Представлено дослідження оптимізації процесу стерилізації м'ясних консервів з використанням м'яса курчат-бройлерів, перепелів та гідроколоїдів у залежності від фізико-хімічних та органолептичних показників. Розглянуто особливості застосування м'яса перепелів у рецептурах м'ясних консервів з м'яса птиці із застосуванням гідроколоїдів. Проведено порівняння впливу процесу стерилізації на показники м'яса курчат-бройлерів та перепелів

Ключові слова: м'ясо птиці, формула стерилізації, гідроколоїди, м'ясо перепелів, м'ясо курчат-бройлерів

Представлено исследование оптимизации процесса стерилизации мясных консервов с использованием мяса цыплят-бройлеров, перепелов и гидроколлоидов в зависимости от физико-химических и органолептических показателей. Рассмотрены особенности применения мяса перепелов в рецептурах мясных консервов из мяса птицы с применением гидроколлоидов. Проведено сравнение влияния процесса стерилизации на показатели мяса цыплят-бройлеров и перепелов

Ключевые слова: мясо птицы, формула стерилизации, гидроколлоиды, мясо перепелов, мясо цыплят-бройлеров

UDC 637.5
DOI: 10.15587/1729-4061.2017.108665

OPTIMIZATION OF THE CANNED POULTRY MEAT STERILIZATION FORMULA WITH HYDROCOLLOIDS

V. Pasichnyi
Doctor of Technical Sciences, Professor*
E-mail: pasww1@ukr.net

A. Ukrainets
Doctor of Technical Sciences, Professor, Rector**
E-mail: info@nuft.edu.ua

D. Shvedyuk
Postgraduate student**
E-mail: shvedyuk.d@ukr.net

Al-Hashimi Haider Muhamed
Postgraduate student*
E-mail: alhashimi3030@gmail.com

Y. Matsuk
PhD, Associate Professor
Departament of Food Technology productions
Poltava University of Economics and trade
Koval str., 3, Poltava, Ukraine, 36014

*Departament of meat and meat products technology***
Problematic scientific research laboratory*
***National University of Food Technologies
Volodymyrska str., 68, Kyiv, Ukraine, 01601

1. Introduction

In modern conditions, the use of hydrocolloids in the meat industry is one of the promising directions for increasing the functional and technological properties of meat and meat products, including poultry meat of an extended shelf life. In accordance with the minimum specifications of the quality of products of animal origin, canned poultry meat must comply with a number of specific requirements regarding functional, technological, physicochemical and organoleptic properties. In addition to achieving high organoleptic and physicochemical parameters of canned poultry meat, it remains important to ensure the complete sterility of this type of canned food, which determines the microbiological safety in consumption.

The search for optimal sterilization modes and the selection of canned meat recipes are achieved by using new types of raw materials and nutritional supplements and working out sterilization formula for new types of canned meat.

The mode of sterilizing canned poultry meat should both ensure the microbiological safety of the product and maintain the highest possible organoleptic parameters. From this point of view, it is particularly relevant to work out a formula for sterilizing new types of canned food with poultry meat.

As raw material in canned meat recipes, poultry meat is used without removing bones, except tubular of some types of poultry. The use of too mild sterilization regimes for poultry-based species does not tenderize the bones, which can pose a danger to the consumer in the presence of sharp edges in them when breaking poultry meat into pieces. During the sterilizing process at more time-consuming and higher sterilization temperatures, besides the high energy consumption of the process, the organoleptic characteristics of the canned foods deteriorate. The meat loses color, its structure becomes too loose, and the proportion of jelly increases, which is not desirable.

The use of hydrocolloids is promising in order to improve the consistency of the product and increase the jelly preservative capacity in canned meat. The use of hydrocolloids improves the organoleptic characteristics and density of the product in the container and reduces the diffusion of nutrients that can pass from the meat raw material to the jelly.

2. Literature review and problem statement

The problem of improving the quality and safety of canned meat is an urgent task for the industry.

According to research results of the residual microflora in poultry meat products, it has been found that some microorganisms, such as Salmonella bacteria, do not require high-temperature treatment. The pasteurization regime with a gradual increase in temperature with a total duration of at least 80 minutes at a temperature of 70 to 85 °C [1] is effective. Other species and strains of microorganisms that are present in meat products require more rigid heat treatment modes [2] because they have high resistance to inactivation, including the action of antibiotics [3]. For example, some types of staphylococci, dysentery agents, and pseudomonads maintain their ability to replicate and function normally at freezing temperatures. This requires careful microbiological control not only of ready-made poultry meat products but also of raw materials for producing the latter [4].

