CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.3373778

Available online at: http://www.iajps.com ***Research Article***

MEAT AND VEGETABLE PATE: OPTIMIZATION OF FUNCTIONAL AND PROCESSING PROPERTIES AND QUALITY PARAMETERS

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Article Received: June 2019 **Accepted:** July 2019 **Published:** August 2019

Abstract:

The article considers a method of optimizing the nutritional value of meat and vegetable pates. Their formulation has been proposed to be added with vegetable raw materials grown in the Lower Volga region and processed in a certain way. The authors have proposed a lentils preparing method that implies their soaking and wet germination with using electro treated solutions of sodium and ammonium salts. Improvement of the lentils processing method made it possible to increase the rate of seeds germination, inactivate inhibitors of the proteolytic enzymes of vegetable materials and enhance the biological value of the product. The results obtained have revealed improvement in the functional and processing properties of the product, with raw meat being partially replaced with vegetable components, while preserving high organoleptic characteristics. The novelty of the recipe developed involves creating a high-protein product of functional nutrition. The general result of the article is that there has been discovered a mechanism of combining vegetable and animal proteins in the formulation that ensures the preservation of the missing and labile essential amino acids and results in a meat and vegetable pate of 84.6% protein and complete set of amino acids in the product.

Keywords: *Amino acid composition, biological value, pate, raw meat, vegetable.*

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Please cite this article in press Natalia Ivanovna Mosolova et al., ***Meat And Vegetable Pate: Optimization Of Functional And Processing Properties And Quality Parameters****., Indo Am. J. P. Sci, 2019; 06(08).*

INTRODUCTION:

One of the modern trends in expanding the assortment and improving the quality of food products is the integrated use of raw materials of animal and vegetable origin. The most popular with manufacturers is the development of procedures and product formulations based on raw materials that are profitable to produce in a particular region.

The purpose of this work was to create a high-quality meat and vegetable product with a high content of protein and vegetable fibers. The recipe was based on beef meat noted for its low fat content. Lentils and carrot were used as vegetable ingredients.

Brown table lentils have many health properties that together have a positive effect on the human body [1]. It is rich in iron, potassium, silicon, folic acid and other vitamins of B complex; beta carotene and vitamin E; valuable protein that is rich in essential amino acids and fiber, improving digestion and creating a sense of fullness [1 and 2]. Carrot roots also contain a lot of fiber, pectin and sugars [3].

The relevance of the topic chosen is due to the fact that meat and vegetable pates with high protein content solve the problem of protein deficiency in nutrition [4, 5 and 6]. Meat and vegetable pates were attributed to the dietary products, since their production uses lean meat raw materials, which allowed obtaining a product of reduced fat content. Adding of vegetable components to the recipe of the pate allowed us to ensure full utilization and fast digestion of the product.

For the first time, in order to optimize the biological value of meat and vegetable pates, it was proposed to use vegetable raw materials grown in the Lower Volga region and processed in a certain way. The lentils preparing procedure implied its soaking and wet germination and differed from the known procedures that have certain disadvantages when implementing them into the food industry [7 and 8] in using electro-treated sodium and ammonium salts, with the ratio between NaCl and NH_4Cl being 89-90% and 10-11%. After electrical treatment, germinated lentils caused enrichment of the product with additional amount of essential substances and allowed shortening the germination period and increasing the availability of biologically active substances of vegetable raw materials.

Thus, the use of vegetable ingredients such as legumes and carrots in the composition of pates caused the enrichment of the product with animal and vegetable proteins, increase in biological value, optimization of functional properties and improvement of organoleptic characteristics of the finished product.

Materials and research methods:

The research work consisted of the following stages: selection and preparation of raw materials, development of control and test samples of pates and assessing the quality of the products obtained according to their organoleptic and physicochemical properties.

The objects of the study were second grade beef, chicken fillet, brown table lentils, carrots, as well as pate samples developed on the basis of these objects and also salt, onion, olive oil, sugar, turmeric, basil, nutmeg, ginger and black pepper additionally used.

