Development of functional products from vegetables for schoolchildren’s nutrition

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Abstract. Modern life requires that products meet the requirements of a healthy nutrition. In the prevention and treatment of cardiovascular diseases, as well as to prevent overweight, it is important to use fruit and vegetable products. In the schoolchildren nutrition, there is currently not enough of it. The article presents the results of studies on the degree of satisfaction of nutrition for schoolchildren of various age categories with a daily set of foods and basic nutrients. The effect of functional vegetable dishes on the daily diet is shown.

1. Introduction
The Strategy for improving the quality of food products in the Russian Federation until 2030 (hereinafter referred to as the Strategy) is the fundamental regulatory document for implementing the order of the Government of the Russian Federation dated June 30, 2012 No.1134-r “On approval of the action plan for the implementation of the Fundamentals of the state policy of the Russian Federation in the field of healthy nutrition of the population until 2020” and is aimed at increasing the duration and improving the quality of life of the country's population, supporting the production of products of higher quality characteristics.

The consumer market for agricultural raw materials and foodstuffs is currently developing quite rapidly and represents an important part of the economy of the agrarian and processing sectors [1–5].

The requirements for food products are unified with national standards for food safety and international (supranational) standards and the fulfillment of the obligations of the Russian Federation as a member of authoritative organizations such as WHO and the Eurasian Economic Union, and others [5–7].

There is a turnover of food products on the Russian market that do not meet the growing needs of consumers of different age groups, as well as found in the distribution network food products that do not meet the requirements for quality and safety [8–10].
Irrational consumption of food products with low consumer properties is the reason for the decline in the quality of life and the development of a number of diseases of the population, including due to unreasonably high calorie content of food products, reduced nutritional value, excessive consumption of saturated fats, micronutrient deficiencies and dietary fiber [11–16].

Federal Law of the Russian Federation No.47-FL introduces the concept of “healthy nutrition”, strengthens its principles, and features of the organization of high-quality, safe and healthy nutrition for children, students and certain categories of the population.

In works on the balanced nutrition of children, it is noted that compliance with dietary regimes and nutritional requirements is a fundamental factor both in the development of the child's body and in the prevention of certain diseases and their facilitation of treatment [17–23].

Educational organizations and children's recreation organizations providing their meals are obliged to provide children with hot meals, taking into account established standards, to comply with the sanitary and epidemiological requirements for the organization of children's nutrition in organized children's groups, and also take into account information on the state of the child’s health submitted at the initiative of the parents (Federal Law No.47-FL).

Students, for whom hot meals are organized, better absorb learning material, and also remain healthy for significantly longer time. In studies on the nutritional characteristics of children, it is noted that lunch in educational institutions should be at least one third of the daily requirement for energy and nutrients.

Based on the recommendations of MP 2.4.5.0107-15, 2.4.5 a set of food products recommended for schoolchildren is formed (table 1).

| Name of food products                      | Age of children, years | 7-10 | 11-13 | 14-17 |
|-------------------------------------------|------------------------|------|-------|-------|
|                                           |                        | boys | girls |       |
| Milk, fermented milk products, ml         |                        | 500  | 500   | 500   |
| Cottage cheese and curd products          |                        | 40   | 45    | 60    |
| Sour cream, cream                         |                        | 15   | 15    | 20    |
| Fish                                      |                        | 40   | 50    | 60    |
| Animal/vegetable fats                     |                        | 25/10| 25/15 | 30/15 |
| Rye/wheat bread                           |                        | 70/150| 100/200| 150/250| 100/200|
| Cereals, pasta                            |                        | 45   | 50    | 60    |
| Wheat flour                               |                        | 25   | 30    | 35    |
| Fresh fruit                               |                        | до 300| до 500| до 500| до 500|
| Confectionery product                     |                        | 10   | 15    | 20    |
| Potato                                    |                        | 200  | 250   | 300   |
| Vegetables are different                   |                        | 275  | 300   | 350   |
| Egg, pcs                                  |                        | 1    | 1     | 1     |
| Berries                                   |                        | 50   | 50-100| 20-200| 50-200 |
| Tea                                       |                        | 0.2  | 0.2   | 0.2   |
| Sugar                                     |                        | 60   | 65    | 80    |
| Salt                                      |                        | 6-7  | 7-8   | 8-9   |

In the composition of schoolchildren nutrition, an insufficient intake of vegetables is noted. In a number of scientific papers and reports of specialized educational organizations, it is noted that vegetable dishes should be of particular importance in a balanced nutrition.
2. Materials and methods
This paper considers the expansion of the assortment of vegetable dishes, namely vegetable cutlets and vegetable casseroles.

