Management Review: An International Journal · Volume 9 · Number 2 · Winter 2014

The Tools to Promote the Development of Marine Biotechnology in Primorski Region

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Received Dec. 5, 2013, Revised Apr. 22, 2014, Accepted Jun. 24, 2014

ABSTRACT

This study presents the tools to promote the development of Marine Biotechnology in Primoski Resion, Russia.. This study was conducted a survey based on the marine biotechnology industry perspective to identify the best practices. In the clause tendencies and problems of development of a fish economy in region are considered. The conclusion about necessity of creation of new technological platforms becomes. Tools of assistance to development of sea biotechnologies in Primorski Territory come to light. The study will provide the marine biotechnology policy-makers with more insights to develop appropriate marine biotechnology policy.

Keywords: Fish economy, sea biotechnologies, innovations, prospects

INTRODUCTION

Primorski Region benefits from access to an enormous and diverse set of aquatic biological resources, which largely unexplored,

underexploited and understudied. Meanwhile, marine ecosystems provide a unique environment with an enormous potential to contribute to the sustainable supply of food, energy, biomaterials and to environmental and human health. This paper presents a range of considerations and options for the content and approach for a potential future fish-industry activity on marine biotechnology.

Fish-industry activity (FIA) traditionally occupies special position in economy of Primorski Region. The Institutional transformations, which are conducted in our country in 90th of last century, stagnation in fish industry has led. Strategic tasks on provision of food safety and accomplishment of the social functions connected with city - forming character of industry in Primorski Krai, have been removed on the second plan. At the same time, primorski fishermen will underuse the raw-material base in some kinds of water biological resources, many of which have powerful biopotential. For example, the seaweed forming essential accumulations at seaside coast, can serve as raw for the most different industries, including food, chemical, building. Besides, trade objects of fishery practically aren't processed in a complex and deeply, casual objects of fishery are thrown out a board, a waste from cutting of fishes and nonconforming products isn't used. Among other fish-industry enterprise structures apply obsolete, ecologically dangerous technologies of processing of hydrobionts that is inevitably reflected in quality of produced goods. Meanwhile, new, perspective technologies not only can promote transformation of available resources to qualitative and necessary products, production efficiency and competitiveness of enterprise structures to a great extent depends on them. Thus, the technology in itself is the major resource FIA. In fish-industry to practice the marine biotechnology which is engaged in studying of active potential of the biological marine environment for the

purpose of its application in practical activities has good prospects of development. Marine Biotechnology encompasses those efforts that involve marine bioresources, either as the source or the target of biotechnology applications. This sphere could become the powerful lever of serious technological break of regional fish industry that will allow to solve many socially-economic problems.

MARINE BIOTECHNOLOGIES DEVELOPMENT

Marine Board-ESF Position Paper 15 on Marine Biotechnology together with the scoping paper of the EU KBBE-net Coordinated Working Group on Marine Biotechnology (CWG-MB) provide a comprehensive overview of the European research priorities for marine biotechnology research and identify some potential areas of common interest which might benefit from transnational cooperation in Europe. Marine Board Position Paper 15 on Marine Biotechnology analyzed the contributions Marine Biotechnology can make to address key societal challenges and identified the associated future research priorities. These are summarised in below table 1 (Marine Biotechnology in the European Research Area, 2013).

Development of business on the basis of marine biotechnologies in Primorski Region can be performed in following directions (Mezenova, 2008):

1. Complex processing of hydrobionts for reception of albuminous products, lipids, mineral substances, healthy food, fodder and technical items. Complex processing allows to create the closed cycle on reception of food, fodder, medical and technical products from industrial wastes, including is direct in fishery places that considerably increases value added, expands release assortment, minimizes losses of production at the maximum use of biopotential of the sea.

Table 1. Marine Biotechnology Research Priorities to Address Key Societal Challenges