The improvement of the lentil preparing method involved the following materials: water distilled according to GOST 2874-82, sodium chloride according to GOST 4223-74, potassium chloride according to GOST 4234-80 and ammonium chloride according to GOST 3773-72. The solutions were electrically treated in a static diaphragmless electrolyzer of the “MELESTA” type (manufactured by OOO MELESTA, Ufa, Russia) improved due to replacing the cover with a plexiglas plate and a VSA-5K type rectifier, which made it possible to monitor the performance of electrical processing. The pH and ORP were measured on the “Nitron” device according to the operational guidelines at room temperature. The cathode material was stainless steel; the anode material was the ORTA type with a surface of 5 cm^2. There were used solutions of 0.8-1.2 g/l of a mixture of sodium chloride and ammonium chloride in a ratio of 89-90% and 10-11% [7 and 8].

Lentils were germinated according to the GOST 12038-84 requirements, with morphological parameters (lengths of germs and roots) being defined and humidity being determined by drying in an oven.

The formulation of the pate developed was optimized using the MS Excel included in the MSOffice2010 package.

The pate samples were produced at cutter MADO MSK 760 in accordance with the current regulatory and technical documentation (GOST R 55334-2012 "Meat and meat-containing pate. Specifications") approved by the director of the V. Gorbatov's All-Russian Meat Research Institute of the Russian Agricultural Academy. The pate samples made from similar raw materials, but without lentils were used as

control samples. The scheme of the experimental study is shown in Figure 1.