The study of the properties of vegetable casseroles made according to traditional recipes showed that they have a moisture content in the range from 67 to 69% [22–25].

To solve the problem associated with low calorie dishes, it was decided to use dry protein composite mixtures corresponding to GOST R 53861-2010 [26–28] – Disrin Nutrinor.

Along with the use of protein fortification in recipes, the work analyzed the compatibility of vegetables and fruits when they were included in the composition of vegetable casseroles. This is the second direction in enriching vegetable casseroles and expanding their assortment.

We have studied the characteristics of plant materials, which can be used as additional ingredients that enhance the taste and nutritional benefits of vegetable casseroles.

Adjusting the composition of the recipes, the use of unconventional raw materials made it possible to obtain a product with improved consumer properties and increased nutritional value [9–13].

3. Results and discussions
The results of the study of the nutritional value of the developed casseroles are shown in table 2.

| Name of production     | Proteins, g | Fat, g | Carbohydrates, g | Energy value, kkal |
|------------------------|-------------|--------|-------------------|-------------------|
|                        | common      | of which animal protein | common | of which vegetable protein | common | of which mono- and disaccharides |
| Control samples:       |             |        |                   |                   |
| Casserole carrot       | 2.78        | 0.06   | 2.11              | 1.75              | 14.48  | 7.58  | 88   |
| Casserole cabbage      | 3.85        | 1.35   | 5.26              | 2.59              | 19.67  | 3.74  | 141  |
| Casserole potato       | 2.30        | 0.26   | 2.05              | 0.89              | 14.01  | 1.20  | 84   |
| Casserole vegetable    | 3.20        | 0.22   | 1.64              | 1.20              | 11.88  | 3.20  | 75   |
| Test samples:          |             |        |                   |                   |
| Casserole carrot       | 10.39       | 9.03   | 9.38              | 1.14              | 22.34  | 10.23 | 215  |
| Casserole cabbage      | 9.09        | 7.93   | 9.75              | 3.35              | 15.05  | 5.56  | 184  |
| Casserole potato       | 10.38       | 7.79   | 8.02              | 6.42              | 19.81  | 3.75  | 193  |
| Casserole vegetable    | 9.19        | 7.40   | 5.22              | 0.9               | 16.86  | 5.17  | 151  |

Evaluation of the nutritional value of the developed casseroles showed that in the developed formulations, the content of basic nutrients is higher.

Based on the data obtained on the nutritional value of new samples and justification of the
compatibility of various types of vegetables in one product, the formulations of cabbage, potato, carrot and vegetable casseroles were developed (table 3).

| Name of raw materials and products | Casserole cabbage | Casserole carrot | Casserole potato | Casserole vegetable |
|-----------------------------------|-------------------|-----------------|-----------------|-------------------|
| White cabbage                     | 87.5              | –               | –               | –                 |
| Potato                            | –                 | 77.5            | –               | 81.3              |
| Carrot                            | –                 | 37.0            | –               | 51.6              |
| Fresh apples                      | –                 | 29.0            | –               | –                 |
| Margarine butter                  | 5.9               | 4.34            | 3.1             | 7.4               |
| Pumpkin                           | –                 | –               | 44.3            | –                 |
| Squashes                          | –                 | –               | –               | 38.0              |
| Onions                            | –                 | –               | –               | 13.0              |
| Granulated sugar                  | –                 | 1.5             | –               | –                 |
| Salt                              | 0.3               | 0.9             | 1.1             | 0.3               |
| Semolina                          | 8.5               | 12              | 25              | 5.3               |
| Dry composite proteinaceous mix   | 18.0              | 18.0            | 18.0            | 18.0              |
| Milk                              | –                 | –               | 10.5            | –                 |
| Bread crumbs                      | 2.5               | 2.5             | 3.0             | 5.3               |
| Sour cream                        | 3.0               | 3.0             | 3.0             | 3.0               |
| Egg                               | 1/7 pcs.          | 1/7 pcs.        | 1/7 pcs.        | 1/7 pcs.          |
| Eggplants                         | 48.1              | –               | –               | –                 |
| **Output**                        | **100**           | **100**         | **100**         | **100**           |