A large number of researchers, under a comparative analysis of various methods of disinfection of poultry meat, have come to the conclusion that autoclaving is one of the most appropriate methods of treatment [5].

The problem of preventing anthroposonotic diseases, such as Newcastle disease, avian influenza and seeding of raw materials by bacteria of the clostridium genus, is also highly important. Studies have determined that for the effective inactivation of pathogens of these diseases, the minimum required duration of treatment is 60 minutes at 110 °C [6].

The positive effect of using hydrocolloids in the technology of poultry meat products has been proved by a number of studies [7, 8]. Thus, scientists have shown a positive influence on the color, texture, and volume of sausage products from poultry meat if the recipes of the products contain or meat is injected with brine comprising a 1–3 % share of hydrocolloids as to the mass of the raw materials [7, 8]. A number of studies have examined the use of alginates based on poultry meat, which, on average, can increase the yield of canned foods by 5–8 % due to the replacement of 5–10 % of the meat raw material with the alginate-base gel [9, 10]. The peculiarity of using alginates is the stability of the gels in the presence of calcium (and the possibility of using calcium alginate itself), while carrageenans are sensitive to the presence of calcium ions in the product medium [10].

A positive result was obtained while researching the effect of heat treatment on the combination of various types of gums and carrageenans. The gels on their basis in the process of treatment exhibit physical and chemical properties close to the values of the corresponding properties in poultry meat and are stable in the presence of food phosphates and plant proteins [11, 12]. These data produce the conclusion that it is advisable to combine several types of hydrocolloids to create a functional composition that will be optimal when used in canned poultry meat.

It is also worth noting the functional and technological properties of hydrocolloids. Despite the fact that polysaccharides, of which hydrocolloids are formed, are ballast substances, they are positively influenced by intestinal peristalsis in the process of digestion and assimilation by the human body [13]. They also lower the level of cholesterol in the blood and contribute to the formation of some fatty acids under the action of enzymes in the gastrointestinal tract [12, 14, 15].

3. The aim and objectives of the study

The aim of the research is to develop new formulations of canned poultry meat foods using hydrocolloids and to establish optimal modes of sterilization of preserved foods based on the recipes developed to ensure that the preserved products meet the safety and quality requirements for this type of food.

To achieve this goal, it is necessary to solve the following tasks:

– to determine the effect on organoleptic, functional and technological and physicochemical parameters of canned quail meat with the use of hydrocolloids in the composition of the canning brine compared with the characteristics of canned meat from broiler chickens;

– to determine the rational sterilization formula for canned quail meat, which will provide industrial sterility and high organoleptic characteristics of the canned product;

– to study the rheological, functional and technological characteristics of the gel (jelly) formed in canned poultry meat under different conditions of sterilization on the physicochemical parameters.

4. Materials and methods of researching canned meat

In the course of the research, wings of broiler chickens of the trademark Nasha Ryaba (Ukraine) and quail meat of industrial cultivation were used as the main raw materials. The meat was used in the form of whole carcasses without cutting into parts. This raw material was used without separating (meat from the bones) and was put directly into glass cans with a capacity of 500 ml at the stage of preparing the canned meat recipe.

The raw materials and additives used were the kitchen rock salt of grade 1 of grinding No. 1, produced by the State Enterprise Artemsil (Ukraine), raw chopped carrot Carotele, and the bay leaf. In addition, the composition of the filling brine consisted of mixtures of the food compositions of the trade mark Nasha, according to TU U 15.8-02070938-037-2003, produced by the PE Nasha in Zhovkva, Lviv Oblast (Ukraine), namely, Nasha CMs No. 393 and No. 269. According to the specifications, the compositional food mixtures include vegetable proteins, k-carrageenan, guar and xanthan gums, food phosphates, and sodium ascorbinate.

More detailed methods used for the study of canned meat are given in [16].

5. The influence of the mixture contents and variations of the sterilization regime on the parameters of the canned poultry meat

The physicochemical characteristics of the first variant of sterilization are shown in Table 1.