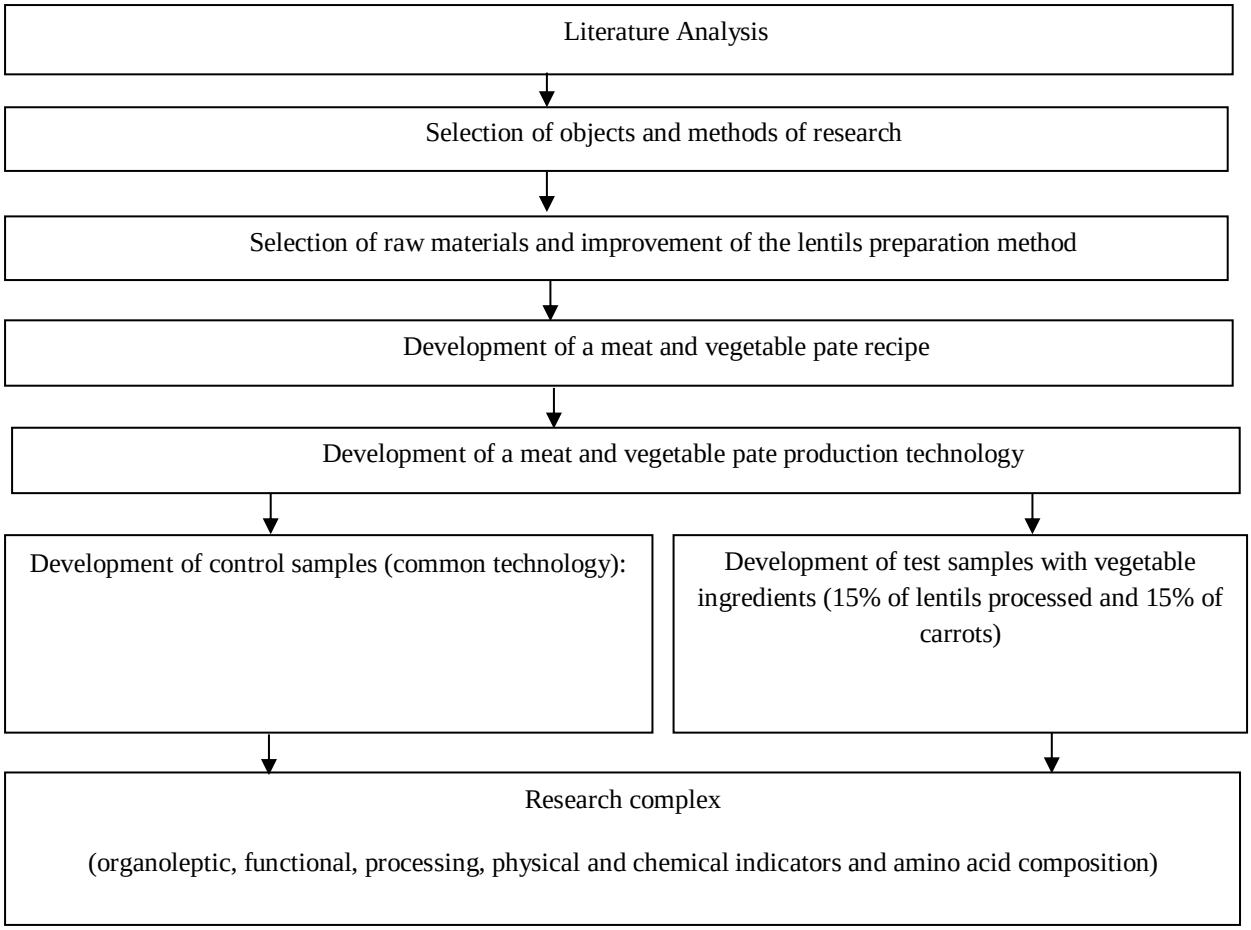

Figure 1. Scheme of experimental studies

The samples for laboratory studies were selected and prepared according to the uniform procedure with the GOST R 51447-99 (ISO 3100-1-91) requirements. The organoleptic indicators were determined by the GOST 9959-91, GOST R 53159-2008 and GOST R 53161-2008 requirements. The weight fraction of fat was determined according to GOST 23042-86; protein to GOST 25011-81; salt by the Folgard method according to GOST R 51480-99 (ISO 1841-1-96); and energy value by calculation.

The functional technological parameters (water-binding, water-retaining, fat-retaining and emulsifying capacities) were studied by sequential determination in one sample (the method by R.M. Salavatulina et al.) [2].

The amino acid composition of the test sample was determined on Aracus amino acid analyzer in accordance with the operational guideline. The amino acid score was defined as the ratio between the content of a specific amino acid in 1 g of a protein of a test sample and the content of this amino acid in 1 g of a reference protein [9]. The biological value (BV) of the protein was calculated taking into account the reference data [9] using the formula:

$$BV = 100 - \frac{\sum_{i=1}^{n}(AC_i - AC_{\min})}{n},$$

where AC_i is the amino acid score of the i-th amino acid; AC_{min} is the minimum amino acid score; and n is the number of amino acids.

RESULTS AND DISCUSSION:

The meat and vegetable pates line expansion, as well as increasing their nutritional and biological value were achieved due to local vegetable ingredients prepared in meat and vegetable pate production,

including the stages of preparing vegetable components and raw meat, grinding and making minced meat, with brown table lentils and carrots being used as raw materials for partial meat replacement. There was used the following ratio of raw components, pts. wt.: second grade beef 29.0; chicken fillet 15.0; olive oil 2.8; lentils 15.0; carrots 15.0; salt 1.5; onion 2.0; sugar granulated 0.36; turmeric ground 0.02; basil ground 0.02; nutmeg ground 0.04; ginger ground 0.13; black pepper ground 0.03; and water - bouillon 19.1.

The novelty of the product formulation developed consisted in creation of a high-protein product—a meat and vegetable pate that is low fat. Combining meat and vegetable raw materials allowed balancing the chemical composition and increasing the yield.

Lentils are a source of many biologically important elements, including an average of 24% of proteins, 46.3% of carbohydrates, 1.5% of fat, 1.5% of vegetable fiber, 2.9% of sugars, 0.5% of unsaturated fatty acids, as well as vitamins A, E, group B, minerals such as potassium, calcium, magnesium, phosphorus, iron, etc. Lentils contain many complex well-digestible carbohydrates and hardly affect the development of glycemia [1 and 10].

