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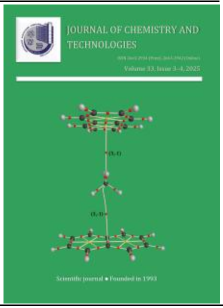

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DEVELOPMENT OF A METHOD FOR PRODUCTION OF MEAT AND VEGETABLE PRESERVES WITH THE USE OF A LOW POWER ELECTRIC AUTOCLAVE

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Abstract

The article presents the results of the development of a method for producing meat and vegetable preserves using a test bench and a low-power electric autoclave at the laboratory of Sumy National Agrarian University. A Programmable Logic Controller (PLC) OWEN PR200 and a Supervisory Control and Data Acquisition (SCADA) system were used to regulate the technological parameters of sterilization. The main focus was placed on the development of recipes for meat and vegetable preserves enriched with plant-based ingredients: peanut flour, sunflower seed meal, white lupine flour, and rape seed meal. Sterilization was conducted at 110 °C for 20 minutes according to a predefined program. Sensory evaluation, based on a five-point expert panel scale, revealed improvements in taste, aroma, texture, and color in samples with plant-based additives. The highest sensory scores were observed in samples containing white lupine flour and rape seed meal. Nutritional value analysis revealed that the inclusion of plant materials enriched the preserves with proteins and fats, leading to increased levels of essential amino acids and fatty acids. The most significant increases were observed in Sample No. 1, with peanut flour (21.7 ± 0.7 %) and Sample No. 2, with sunflower seed meal (21.4 ± 0.6 %), highlighting the positive impact of peanut flour and sunflower seed meal. The control Sample No. 0 had a fat content of 6.5 ± 0.1 %, whereas all experimental samples had lower fat content, ranging from 2.7 ± 0.2 % to 3.4 ± 0.2 %. The article provides a detailed description of the technological stages in the production process, including raw material preparation, sterilization, parameter control, and the application of automated bench. The results demonstrate the potential of the developed method for producing high-quality meat and vegetable preserves.

Keywords: sterilization; process parameters; canned meat; nutritional and biological value; PLC; SCADA.

РОЗРОБКА МЕТОДУ ВИРОБНИЦТВА М'ЯСНО-ОВОЧЕВИХ КОНСЕРВІВ З ВИКОРИСТАННЯМ НИЗЬКОПОТУЖНОГО ЕЛЕКТРИЧНОГО АВТОКЛАВА

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Анотація

У статті представлені результати розробки методу виробництва м'ясо-овочевих консервів із використанням випробувального стенду та низькопотужного електричного автоклава в лабораторії Сумського національного аграрного університету. Для регулювання технологічних параметрів стерилізації використаний програмований логічний контролер (PLC) OWEN PR200 та систему диспетчерського контролю і збору даних (SCADA). Основну увагу приділено розробці рецептур м'ясо-овочевих консервів, збагачених рослинними інгредієнтами: арахісовим борошном, шротом соняшникового насіння, борошном білого люпину та шротом ріпака. Стерилізацію проводили за температури 110 °С протягом 20 хв за заданою програмою. Органолептична оцінка, проведена за п'ятибальною шкалою експертною групою, показала покращення смаку, аромату, текстури та кольору в зразках із рослинними добавками. Найвищі органолептичні показники спостерігалися в зразках із борошном білого люпину та шроту ріпака. Аналіз поживної цінності виявив, що додавання рослинних матеріалів збагатило консерви білками та жирами, що призвело до підвищення вмісту незамінних амінокислот і жирних кислот. Найвищі показники спостерігалися у зразку № 1 з арахісовим борошном (21.7 ± 0.7 %) та зразку № 2 зі шротом соняшникового насіння (21.4 ± 0.6 %), що підкреслює позитивний вплив арахісового борошна та шроту соняшникового насіння. Контрольний зразок № 0 мав вміст жиру 6.5 ± 0.1 %, проте всі експериментальні зразки мали нижчий вміст жиру, що коливався від 2.7 ± 0.2 % до 3.4 ± 0.2 %. У статті детально описано технологічні етапи виробничого процесу, включаючи підготовку сировини, стерилізацію, контроль параметрів та використання автоматизованого стенду. Результати демонструють потенціал розробленого методу для виробництва високоякісних м'ясо-овочевих консервів.

Ключові слова: стерилізація; технологічні параметри; м'ясні консерви; поживна та біологічна цінність; PLC; SCADA.

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Journal of Chemistry and Technologies, 2025, *33*(3), 734-745

Introduction

Today, in wartime conditions in Ukraine, canned meat has become one of the most popular food products that perform one of the main tasks in ensuring the food security of the population, in particular in meeting the needs for a diet with a full and safe composition of protein components, dietary fiber, vitamins, fatty acids and other biological compounds [1].

Since 2022, the number of production facilities in the meat processing industry has decreased due to the loss of control over them in active combat zones and temporarily occupied territories [2]. Compared to recent years, due to a decrease in cattle and pigs, there is a shortage of meat raw materials [3].

