The Impact of Innovations in the Production of Biologically Valuable Food Products on Supply Chain Management in the Regional Economy

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***Abstract*— The article shows a study of the role of supply chain management of innovative biologically valuable food products in the industrial development and economy of the region. The analysis of the process of updating the assortment of food products based on the introduction of innovative developments and production principles conducive to the release of a healthy diet product (innovative product) is presented. The main provisions of the concept of healthy food products, the category of "innovative food products" are analyzed. The article systematizes the definitions of the concept of "innovative product". Based on the results of the study, features, functional properties and characteristic features of an innovative food product are determined. Based on the concept of "innovative food product", the concepts of "new food product", "improved food product", and "modified food product" are formulated. A classification model of innovative food products is presented. Based on it, it is shown that the development, production and sale of an innovative food product two functions: economic and social. The study made it possible to formulate the main criteria that make it possible to attribute a food product to a group of innovative food products. The article describes the characteristics of an innovative food product, describes market and consumer properties. The author's definitions of concepts are given: "innovative food product", "new food product", "improved food product", "modified food product". A classification of innovative food products is proposed.**

***Keywords*—** *agriculture, supply chain management, food, regional economy, economics, econometrics*

1. Introduction

The effectiveness of the economic development of food industry enterprises today is determined by the degree of taking into account objective market and social factors occurring in modern society [1, 2]. The issues of a healthy and balanced diet, quality and variety of food products are currently very relevant, since the nutrition problem is basically socio-economic [3] and is determined by a person's need for healthy products, in sufficient quantities, which ensures the maintenance of a full-fledged physical, mental and social well-being [4]. The development of new technologies in polymer chemistry creates alternative opportunities for innovative food products [5-8]. The choice of directions for improving the assortment of food products affects all subjects of the food system and involves their interaction at the micro, macro, mesa levels:

The state, in terms of the effectiveness of its management measures;

Science, in terms of the effectiveness of research and development, the possibility of their practical implementation;

Consumers, from the position of optimality of the selected assortment of food products, depending on the ratio of prices and values;

Producer, from the point of view of implementing the basic principle of marketing (to produce not what can be produced [9-12], but what the consumer needs), provided that consumer preferences are considered as an economic function to maximize benefits while minimizing monetary costs.

Taking into account global trends in the development of the food industry, the basis of the process of updating the assortment, qualitative and quantitative characteristics of manufactured and sold food products should be the integrated implementation of innovative developments [13] and production principles that contribute to the production of a healthy food product (innovative product), the value of which is defined as the cost ratio and utility.

The term "healthy nutrition system" in Western food market development practice implies consideration of a food product not only from the standpoint of the chemical structure [14] and

composition (volume of energy), but also the impact on human health, life expectancy.

The concept of healthy nutrition products implies the implementation of the principle of a traditional approach to nutrition with the possibility of improving the functioning of body systems due to the presence in the product of additional value expressed through the utility criterion [15]. Innovative ways to develop polymerization can create the basis for the development of new useful biopolymers [16]. The usefulness of healthy food products is achieved by transforming the recipe through the use of innovations, that is, giving the product new properties and characteristics, which allows recognizing healthy food product groups as innovative products.

Currently, in many developed countries, the category of "innovative food" refers to a new or improved food product, which is the result of applied research and experimental work, the main purpose of which is to provide benefits to human health, increase the body's resistance to disease, the ability to improve many physiological processes.

In the European Union, innovative food products define how foods that are good for human health and possess properties that are additional to conventional foods can be whole or fortified, and when eaten regularly as part of the diet, they can positively influence to health. In order to reveal the essence of the concept of “innovative product”, we systematized its interpretations.

2. Methods

For the implementation of logistics processes, rational management is necessary, which periodically requires optimization due to changing company activities or changing external environment. The number of optimization tasks in logistics is very large, and their composition is diverse [5, 6]. A meaningful statement of the problem implies its formulation. It is at this stage that logical reflections on a specific problem take place. By analyzing all the available resources needed to build the model, decisions can be made, for example, to reduce the scale of the problem to be solved (this is due to the lack of necessary resources). In addition, based on the analysis of resources, restrictions are formed for the problem under consideration.

The objectives of a specific task are described using the criterial (target) function [17]. It is an evaluation function needed to quantify several alternatives and select the best one. In this paper, when considering the optimization problem, the choice of the best alternative is specified using the requirement to maximize the objective function.

Due to the fact that most of the optimization tasks of integrated supply chains do not have an analytical solution presented in the form of calculation formulas, there is a need to choose the most suitable computational method, as well as the most suitable software [18]. When choosing a method, the nature of the mathematical model is essential. When choosing the right software, the main focus is on existing mathematical packages (MATLAB, Wolfram Mathematica, Mathcad, MS Excel). Their main advantage is the presence of a large number of built-in mathematical functions and computational algorithms necessary for practical calculations.