Carrots are rich in vitamins of B, PP, C, E and K groups and contain a considerable amount of carotene—a substance that in the human body is synthesized into vitamin A. Moreover, carrots are a source of a complex of minerals: potassium, iron, phosphorus, magnesium, cobalt, copper, iodine, zinc, chromium, nickel and fluorine [3].

The experimental studies optimized the meat and vegetable pate recipe [10], which resulted in a pate with raw meat (pork and beef) being replaced with vegetables (lentils and carrots) without deteriorated quality or organoleptic characteristics. This was achieved by a certain lentils preparation method before adding them to the stuffing.

The feature of this preparation was the use of electro-treated solutions of sodium and ammonium salts as a solution for soaking lentils.

Electrical processing at a temperature of 20–30 °C resulted in solutions obtained for soaking and germinating lentils. In the control, initial solutions of the salts mixture were used. The initial solutions were prepared by taking up samples of salts and dissolving them in a small flask. After electro treatment, the solutions had the following parameters: pH of 3.5-4.5 and ORP of + 450 ... + 550 mV [7 and 8].

The lentil grain was soaked at 18 ºC for 18 hours to a moisture content of 26-28% and then germinated for 4 days at room temperature (20-26 ºC) for 4 days before the germs being 3-4 cm long. The experiment found that the electro processed solutions of sodium and ammonium salts worked as plant stimulants; in comparison with the control, the increase in the length of roots growth was 13.0 mm (16.0%) and seedlings 7.0 mm (7.1%).

When using a diaphragmless electrolyzer, the lentil processing technology was optimized and resulted in increased bioavailability of proteins and essential amino acids. There was observed rapid softening of the lentil grain structure, destruction of cell walls, diffusion of solution molecules accelerated when moving inwards towards proteins, swelling and active hydration of anti-nutrients, which in turn led to inhibition of proteolytic enzymes of the plant culture.

It was established that it is advisable to add lentils in an amount of 15% to the mass of the raw material; with an increase in its content, there was marked some deterioration in the organoleptic properties of the product due to the enhancement of the bean flavor. Chicken fillet was used in the product recipe improved due to increasing popularity of white poultry meat in global meat consumption [4], its optimal price-quality ratio, low fat content and culinary and processing advantages.

The particularity of the meat and vegetable pate production technology was as follows. Beef in half carcasses and 1st grade broiler chicken carcasses chilled were delivered to the production site, where regulatory and technical documentation and temperature of raw materials were checked. Raw meat went through the stages of cutting, boning, trimming and sorting. Meat (second grade beef) selected with respect to the quality was boiled at 100 ºC for 3 hours to soften the structures and cooled to a temperature of 4 ºC. Broiler chicken fillets were being blanched for 3-5 minutes at 100 ºC in broth after cooking beef and cooled to 4 ºC. Lentils were soaked in electro processed salts solutions for 2-3 hours in advance, germinated for 4 days, washed gently, dried at room temperature for 10-12 hours and cooked for 30 minutes in broth. The broth and lentils were cooled to 4 °C. If required, carrots were hydrated to water at a ratio of 1:2. The raw meat prepared was being cut for 5 minutes; the meal particle size was 2-3 mm. When cutting, vegetable ingredients prepared, spices and

chilled broth were added; homogenization lasted 5 minutes. Preparation of the polyamide casing consisted in soaking in warm water at 35-40 ºC for 40 minutes. Then, the homogenized mass was filled into a polyamide casing and clipped; the linked pate units of 12 cm in length were boiled at a temperature of 80-85 ºC and 72 ºC in the center of the linked pate unit, cooled to 8 ºC and further stored at 8 ºC and relative humidity of 85% for 24-48 hours.

In determining the functional and processing characteristics of the pate according to the recipe, containing lentils and carrots in the amount of 30%, there was revealed an increase in the water-binding capacity (WBC) by 4.5%, water-retaining capacity (WRC) by 3.0%, fat-retaining capacity (FRC) by 9.0% and emulsifying capacity (EC) by 5.0% (Figure 2).