In the consumer market, canned meat is represented by products from offal, pork and beef, while 3.5% from poultry meat [4; 5]. Therefore, proteins of plant origin and the use of poultry meat have become widely used in the manufacture of canned meat, which is economically feasible with a simultaneous increase in nutritional and biological values [6; 7].

In recent years, the world has begun to rapidly move into the era of automation and robotics [8; 9]. Like any other industry, the food industry uses profitable and cost-effective technologies and equipment [10; 11]. Effective automation solutions will help improve quality and safety standards, increase productivity, and reduce production losses amid growing demand for food products [12; 13].

Modern innovative achievements in the field of automation of food production lead to the emergence of competitive systems, in particular automated process control systems, increasing the efficiency of the production process [14; 15]. Therefore, the development of a new method of making canned food using poultry meat, plant materials and modern automation tools is a promising and relevant study. Energy conservation remains a critical aspect in the operation of electric autoclaves. Numerous methodological approaches exist for calculating energy losses associated with electric autoclaves as well as across entire production facilities [16].

There is a lot of research on the development and improvement of canned meat technology using various methods and types of raw materials. For example, [17] shows the latest trends in the use of natural essential oils in packaging, their active role in the preservation of meat and in food preservation technologies. It was found that the coating, which contains essential oils, prevents softening of the texture, gives antimicrobial and antioxidant properties, and also increases the shelf life of canned products.

Scientists [18] investigated the use of plant extracts as preservatives to increase the shelf life of canned chicken meat. It is shown that plant extracts have a rich biological composition, prevent oxidation of proteins and lipids, and also enhance the sensory characteristics of chicken meat.

Ulloa-Saavedra A., Garcia-Betanzos C. and others have investigated recent developments and uses of nanosystems in the production of meat products. Dietary fibers, vegetable proteins, spices, herbs, probiotics were added to reduce the cost and improve the functional properties of meat products. It was found that the addition of oregano essential oil to the composition of nanoemulsions helped to reduce the growth of microbes and extended the shelf life of chicken pate [19].

Researchers [20] conducted a review of the technologies used to preserve meat and meat products by eliminating microbes or inactivation. In particular, the use of corn flour in the technology of making meat and vegetable canned food is considered. The addition of processed flour affects the consistency, as it absorbs twice as much water as untreated corn flour.

Other scientists have studied the use of ultrasound in combination with additional means in the preservation of meat products [21]. The use of ultrasound and salt solutions for pork meat [22], ultrasound and plasma-activated water [23] and peroxyacetic acid [24] for chicken meat are shown.

Khalilov F. V. in his study [25] analyzed the features of sterilization of canned products using the automatic control system SCADA. It is shown that the use of SCADA allows you to control the parameters of technological processes of sterilization, reducing the production of low-quality product and reducing energy consumption by reducing the time of exposure to high temperature.

SCADA systems play a key role in tracking critical process variables [26; 27]. Process parameters are controlled by a predefined application type. Scientists [28; 29] developed a PLC program for multi-profile control logic and multi-processor parameters for heat treatment applications, in particular sterilization in autoclaves.

A promising source of biological compounds, dietary fiber, proteins, fats, essential amino acids

Journal of Chemistry and Technologies, 2025, *33*(3), 734-745

and fatty acids, which can enrich canned poultry meat, are the fruits and products of processing lupine white (*Lupinus albus L.*), rape (*Brassica napus L.*), peanuts (*Arachis hypogaea L.*) and sunflower (*Helianthus L.*).

Lupine white seeds are characterized by a high protein content of 28–48 %, a corresponding balance of fatty acids, 10 % saturated and 90 % unsaturated fatty acids, a wide composition of minerals, a good source of essential amino acids, a high content of dietary fiber. In its composition it has phytochemical and antioxidant compounds, does not contain gluten, stomach irritants, cholesterol [30; 31].

Rape seed meal has a high protein content of 30–35 %, ash 5.5–6.8 %, fiber 30–40 %. Rape seed proteins are a source of bioactive peptides, have antioxidant and functional properties, water-binding, gelling and foaming properties [32]. The microelement and mineral profile of rape seed meal is characterized by a high content of potassium, calcium, phosphorus, magnesium. The content of fatty acids is represented by oleic 51–57 %, linoleic 28–29 %, palmitic 9–11 % and α-linoleic 4–5 % fatty acids [33; 34].

Peanut flour is rich in protein 20–30%, lipids 40–55%, fatty acids, dietary fiber, minerals and vitamins, including A, E, B1, B2, functional bioactive and antioxidant components. In addition, peanut flour contains resveratrol, flavanoids and phenolic acids [35]. Peanut proteins have functional characteristics such as emulsification, foaming, binding and solubility [36; 37].

