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POST-PACKAGE PASTEURIZATION OF PACKAGED WHOLE-MUSCLE PRODUCT

L. Vinnikova, doctor of techn. sciences, Professor, O. Synytsia, postgraduate student,
Odessa National Academy of Food Technologies, Odessa

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Abstract. The study considers a problem of repeated contamination of delicious products, ready for consumption. The aim of the work is to study the repeated thermal processing of a ready vacuum-packed whole-muscular meat product for inhibiting a surface microbiota.

Today it is urgent for the meat industry, because it influences safety and quality, and also limits a storage term of a product. After bringing a meat product to culinary readiness by thermal processing, it has an unessential amount of microbiota. Microorganisms, including pathogenic and conventionally pathogenic ones, fall on a product after its cooking at cutting, prepa-ration to package and at the package stage itself. Microbiological contamination of a ready meat product results in fast spoilage and is a serious problem for producers, because the microbiota growth shortens its storage life. In its turn, it results in a refuse of a consumer to buy this product and great economic losses for producers.

The study is directed on a possibility of solving a problem of contamination of a whole-muscular delicious meat product. The solution is in package of a ready product under vacuum and short-term heating at a high temperature.

The work is devoted to the complex study of an influence of repeated pasteurization on safety and quality of a product. There was studied an influence of the repeated thermal processing (post-pasteurization) on microbiological, physical-chemical and also organoleptic parameters of a delicious meat product.

The special attention is paid to an influence of post-pasteurization regimes on a microbiological condition of studied sam-ples. Studies of a total amount of microbiota and also the presence of sanitary-representative microorganisms were conducted.

It has been proven, that the use of post-pasteurization essentially inhibits a number of microorganisms, and also doesn't influence physical-chemical parameters outlook of a product and organoleptic characteristics.

Based on studying an influence of post-pasteurization, it has been established, that inhibition of a microbiota essentially influences safety and prolongs the storage term of a product.

Key words: post-pasteurization, thermal treatment, microbiota, delicious meat products, food safety, shelf life.

ПОСТПАКЕТНА ПАСТЕРИЗАЦІЯ УПАКОВАНОВОГО ЦІЛЬНОМ'ЯЗОВОГО ПРОДУКТУ

Віннікова Л.Г., д.т.н., професор, Синиця О.В., аспірант
Одеська національна академія харчових технологій, м. Одеса

Анотація. У роботі розглядається проблема повторної контамінації готових до вживання делікатесних м'ясних продуктів.

В даний час це актуально для м'ясної промисловості, оскільки, впливає на безпеку і якість, а також лімітує термін придатності продукту.

Після доведення м'ясного продукту до кулінарної готовності шляхом термічного оброблення, він має незначну кількість мікробіоти. Мікроорганізми, в тому числі патогенні і умовно патогенні, потрапляють на продукт після його приготування під час нарізання, підготовки до упаковки, а також на самій стадії упаковки. Мікробіологічне забруднення приготованого м'ясного продукту призводить до швидко-

го псування і є серйозною проблемою для виробників, так як зростання мікробіоти скорочує термін придатності продукту. У свою чергу це призводить до відмови споживачів купувати продукцію і великих економічних втрат для виробників.

У роботі представлена можливість вирішення проблеми контамінації цільном'язових делікатесних м'ясних продуктів. Рішення полягає в упаковці готового продукту під вакуумом і короткочасному нагріванні при високій температурі.

Робота присвячена комплексному дослідженню впливу повторної пастеризації на якість і безпеку продукту. Вивчався вплив повторного термічного оброблення (пост-пастеризації) на мікробіологічні, фізико-хімічні, а також органолептичні показники делікатесного м'ясного продукту.

Особливу увагу приділено впливу режимів пост-пастеризації на мікробіологічний стан досліджуваних зразків. Були проведені дослідження загальної кількості мікробіоти, а також наявності санітарно-показових мікроорганізмів.

Доведено, що використання пост-пастеризації істотно пригнічує кількість мікроорганізмів, а також не впливає на фізико-хімічні показники, зовнішній вигляд продукту і органолептичні характеристики.

На основі вивчення впливу пост-пастеризації, встановлено, що інгібування мікробіоти суттєво впливає на безпеку та продовжує термін зберігання продукту.

Ключові слова: пост-пастеризація, термічне оброблення, мікробіота, делікатесні м'ясні продукти, безпечність, термін зберігання.

Introduction. Problem formulation. Meat and meat products contain valuable nutritive substances for the human growth and health and are an important part of a ration. Because of a high food value, meat products are ones of most demanded for consumption. Unfortunately, meat products are fast-spoiling and subjected to microbiological contamination. Semination by microorganisms results in serious problems with safety and quality of a product, and also in economic losses for a producer [1–3].

