Competitive products design in public catering

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Abstract. A nutritious and safe diet maintains human health and endurance. In addition, it preserves the national gene pool. Unfortunately, Russian diet is poor in vitamins C, PP, B₁, and E, as well as in folacin, calcium, phosphorus, iodine, iron, magnesium, and zinc. The present research introduces a new method of assessing the degree of demand for designing new foods and dishes that provide various socio-demographic groups with essential nutrients. The research employed standard scientific methods, both empirical and analytical. The new method presupposes scoring four main sets of properties of the product under development. They include 1) formula components; 2) functional properties; 3) technological effectiveness of the cooking process; 4) consumer performance. The paper describes the score assessment for each indicator that forms the basis of each set of integrated properties. It also defines the weight coefficients for each indicator and each set of product properties. The research provides boundary values for the feasibility coefficient. The practical application of the proposed method allows to create functional competitive dishes for catering enterprises of different ownership forms. The developed method makes it possible to design functional dishes with a sufficient content of nutrients and consumer performance required for a particular social group, e.g. pre-schoolers, school children, coal miners, chemical industry workers, etc. The method will allow producers to design competitive products and expand the range of functional products.

1. Introduction

The attributive role of nutrition has always been beyond doubt at any stage of human history. However, the nature, peculiarities, and main components of nutrition depend on the general level of technology, science, society, economy, geography, etc.

Nutrition and diet are based on foods and dishes that provide an individual with basic nutrients and energy. The key problem in the development of new foods and dishes is how to balance the production expenses and such characteristics as usefulness and sensory properties, which often get poor attention from the developers. Therefore, it is of highest importance to study the sphere of food design by state organizations and various forms of private businesses.

To create a new useful and more competitive product, a developer must take into account the food patterns of the targeted group. In this regard, the most notorious disadvantages of the diet of the Russian population include a lack of vitamins of polyunsaturated fatty acids, an excessive consumption of animal fats, and a deficiency of macronutrients and dietary fiber [1, 2]. Deficiency or excess of essential nutrients in the diet may trigger alimentary-dependent diseases, since nutrition has a great influence on human immune system. Alimentary deficiency reduces the body's ability to produce antibodies, slows down the process of wound healing and the formation of collagen, and affects the function of the endocrine glands [3, 4]. A poor diet affects the severity of infectious
diseases in 50% of cases. The normal functioning of the body requires a sufficient quantity of vitamins and minerals. More than 80.0% of the country's population suffer from excessive fat intake, while 95.3% do not get enough protein. In Russia, the low level of carbohydrate consumption is experienced by 96.0% of population. It is caused by an insufficient intake of fruit and vegetables. Moreover, the diet lacks such micronutrients as vitamins C, PP, B1, and E, as well as folacin, calcium, phosphorus, iodine, iron, magnesium, and zinc [5-7].

The present research introduces an original method for assessing the feasibility of dishes under design, including functional foods. The study is aimed at reducing the deficiency of essential nutrients, e.g. calcium, iron, vitamin C, magnesium, vitamin E, vitamin B1, etc. If applied at the development stage, it can contribute to preventive measures aimed at reducing those alimentary-dependent diseases that are typical of the population of the Russian Federation [8-11].

Thus, the research objective was to develop a comprehensive method for assessing the feasibility of competitive products designed for the prevention of nutrient deficiencies in the diet of various socio-demographic groups [12, 13]. The research objective presupposed the following tasks:
- to identify the main sets of integral properties of products to be assessed during development stage;
- to develop a description of the indicators at the basis of each set of integrated properties;
- to define the values of weight coefficients for individual indicators and sets of properties;
- to define the boundary values for the coefficient of feasibility of a dish during its development stage.

2. Materials and methods

Experimental site: The research was conducted at the Department of Technology and Catering of the Kemerovo State University (Kemerovo, Russia).

Materials and Research Tools, Research Procedure: The research employed both standard and special research methods. The controlling methods included analysis, diagnostics, programming and systematization methods. Consumer preferences were studied using the questionnaire method. The sampling was based on a quota prior selection with strict sampling requirements by sex and age. The significance of consumer properties was evaluated with the help of a questionnaire and the method of semantic differential. The significance (weight coefficients) of individual indicators and sets of integrated properties was identified by using expert evaluation and ranking.