Organoleptic characteristics of the meat and vegetable pate obtained are presented in Table 1.

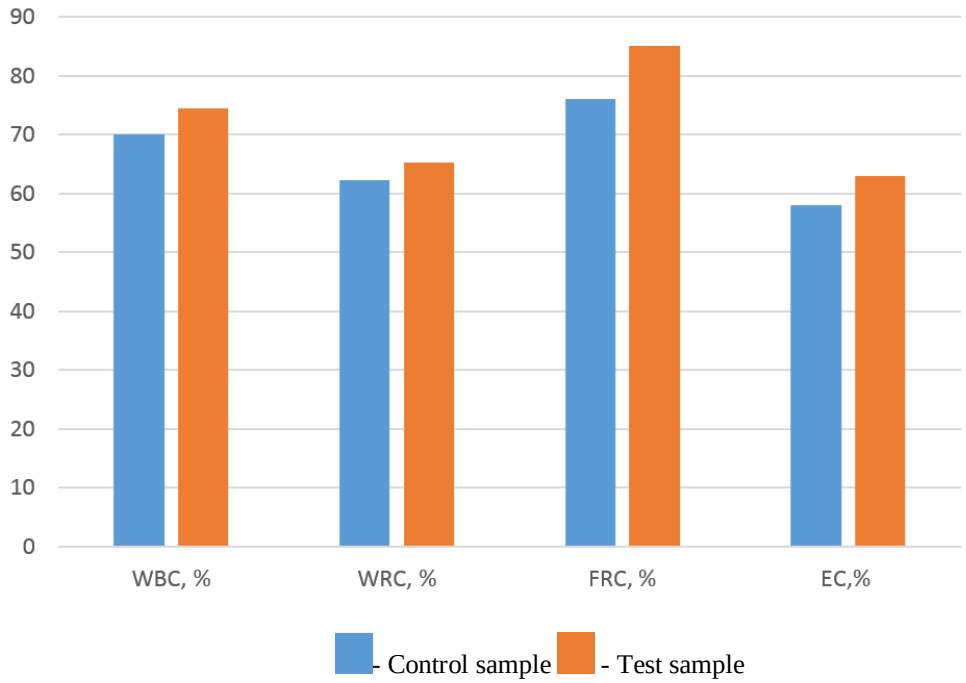

Figure 2. Characteristics of functional and processing pate properties

Table 1: Characteristics of organoleptic parameters of the test pate sample

Parameter	Characteristics
Appearance	In casing, linked pate with clean dry surface without damage
Consistency	Tender, spreadable
Section view	Uniformly mixed mass of colour from gray to pale pink, with food particles being sensed
Taste and smell	Characteristic of this type of product, moderately salty, without foreign taste and smell, with a pronounced aroma of spices
Colour	Pale pink

The nine-point organoleptic evaluation diagram in comparison with the control sample (without lentils) is shown in Figure 3.

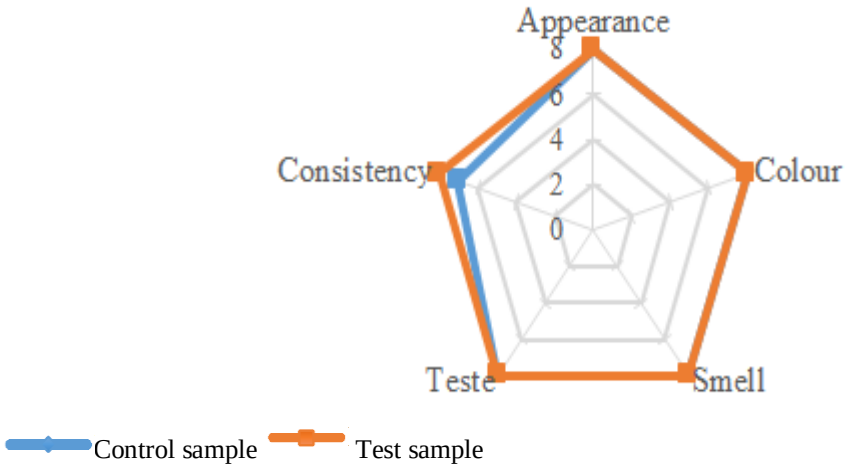

Figure 3. Diagram of the organoleptic quality evaluation of pates.