A question of microbiological safety is important for the meat industry, because spoilage of meat products takes place mainly because of microorganisms [4]. Meat and meat products contain plenty of proteins, enough quantity of water and main nutritive substances with pH, favorable for the microbiota growth [5; 6]. As a result of the life activity of microorganisms, proteins and lipids in a meat product are subjected to denaturation, unfavorable changes of microbiological characteristics, worsening of taste characteristics takes place [2].

Microbiological contamination is the most important factor that determines safety of a meat product and limits its shelf life [1; 2]. Microorganisms can enter the product at any stage of the production process where their development depends on their species, the product and environmental conditions determining reproducibility of microorganisms [3–6].

When a meat product gets ready-to-eat after thermal treatment, it has an insignificant number of microorganisms [7; 8]. As regards mortality of the microbiota, thermal treatment used in the production of meat products is effective but it cannot prevent recontamination during its cutting and packaging [9; 10].

A microbiota that causes spoilage of meat and meat products is represented by such mechanisms as *Pseudomonas*, *Acinetobacter*, *Brochothrix thermosphacta*, *Moraxella*, *Enterobacter*, *Lactobacillus*, *Leuconostoc* and *Proteus*. As a rule, microorganisms that cause a fact that a product is spoiled, doesn't cause damage to a human, but at their great number can result in disorders of the work of the gastrointestinal tract [7].

The products packed after the boiling stage, are more prone to bacterial contamination. Contamination is mainly caused by growth of *Lactobacillus* and *Carnobacterium* which produce lactic acid and impart a sour-sweet odor [13].

For improving a microbiological condition and prolonging a storage term of meat products, it is possible to affect a product after cooking by inhibiting a surface microbiota that fell on a product after its cross contamination [8–11].

Whole-muscle gourmet meat products are made from the parts of slaughtered animal carcass subjected to salting and thermal treatment to the ready-to-eat condition [2]. These products are characterized by excellent taste, high nutritional value and are in high demand among consumers [12]. The whole-muscle meat products differ from other meat products in that they retain cellular structure of meat components during the production process, up to consumption [21].

The problem of re-contamination of gourmet meat products is extremely important as they are the non-encapsulated products mostly eaten without additional thermal treatment.

One of ways of improving a microbiological condition of a meat product and prolonging storage terms may be the use of repeated thermal processing of a vacuum-packed product [12–14].

Analysis of recent research and publications. In-package pasteurization of ready-to-eat products can be the final stage in destroying vegetative microbiota and be an effective method of preventing product spoilage [23].

Effect of thermal treatment and high pressure on ready-to-eat boiled sausages for inhibiting microbiota and extension of the product shelf life were studied in [24]. Samples of boiled sausages in a vacuum package were kept in a water bath at 80 °C for 15 min. after temperature in the product reached 75 °C. High pressure treatment was carried out at 600 MPa. Studies have shown that pasteurization and high-pressure processing can be used to increase the product safety and extend its shelf life. Studies have also shown that pasteurization is more effective than high-pressure treatment.

The results of studies in [25] demonstrate effectiveness of using thermal treatment to extend shelf life of Viennese sausages. For example, to extend shelf life up to 4 times, thermal treatment of ready-to-eat vacuum-packed sausages at a temperature of 80 °C for 20 min. was used. Studies on the use of thermal treatment of ready-to-eat sausage products were also carried out in [26]. The study results indicate effectiveness of pasteurization in relation to microbiological safety.

Possibility of extending shelf life of boiled sausages using repeated pasteurization was studied in [27]. To extend shelf life of boiled small sausages up to 72 days, repeated pasteurization at a temperature of 85–90 °C for 15–20 minutes was used.

The use of pasteurization of cooked chicken thighs individually packed in a vacuum bag was effective to reduce number of microorganisms including *Listeria innocua* [28].

In [29], vacuum packed sausages heat treated to a core temperature of 90 °C and 100 °C were edible for 9 days at a storage temperature of 31 °C.

Experiments with small sausages which were grilled, vacuum packed and then heated at 95 °C for 5 min. in a steam chamber were conducted in [30]. Repeated thermal treatment of packaged products substantially extended their shelf life. However, thermal treatment of sliced sausage in these conditions has destroyed the product structure.

Appearance of samples of baked and vacuum-packed turkey heated at 95 °C has changed, however the shelf life was 4 weeks longer than that of the control sample.

Studies of pasteurization of a ready-to-eat product that were carried out with samples having protective covering (encapsulation) have shown no organoleptic changes. However, there is a significant problem of repeated processing non-encapsulated meat products because of possibility of alteration of their appearance, structural and qualitative characteristics under long influence of heat [31].

It is clear from the literature analysis that the issue of thermal treatment of non-encapsulated whole-muscle meat gourmet has not been resolved.

The aim of the work is to estimate a possibility of inhibiting a surface microbiota of a ready delicious meat product, packed in vacuum by pasteurization, without changing organoleptic characteristics.