Sunflower seeds are a source of unsaturated fatty acids, antioxidants, dietary fiber, flavanoids, proteins, amino acids, vitamins and minerals. The content of saturated fatty acids in seeds is 6.85–7.16 %, monounsaturated fatty acids 48.05–48.44 %, polyunsaturated fatty acids 44.02–44.91 % [38; 39]. Sunflower seed meal proteins have functional properties such as emulsification and foaming [40; 41].

The article is aimed at developing a method of production of meat and vegetable preserves using an automated stand and a low-power electric autoclave using a programmable logic controller OWEN PR200 and Supervisory Control and Data Acquisition (SCADA) based on the laboratory of Sumy National Agrarian University of the Faculty of Food Technologies.

To achieve the goal, the following research tasks were set:

– analyze the operation of the stand and auxiliary equipment, which is necessary for the technological process of sterilization of canned food, control and management of its technological parameters;

– describe the technological process of sterilization of meat and vegetable preserves according to the corresponding program number;

– investigate the effect of added plant raw materials on the sensory profile of meat and vegetable preserves;

– calculate the nutritional value of meat and vegetable preserves.

Results and their discussion

At the Faculty of Food Technologies in the laboratory of Sumy National Agrarian University, a method for the production of meat and vegetable canned food using a stand has been developed. The production process of which is shown in Figure 1.

Figure 2 shows the appearance of the developed meat and vegetable preserves.

The sensory evaluation of the developed meat-plant preserves was carried out by an expert panel consisting of five specialists from the Department of Food Technology using a five-point hedonic scale. The main sensory attributes assessed included appearance, color, odor, taste, and texture.

The results of the evaluation demonstrated that all tested samples met the requirements of the normative documentation DSTU 4443:2005, exhibiting high sensory quality. Sample No. 0, prepared according to the standard formulation and used as the control, received high scores and served as a reference point for comparative analysis.

Figure 3 shows the statistically processed evaluation results as a profilogram.

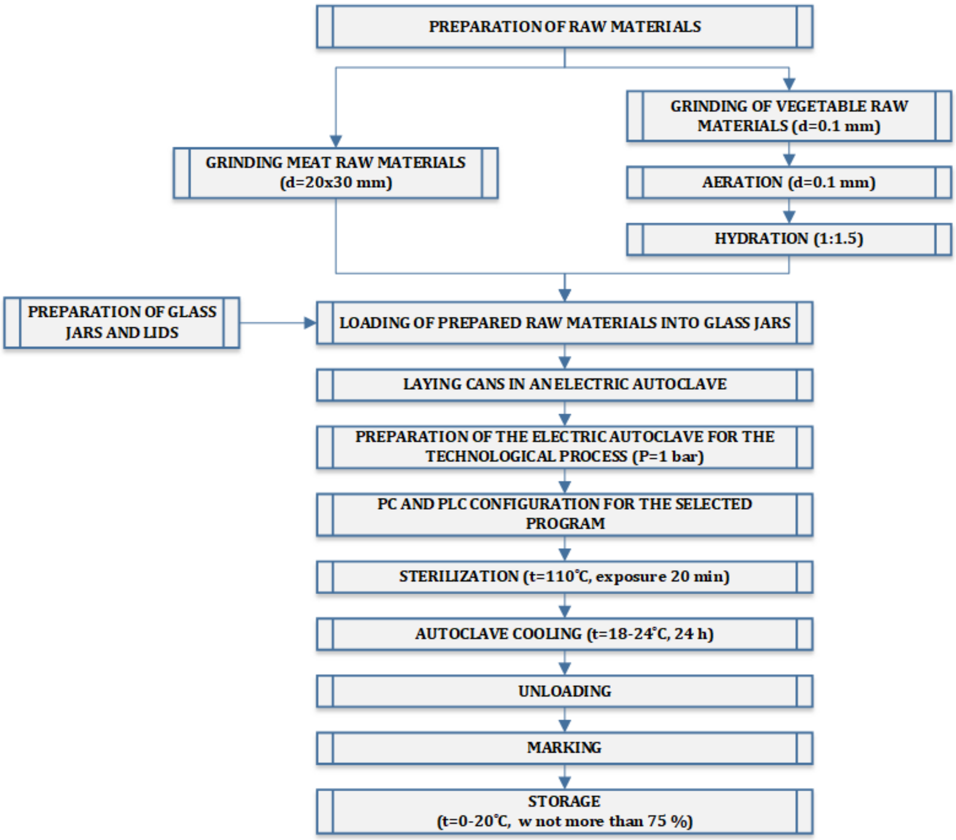


Fig. 1. Technological scheme of production of meat and vegetable preserves using an automated stand

Fig. 2. Appearance of the developed meat and vegetable preserves:
a) sample № 1; b) sample № 2; c) sample № 3; d) sample № 4