Target research area for development	Research priorities and objectives
Food: Development of food products and ingredients of marine origin (algae, invertebrates, fish) with optimal nutritional properties for human health.	- Develop innovative methods based on -omics and systems biology for selective breeding of aquaculture species; - Develop biotechnological applications and methods to increase sustainability of aquaculture production, including alternative preventive and therapeutic measures to enhance environmental welfare, sustainable production technologies for feed supply, and zero-waste recirculation systems; - Integration of new, low environmental impact feed ingredients to improve quality of products and human health benefits.
Energy: Development and demonstration of viable renewable energy products and processes, notably through the use of marine algae	- Produce an inventory of microalgae resources for biofuel production to support optimisation of the most appropriate strains; - Improve knowledge of basic biological functions, tools for steering the metabolism and cultivation methods of marine microalgae to improve the photosynthetic efficiency, enhance lipid productivity and obtain microalgae with optimum characteristics for mass cultivation (mixed & mono cultures), biofuel production and biorefinery; - Develop efficient harvest, separation and purification processes for micro- and macro-algae.
Health: Development of novel drugs, treatments and health and personal care products	- Increase the focus on the basic research (taxonomy, systematics, physiology, molecular genetics and (chemical) ecology of marine species and organisms from unusual and extreme environments to increase

	chances of success in finding novel bioactives; - Improve the technical aspects of the biodiscovery pipeline, including the separation of bioactives, bio-assays that can accommodate diverse material from marine sources, dereplication strategies and structure determination methods and software; - Overcome the supply problem to provide a sustainable source of novel pharmaceutical and healthcare products through scientific advances in the fields of aquaculture, microbial and tissue culture, chemical synthesis and biosynthetic engineering.
Environment: Development of biotechnological approaches, mechanisms and applications to address key environmental issues	- Develop automated high-resolution biosensing technologies allowing in situ marine environmental monitoring to address coastal water quality, including prediction and detection of HABs and human health hazards; - Develop cost-effective and non-toxic antifouling technologies combining novel antifouling compounds and surface engineering; - Consolidate knowledge on DNA-based technologies for organism and population identification and support the development of commercial tools and platforms for routine analysis.
Industrial Products and Processes: Development of marine derived molecules exploitable by industry including enzymes, biopolymers and biomaterials.	- Develop enabling technologies for high throughput enzyme screening and for the expression of marine proteins and enzymes through dedicated hosts; - Produce marine biopolymers as novel competitive commercial products in food, cosmetics and health.

2. Development of biotechnologies of products of a functional food, biologically active substances (BAS), additives (BAA) and compositions on the basis of marine biological resources. Biotechnologies on creation of ecologically safe foodstuff (for example, on the basis of smokeless smoking) or on production of the polycomponental items enriched BAS are known. Company "Biopolymers" created on the basis of the Partizanskiy himiko-pharmaceutical enterprise for introduction in production of scientific developments Pacific research fish-industry center, is engaged in BAA'S production from marine hydrobionts (Bocharov, 2010). However development of this market restrains various terminators (food stereotypes, absence of mechanisms of forming of consumer value and management of behavior of the consumer, etc.) in spite of the fact that in the world there is BAA'S boom of marine origin.

3. Bio-energetics - reception of power means and materials on the basis of not enough used marine resources. For example, production of bioethanol from seaweed and biodiesel from technical fish fat. A lot of research has already been done demonstrating that both microalgae and seaweeds are possible resources for the production of renewable fuels. A lot of tones of undesirable seaweeds are polluting the coasts and regularly need to be collected. Despite various trials, it appears that bioconversion of this huge quantity of seaweeds is technically feasible. In fact, microalgae can accumulate large quantities of hydrophobic compounds which can be converted into biodiesel and the production of biodiesel from microalgal triacylglycerides is the focus of much interest. We need to improve knowledge of basic biological functions, tools for steering the metabolism, and cultivation methods of marine microalgae to improve the photosynthetic efficiency, enhance lipid productivity and obtain microalgae with optimum characteristics for mass cultivation, biofuel production and biorefinery.

4. Akva - and Marine- culture - cultivation of valuable kinds of fishes, not fish objects of a craft (crustaceans) and seaweed. It is obvious that in the conditions of the tendencies which have appeared in the middle of the XX-th century of a stock depletion of water biological resources, a

competition aggravation in the world markets, and also at an increasing demand for it under the influence of increase in population of the Earth the increasing development receives reducings of a gain of production of the foodstuffs akva - and marine- culturevaluable kinds of fishes, crustaceans and seaweed. China, India, Indonesia, Vietnam increase deliveries of fish goods to the world market at the expense of aquaculture goods. Commercial aquaculture in Primorski krai is faced with several important challenges at the level of overall performance, reproduction, interactions with the environment. Challenges include the physical constraints of temperature and weather conditions, and light and pressure deeper in the water. In our opinion, inertial development of fish culture in Primorski Region can be stopped by introduction of the modern equipment for all engineering procedures of cultivation of fish, and also use of high-grade fish forages of high quality. The industrial aquaculture of especially valuable, currency objects undermined by an illegal craft has a long production cycle from a fish cub to a commodity output in some years that reduces appeal of this activity to private enterprise structures and demands state participation.

