.

❑ **Biotechnology Platform based on knowledge (**http://www.usamvcluj.ro/html/cercetare/platforma/**)** aims to increase the capacity of integration in the European area of education and research, to increase the performance and compatibility with the requirements of scientific knowledge-based society, to ensure highly qualified human resources for biotechnology education and research, development and post-doctoral schools in biotechnology etc.

- **BIOINGTECH Platform** (http://www.pub.ro/ro/cercetare/platforme/platforme-02.html) has as main objectives vocational education in Bioengineering and Biotechnology with a focus on understanding specific business goals and balancing career and professional specialization on market realities.
- **PFCI - RENATSIL - Platform for sustainable recovery of natural resources through biotechnology and ecological processes in tourism, forestry and wood processing** (http://www.unitbv.ro/renatsil/index.html). The primarily aims is to identify technical solutions and new products through interdisciplinary research and training of competent researchers, high exploitation of natural resources in the agro-silviculture area, agro-food, forestry and wood processing.

Based on these research platforms, three doctoral schools on biotechnology were developed in Romania. Currently, three Romanian universities develop within the Sectorial Operational Programme Human Resources Development 2007-2013, the postdoctoral schools of national interest *Applied Biotechnology with impact in Romanian bio-economy*, acronym PDS-BIOTECH. This project is co-financed by European Social Fund through Operational Programme Human Resources Development 2007- 2013, priority axis no. 1 *Education and professional training to support the growth and development of knowledge-based society*, area of intervention 1.5 *Doctoral and postdoctoral programs to assistance the research*.

The overall objective of the project consists in organizing two annual cycles of postdoctoral graduates in applied biotechnology in agriculture, food industry and environmental protection, industrial processes and medicine. PDS-BIOTECH organizing consortium includes three prestigious universities with expertise in biotechnology – University of Agricultural Science and Veterinary Medicine Cluj-Napoca (consortium coordinator), Polytechnic University of Bucharest (partner 1) and the ”Dunarea de Jos” University of Galati (partner 2).

PDS-BIOTECH is built-up on the premises of the European Strategy Action Plan *Life Sciences and Biotechnology* (2002) developed by the EC in the context of a global market where life sciences and biotechnology have a major impact with appraised value more than 2000 billion of Euros.

The specific objectives of PDS-BIOTECH are:

- synthesis of information on relevant educational training programmes in Romania and European country;
- development of organizational structure and curricula, selection of the target group of researchers, monitoring and analysis of educational outcome indicators obtained after the first training cycle; improving the whole management system;
- completion of two complete cycles for monitoring progress and continuous improvement;
- specific activities such as: organizing, tutoring, management, quality assurance and horizontal activities (information, advertising,purchasing, implementation control).

This project covers the needs of specialists in this area, which currently do not have similar opportunities for training in Romania, using the skills of experts from the consortium involved in the research project as research tutors or teachers.

## Evaluation of requirements for postdoc specialists in applied biotech in Romania

The aim of this study was to evaluate the actual status of biotechnology in industrial sector in order to measure the requirements, awareness, perceptions and attitudes of manufacturers relating to biotechnology.

Research was carried out during the period of April to September 2010. A total of 21 universities and 65 Romanian companies participate in this study. The assessment of the needs of specialists with post doctoral training in biotechnology applied to food science and environmental was conducted in the fields of education, research and production. To obtain relevant results specific methods of marketing research were used, emphasizing the

successive stages of data collection, measurement and analysis of information.

Research area was established by the potential beneficiaries of the PDS-BIOTECH postdoc program, in conjunction with the organization's external environment.

A pertinent analysis of information received cannot be achieved without considered specific aspects of the external environment, namely economic and social elements. In the evaluation was used directly descriptive research method, simple cross variant, which involves collecting information by conducting research once on a pattern of respondents.

The sources of information were external, such bodies and organizations, with a target in collecting the data through the conscious participation of information carriers. This method was used because it brings specific advantages, namely the adequacy of data, timeliness and confidentiality, accuracy and uniqueness of data obtained from respondents.

Survey respondents were questioned using questionnaires. Communication with the respondent was conducted via electronic mail by sending a questionnaire which was completed and returned to the research team. This version of the survey was considered appropriate because of geographical dispersion of respondents, and relatively low cost, although hampered by a number of specific limits, such as low response rate, lack of control and assistance from the operator, time consuming etc.

The survey was based on a questionnaire with 12 closed questions, dichotomous and multidihotomice. The questions were short, using simple words, interpreted in the same way by all respondents. The first questions were filter, followed by general questions and specific ones.