Table 1

Physicochemical parameters for the first variant of sterilization (recommended regimes according to TU U 15.1-02070938-054:2005 for broiler chicken meat)

Properties	Recipe variants of experimental samples of canned food		
	Reference	Sample 1	Sample 2
Salt content in the jelly, %	1.69	1.49	1.54
Salt content in the meat, %	1.33	1.42	1.35
WBP of the meat, %	92.46	69.28	76.15
Plasticity, cm^2/g	4.428	4.702	6.256

The evaluation of the organoleptic parameters of the canned product sterilized by variant 1 has revealed high organoleptic parameters in the reference sample. The meat in the reference was well separated from the jelly; its consistency was quite soft and juicy, whereas the meat and the jelly had pleasant taste and color. The jelly in the reference had a high density. Sample 1 of the canned meat had somewhat worse properties than the reference. The jelly in sample 1 was less dense, and the meat had a denser consistency. The taste and smell of the product were less distinct than in the reference. The organoleptic characteristics of sample 2 (canned quail meat) were considerably inferior to the reference. The meat was insufficiently tenderized, and it was dense with the inclusion of untenderized small bones, which could pose a danger to the consumer.

According to the microbiological parameters, all the samples conformed to the standards for industrial sterility, which are given in Table 2.

Table 2

Parameters of industrial sterility of the canned meat

Spore-forming microorganisms of the Bacillus group	Not allowed	Not detected (for all the samples)	GOST 30425-97
Mesophilic clostridia in addition to Cl. botulinum, Cl. Perfringens, in 1 g	Not more than 1 cl.	Not detected (for all the samples)	GOST 30425-97

The difference between the physicochemical parameters of the canned product was not significant except for the value of the water-binding power (WBP).

From the data of Table 2, it can be concluded that the used variant 1 of the sterilization formula (20–90–20/115 °C) is sufficient to ensure the commercial sterility of cans with a capacity of 500 ml. However, this sterilization regime is not suitable for the production of canned food using quail meat. The samples did not achieve a sufficient effect in terms of tenderizing the meat and small bones present in it.

Sterilization in variants 2, 3 and 4 [16] was carried out only for canned quail meat according to recipe 2 [16].

During sterilization at 120 °C for 90 minutes (variant 2), a significant improvement in the organoleptic and physicochemical properties was noted, but there was an insufficient level of tenderizing small bones of the quail meat.

Table 3

Parameters of sample 2 under different sterilization conditions

Parameter	Sterilization variant 2	Sterilization variant 3	Sterilization variant 4
Sterilization temperature, °C	120	115	120
Sterilization time, min	90	120	120
Salt content in the jelly, %	1.49	1.39	1.35
Salt content in the meat, %	1.31	1.33	1.22
WBP of the meat, %	63.5	64.3	55.65
Plasticity, cm²/g	6.418	6.616	7.031

The physicochemical parameters of the canned food have decreased significantly, which was especially noticeable by the example of the WBP value (63.5 % vs. 76.15 % for the first variant of sterilization). From the obtained results, it can be concluded that the regime of sterilization does not meet the declared requirements.

The properties of the canned products by the third variant of sterilization showed high organoleptic and physicochemical characteristics of the canned quail meat. The salt content was within the normal range and did not undergo significant changes, the plasticity of the product had increased, its consistency had become considerably more delicate, and the small bones could be chewed. The WBP value for the meat product was somewhat greater than the value obtained in the previous series of the experiments. We can conclude that this formula of sterilization ensures the achievement of the declared properties.

According to the fourth variant of sterilization with the maximum thermal exposure, canned meat with a low excessive plasticity of meat and with low organoleptic characteristics of meat and jelly was obtained. The jelly contained clots that did not melt and formed a heterogeneous structure.

The taste of the sterilized meat was poorly expressed. The physicochemical parameters of the canned product in the fourth variant of sterilization were worse than of the other variants of sterilization.

Fig. 1 shows the effect of the deformation rate on the value of effective viscosity of the jelly with different kinds of meat raw material.