5. The vital medical products on the basis of biotechnological substances. The chemicals from the sea have numerous biomedical applications including antibacterial, antifungal, antiviral and anti-inflammatory uses. For comparison, now a share of the USA in world volume of pharmaceutical biotechnology - 51 %, and Russia – 1 %. Obviously, that the Russian researchers are facing with a lot of problems to make pharmaceutical discovery from marine bioresources. The main challenges are:

- Legal aspects: secure access to marine resources, property rights and intellectual property;
- Quality of marine resources: identification and variability;
- Technology: screening of active compounds and dereplication (preventing repeated rediscovery);

• Structural costs of drug discovery from natural products and especially marine products.

To solve these problems we need to create a workable legislation to bring functional products to the market quickly, safely and at low cost. We also need to implement further investigations to verify the actual health benefits of functional products of marine origin, to increase industry awareness of opportunities for drug discovery based on marine resources.

6. Biodegraded polymers (chitin, chitozan, sulphatic polysaccharides, collagen, etc.). Biopolymers of marine origin are currently being examined for a wide variety of applications. There is a particularly strong interest in the biomedical sphere, with developments such as pharmaceutical and medical polymers, bio-adhesives, wound dressings, dental biomaterials, tissue regeneration and 3D tissue culture scaffolds. Japanese and American specialists name chitin (and its derivative chitozan) substance of the XXI-st century.

In their opinion, goods world market on a basis chitozan will have in the near future global character with a turnover in 2 billion US dollars a year. Influence of chitin on increases of productivity of plants of agricultural crops that negative impact on functioning of agroecosystems, unlike pesticides and poisonous chemicals doesn't make is known. Meanwhile in Primorski Krai there are no enterprises for production chitozan, therefore guerrilla Biopolymers buy it in the next China. We need to produce marine biopolymers as novel competitive commercial products in food, cosmetics and health.

7. Biological safety in circulation seafood. Some of biological hazards may pose serious risks to health, such as Listeria monocytogenes in fishery products, biotoxins in live mollusks. For another thing, there is a growing interest in applying transgenic technologies in aquaculture. However, there is increasing consumer concern regarding genetically modified organisms (GMOs) and transgenic products. Therefore, the introduction of transgenic technology necessitates the need for production of sterile progeny and the development of better engineered aquaculture systems in order to minimise the risk of released transgenic stocks mixing

with wild populations, and this may, in turn, question the long-term benefits of such manipulations. For these reasons biotechnological applications should focus on disease control and production of healthy fish instead of boosting growth rates (European Commission, 2013).

8. A professional training in the field of sea biotechnology. There are many options and relevant activities possible. Organising specific marine biotech summer schools and training courses should be improved and increased because trained personnel in this field is lacking. In particular, promoting "work-place training" which combines academic training with industry would be interesting to consider as it allows compliance with the needs of industry. Organising specific network activities such as workshops on technical issues or technical staff exchanges may be another area of relevant work, for example in relation to sampling techniques, operation of biobanks, data gathering and management, support for marine biotech activities, etc. To promote marine biotechnological innovation, training of the next generation of scientists is critical. They must have more interdisciplinary expertise and use tools from various disciplines to address questions related to marine organisms and to solve problems posed by the marine environment. This statement is not specific to marine biotechnology; in fact the future of life sciences in the 21st century will depend upon the ability of scientists to develop interdisciplinary projects embracing skills and concepts from, for example, phylogeny, mathematics, chemistry, and the physical, engineering, computational and social sciences. The challenge for the development of the marine biotechnology sector is to ensure that undergraduate and graduate training programmes related to marine sciences include adequate training in biotechnology (Marine Biotechnology ERA-NET, 2010).

9. International cooperation under biotechnological projects. We need to mobilize a worldwide marine biotech research community, especially community of Asia- Pacific countries. The using professional public relations and communications services will assist with communication, dissemination and outreach products and efforts towards various targets based on a dedicated communication strategy. The

organization a series of topical workshops will bring together principal investigator of national research efforts in specific research areas, as well as private sector researchers or representatives.