Currently, optimization packages such as ILOG Cplex and Xpress-Optimizer are gaining popularity. They are used by many analysts to find solutions to various business problems, including large-scale tasks containing about variables [19]. The main advantages of using these optimization packages:

A flexible language for describing mathematical models, thanks to which there is an opportunity take into account a wide range of limitations;

Reliable algorithms used in solving complex problems and high performance.

All possibilities are provided for solving large-scale optimization problems. At the same time, the optimal speed of finding solutions is ensured;

Flexible interfaces and availability of trial versions of both considered software products.

3. Results and Discussion

The systematization of definitions allows us to establish that an innovative product is characterized by the presence of the property of novelty or improvement acquired as a result of innovative transformation. At the same time, the acquired consumer value (novelty, improvement) concerns both the functional properties of the product, expressed in a healing, therapeutic and prophylactic effect, and changes in nutritional value and organoleptic indicators [20-24]. This suggests that the concept of “innovative food product” is broader than the category of “healthy food products” due to the presence of additional

value in changing the nutritional structure and organoleptic properties (Fig. 1).

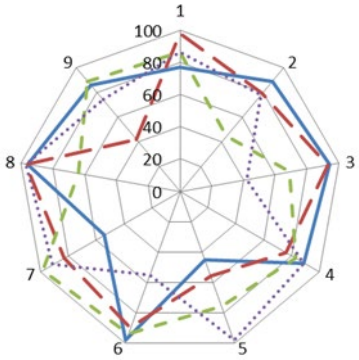

Figure 1. Systematization of consumer value of an innovative food product

According to the international document "Recommendations on the collection and analysis of data on innovation", an innovative food product includes:

New food products obtained through the use of radical innovations;

Significantly improved food products that already exist on the national market, but received a new designation or definition (name) in connection with a significant degree of improvement;

Products with a modification of properties, parameters, signs or characteristics, as well as a changed scope, new or significantly different, in comparison with previously manufactured products (services), the composition of the materials or components used.

The results obtained during the study of the features of supply chain management of innovative food products allow us to determine their characteristic features (Fig. 2).

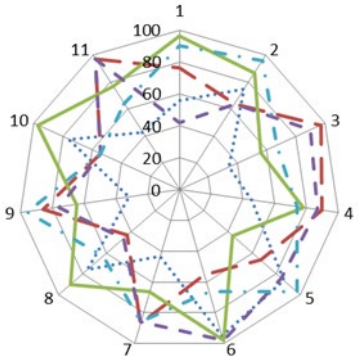

Figure 2. Features of supply chain management of innovative food products with biologically valuable properties

Thus, the goal of developing and producing an innovative food product is to obtain an improved quality food product that is healthy than a traditional product. This is possible through the use of new technology, which differs from the traditional one and allows you to get a product with higher functional properties, while maintaining quality and ensuring its safety. Product features are revealed through its functional properties, which include:

High organoleptic characteristics of an innovative food product;

The content of ingredients that determine preventive, dietary and other effects;

An optimally selected combination of formulation components, ensuring the digestibility of the product;

Competitiveness of a new product in the food market

In accordance with this, an innovative food product is characterized by:

1. Relative advantage: the degree of superiority of an innovative product compared to existing alternatives.

2. Complexity: how much innovation (innovation) coincides with the existing practice of potential consumers. If consumers must change their usual course of action, the costs of switching or adapting arise, and the diffusion rate of innovation is reduced. Conversely, if a new product is fully compatible with shopping habits, adoption is quick.

3. Communication: the simplicity of conveying the essence of innovation and features of an innovative product to potential consumers.

4. Possibility of testing: the ability to try a new product in small volume before making a full-scale purchase reduces the cost of adoption.

5. Providing benefits to human health, increasing the body's resistance to disease, the ability to improve many physiological processes.

Of scientific and practical interest is the study of the "new product" category from the standpoint of determining the physical expression of the properties of novelty (innovation) in an innovative food product [25-30]. New products - products manufactured for the first time in the country (at the enterprise) or characterized by improved properties or characteristics. From this definition it follows that the category of "novelty" of the properties of an innovative product is expressed

through a hierarchy of levels: new for the world market; new for the national market, new for the enterprise.

The technical regulations of the Customs Union contain a definition of the category “food products of a new kind”. These are food products (including food additives and flavorings), previously not used by humans for food in the customs territory of the Customs Union, namely:

With a new or intentionally modified molecular structure;

Consisting of or isolated from microorganisms, microscopic fungi and algae, plants, isolated from animals, obtained from or using GMOs, nanomaterials and nanotechnology products;

With the exception of food products obtained by traditional methods, which are in circulation and, by virtue of experience, are considered safe.