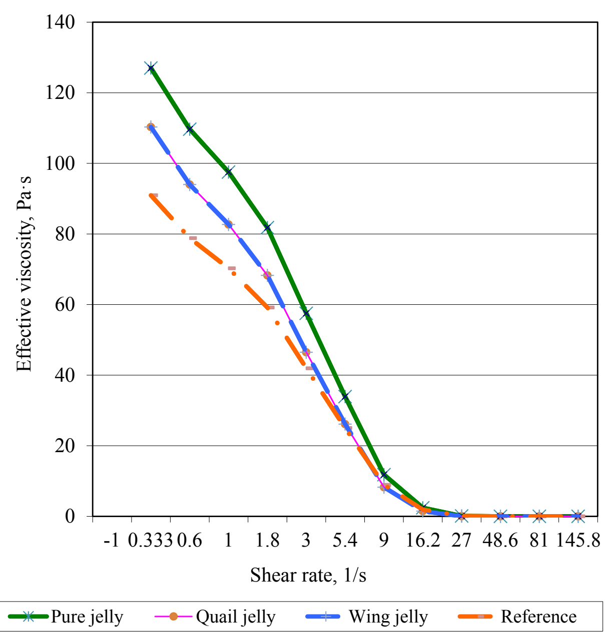

Fig. 1. Effective viscosity of the jelly samples according to the first variant of sterilization

The rheological characteristics of the canned jelly during sterilization under the first variant of sterilization (for 90 minutes at 115 °C) did not have significant differences for viscous characteristics (Fig. 1).

A significant difference in the properties was observed only between the jellies with the introduction of hydrocolloids and the jellies that included only the broth that was released by the meat raw material in the process of sterilization and spices.

The sample of the jelly that was sterilized without adding meat and vegetable raw materials had better rheological characteristics. The reference sample, which, on the contrary, did not have hydrocolloids but contained only the broth, showed the worst rheological characteristics among all the samples. This allows us to conclude that the main factor affecting viscosity characteristics of jellies is the presence of hydrocolloids in their composition as the main jelly formation component of canned poultry meat.

Fig. 2 shows the change in the strain shift of the jellies with different kinds of meat raw material depending on the shear rate.

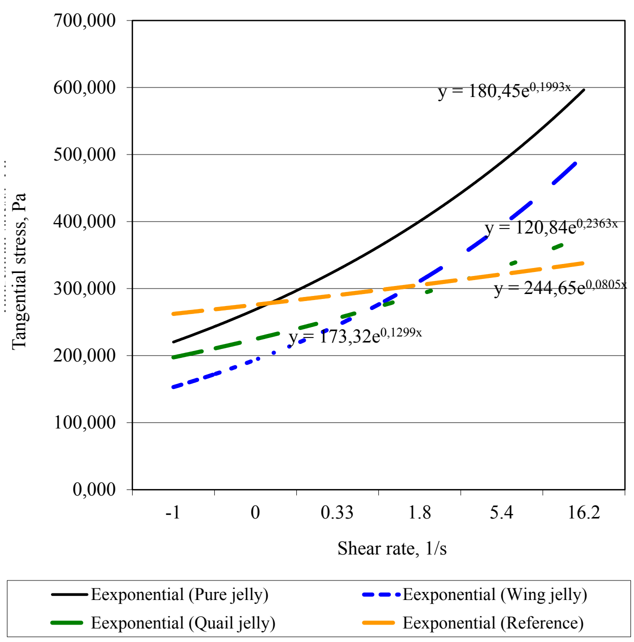

Fig. 2. The tangential stress of the jelly samples sterilized according to the first variant

The physical characteristics of the jellies underwent a significant variation due to changes in the time and temperature of sterilization. According to these characteristics, the experimental samples could be clearly divided into two groups: the first one with a shorter time of sterilization (90 minutes) and the second one with a longer sterilization time (120 minutes).

This makes it possible to conclude that the main factor influencing the temperature and time of melting the canned jellies with poultry meat is the time (duration) of sterilization.

The samples with longer time of sterilization (120 minutes) showed (Table 4) much higher melting points, had a darker color, a thicker consistency, and a longer melting time even at melting temperatures. Thus, the lowest melting point was observed for the jelly obtained from sample 2 by the first sterilization variant (sterilization for 90 minutes at 115 °C) and amounted to 82 °C, which is significantly different from that for the jelly that was produced by sterilizing at a temperature of 120 °C for 120 minutes (91 °C).

The melting time of all the samples also changed in direct proportion to the time of sterilization, and samples with longer sterilization times were stable at the temperature of 85 °C, which exceeded the melting temperatures of the jelly samples that were sterilized during a shorter time.