METHODOLOGY AND DISCUSSIONS

Survey helped identify the main constraints the implementation of the above directions. They are:

- Lack of economic, political and social incentives of fisheries business to participate in the growing high-tech industries in all stages of the process.
- Insufficiency of effective demand for biotech products, both among business organizations, and the public, due to the lack of sufficient funding, the stereotypes in the diet.
- Contradictions between the process of the development of new knowledge in the field of marine biotechnology and their commercialization. Commercialization of new biotechnology products requires significant capital investment and a well-structured program to develop and to market.
- Shortage of capacity, lack of domestic biotechnological Instrumentation.
- The complexity of circuits patenting of scientific research, unprotected ability copyright, intellectual property.
- The complexity of the certification process of the new product, the presence of control of clinical trials of biological products.

The study of national and international experience to support knowledge-based industries and technologies has allowed to identify the most important tools for the promotion of marine biotechnology in the Primorsky region (Table 2). In constructing the table, we proceeded from the fact that the creation, maintenance and development of biotechnological enterprise

resource defined in equal measure the intensity of research activity of the innovation process in the region, the rate of diffusion of knowledge and technology and the company's ability to absorb new technologies. In addition we should not forget that for carrying out technological breakthrough in fishing activity requires substantial financial resources that are sufficient only to the state. Consequently, the government is involved in the implementation of innovative strategies not only as a regulator, but also a direct participant, using different forms of public-private cooperation. Search mechanism of interaction between science, government and business organizations are in different directions: prioritizing the development of marine biotechnology, the system of financing of scientific and technical sphere, the creation of innovation infrastructure, addressing staffing issues, the development of forms of cooperation and international cooperation.

Table 2. The Tools to Promote the Development of Marine Biotechnology in Primorski Region

Strategy	Tools
Creating a research infrastructure and training	Construction of marine biotechnology centers
	Government contracts for research
	Training programs for bachelors, masters, doctors, professional development in the field of marine biotechnology
	Training and advising managers
	Preferential hiring of graduates in business РХД
	Creation of special classes in schools
Promotion of industrial	Science and business cooperation in various

and academic cooperation	organizational forms, such as the creation of biotech clusters
	Execution of works for business organizations on business planning, formation of competitive strategy, brand management, pricing and most importantly, the management of consumer behavior with regard to new products Marine Biotechnology
	Participation of business structures in the creation of fishery biotechnology from "zero"
Marine biotechnology commercialization and market entry	Creation of funds of commercial technologies
	simplification of patenting
	Government support in the design patents, quality standards (standards GMP, compliance with ISO - 9000) abroad
	State financial backing
Simplify access to capital	The compensation of the cost of production and implementation of the technology
	Tax and customs exemptions, tax holidays
	Direct subsidies venture organizations
	Creating a leasing company to provide a comprehensive equipment
Construction of office space for biotech companies	Creation of business incubators, technology parks, research parks, etc.

It is obvious that growth of scales fish-industry businesses on the basis of marine biotechnologies will allow to solve following actual tasks of region:

• to provide the population with socially significant accessible foodstuff and biologically active compositions;

• it is rational to use traditional objects of fishery, stocks of seaweed, a waste of fish processing, not food seafood;

• to reduce harmful influence of productions by ecology;

• to create new work places in region;

• to receive and deliver on the world market new kinds of biofuel;

• to create new directions in business and trade;

• to leave on world level in the field of biotechnology of hydrobionts.

CONCLUSION

The economic and scientific potentials of marine environments remain insufficiently explored using the power that modern biotechnology provides. Moreover, their resources remain largely untapped by Primorski Krai industry. Extreme or specific environmental conditions (e.g. in temperature, pressure, salt content, pH, chemical composition) and the enormous biodiversity of these ecosystems offer multiple opportunities for bio-prospecting, exploitation and use of microbes (e.g. cyanobacteria, fungi), plants (micro- and macro-algae) and animals (e.g. fish, molluscs, sponges) and their physiological performance and genes. This can lead to novel products or sources for industrial applications (e.g. bio-processing, biomass, bio-energy, bio-materials, specialties, pharmaceuticals, and aquaculture) and beyond.

There is now a strong momentum to drive progress marine biotechnology in Primorski Region. If we do not act now through a concerted effort by all the identified actors and stakeholders and through increasing its support with targeted funding and coordinated research, it will continue to lose ground on the leaders in this field such as the USA, Japan and China. This sphere could become the powerful lever of serious technological break of regional fish industry that will allow to solve many socially - economic problems and to meet critical societal challenges in the areas of food, environment, energy and health.

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