Respondents requested information concerned the following issues:

- ❑ entity identification data (name of institution, address, phone/fax);
- ❑ the size and form of ownership entity;
- ❑ main and specific activities related to biotechnology;
- ❑ staff and its structure (men, women, disadvantaged social categories, people with disabilities, etc.).
- ❑ level of employee training;
- ❑ the opportunity for employment specialist with higher education in biotechnology and potential benefits there from;
- ❑ possible strategies and the skills required.

Corresponding addresses of the respondents were taken from the database of the Faculty of Food Science and Engineering Galati, Romanian Association of Dairy Specialists (ASIL), Association of Specialists in Food Biotechnology (ASBA), Romanian Association of Specialists in Education, Research and Food Industry Romania (ASIAR), databases with the faculty graduates etc.

Analyzing the data presented in Table 1 it can be seen the relatively low response rate from business sector, which can be explained primarily by the current economic conditions. During the last period, economic changes related to pessimistic economic forecasts, budgetary restrictions had a strong negative impact on firm's forecasts on medium and long term.

***Table 1.*** *Structure of responses*

| Field of activity | Number of forms submitted | Number of completed forms | Response rate (%) |
|---|---|---|---|
| Research - education | 21 | 6 | 28,5 |
| Manufacture | 65 | 20 | 30,76 |
| Total | 86 | 26 | 30,23 |

### Size of respondents

In Figure 4 are presented the information collected from the respondents depending on the firm size.

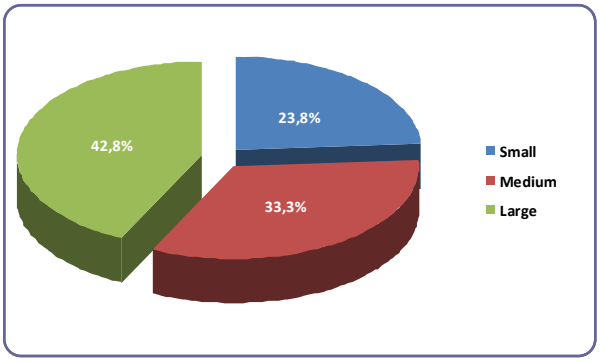


***Figure 4.*** *Response rate as a function of organizations size*

Highest response rate is recorded in case of large organizations (approx. 42%) and has lower values in case of medium-sized firms (33%) and low (23%).

### Ownership

Most respondents are companies with Romanian private capital, foreign or mixed. This distribution of capital, coupled with current economic realities reflects the specific situation of the Romanian economy, where the state is low involved, mainly in education and research.

Some positive signs were found in research institutes regarding the emergence of private capital, although in relatively small proportions (~15%).

The ratio of public and private capital is shown in Figure 5.

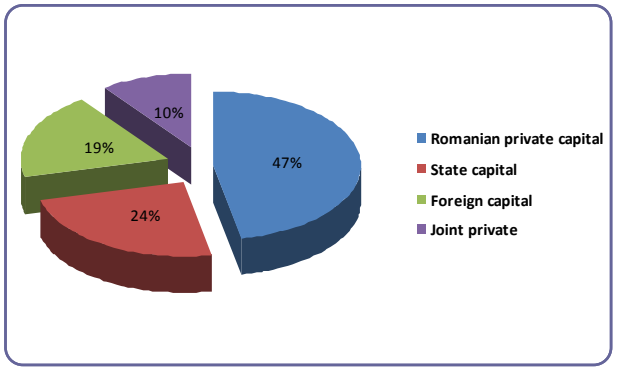


***Figure 5.*** *Capital structure by type of property*

Romanian private capital has the largest proportion, about 47%, followed by state capital (24%) and foreign (19%).

### Association Form

Predominant association form found in the respondents is the limited liability company, which is mainly characteristic to local private businesses (small and medium sized companies) when compare with large institutions, schools and research institutes.

### Main and specific activities related to biotechnology

Main areas of activities are production, trade and services (70%); a lower share being allocated to those with research and education (30%). Most organizations use the complex bioprocesses, like fermentation in food industry (bread and bakery technology, dairy technology, technology of meat products, wine and beer technology etc.).

Other productive areas of interest are those of environmental protection, processing and recovery of waste, obtaining of biofuels etc.

### Staff Structure

All respondents have qualified personnel with higher education. Its ratio from total number of employees varies between 5% (for small firms with specific business - food service and food additives or consulting) reaching over 75% for research and educational institutes.