The maximum melting time at the melting point of 91 °C was 720 s for the sample by the third variant of sterilization, and the minimum was 600 s for the sample in the first variant of sterilization.

Thus, it is obvious that the use of hydrocolloids in combination with the meat broth in the process of sterilization makes it possible to form heat-resistant jellies with high rheological properties. In this case, the use of rigid sterilization regimes (variant 4) resulted in a deterioration of the organolepticity of the finished canned meat.

Table 4

Thermophysical characteristics of the jellies depending on the sterilization modes

Parameters	Variants for canning sterilization			
	Variant 1	Variant 2	Variant 3	Variant 4
Part of the separated moisture (at T=20 °C), %	14.8	12.4	9.1	7.9
Melting point, °C	82	84	89	91
Melting time, s, at the melting point, °C	600	570	680	720
Melting time, s, at 85 °C	240	430	–	–
Starting and finishing temperatures, °C	82–86	84–89	89–92	91–93

The difference between the initial and final melting temperatures also varied according to the change in the heat treatment modes. The intervals of this variation were not significant, and the average difference between the start and end temperatures was 2–7 °C. The fraction of the separated moisture is an important characteristic that makes it possible to form an idea about the effect of heat treatment on the ability of the substance to retain moisture. This is especially important in canned food because it allows predicting the effect of long-term storage at ambient temperature (10–20 °C) on the organoleptic characteristics of canned food. Typically, with the application of many types of hydrocolloids, the ability to retain moisture by a jelly drops sharply as a result of manifestation of the syneresis phenomenon in the long-term storage. This leads to a deterioration of the organoleptic characteristics of canned food and in some cases may increase the activity of water Aw, thus reducing the microbiological stability of canned food during storage.

The value of the fraction of separated moisture under different sterilization regimes varied significantly and depended on the time of the canned product sterilization.

The highest proportion of the selected moisture was recorded in the sample after the first variant of sterilization (with the least time and temperature of treatment) and was 14.8 %. Accordingly, the lowest moisture distribution during cooling was observed in samples under the fourth variant of sterilization and amounted to 7.9 %, which is almost twice less than the corresponding value of the samples of the first variant of sterilization.

6. Discussion of the results of the study of the effects of sterilization on the characteristics of jellies of canned poultry meat

Based on the research on the rheological and thermal characteristics of samples of canned meat jelly of quail meat and broiler chickens, we can draw conclusions about the thermal stability of the jelly system of canned products with the applied composite mixture of hydrocolloids and a positive impact of composite food mixtures on the organoleptic properties of canned poultry meat.

The rational selection of time and temperature of sterilizing canned meat with composite mixtures to improve jelly properties helps achieve unification of the product quality regardless of raw meat in the recipe for canning.

Jellies that are based on hydrocolloids that are combined with poultry broth exhibit higher performance than jellies that are based on broth only. However, it is necessary to take into account the thermal stability of hydrocolloids in terms of duration and time of sterilizing the canned product. They are caused by the deterioration of the organoleptic characteristics of the jelly (gel) due to the formation of clots and excessive compression of meat in the canned product.

The presented results prove the difference in the effect of the compositional mixtures of hydrocolloids on canned meat with different types of poultry meat in the recipes, which is characterized by changes in the rheological parameters of jellies during sterilization as well as changes in their physical and chemical parameters: temperature and melting time.

The obtained results allow predicting the change in the qualitative and quantitative characteristics of canned quail meat in varying the conditions of sterilization and the composition of the preserves recipes; the findings can contribute to the expansion of the range of canned products on the basis of poultry meat.

Further research entails determining the effect of sterilization conditions on the nutritional and biological values of the developed canned food with quail meat.

7. Conclusions

1. The study has revealed a significant difference of the influence on functional and technological parameters of canned quail meat produced by the use of mixtures of hydrocolloids in comparison with canned meat on the basis of broiler chickens, which is reflected in the change of the WBP values, plasticity and residual salt content in the jelly. Under changing conditions of sterilization, there happen changes in the physical and chemical characteristics of jellies, which correlate with the change in the organoleptic characteristics of the canned food.

2. To ensure high quality of canned poultry meat and to achieve industrial sterility, the sterilization regime for canned meat from chicken broilers should be provided for 500-ml containers with the sterilization time of no more than 90 minutes. For canned quail meat, the duration of the sterilization process must be increased to 120 minutes at 115 °C.

