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Development of recipes for meat pates of a herodietic orientation for the prevention of dysphagia syndrome

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Abstract. The development of recipes for meat pates of a herodietic orientation includes the design and statistical confirmation of the adequacy of selected factors and target values that play a key role in shaping the texture of the finished product for the prevention of dysphagia syndrome. To design model formulations, a complete factorial experiment was carried out and regression equations were obtained for meat pates with Brussels sprouts, broccoli and cauliflower. Based on the response surfaces constructed using the STATISTICA (StatSoft) software package, the dependences of the formation of the viscosity of meat pates on the amount of sunflower oil and puree of various types of cabbage introduced into the formulation were obtained for the first time. The results are presented that provide the specified structural and mechanical characteristics of food products of a gerodietetic orientation for the prevention of dysphagia syndrome. The research formed the basis for the development of recipes for meat pates with a texture that meets the needs of elderly people with involutive changes in the gastrointestinal tract. The developed product has a viscosity (15-20 Pa*s) and elasticity (DH = 0.138), which allow the formation of a food bolus during chewing and facilitate the swallowing process.

1 Introduction

Elderly people make up a large proportion of the total population of the Russian Federation – 35,846.8 thousand people according to Rosstat data for 2023 [1]. The relevance of the process of improving the quality of life of the older age group is becoming obvious. A balanced diet is one of the key factors in maintaining and prolonging a healthy and active aging period [1-3]. The increased risks of developing dystrophy of organs and tissues of an aging body actualize the need to expand personalized sources of nutrients for certain groups of the population. The focus on expanding the range of products of a gerodietetic orientation needs to be adjusted towards the creation of meat-based food products [3, 4].

Dysphagia syndrome, characterized by difficulty or inability to prepare and/or deliver a food bolus from the oral cavity to the stomach, affects 15-30% of elderly people living independently and about 80% living in specialized institutions [2, 5, 6]. Dysphagia in old

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age occurs due to biological age-associated changes in the body or may be caused by certain diseases, for example, Alzheimer's disease, Parkinson's disease, stroke or local structural lesions (malignant tumors of the digestive organs) [7, 8]. Due to reduced food intake, people with dysphagia are at high risk of malnutrition, optimal intake of proteins, dietary fiber, and other biologically active compounds can reduce the risk of neurodegenerative diseases – the main sources of dysphagia [3, 10-11]. For these reasons, increasing the intake of dietary proteins by functional foods and enriching their composition by adding beneficial nutrients may constitute adjuvant therapy for elderly consumers with impaired swallowing ability [12-13].

The purpose of this study is to develop recipes for meat pates of a gerodietetic orientation with a texture that meets the recommendations on rational nutrition for the elderly with dysphagia syndrome.

2 Materials and Methods

The method of a complete factorial experiment in the study of technological processes. To determine the studied factors and the area of experimental planning, as well as to obtain regression equations, the STATISTICA software package (StatSoft) was used; to conduct a dispersion analysis and determine the degree of influence of various types of cabbage, as well as the effect of different dosages of vegetable oil and cabbage on the viscosity of the finished product, the Microsoft Excel 2016 analysis software package was used [14].

A vibratory viscometer VibroViscometer SV-100 was used to study the viscosity of finished meat pates.

The objects of the study were selected: turkey meat, rabbit, Brussels sprouts, broccoli and cauliflower.

To confirm the adequacy of formulations with an easily formed texture of a food bolus and its further ingestion, a texture analyzer "Structurometer CT-2" was used.

3 Results

Two-factor variance analysis was used to statistically assess the influence of factors such as "vegetable oil mass" and "cabbage mass" on the target viscosity of finished pates. In this case, the authors tested the following hypotheses: 1 – the "vegetable oil mass" factor is not related to the viscosity of the finished product; 2 – the "cabbage mass" factor is not related to changes in viscosity and 3 – the combination of factors "vegetable oil mass" and "cabbage mass" does not affect viscosity (Table 1).

When conducting a two-level full-factor experiment (hereinafter referred to as FFE), where the levels of factors represent the boundaries of the studied area - the viscosity of ready-made meat pates of a gerodietetic orientation for people with swallowing difficulty. During the FFE, we obtained the following regression equations for three model formulations of meat pates with different types of cabbage:

with Brussels sprouts:

$$Z = -16{,}7773-3{,}5922*x+7{,}3682*y+0{,}3521*x*x+0{,}1054*x*y-0{,}3143*y*y;$$

with broccoli:

$$Z = 14{,}4598-1{,}4066*x-2{,}3335*y+0{,}0806*x*x+0{,}2035*x*y+0{,}1277*y*y;$$

with cauliflower:

$$Z = -10{,}4745-0{,}624*x+3{,}3689*y+0{,}0962*x*x+0{,}0995*x*y-0{,}1347*y*y.$$

where: Z is the effective indicator;
x is the vegetable oil mass in the model sample, g;
y is the cabbage mass in the model sample, g.