It can be noted that to create a structure that allows the use of these products as semi-finished products of high degree of readiness, which can be transported to various enterprises (school canteens, canteens at hospitals, sanatoriums, factories and other organizations), structure-forming agents, such as semolina, were introduced into the formulations in an amount of 4.34–20.0% and eggs in a concentration of 4.8–4.95%.

A study of the mass loss of products during heat treatment was carried out in comparison with traditional technologies. The results of the tests are presented in table 4.

| Name of samples | Vegetable | Cabbage | Carrot | Potato |
|-----------------|-----------|---------|--------|--------|
| Control         | 22.84     | 20.89   | 20.00  | 14.97  |
| Development     | 23.14     | 20.32   | 24.70  | 23.61  |

Our vegetable casseroles, as compared to control samples (made according to the traditional approved technology in the Recipe Collections), have large mass losses during heat treatment.

Samples of the developed vegetable casseroles were stored at a temperature of 4±2°C, organoleptic analyzes were carried out after 2 hours. Tasting of vegetable casseroles was carried out at a serving temperature of 60 to 65°C.

Designed vegetable casseroles: cabbage, potato, carrot and vegetable, as a semi-finished product of high degree of readiness differ from traditional casseroles in high organoleptic characteristics, nutritional and energy value. The results of the organoleptic quality assessment of the experimental
samples of semi-finished products of a high degree of preparedness of vegetable casseroles are shown in table 5.

**Table 5.** Results of organoleptic quality assessment of samples of semi-finished products of a high degree of readiness of vegetable casseroles.

| Name of casserole | Appearance | Flavor | Smell | Colour | Consistency | Comments |
|------------------|------------|--------|-------|--------|-------------|----------|
| Vegetable        | Normal, corresponds to the name | Pleasant, corresponds to the name of the components | From white to cream, without defects | Juicy, soft, not boiled | Approve recommend to develop ND, issue materials for patenting the method and recommend for widespread implementation |
| Cabbage          | Normal, corresponds to the normative document | Pleasant, characteristic of cabbage and eggplant | Yellow with a greenish tinge of young cabbage; grayish-white | Juicy, soft, uniform, without foreign inclusions |
| Carrot           | The surface is smooth, ruddy crust | Pleasant, sweet, not sour | White with orange tint | Juicy, soft, uniform |
| Potato           | Without cracks, with applied relief | Pleasant, characteristic of vegetables | Orange-white, ruddy crust | Uniform, elastic, without lumps |

Using analytical methods of organoleptic analysis based on a quantitative assessment of quality indicators, we have established a correlation between individual characteristics.

All test samples had high quality indicators.

The results of the evaluation of the chemical composition of the developed casseroles are given in table 6.

The developed recipes for vegetable casseroles enriched using dry protein composite mixtures can be used in dietary nutrition, and are also classified as functional products [28].