3. The research has proved the efficiency of using hydrocolloids in the technology of producing canned quail meat and the influence of the sterilization modes on the change of the physicochemical parameters of jellies in the composition of the canned products.

References

1. Silva, F. V. M. Thermal pasteurization requirements for the inactivation of Salmonella in foods [Text] / F. V. M. Silva, P. A. Gibbs // Food Research International. – 2012. – Vol. 45, Issue 2. – P. 695–699. doi: 10.1016/j.foodres.2011.06.018
2. Ruzauskas, M. Antimicrobial Resistance of Enterococcus SPP. Spread in Poultry Products in Lithuania [Text] / M. Ruzauskas, E. Suziedeliene, R. Siugzdiniene, V. Seputiene, J. Povilonis // Journal of Food Safety. – 2010. – Vol. 30, Issue 4. – P. 902–915. doi: 10.1111/j.1745-4565.2010.00249.x
3. Fadi Jamal Mohammad, A. L. H. Effect of Temperature preservation on Bacterial Survival of Poultry Meat [Text] / A. L. H. Fadi Jamal Mohammad, G. E. ElAzhari Mohammed. – Sudan University of Science and Technology, 2012. – 80 p. – Available at: http://repository.sustech.edu/handle/123456789/1654
4. Lee, J. J. Sterilization effects of avian influenza virus and newcastle disease virus in chicken muscle and organs dependent on autoclaving time [Text] / J. J. Lee, D. H. Kim, J. J. Lim, D. G. Kim et. al. // Korean Journal of Veterinary Public Health. – 2011. – Vol. 35, Issue 4. – P. 270–274. – Available at: http://agris.fao.org/agris-search/search.do?recordID=KR2012004468
5. Muhammad, J. Assessment Of Different Preservative Methods For Microbial Quality And Shelf Life Of Chicken Meat [Text] / J. Muhammad, U. Bacha, A. A. Anjum, A. A. Sheikh, A. Ahmad, F. Hussain, M. M. Salman // Journal of Infection and Molecular Biology. – 2015. – Vol. 1, Issue 3. – P. 38–40. – Available at: http://www.nexusacademicpublishers.com/journal/2
6. Mohammed, H. N. Study of some chemical, physical, sensory and bacteriology characteristics of canned chicken meat imported to Sulaymaniyah markets, Iraq [Text] / H. N. Mohammed // International Journal of nutrition and Metabolism. – 2013. – Vol. 5, Issue 7. – P. 128–133.
7. Bater, B. Quality Characteristics of Hydrocolloid-added Oven-Roasted Turkey Breasts [Text] / B. Bater, O. Descamps, A. J. Maurer // Journal of Food Science. – 1992. – Vol. 57, Issue 5. – P. 1068–1070. doi: 10.1111/j.1365-2621.1992.tb11265.x
8. Andres, S. The effect of whey protein concentrates and hydrocolloids on the texture and colour characteristics of chicken sausages [Text] / S. Andres, N. Zaritzky, A. Califano // International Journal of Food Science and Technology. – 2006. – Vol. 41, Issue 8. – P. 954–961. doi: 10.1111/j.1365-2621.2005.01152.x
9. Yastreba, Yu. A. Tekhnologiya myasnyh konservov s ispol'zovaniem al'ginata natriya [Text] / Yu. A. Yastreba, L. A. Polozhishnikova, V. N. Pasichniy // Naukovyi visnyk Lvivskoho natsionalnoho universytetu veterynarnoi medytsyny ta biotekhnolohyi im. Gzhytskoho. – 2015. – Vol. 17, Issue 4 (64). – P. 197–201.
10. Slipchenko, A. O. Zastosuvannia hidrokoloidiv u kharchovykh systemakh [Text] / A. O. Slipchenko, O. A. Shtonda // Naukovyi visnyk Lvivskoho natsionalnoho universytetu veterynarnoi medytsyny ta biotekhnolohiy im. Gzhytskoho. – 2012. – Vol. 14, Issue 2 (3). – P. 268–271.
11. Pasichnyi, V. M. Vykorystannia hidrokoloidiv u vyrobnytstvi konserviv z miasom ptytsi [Text] / V. M. Pasichnyi, P. M. Sabadash // Kharchova promyslovist. – 2005. – Issue 4. – P. 61–63.
12. Blinova, O. A. Vliyanie gidrokolloida na kachestvo sosisok vetchinno-rublenyh iz myasa ptitsy [Text] / O. A. Blinova // Agronomiya i zashchita rasteniy. – 2013. – Issue 4. – P. 65–69.