Data collection and experimental design: The research was performed in the first decade of 2019.

Parameters Measured: The research involved consumer preferences of the population of the city of Kemerovo (Western Siberia, Russia) and the degree of significance of consumer properties of foods to be used in public catering.

Statistical Analysis: The study estimated the mean and standard deviations.

3. Results and discussions

The existing methods of food design for catering enterprises are focused on one solution only, e.g. expanding the range, reducing the price, etc. The suggested comprehensive method was developed specifically for the modern socio-economic conditions. The method makes it possible to assess the effectiveness of a new dish at the development stage, taking into consideration the current highly competitive market.

The new comprehensive method of food development includes the following stages.

A step-by-step assessment method is proposed to assess the feasibility of developing a new dish. It is based on a point scale according to sets of integral properties:
- 1) formula components, i.e. origin of raw materials;
- 2) functional properties of products, i.e. the presence of critical nutrients;
- 3) technological effectiveness of the cooking process, i.e. labor-output ratio;
- 4) consumer performance, i.e. appearance, texture, smell, taste, calorie and fat content, and ingredients.
The first indicator is especially important in the modern economic conditions. It assesses the formula for the presence of local raw materials, which are characteristic for this region (coefficient C). The assessment involves the following ranking:

- 5 points: all the ingredients are not just domestic raw materials, but of local (regional) origin;
- 4 points: the formula includes domestic raw materials, but at least one of them is of non-local (non-regional) origin;
- 3 points: in addition to domestic raw materials, there is one imported component;
- 2 points: in addition to domestic raw materials, there are two imported components;
- 1 point: in addition to domestic raw materials, there are three or more imported components.

The second set of characteristics assesses the functional aspect of the dish. Firstly, it is necessary to select the critical nutrients and/or food substances, the content of which should be sufficient in the dish. Secondly, one has to calculate the percentage of the critical nutrients in the dish from the daily requirement according to the following formula developed by the authors:

\[ NC = \frac{N}{N_d} \times 100, \]

where:
- NC is the percentage of the critical nutrient from the daily requirement, %;
- N is the mass of the critical nutrient per portion, g (mg, μg);
- \( N_d \) is the daily requirement for the critical nutrient, g (mg, μg).

After the content of the critical nutrient in the dish has been calculated, it is scored according to the proposed scale (Table 1).

**Table 1. Assessment scale for the content of nutrients in the dish.**

| Nutrient content (NC),% | Points |
|------------------------|--------|
| ≤ 0.9                  | 0      |
| 1-5.9                  | 1      |
| 6-10.9                 | 2      |
| 11-14.9                | 3      |
| 15-30 (max)            | 4      |
| 30.1-40.9              | 5      |
| 41-50.9                | 6      |
| 51-60.9                | 7      |
| 61-70.9                | 8      |
| 71-80.9                | 9      |
| 81-90.9                | 10     |
| 91-99.9                | 11     |
| ≥100                   | 12     |

The score depends on the rational content of nutrients per portion from the daily requirement. Therefore, as the nutrient content approaches 100% of daily requirement, the score decreases. The closer the nutrient content to 0%, the lower the score, because in this case the dish under design stops being functional.

Functional catering products preserve and improve human health due to the presence of functional food ingredients in their composition, which means that the content of a specific critical nutrient is 15–30% of daily requirement [14-16]. At this point, it is necessary to calculate the average score of the content of the critical nutrient in the dish according to the following formula developed by the authors:

\[ NC_d = \frac{\sum_{i=1}^{n} D_{nci}}{n}, \]

where:
- \( NC_d \) is the average score of the critical nutrient content in the dish;
- \( D_{nci} \) is the score given for the content of a certain critical nutrient in the dish from the daily requirement;
- \( n \) is the number of critical nutrients in the dish.
In this formula, \( n \) (the number of critical or specific nutrients) is determined at the design stage. Thus, the number of selected nutrients depends on the research objective and conditions, e.g. statistical data on the regional nutritional deficiencies, their prevention and reduction, development of specialized diets for a certain target group, etc. The number of selected nutrients is determined by the developer.