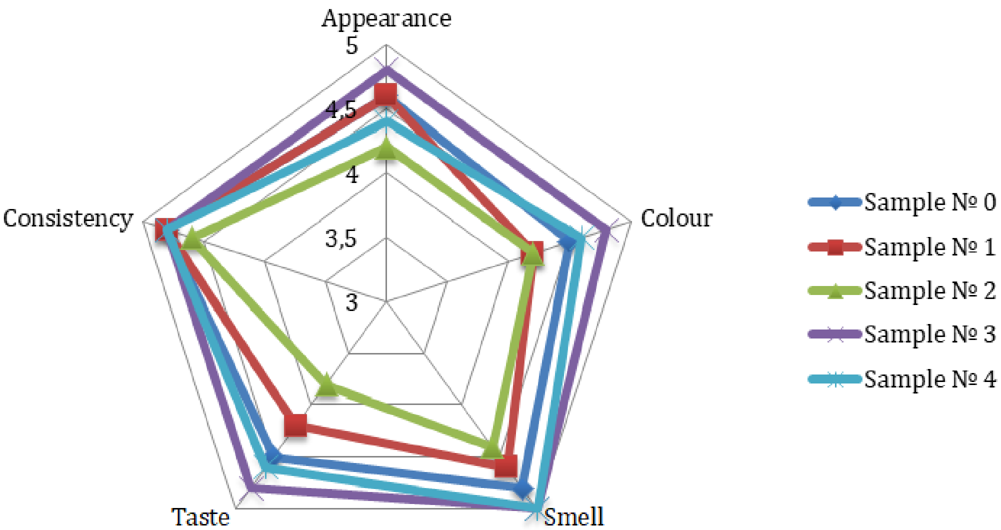


Fig. 3. Profilogram of sensory evaluation of developed meat and vegetable preserves

Among the experimental samples, the highest scores were attributed to Sample No. 3, which included white lupine flour, and Sample No. 4, which contained rape seed meal. These samples were characterized by a harmonious combination of sensory attributes, particularly an intense color, balanced taste, and pleasant texture. Sample No. 1 (with peanut flour) and Sample No. 2 (with sunflower seed meal) also received satisfactory evaluations, though slightly lower in certain parameters.

The incorporation of plant-based ingredients positively influenced the sensory properties of the preserves, enhancing their overall profile and contributing to the development of new characteristics that may appeal to consumers.

Detailed characteristics of sensory parameters of meat and vegetable preserves are presented in Table 1.

Table 1

Characteristics of sensory indicators based on the results of expert evaluation of the developed meat and vegetable preserves

Indicators	Characteristics				
	Sample № 0	Sample № 1	Sample № 2	Sample № 3	Sample № 4
Appearance	Whole pieces of meat with a fat layer on top	Whole pieces of meat, homogeneous broth	Whole pieces of meat with a fat layer on top	Whole pieces of meat, homogeneous broth	Whole pieces of meat, the outer shell of the seed is observed in the lower part
Colour	The color of the meat meets the requirements, the total mass has a color from beige to light brown	The color of the meat meets the requirements, the total mass has a color from beige to light brown	The color of the meat meets the requirements, the total mass has a color from dark beige to brown with a grayish tint	The color of the meat meets the requirements, the total mass has a yellowish color with a cream tint	The color of the meat meets the requirements, the total mass is light yellowish with dark patches at the bottom
Smell	The smell of meat is inherent in chicken	The smell of meat is inherent in chicken, the light aroma of peanuts is noticeable	The smell of meat is inherent in chicken, the light aroma of sunflower seeds is noticeable	The smell of meat is inherent in chicken, a pleasant bean flavor is noticeable	The smell of meat is inherent in chicken, a light seed aroma is noticeable
Taste	Taste balanced, moderately salty, without bitterness	Taste balanced, rich, tender, with a light nutty note, moderately salty, without bitterness	Taste balanced, rich, tender, with a light nut-seed note, moderately salty, without bitterness	Taste balanced, rich, tender, with a pleasant light bean note, moderately salty, without bitterness	Taste balanced, rich, tender, with a pleasant light seed note, moderately salty, without bitterness
Consistency	Chicken meat is soft, juicy, without lumps	Chicken meat is soft, juicy, the broth has a uniform texture, without lumps	Chicken meat is soft, juicy, broth has a pleasant texture, without lumps	Chicken meat is soft, juicy, broth has a light thick homogeneous texture, without lumps	Chicken meat is soft, juicy, the broth has a light graininess, a pleasant texture, without lumps

The addition of peanut flour and sunflower seed meal to the formulation of meat-and-plant-based canned products had a positive effect on their organoleptic properties, in particular by enhancing taste characteristics and contributing to the development of new mild aromatic notes. The inclusion of rape seed cake improved the flavor profile of the product. The use of lupin flour contributed to improvements in color, texture, taste, and aroma of the canned products, indicating its functional and technological effectiveness within the meat-plant composition.

The energy value of meat and vegetable preserves was calculated using formula (1):

$$E = W_p \times k_p + W_f \times k_f + W_c \times k_c, \qquad (1)$$

where E – energy value, kcal;

W_p – weight fraction of protein, g/100 g of canned food;

W_f – fat mass fraction, g/100 g of canned food;

W_c – mass fraction of carbohydrates, g/100 g of canned food;

k_p, k_c = 4 – energy value coefficients of 1 g of protein or carbohydrates in canned food, kcal/g;

k_f = 9 – energy value coefficient of 1 g of fat in canned food, kcal/g.