Figure 1 shows the response surfaces of the obtained regression equations.

Table 1. Two-factor variance analysis

Variance analysis						
Variation source	SS	df	MS	F	P-value	F critical
Selection	707.78	3	235.93	9.88	0.00	3.01
Columns	1617.59	2	808.79	33.88	0.00	3.40
Interaction	57.14	6	9.52	0.40	0.87	2.51
Inside	572.98	24	23.87	-	-	-
Total	2955.49	35	-	-	-	-

where, SS is the sum of squares; df is the number of degrees of freedom; MS is the standard deviation; F is the actual value of the Fisher criterion; P-value is the significant probability; F critical is the Fisher critical value (assessment of the variance difference significance)

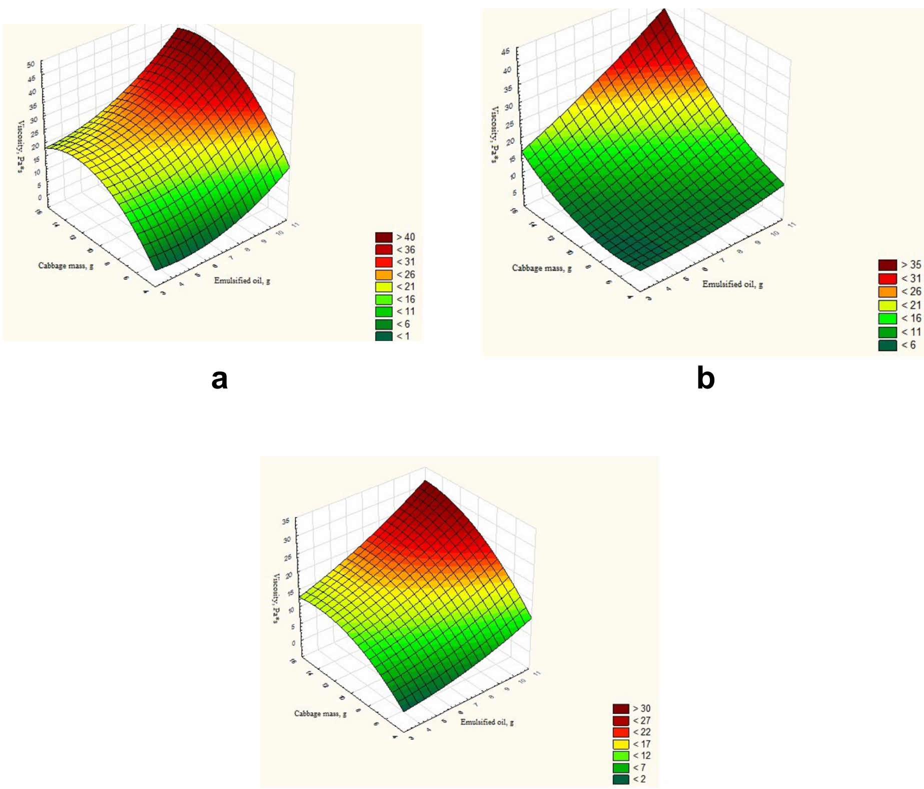

Fig. 1. The response surface of the effect of the mass fraction of cabbage and vegetable oil on the target viscosity value: a — brussels sprout, b — broccoli sprout, c — cauliflower

Based on the data obtained, the formulations of meat pates of a gerodietetic orientation were calculated with a target indicator – viscosity, the main indicator for ensuring normal ingestion of a food lump, trial production was carried out and the most adequate formulations were determined depending on the type of cabbage used and the mass of vegetable oil and cabbage added (Table 2).

Table 2. Recipes of meat pates of a gerodietetic orientation.

Ingredients, g	Formulation 1	Formulation 2	Formulation 3
Turkey meat	30	30	30
Coney	25	25	25
Vegetable oil	4	6	8
Drinking water	22	25	23
Brussels sprouts	15	-	-
Cauliflower	-	-	10,0
Broccoli	-	10	-
Spelt flour	3	3	3
Spices	0,3	0,3	0,3
Table salt	0,7	0,7	0,7
Total	100	100	100

The authors conducted studies on the calculation of a secondary mechanical structural feature – chewability. A primary parameter such as adhesion, the degree to which a product can be deformed before destruction, was measured and analyzed. It is also necessary to calculate the duration or number of movements necessary for the transition of the paste to a state suitable for swallowing. We have adapted the technique developed by Dr. Chernykh V.Ya. to work on the "ST-2 Structurometer". A fragment of data on elasticity and deformation characteristics of meat pates of a gerodietetic orientation is presented in Figure 2.