The third step in assessing the feasibility of a dish is its labor-output ratio (coefficient \( L \)). The technological effectiveness of cooking includes the necessary equipment, modes and characteristic of the cooking process, time of cooking, as well as the complexity, repeatability, and number of technological operations.

The labor coefficient is required to estimate this indicator [17]. This coefficient takes into account all the technological operations necessary to prepare a particular dish. Each type of dish has its own coefficient. The minimum value of the coefficient is 0.2, maximum – 3.9. Thus, the higher the labor coefficient, the more complex and time-consuming the cooking process. Accordingly, the lower the labor coefficient, the easier the cooking.

The following scale can assess the technological effectiveness of a dish according to its labor coefficient (Table 2).

| Labor coefficient | Points |
|-------------------|--------|
| ≤ 0.8             | 5      |
| 0.9–1.5           | 4      |
| 1.6–2.2           | 3      |
| 2.3–2.9           | 2      |
| ≥3.0              | 1      |

A low labor intensity ratio is especially important when developing new dishes for such social catering enterprises as refectories or canteens. Commercial sector enterprises, e.g. cafes, restaurants, etc., can compensate the high value of this coefficient by raising the price of the dish.

The fourth set of properties is very important for enterprises of the commercial sector in the modern competitive environment. It involves a five-point scale that can help both commercial and social enterprises to assess consumer properties. The rating shows whether the dish under development can satisfy the needs of real and potential consumers, and to what degree.

The survey is conducted in two stages. The questioning method provides weight coefficients for each property. The first stage results in a list of important consumer properties the panelists named by themselves. The properties are then grouped into sets. At the second stage, the semantic differential scale is used to define the degree of significance for each property. The data are mathematically processed, and each property is given points according to a 100-point scale. After that, the obtained score is used to establish the weight coefficient (Table 3).

| Consumer property     | Commercial sector | Weight coefficient | Social sector | Weight coefficient |
|-----------------------|-------------------|--------------------|---------------|--------------------|
| Appearance            | ...               | 0.1604             | ...           | 0.1445             |
| Texture               | ...               | 0.1315             | ...           | 0.1368             |
| Smell                 | ...               | 0.1568             | ...           | 0.1657             |
| Taste                 | ...               | 0.1676             | ...           | 0.1715             |
| Low calorie content   | ...               | 0.0829             | ...           | 0.0829             |
| High calorie content  | ...               | 0.1009             | ...           | 0.1060             |
| Low fat content       | ...               | 0.0811             | ...           | 0.0828             |
| Ingredients           | ...               | 0.1188             | ...           | 0.1098             |

The sensory properties include appearance, texture, smell, and taste. They are assessed according to a five-point scale by sensory analysis of model samples by panelists who rely on their sense of smell, taste, sight, and touch.

A special scale is developed to assess the calorie and fat content and the ingredients. The scale is based on the technical regulations of the Customs Union TR CU 022/2011.
The following scale is proposed to assess the low calorie content:
- 5 points: energy value is ≤ 40 kcal per 100 g of the product for solid dishes and ≤ 20 kcal per 100 g for liquids;
- 4 points: energy value is 41–50 kcal / 100 g for solid dishes and 21–30 kcal / 100 g for liquids;
- 3 points: energy value is 51–60 kcal / 100 g for solid dishes and 31–40 kcal / 100 g for liquids;
- 2 points: energy value is 61–70 kcal / 100 g for solid dishes and 41–50 kcal / 100 g for liquids;
- 1 point: energy value is ≥71 kcal / 100 g for solid dishes and ≥51 kcal / 100 g for liquids.

The high calorie content depends on the fact that one meal should not exceed 24% of the daily energy intake. If the energy value exceeds 24% or is significantly lower, the dish gets a low score. The scale looks as follows:

- 5 points: energy value is 450–600 kcal per 100 g of the product for solid dishes and 51–60 kcal per 100 g for liquids;
- 4 points: energy value is 300–449 kcal / 100 g for solid dishes and 41–50 kcal / 100 g for liquids;
- 3 points: energy value is 150–299 kcal / 100 g for solid dishes and 31–40 kcal / 100 g for liquids;
- 2 points: energy value is 41–149 kcal / 100 g for solid dishes and 21–30 kcal / 100 g for liquids;
- 1 point: energy value is 0–40 kcal or ≥601 kcal / 100 g for solid dishes and 0–20 kcal or ≥61 kcal / 100 g for liquids.