Indicators of nutritional value of the developed meat and vegetable preserves are presented in Table 2.

Journal of Chemistry and Technologies, 2025, *33*(3), 734-745

Table 2

Indicators of nutritional value of the developed meat and vegetable preserves

Indicators	Content, %				
	Sample № 0	Sample № 1	Sample № 2	Sample № 3	Sample № 4
Proteins	16.8±0.7	21.7±0.7	21.4±0.6	20.1±0.6	19.6±0.5
Fats	6.5±0.1	2.8±0.1	3.4±0.2	2.9±0.1	2.7±0.2
Carbohydrates	0.01±0.005	4.1±0.2	3.9±0.3	2.4±0.1	2.3±0.2
Energy value, kcal	125.7	128.4	131.8	116.1	111.9

Analyzing the Table 2 data, the control Sample (No. 0) contained 16.8 ± 0.7 % protein.

All experimental Samples (No. 1–4) demonstrated a notable increase in protein content, ranging from 19.6 ± 0.5 % to 21.7 ± 0.7 %.

The most significant increase was observed in Sample No. 1 (21.7 ± 0.7 %) and Sample No. 2 (21.4 ± 0.6 %), indicating the positive effect of peanut flour and sunflower seed meal.

The control sample had a fat content of 6.5 ± 0.1 %, whereas in all experimental samples the fat content was lower (from 2.7 ± 0.2 % to 3.4 ± 0.2 %).

Despite the reduction in total fat content, the fats derived from plant components (especially from sunflower seeds and peanuts) are rich in unsaturated and essential fatty acids, which improve the lipid profile of the product.

The carbohydrate content increased in all experimental samples compared to the control (0.01 ± 0.005 %), with values ranging from 2.3 % to 4.1 %.

This contributed to a slight increase in the energy value, especially in Samples No. 1 and 2, where values reached 128.4 and 131.8 kcal, respectively (vs. 125.7 kcal in the control).

The content of essential amino acids of meat and vegetable preserves was calculated using formula (2):

$$A_i = \sum_{j=1}^{n}(W_j \times a_{ij}), \quad (2)$$

where A_i – total content of the i-th essential amino acid in the final product, mg/100 g;
W_j – mass fraction of the *j*-th ingredient in the product, g/100 g;
a_{ij} – content of the i-th amino acid in the j-th ingredient, mg/100 g;
n – number of ingredients used in the product.

The content of essential amino acids in 100 g of meat and vegetable preserves is given in Table 3.

Table 3

Content of essential amino acids in 100 g of meat and vegetable preserves

Essential amino acid	Content, g/100 g				
	Sample № 0	Sample № 1	Sample № 2	Sample № 3	Sample № 4
Thr	0.66±0.03	0.68±0.03	0.71±0.04	0.73±0.04	0.77±0.04
Val	0.65±0.03	1.01±0.05	1.06±0.05	1.07±0.05	1.14±0.06
Met	0.50±0.03	0.49±0.02	0.51±0.03	0.51±0.03	0.54±0.03
Ile	0.52±0.03	0.74±0.04	0.78±0.04	0.80±0.04	0.83±0.04
Leu	1.06±0.05	1.35±0.07	1.40±0.07	1.42±0.07	1.51±0.08
His	0.36±0.02	0.41±0.02	0.43±0.02	0.43±0.02	0.45±0.03
Phe	0.56±0.03	0.82±0.04	0.86±0.04	0.87±0.04	0.90±0.05
Trp	0.19±0.01	0.17±0.01	0.18±0.01	0.18±0.01	0.19±0.01
Lys	1.19±0.06	1.69±0.07	1.74±0.09	1.76±0.09	1.89±0.09

Amino acid score of meat and vegetable preserves was calculated using formula (3):

$$AAS = \frac{AA_x}{AA_r} \times 100, \quad (3)$$

where AAS – amino acid score, %;
AA_x – amino acid content in the preserves test sample, mg/g protein;
AA_r – amino acid content in the reference protein, mg/g protein.

The results of calculating the amino acid score of meat and vegetable preserves are shown in Figure 4.