As regarding the equal opportunity and employment of persons with disabilities we can make the following observations:

- The percentage of female employees in respondent companies varies between 42% and 88% of total employees, with an average of approx. 51%. The highest value is common in research and education institutions (88,4%) and in the field of food production (77%). Relatively low proportions, up to 41.4% were found in

distribution of food ingredients, mainly justified by the specific of activity.

❑ 67.34 % from responding firms have employed people with disabilities.

**Potential benefits due to employment of specialists in biotechnology**

When asked about hiring qualified staff with training in biotechnology, the response was positive from all respondents and showed high demand for specialists with advanced training.

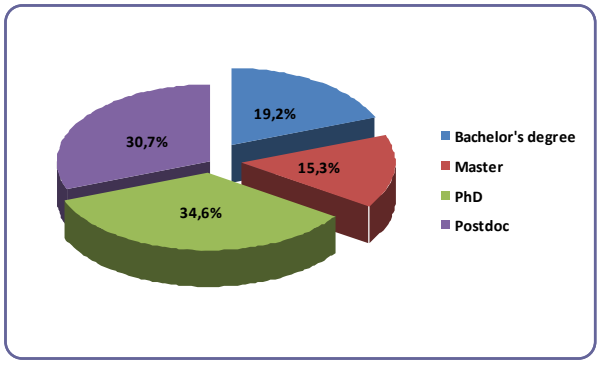


***Figure 6.*** *The demand for specialists with university and postgraduate studies in biotechnology in Romania*

It can be seen from Figure 6 that the demand for staff with a high level of training was significantly higher compared with necessity for graduates with master's and bachelor's license.

The main benefits expected by traders due to employment of staff with doctoral and post doctoral training are:

❑ increase economic efficiency;

❑ product diversification and food safety;

❑ improving quality of life;

❑ environmental protection;

❑ easy access to projects and structural funds;

❑ development of partnerships at local, regional, and/or internationally level.

Training of specialist should be done in conjunction with employer expectations, namely:

1) improving processes and diversification of products;

2) automation and advanced process control;

3) innovative solutions to ensure product quality and environmental protection (superior recovery of waste);

4) research - development - innovation;

5) access of funds with economic and innovative impact.

Classification of these expectations by their importance is shown in Figure 7.

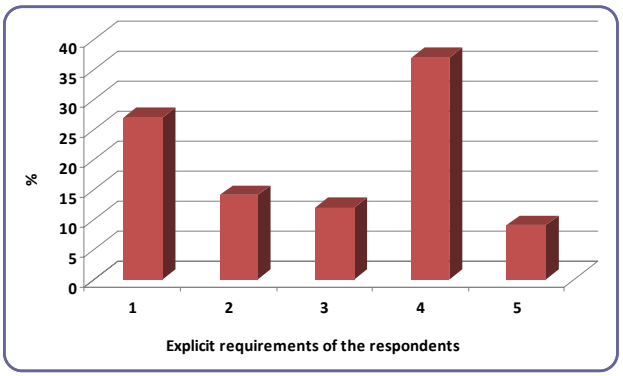


***Figure 7.*** *Classification of explicit requirements of respondents depending on their importance*

Analyzing these data on a scale of importance from 0 to 100, it can be seen that the most important needs of the bio-economic medium and research institute can be achieved by preparing the graduates in fields of research-development-innovation and improving processes and diversification of products.

These data can be considered key elements in developing curricula that will provide training of specialists who will to meet market demands.

Applications of highly qualified specialists in biotechnology or related fields for terms of medium and long perspective are relatively reserved, taking into consideration the actual status of economy. Thus, 15% of all completed questionnaires do not predict as necessary highly specialized staff. The reluctance is manifested mainly in trade and distribution of food ingredients where specific activity does not require highly skilled personnel.

The prognosis is relatively optimistic in the case of large companies, specialized in research and production with a demand of 35 postdoctoral graduates in the field of biotechnology generally

and food technology and environmental protection particularly.

## Conclusions

From the foods that sustain us and fuel that drive the equipments to the molecular samples that target diseased cells and genetic engineering that can affect physical characteristics, biotechnology plays an increasingly important role for life and society development.

More and new ways to improve communication between scientists in the development of products and society on the subject of the desired outcomes of public goods should be found. Financial tools to ensure the development of public goods also need to be created.

There is a need to investigate opportunities to shape social and market conditions where biotechnology can contribute to regional needs. Such opportunities should be based on sustainable food production preserving biodiversity and respecting the values of nature, while taking into consideration ethical objectives and social equity in respect to regional conditions, needs and wants.

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