A dish is considered low-fat if it contains ≤ 3 g of fat per 100 g of the dish. The scale for fat content looks as follows:

- 5 points: ≤3 g of fat / 100 g;
- 4 points: 3.1–4 g of fat / 100 g;
- 3 points: 4.1–5 g of fat / 100 g;
- 2 points: 5.1–6 g of fat / 100 g;
- 1 point: ≥6.1 g of fat / 100 g.

The ingredient composition of the dish is assessed according to its originality. If the composition is simple, or all the ingredients belong to one category of food products (e.g., only vegetables), the originality is low. The proposed rating scale looks as follows:

- 5 points: ≥6 ingredients;
- 4 points: 5 ingredients;
- 3 points: 4 ingredients;
- 2 points: 3 ingredients;
- 1 point: ≤2 ingredients.

After each consumer property (Table 3) was assessed according to the five-point scale, the authors used the weight coefficient to obtain a formula. The formula calculates the total score for each set of consumer properties:

\[ CP = \sum_{i=1}^{n} CP_i \times C_i, \]  

where:
- \( CP \) is the total score for all consumer properties;
- \( CP_i \) is the score for the corresponding consumer property;
- \( C_i \) is the weight coefficient of a particular consumer property.

Thus, the coefficient of feasibility for developing a new dish is be the sum of the points obtained for each set of properties.

Finally, an expert assessment is applied to the four sets of integral properties to identify their significance for social and commercial sectors. In this case, it involved ranking by 28 experts in the field of public catering. The obtained results were processed, and each set of properties was assigned an integral weight coefficient (Table 4).
Table 4. Weight coefficients for each set of properties.

| Set of properties            | Integral weight coefficient | Commercial sector | Social sector |
|-----------------------------|-----------------------------|-------------------|---------------|
| Consumer properties         |                             | 0.3191            | 0.3015        |
| Critical nutrients          |                             | 0.1710            | 0.2083        |
| Labor-output ratio          |                             | 0.2834            | 0.2614        |
| Origin of raw materials     |                             | 0.2265            | 0.2288        |
| Total                       |                             | 1.0000            | 1.0000        |

Thus, the coefficient of feasibility for developing a new dish can be calculated according to the following formula developed by the authors:

\[ C_g = R \times \omega_1 + NC_P \times \omega_2 + M \times \omega_3 + CP \times \omega_4, \]  

where:
- \( C_g \) is the coefficient of feasibility;
- \( R \) is the score for the origin of raw materials;
- \( NC_P \) is the score for the content of critical nutrients;
- \( M \) is the score for the labor-output ratio;
- \( CP \) is the score for consumer properties;
- \( \omega_1 \) is the weight coefficient for the set of raw materials;
- \( \omega_2 \) is the weight coefficient for the set of functional properties;
- \( \omega_3 \) is the weight coefficient for the set of labor-output ratio;
- \( \omega_4 \) is the weight coefficient for the set of consumer properties.

The determined feasibility coefficient can range from 1 to 5. Only the dishes with feasibility coefficient of 4.1–5.0 can be recommended for further development. Those with coefficient 1.0–3.0 are considered economically impractical. Dishes with an average coefficient of 3.1–4.0 can be accepted for further development at the discretion of the developer.

A dish may be considered impractical to develop due to its high price if, under all other equal conditions, the price appears to be inexpediently high.

4. Conclusions
The research proposes a comprehensive method of food product design. The method is aimed at preventing the deficiency of nutrients that are essential to the diet of various socio-demographic groups. The method consists of four interconnected sets of properties, which makes it possible to determine the effectiveness of the dish at the design stage.

The proposed method allows both social and commercial catering enterprises to design dishes and introduce them into the menu according to specific requirements.

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