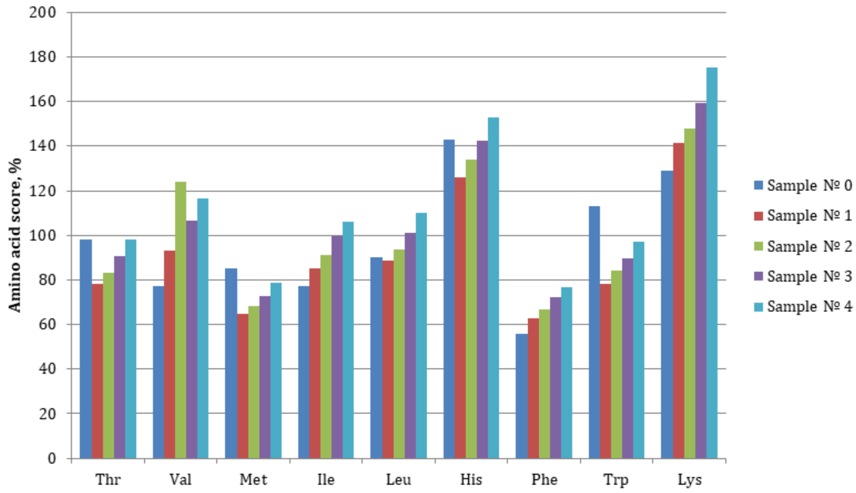


Fig. 4. Amino acid score of meat and vegetable preserves

The results show that the introduction of plant raw materials contributed to the enrichment of the product with a protein component, respectively, with an increase in the content of essential amino acids, and a fat component, with an increase in the content of essential fatty acids, taking into account the chemical composition of the added plant raw materials.

The content of fatty acids of meat and vegetable preserves was calculated using formula (4):

$$FA_i = \sum_{j=1}^{n}(F_j \times f_{ij}), \qquad (4)$$

where FA_i – content of the *i*-th fatty acid in the final product, mg/100 g;

F_j – fat content of the *j*-th ingredient in the product, g/100 g;

f_{ij} – content of the *i*-th fatty acid in the fat of the *j*-th ingredient, mg/100 g;

n – number of ingredients used in the product.

The fatty acid composition is given in Table 4.

Table 4

Content of fatty acids in 100 g of meat and vegetable preserves

Name of acid	Fatty acid	Content, mg/100 g				
		Sample № 0	Sample № 1	Sample № 2	Sample № 3	Sample № 4
Saturated fatty acids						
Lauric	C 12:0	6	16	7	10	8
Myristic	C 14:0	3	79	3	11	7
Palmitic	C 16:0	87	386	434	429	338
Stearic	C 18:0	37	125	290	121	78
Monounsaturated fatty acids						
Palmitoleic	C 16:1	13	27	28	39	31
Oleic	C 18:1	918	1276	1317	1159	1284
Polyunsaturated fatty acids						
Linoleic	C 18:2	667	1126	1643	586	867
Linolenic	C 18:3	39	55	74	423	156

Experimental part

White lupine flour, peanut flour, rape seed extraction cake and sunflower seed extraction cake were used as vegetable raw materials for production of meat and vegetable preserves.

Taking into account the chemical composition and properties of the selected raw materials, we developed recipes for canned meat and vegetables, which are presented in Table 5.

Table 5

Recipes of meat and vegetable preserves

Name of ingredient	Content, g/100 g			
	Sample № 1	Sample № 2	Sample № 3	Sample № 4
Chicken fillet	66.0	66.0	66.0	71.0
Fresh carrots	4.0	4.0	4.0	4.0
Fresh onions	3.0	3.0	3.0	3.0
Peanut flour	10.0	-	-	-

Journal of Chemistry and Technologies, 2025, *33*(3), 734-745

Sunflower seed meal	-	10.0	-	-
White lupine flour	-	-	10.0	-
Rape seed meal	-	-	-	5.0
Bay leaf	0.02	0.02	0.02	0.02
Table salt	1.0	1.0	1.0	1.0
Water	16.0	16.0	16.0	16.0

The technology of production of meat and vegetable preserves using the stand and the necessary equipment involves the following technological operations:

1) Preparation of raw materials according to the recipes (Table 5) and containers (glass jars with a volume of 0.5 liters);

2) Grinding of prepared raw materials and screening of powdered components through laboratory sieves to 0.1 mm fraction;

3) Mixing pre-sieved raw materials with water;

4) Loading the prepared raw materials into glass jars and closing them with a lid;

5) Laying cans in electric enclosures and pouring water according to the instructions;

6) Hermetic closure of the cover of the electric autoclave, connection of the opera thermometer, the pressure sensor to the programmable logic controller (PLC) and pumping the preliminary pressure into the 1 Bar electric autoclave;

7) Connecting power wires, turning on a personal computer (PC) and PLC power;

8) Configuration on the PC of the Supervisory Control and Data Acquisition (SCADA) application;

9) Selecting the desired program on the microprocessor and executing it using a switch with a sterilization temperature of 110 ^{0}C and a holding time of 20 min;

10) Autoclave cooling at room temperature;

11) Unloading of ready meat and vegetable preserves, labeling and storage at a temperature of 0 °C to 20 °C at a relative humidity of not higher than 75%.

The stand and equipment used in the production of meat and vegetable preserves in the laboratory of Sumy National Agrarian University [42] are shown in Figure 5.

The heating time of the electric autoclave before reaching the specified temperature value was 51 minutes.

The exposure time according to the program selection lasted 20 minutes. Control of the parameters of the canned food sterilization process was carried out using the SCADA program, as shown in Figure 6 a,b.