Figure 3 shows that the control and test products are almost identical in appearance, colour, smell and taste, but the developed pate, containing 15% of lentils and 15% of carrots, had an improved consistency.

The main quality parameters of the pate prototype developed had the following values: fat content of 4.52%, protein of 17.44%, carbohydrates of 12.22% and salt (chlorides) of 2.0%. The energy value (calories) in 100 g of product was 670 kJ (159.5 kcal).

The research study analyzed the content of amino acids in the product and proportion of the daily consumption they make up [9]. The results of the calculations are presented in Table 2.

Table 2: Characteristics of the amino acid composition of the product in comparison with the consumption norms

Amino acid	Amino acid content in test samples of pate, mg/100 g	Consumption rate, mg/day	Percentage of daily consumption, %
Valine	667	2500	26.6
Leucine+isoleucine	1765	6600	26.7
Lysin	847	4100	20.7
Methionine	380	1800	21.1
Threonine	551	2400	23.0
Tryptophan	155	800	19.4
Phenylalanine	652	4400	14.8
Alanine	658	3000	21.9
Arginine	1100	6000	18.4
Histidine	348	2000	17.4
Glycine	691	300	230.3
Proline	659	5000	13.2
Serine	519	3000	17.3
Tyrosine	554	3000	18.5

The protein was also compared with the reference proposed by the FAO WHO, and the essential amino acid score was calculated [9]. The results of the calculations are presented in Table 3. So, the limiting amino acid was methionine; its amino acid score was 60.2%.

Table 3: Amino acid score characteristics

Amino acid	Amino acid content in test samples of pate, mg/100 g of protein in product	Amino acid content in the reference protein, mg/100 g	Amino acid score,%
Valine	3694	2500	147.8
Leucine+isoleucine	9784	11000	88.9
Lysin	4698	5500	85.4
Methionine	2108	3500	60.2
Threonine	3056	4000	76.4
Tryptophan	860	1000	86.0
Phenylalanine	3616	6000	60.3

The biological value of proteins in the processes of thermal, mechanical, or other types of processing, as well as transportation and storage may be reduced, especially due to the interaction of essential amino acids with other components. At the same time, compounds indigestible in the human body are formed. In this work, products that are sources of vegetable and animal proteins combined in the recipe ensured the missing and labile essential amino acids being preserved. This resulted in a meat and vegetable pate product with a high biological value of proteins of 84.6%, which indicated a complete set of amino acids in the product.

CONCLUSIONS:

For the production of meat and vegetable pates it is advisable to use lentils after the following stages of preparation: soaking and germination in electro processed solutions of sodium and ammonium salts. Improving the lentils processing method allowed increasing of the grain germination rate, inactivating inhibitors of proteolytic enzymes of vegetable materials, enhancing the biological value of the product, as well as optimizing of functional and processing properties of meat and vegetable pates.

Improvement of the water-binding, water-retaining, fat-retaining and emulsifying capacities of the product was revealed in the formulation improved, with high organoleptic quality indicators being preserved and raw meat being partially replaced with vegetable components (15% lentils and 15% carrots).

The conducted work resulted in a meat and vegetable product developed to meet the needs of people who require a balanced dietetic nutrition that contains a high protein component, namely athletes, school-age children and the elderly. The pate obtained in this way is characterized by increased nutritional value, high protein content and quality due to the combination of meat and legumes proteins and also reduces the cost of production through the use of available local vegetable raw materials.

Acknowledgements:
The work was carried out within the framework of the grant of Russian Science Foundation 15-16-10000-NIIMMP. Sponsors of the grant did not directly participate in the development, analysis or writing of this article.

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