To achieve this objective, the following tasks were set:

- to experimentally determine rational temperature and time conditions of post-pasteurization;
- to determine safety and quality of the product after post-pasteurization based on microbiological, physical-chemical and organoleptic characteristics.

The studying procedure is based on the following generalized knowledge: an influence of thermal processing on microorganisms and also quality, structural-mechanical and organoleptic parameters of a product [2; 32; 33]; an influence of vacuum package on the microbiota life activity in a meat product [34; 35]; thermostable properties of packing films.

Materials and methods of research. Samples of smoked-boiled meat «Balyk vintage» of the highest sort were used in the study. All samples were produced at PE «GARMASH» (Ukraine, Odessa region). The samples were cooked of 100% meat of spine-lumbar muscles of pork semi-carcass.

All raw and ready materials, used in the study, corresponded to actual standards of Ukraine in the aspect of quality and safety.

Experiments. After bringing the product to culinary readiness, it was cooled to temperature 6–8 °C, cut in pieces of 100 g and packed under vacuum in multi-layer polymeric films with width 95 microns, produced by “Orved” (Italy). Package was realized on the vacuum-packing machine, produced by “Cryovac” (Switzerland).

The experimental samples, packed in vacuum, were subjected to post-pasteurization in the electric digester SVC-14, produced by Sammic S. L. (Spain). After post-pasteurization, the samples were cooled to temperature 6–8 °C and kept in the refrigerator Liebherr (Germany) at temperature 4 °C during the whole term.

Together with the experimental samples, subjected to post-pasteurization, balyk samples in a vacuum

package without post-pasteurization (control samples) were kept under equal conditions in the refrigerator.

All samples were kept in the refrigerator during 35 days.

The experimental studies were three- and fivefold repeated. The obtained results were presented in units of the international system SI [36; 37].

Results of the research and their discussion. During the study there were determined main microbiological, physical-chemical and organoleptic parameters of the experimental and control samples of whole-muscular delicious meat products.

Meat products of 100 g in a vacuum package were heated at temperature 90 °C during 1 min (sample 1), 2 min (sample 2) and 3 min (sample 3).

Table 1 presents the results of the total number of microorganisms (MAFAnM) in the control sample, and also the number of microorganisms in the experimental samples at 1 day of storage.

Table 1 – Index of the total number of mesophilic aerobic and facultative-anaerobic microorganisms at 1 day of storage

Parameter	Control	Sample 1.	Sample 2	Sample 3
MAFAnM, CFU in 1g	$2,0 \cdot 10^2$	$1,4 \cdot 10^2$	$9,5 \cdot 10^1$	< 10

Table 1 testifies that the use of pasteurization of the ready delicious meat product, packed in vacuum, essentially inhibits the microbiota.

There were studied the sanitary-representative microorganisms, such as sulfite-reducing clostridia, Salmonella, St. aureus, and also bacteria of the colon bacillus group. The results of these studies demonstrated that no listed microorganisms were found in the product.

The microbiological studies were conducted during the whole storage term in each 7 days.

During the storage process there was observed the intensive growth of microorganisms in the control sample, and at 28 day of storage the norm of MAFAnM was essentially exceeded [18].

The growth of microorganisms in experimental samples 1 and 2 was less intensive, but at 28 day it exceeded the norm of MAFAnM along with the control. During the storage process sample 3 had the inessential growth of the microbiota and even at 35 day didn't exceed the normative index of total semination.

The sanitary-representative microorganisms were not found during all 35 days of storage in the control and experimental samples.

The effect of thermal processing has the influence on all components of the meat product and can change its outlook and structure [15]. The aim of our work was to diminish the number of microorganisms without changing organoleptic indices of the product. At the same time the storage term of the product is determined by not only microbiological parameters, but also by organoleptic characteristics. The sour-milk bacteria, such as: Lactobacillus, Carnobacterium and Leuconostoc mainly dominate in the product, packed under vacuum. The presented bacteria produce acids: lactic, acetic and formic ones and influence the product taste [20].

The studies of the organoleptic parameters testify to the fact that post-pasteurization doesn't influence the outlook of the product and doesn't cause changes of its organoleptic parameters.

During the process of storage the control sample at 28 day had spoilage signs, namely the sour smell. Control sample 3 didn't have any outlook changes and also taste and smell ones, even at 35 day of storage.

The studies of pH and mass share of moisture demonstrated that post-pasteurization has no influence on the concentration of nitrogen ions and doesn't cause free moisture release from the product.

Conclusions:

1. Inhibition of the microbiota of the ready whole-muscular delicious meat product, packed in vacuum, has been proven.
2. It has been established, that post-pasteurization essentially improves the microbiological condition of the product.
3. Temperature-temporal regimes of repeated pasteurization don't cause changes of the product outlook.
4. It has been proven, that the product, subjected to post-pasteurization, has more storage term.

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