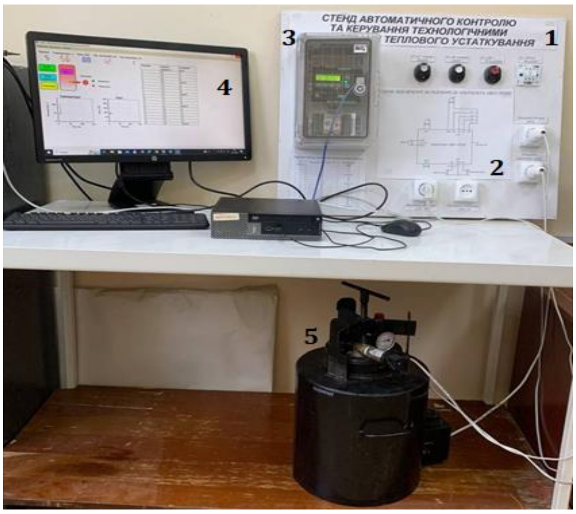
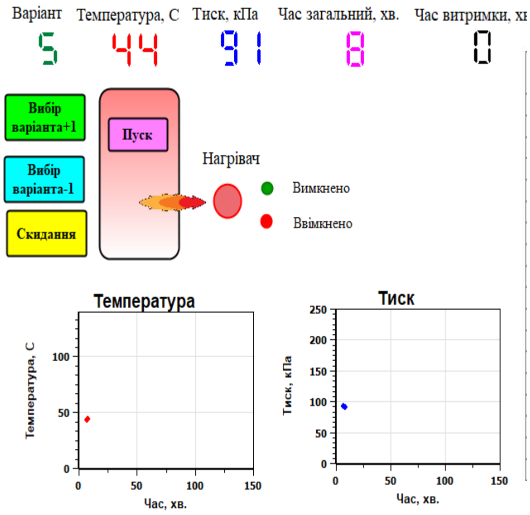


Fig. 5. General view of the stand with auxiliary equipment:
1) "Stand for automatic monitoring and control of process parameters of thermal equipment"; 2) block diagram of equipment connection to OWEN PR200; 3) PLC OWEN PR200; 4) SCADA; 5) low-power electric enclosures

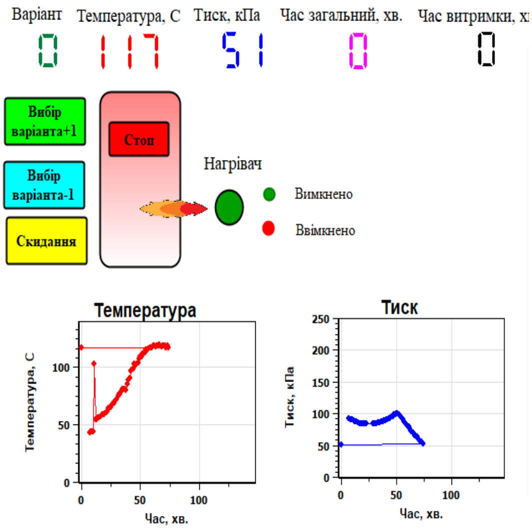
During the sterilization process of canned products, the temperature parameter exhibited fluctuations, which were observed throughout the technological cycle. These variations in temperature are inherent to the dynamics of heat transfer within the cans, influencing both the efficiency of microbial inactivation and the preservation of product quality. PLC turned off the power of the heating element as soon as the set temperature reached 110 °C, but the temperature continued to rise to 120 °C for 19 minutes. This temperature increase is directly related to the high inertia of the electric autoclave and the thermal processes in it.

Journal of Chemistry and Technologies, 2025, *33*(3), 734-745



a

Fig. 6a. Control of technological parameters of sterilization of canned meat and vegetable in SCADA: at the beginning of activation of the selected program



b

Fig. 6b. Control of technological parameters of sterilization of canned meat and vegetable in SCADA: b) after program execution

The duration of the sterilization process depends on the experimentally obtained graph of pressure (blue), temperature (red), total duration of the technological process (green) and duration of exposure (purple), as shown in Figure 7.

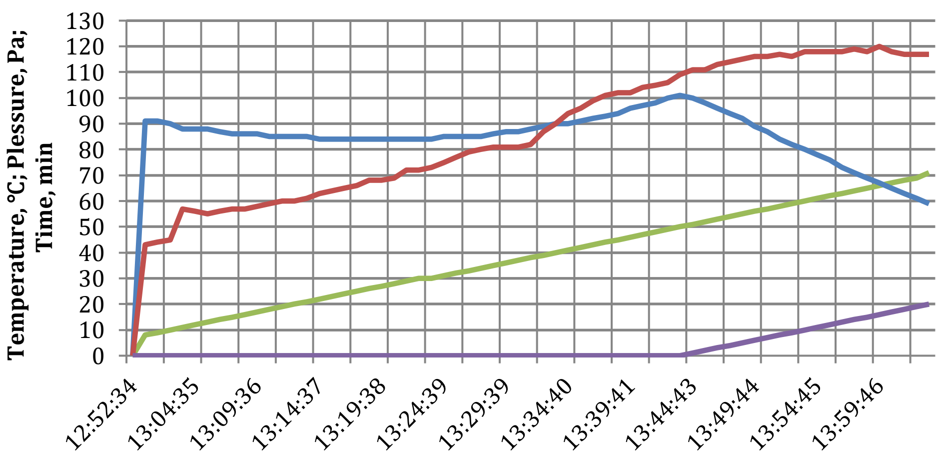


Fig. 7. Dependence graph of technological parameters of sterilization of meat and vegetable preserves