13. Industrial gums: polysaccharides and their derivatives [Text] / R. Whistler (Ed.). – Elsevier, 2012.
14. Pryanishnikov, V. V. Innovatsionnye tekhnologyi proizvodstva konservov iz myasa ptitsy [Text] / V. V. Pryanishnikov // Ptitsa i ptitseprodukty. – 2010. – Issue 5. – P. 21–22.
15. Semenova, A. Yu. Razrabotka retseptury i tekhnologyi funktsional'nogo produkta iz myasa ptitsy [Text] / A. Yu. Semenova, O. Yu. Petrov, V. L. Berdnikov // Vestnik Mariyskogo gosudarstvennogo universiteta. – 2015. – Issue 1. – P. 23–27.
16. Pasichnyi, V. Determination of the Optimal Sterilization Regime of Canned Quail Meat with Hydrocoloids Application [Text] / V. Pasichnyi, A. Ukrainets, D. Shvedyuk, H. M. Al-Hashimi, Y. Matsuk // EUREKA: Life Sciences. – 2017. – Issue 4. – P. 21–25. doi: 10.21303/2504-5695.2017.00379

UDC 664.023.061.3-048.34:66.021.3:004.94
DOI: 10.15587/1729-4061.2017.108843

DEVELOPMENT OF WAVE TECHNOLOGIES TO INTENSIFY HEAT AND MASS TRANSFER PROCESSES

O. Burdo
Doctor of Technical Sciences, Professor, Head of Department*
E-mail: burdo.onaft@gmail.com

V. Bandura
PhD, Associate Professor**
E-mail: bandura_3@ukr.net

A. Zykov
PhD, Associate professor*
E-mail: zav380@gmail.com

I. Zozulyak
PhD, Assistant**
E-mail: ihorzozulyak@gmail.com

J. Levtrinskaya
Postgraduate student*
E-mail: levtrinska@ukr.net

E. Marenchenko
Postgraduate student*
E-mail: marenchenco.onaft@gmail.com

*Department of processes, equipment and energy management
Odessa National Academy of Food Technologies
Kanatna str., 112, Odessa, Ukraine, 65039

**Department of Processes and equipment processing and food production named after Prof. P. S. Bernik
Vinnytsia National Agrarian University
Solniachna str., 3, Vinnytsia, Ukraine, 21008

Запропоновано технології адресної доставки енергії для інтенсифікації тепломасопереносу при переробці харчової сировини. У основі запропонованих гіпотез – хвильові технології комбінованої електромагнітної і вібраційної дії. Обгрунтовано механізми, ефекти і математичні моделі бародіффузії і дії вібраційних полів. Запропоновано числа хвильової подібності, на основі яких узагальнені бази експериментальних даних по екстрагуванню і сушінню. Наведено результати оптимізації мікрохвильового екстрактора

Ключові слова: харчові технології, адресна доставка енергії, інтенсифікація масопереносу, екстрагування, сушіння

Предложены технологии адресной доставки энергии для интенсификации тепломассопереноса при переработке пищевого сырья. В основе предложенных гипотез – волновые технологии комбинированного электромагнитного и вибрационного действия. Обоснованы механизмы, эффекты и математические модели бародиффузии и действия вибрационных полей. Предложены числа волнового подобия, на основе которых обобщены базы экспериментальных данных по экстрагированию и сушке. Приведены результаты оптимизации микроволнового экстрактора

Ключевые слова: пищевые технологии, адресная доставка энергии, микроволновые технологии интенсификация массопереноса, экстрагирование

1. Introduction

Providing mankind with energy resources is one of the key problems of the present time. This is especially true of food technologies, which are considered among the primary elements of consuming energy resources in economically developed countries [1, 2].

In the food industry, significant energy losses are observed when water is transferred to steam in drying processes. Heat treatment often causes overheating and deterioration in the quality of the product. When drying fruit and vegetable raw materials, the effect of high temperatures destroys valuable components such as vitamins, antioxidants, and aromatic substances. As a result, there happen tangible losses of a significant