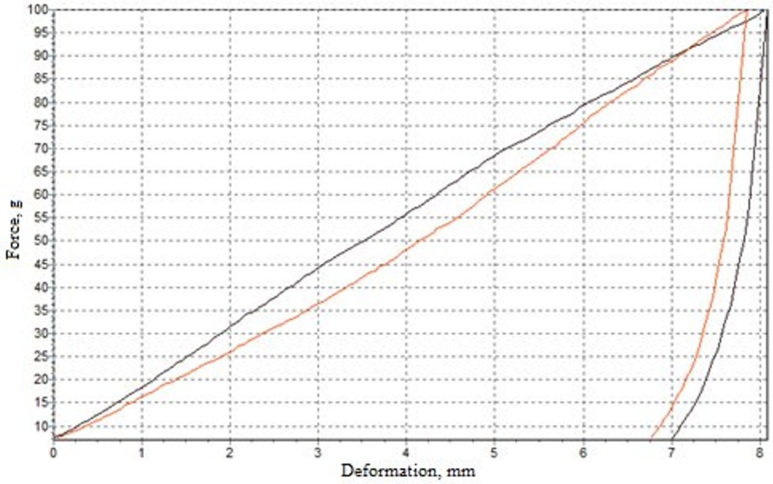

Fig. 2. Deformation characteristics for Formulation 2

A distinctive feature of the research methodology of the prototype is the stage of implementation: the speed of movement is 0.5 mm/s; the maximum force was 100 g/cm2. The following measurement results were obtained: Htotal (total deformation, mm) at the first introduction is equal to 8,086; at the second – 7,859. Hpl (plastic deformation, mm) at the first introduction is 7,000; at the second – 6,742. Hel (elastic deformation, mm) – 1,086 and 1,117, respectively, for the first and second embeddings. The elasticity for formulation 2 is DH = 0.138, which confirms the suitability of the texture of the product for easy formation of a food lump and further ingestion.

4 Discussion

The obtained research results prove that the null hypothesis of the absence of an interaction effect is confirmed, because with respect to the interaction of factors, the observed F–criterion is less than the critical value, therefore, there is no reason to assert that the factors "vegetable oil mass" and "cabbage mass" do not affect the viscosity of the finished product. Considering the main effects, with a given significance level of 0.05, we can say that the basis for checking the difference between the factors "oil mass" and "cabbage mass" is the following rule: the null hypothesis will be rejected if the calculated value is greater than the critical value of the distribution, while the P-Value should be less than the significance level, therefore, we have a relationship between the amount of vegetable oil added and the viscosity of the finished product and we can also say about the weight of the added cabbage – the relationship between this factor and the target value is confirmed.

After selecting statistically significant factors and confirming their relationship with the target viscosity value, regression equations were obtained describing the influence of the main parameters of the formulation, as well as the response surfaces reflecting the relationship between the mass of the added ingredients – vegetable oil and cabbage, and the viscosity of finished meat pates.

The recipes of meat pates are statistically justified and meet the recommendations for food products of people with dysphagia syndrome. The samples of the formulations contain the necessary amount of nutrients, namely the amount of proteins, fats, carbohydrates. The content of lipids and carbohydrates is low, but the protein component of the product has high values, which indicates an increased biological value of the finished products. The numerical values obtained reflect the balanced composition of the experimental samples of meat pates of gerodietetic orientation.

5 Conclusion

The study of the factors influencing the main indicator of food for the elderly with dysphagia – viscosity are basic in the design of personalized food formulations. Statistical confirmation of the interaction of factors – the mass of the added ingredients, and the target value of viscosity in meat pates gave the basis for the design of model samples using FFE.

The response surfaces of adequately selected factors for the design of formulations of prototypes showed that vegetable oil and cabbage are the main structure-forming agents and can act as improvers of textural indicators of ready-made meat pates for people with swallowing disorders.

As a result of the analysis of the obtained data and trial production, followed by organoleptic analysis, the formulations of meat pates for elderly people with dysphagia syndrome were substantiated.

The use of different types of cabbage – Brussels sprouts, broccoli and cauliflower - was analyzed. It was determined that the balance of textural indicators and indicators of taste and aroma for the prototypes is achieved with 15 g of Brussels sprouts and 10 g of broccoli and cauliflower, respectively. The amount of added vegetable oil per 100 g of the product is determined: for the recipe with Brussels sprouts – 4 g, for the recipe with broccoli – 6 g, and for the recipe with cauliflower – 8 g.

Studies on a textureanalyzer have confirmed reduced requirements for efforts aimed at forming a food lump and swallowing it.

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