During the sterilization process of canned products, the temperature parameter exhibited fluctuations, which were observed throughout the technological cycle. These variations in temperature are inherent to the dynamics of heat transfer within the cans, influencing both the efficiency of microbial inactivation and the preservation of product quality. PLC turned off the power of the heating element as soon as the set temperature reached 110 ℃, but the temperature continued to rise to 120 ℃ for 19 minutes. This temperature increase is directly related to the high inertia of the electric autoclave and the thermal processes in it.

The content of basic nutrients in the finished samples of meat and vegetable preserves was determined in accordance with DSTU 4443:2005. Sensory analysis and evaluation were performed on the entire contents of the sealed jars. In assessing the appearance of the canned products, attention was given to color, surface characteristics, shape, and the quality of product arrangement. Consistency was evaluated by cutting and pressing, taking into account parameters such as tenderness, uniformity, elasticity, density, juiciness, and the presence of coarse fragments.

Taste evaluation involved placing a 3–10 g portion of the product in the oral cavity for up to 30 seconds. A trained expert panel comprising five members conducted the descriptive sensory profiling. Prior to evaluation, the panelists were familiarized with standardized sensory terminology and evaluation protocols.

All experimental investigations were carried out in triplicate to ensure repeatability. The data obtained were expressed in units of the International System of Units (SI). Statistical analysis of the results was performed using standard methods with the MS Office XP Professional software suite, specifically Microsoft Office Excel.

Conclusions

At the laboratory of Sumy National Agrarian University, a novel method for the production of meat and vegetable preserves was developed for the first time using an automated experimental setup and a low-capacity electric autoclave equipped with a programmable logic controller (PLC) and SCADA system.

Formulations of meat and vegetable preserves were designed with the incorporation of 5 % rape seed meal, 10% sunflower seed meal, as well as peanut and lupine flour. Based on the outcomes of sensory analysis, the inclusion of alternative plant-based components in the formulation of meat and vegetable preserves represents a promising strategy for enhancing product quality and expanding the assortment of innovative, functionally oriented food products.

For the canning process, a sterilization program with a set temperature of 110 °C and a holding time of 20 minutes was selected. The technological parameters of the sterilization process were continuously monitored using the SCADA system throughout production.

The incorporation of plant-derived raw materials positively influenced the sensory profile of the developed meat and vegetable preserves. The sensory attributes of the products were found to comply with the requirements of the regulatory documentation and demonstrated high quality indicators based on expert evaluation.

The incorporation of plant-based ingredients into the formulation of meat and vegetable preserves contributed to a significant improvement in their nutritional profile. In particular, the addition of rape seed meal, sunflower seed meal, peanut flour, and lupine flour led to an increase in protein content, as well as an enhancement in the levels of essential amino acids and lipids, including essential fatty acids, consistent with the chemical composition of the incorporated plant components.

The control sample (Sample No. 0) contained 16.8 ± 0.7 % protein. In contrast, all experimental samples (Samples No. 1–4) exhibited a notable increase in protein content, ranging from 19.6 ± 0.5 % to 21.7 ± 0.7 %. The highest protein levels were observed in Sample No. 1 (21.7 ± 0.7 %) and Sample No. 2 (21.4 ± 0.6 %), which contained peanut flour and sunflower seed meal, respectively, indicating the efficacy of these components in protein enrichment.

The fat content in the control sample was 6.5 ± 0.1 %, while the experimental samples demonstrated lower values, ranging from 2.7 ± 0.2 % to 3.4 ± 0.2 %. Despite this reduction, the inclusion of fats from plant sources, particularly sunflower seeds and peanuts, is nutritionally advantageous due to their high content of unsaturated and essential fatty acids, thereby contributing to an improved lipid profile of the final product.

Additionally, the carbohydrate content in the experimental samples increased compared to the control (0.01 ± 0.005 %), with values ranging from 2.3 % to 4.1 %. This increase in carbohydrate content led to a slight elevation in energy value, particularly in Samples No. 1 and 2, which reached 128.4 and 131.8 kcal, respectively, compared to 125.7 kcal in the control sample.

Overall, the results indicate that the strategic use of plant-derived components in meat preserves can effectively enhance their nutritional value and contribute to the development of functionally enriched food products.

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