In accordance with this regulation, an innovative change in the food product should be aimed at obtaining a beneficial therapeutic effect from its use. Thus, we can assume that the degree of novelty of an innovative product has the following levels of physical expression: new, improved, modification. Based on the theoretical principles set forth above, we proposed to consider an innovative food product depending on the manifestation of the degree of novelty of consumer properties through a system of categories: a new food product, an improved food product, a modified food product (Fig. 3).

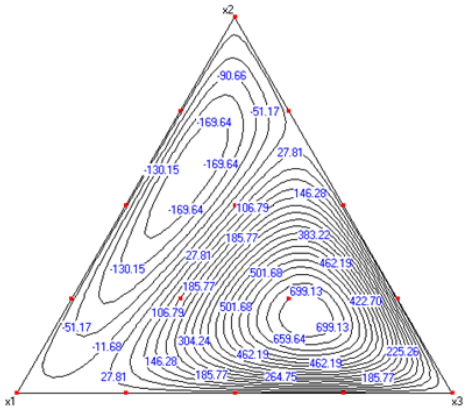

Figure 3. The degree of manifestation of the novelty of consumer properties of innovative food products through a system of categories: new food product (x1), improved food product (x2), modified food product (x3)

An innovative food product is a new or significantly improved food product, which is characterized by the presence of additional consumer value obtained as a result of an innovative transformation that has a positive effect on the full functioning of the body and an increase in life expectancy. An innovative food product includes:

A new food product - a food product that is characterized by a new, previously uncharacteristic consumer value, expressed in the energy, biological benefits of the food product.

Improved food product - a food product with significant novelty elements expressed in the functional properties of the product (healing, therapeutic and prophylactic effect), in a change in nutritional value and organoleptic indicators, significantly different in their properties and purpose from food products produced by the enterprise earlier;

A modified food product is a food product in which the degree of novelty is ensured by changing the production technology, prescription composition, using a new raw material that was previously not typical for this product, or changing the percentage of components (protein, fat, carbohydrates, vitamins, macro- and trace elements, microorganisms). This leads to the appearance in the food product of new consumer properties and characteristics.

The study of an innovative food product as a vector for improving and expanding the assortment and nomenclature of food products determined the need to develop a classification model for managing the supply chains of innovative food products with biologically valuable properties in the regional economy (Fig. 4).

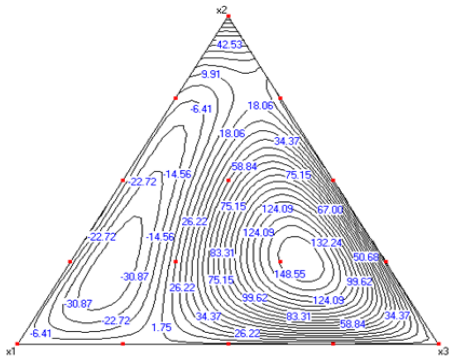

Figure 4. Classification model of supply chain management of innovative food products with biologically valuable properties in the reproductive (x1), financial (x2) and budget (x3) systems of the region

Based on the proposed classification, it can be stated that the development, production and sale of an innovative food product fulfills both an economic function for food industry enterprises, allowing it to expand sales markets, enter new segments, increase competitiveness and competitive advantages, maximize profit, and social for society and the consumer, providing the latter with the possibility of acquiring and consuming food products corresponding to the physiological needs of the body and normal functioning and active lifestyle.

4. Conclusions

The study made it possible to formulate the main criteria that make it possible to attribute a food product to a group of innovative food products:

1. Type of food: healthy, medical, preventive, dietary nutrition.
2. The main purpose: to prevent the development of nutritional diseases; providing a balanced, wholesome, healthy diet.
3. The main function: maintaining the optimal ratio of macro- and micronutrients in the human body, which have a strengthening, tonic character.
4. Full compliance with physico-chemical, microbiological and safety indicators requirements of normative and technical documentation.
5. The use of environmentally friendly food raw materials and packaging.
6. Rationality: compliance of the nutrients introduced (reduction or increase in their content) with physiological norms and the needs of certain categories of the population, taking into account physical activity, diet and lifestyle.

Market fluctuations, social transformations, reorientation of consumer values in the selection and purchase of food products imply the objective need for new approaches and tools to formulate an assortment of food products. One of the main tasks of food industry enterprises is the need to reorient the concept of organizing production from the traditional to the concept of innovative restructuring of all aspects of activity, which implies the introduction of new technologies that facilitate the production and sale of new or improved products that meet the requirements and expectations of end consumers.

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