**Table 6.** Chemical composition and nutritional value of casseroles.

| Name of performance indicators | Control Casserole | Development Casserole |
|--------------------------------|-------------------|-----------------------|
|                                | Vegetable | Cabbage | Carrot | Potato | Vegetable | Cabbage | Carrot | Potato |
| Protein, g                     | 3.20      | 3.85    | 2.78   | 2.30   | 9.19      | 9.09    | 10.39  | 10.38  |
| Fat, g                         | 1.64      | 5.26    | 2.11   | 2.05   | 5.22      | 9.75    | 9.38   | 8.02   |
| Food fibres, g                 | 1.82      | 2.93    | 2.13   | 1.21   | 1.01      | 4.12    | 2.70   | 2.10   |
| Humidity, g                    | 79.42     | 67.14   | 75.56  | 78.37  | 66.34     | 60.33   | 52.59  | 55.20  |
| Organic acid, g incl. animal   | 0.22      | 0.14    | 0.27   | 0.25   | 0.16      | 0.19    | 0.38   | 0.26   |
| incl. vegetable                | 0.22      | 1.35    | 0.06   | 0.26   | 7.4       | 7.93    | 9.03   | 7.79   |
| Common carbohydrates, g incl. mono- and disaccharides, g | 1.12 | 2.59 | 1.75 | 0.89 | 0.90 | 3.35 | 1.14 | 6.42 |
| Starch, g                      | 11.88     | 19.67   | 14.48  | 14.01  | 16.86     | 15.05   | 22.34  | 19.81  |
| Ash, g                         | 3.20      | 3.74    | 7.58   | 1.20   | 5.17      | 5.56    | 10.23  | 3.75   |
| Mineral substances, mg         | 8.68      | 15.93   | 6.90   | 12.81  | 11.69     | 9.49    | 12.10  | 16.06  |
Adding a mixture of protein composite dry leads to an increase in animal protein in all casseroles. The introduction of vegetable additives: pumpkins, zucchini, eggplant and apples allowed to enrich traditional casseroles with dietary fiber, mono- and disaccharides.

For developed products, it is required to study the degree of satisfaction of the daily requirement for nutrients and energy value. It has been established that vegetable casseroles developed using innovative technologies are products of increased nutritional value, enriched with protein. So, the degree of satisfaction with the daily norm was: protein from 11.81% to 13.48% for the first age group and from 10.22% to 11.53% for the second age group; fat from 6.61% to 12.34% and from 5.67% to 10.6%; carbohydrates from 4.95% to 5.91% and from 3.93% to 5.17%, respectively, of age groups.

The energy value of vegetable casseroles in satisfying the daily needs was from 7.83% to 8.21% for the first age group and from 6.78% to 7.11% for the second age group.

The ratio of protein to fat in the developed vegetable casseroles ranged from 0.93 to 1.76 compared with control samples from 0.73 to 1.95. In developed vegetable casseroles, the ratio is in good condition for the absorption of protein substances.

The content of vitamins and minerals in the developed vegetable casseroles is higher compared to traditional technologies (control).

Vegetable casseroles are most often recommended for breakfast or dinner. The degree of satisfaction with breakfast protein vegetable casseroles are presented in table 7.

| Table 7. The degree of satisfaction of Breakfast protein vegetable casseroles. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Name of casseroles              | Control, protein | Development, protein | % of the diet | % of the diet |
|                                 | Content, %       | from 7 to 11 years old | 11 years and older | from 7 to 11 years old | 11 years and older |
| Vegetable                       | 3.2             | 15.58             | 14.2            | 9.19             | 47.74             | 40.84             |
| Cabbage                         | 3.85            | 20.0              | 17.1            | 9.09             | 47.22             | 40.4              |
| Potato                          | 2.30            | 11.95             | 10.22           | 10.38            | 53.92             | 46.13             |
| Carrot                          | 2.78            | 14.44             | 12.36           | 10.38            | 53.92             | 46.13             |

The degree of satisfaction with breakfast protein with vegetable casseroles was for control images: from 10.22% to 20% for the first age group and from 10.22% to 17.1% for the second age group.

For developed casseroles, the level of protein breakfast was: for the first age group from 47.22% to 53.92%, for the second age group from 40.4% to 46.13%, depending on the type of casseroles.
4. Conclusion
Developed vegetable casseroles, enriched and the use of dry protein composite mixtures in comparison with traditional formulations, have higher indicators of organoleptic properties, as well as in the content of vitamins, macro- and microelements. The use of the Nutrinor dry mix made it possible to create a new assortment of vegetable casseroles and enrich with proteins: cabbage by 116.1%; vegetable by 187.19%; carrot by 273.74% and potato by 351.3%.

The developed products have a high content of proteins and fat, which are in a ratio of 1: 1 or 1: 0.95. The developed recipes for vegetable casseroles can be used in the diets of preventive and dietary nutrition.

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