МРНТИ 65.59.31 https://doi.org/10.48184/2304-568X-2023-3-63-69

TRACEABILITY OF MEAT PRODUCTS WITH INCORPORATED FUNCTIONAL INGREDIENTS

*[1]T.K. KULAZHANOV , [1]L.K. BAIBOLOVA , [1]M.S. SERIKKYZY *,*
[2]D.K. BALEV , [2]D.B. VLAHOVA-VANGELOVA

([1]Almaty Technological University, Kazakhstan, 050012, Almaty, Tole bi str., 100
[2]University of Food Technologies, Bulgaria, 4002, Plovdiv, 26 Maritza blvd)
Corresponding author e-mail: mira.serikkyzy@mail.ru*

The demand for natural and functional food products is constantly increasing, driving the research on new ingredients and technologies to enhance the quality and safety of meat products. This literature review focuses on the application of new functional ingredients and traceability of meat products to ensure their quality. The study examines the surface treatment of meat with bioactive substances such as dihydroquercetin from Larix sibirica Ledeb, rosemary extract (Rosmarinus officinalis), and distilled rose petal extract (Rosa damescena Mill.). Additionally, the inclusion of functional ingredients such as dried goji berries (Lycium barbarum) and pumpkin (Cucurbita moschata) in meat matrices is discussed. The research highlights the potential benefits of these functional ingredients in inhibiting lipid oxidation, preserving color, and improving the taste qualities of meat products. The inclusion of natural antioxidants and bioactive compounds derived from plants presents a promising alternative to synthetic additives. Furthermore, the reduction of potentially harmful substances, such as nitrites, in meat products is achieved through the inclusion of functional ingredients. To ensure the quality and safety of these functionally processed meat products, a traceability system is proposed. This system includes documentation of ingredient origin, production processes, and packaging information. Implementing a traceability system enables the tracking of product movement and distribution throughout the supply chain, thereby confirming the positive effects of the ingredients and ensuring consumer trust. The aim of this article is to integrate new functional ingredients and implement a traceability system to enhance the quality, safety, and acceptability of meat products by consumers. These approaches align with the growing demand for natural and high-quality food products, opening opportunities for innovation in the meat industry. Funding information: The materials were prepared within the framework of the "Zhas Galym" project within the scientific and technical program AP15473123 "Digitalization of the traceability system of meat products to improve the quality of semi-smoked sausages during long-term storage" of the budget program 217 "Development of Science" subprogram 102 "Grant financing of scientific research" of the Ministry of Science and Higher Education of the Republic of Kazakhstan for 2022-2024.

Keywords: functional ingredients, meat products, quality, biologically active substances, traceability.

ПРОСЛЕЖИВАЕМОСТЬ КАЧЕСТВА МЯСНЫХ ПРОДУКТОВ С ИНКОРПОРИРОВАННЫМИ ФУНКЦИОНАЛЬНЫМИ ИНГРЕДИЕНТАМИ

[1]Т.К. КУЛАЖАНОВ, [1]Л.К. БАЙБОЛОВА, [1]М.С. СЕРИККЫЗЫ,*
[2]Д.К. БАЛЕВ, [2]Д.Б. ВЛАХОВА-ВАНГЕЛОВА

([1]Алматинский технологический университет, Казахстан, 050012, г.Алматы, Толе би 100
[2]Университет пищевых технологий, Болгария, 4002, г. Пловдив, бульвар Марица, 26)
Электронная почта автора корреспондента: mira.serikkyzy@mail.ru*

Спрос на натуральные и функциональные пищевые продукты постоянно растет, что побуждает к изучению новых ингредиентов и технологий для повышения качества и безопасности мясных продуктов. Этот обзор литературы посвящен применению новых функциональных ингредиентов и прослеживаемости мясных продуктов для обеспечения их качества. В исследовании изучалась обработка поверхности мяса биологически активными веществами, такими как дигидрокверцетин из Larix sibirica Ledeb, экстракт розмарина (Rosmarinus officinalis) и дистиллированный экстракт лепестков розы (Rosa damescena Mill.). Кроме того, обсуждается включение функциональных ингредиентов, таких как сушеные ягоды годжи (Lycium barbarum) и тыква (Cucurbita moschata), в мясные матрицы. Исследование подчеркивает потенциальные преимущества этих функциональных ингредиентов в ингибировании окисления липидов,

сохранении цвета и улучшении вкусовых качеств мясных продуктов. Включение природных антиоксидантов и биологически активных соединений, полученных из растений, является многообещающей альтернативой синтетическим добавкам. Кроме того, снижение содержания потенциально вредных веществ, таких как нитриты, в мясных продуктах достигается за счет включения функциональных ингредиентов. Для обеспечения качества и безопасности этих функционально обработанных мясных продуктов предлагается система прослеживаемости. Эта система включает в себя документирование происхождения ингредиентов, производственного процесса и информации об упаковке. Благодаря внедрению системы прослеживаемости становится возможным отслеживать перемещение и распределение продуктов по всей цепочке поставок, тем самым подтверждая положительный эффект ингредиентов и обеспечивая доверие потребителей. Целью данной статьи является интеграция новых функциональных ингредиентов и внедрение системы прослеживаемости, что способствует повышению качества, безопасности и приемлемости мясных продуктов потребителями,что. Эти подходы соответствуют растущему спросу на натуральные и высококачественные продукты питания, открывая возможности для инноваций в мясной промышленности.

Ключевые слова: функциональные ингредиенты, мясные продукты, качество, биологически активные вещества, прослеживаемость.

БІРІКТІРІЛГЕН ФУНКЦИОНАЛДЫ ИНГРЕДИЕНТТЕРІ БАР ЕТ ӨНІМДЕРІНІҢ САПАСЫН БАҚЫЛАУ

[1]Т.К. КУЛАЖАНОВ, [1]Л.К. БАЙБОЛОВА, [1]М.С. СЕРИККЫЗЫ,*
[2]Д.К. БАЛЕВ, [2]Д.Б. ВЛАХОВА-ВАНГЕЛОВА

([1]Алматы технологиялық университеті, 050012, Алматы қ., Төле би к-сі, 100
[2]Тағам технологиясы университеті, 4002, Пловдив қ., Марица бульвары, 26)
Автор-корреспонденттің электрондық поштасы: mira.serikkyzy@mail.ru*

Табиғи және функционалды тағамға сұраныс үнемі өсіп келеді, бұл ет өнімдерінің сапасы мен қауіпсіздігін жақсарту үшін жаңа ингредиенттер мен технологияларды зерттеуге итермелейді. Бұл әдебиеттерге шолу жаңа функционалды ингредиенттерді қолдануға және олардың сапасын қамтамасыз ету үшін ет өнімдерінің қадағалануына бағытталған. Зерттеу еттің бетін Larix sibirica Ledeb дигидрокверцетині, розмарин сығындысы (Rosmarinus officinalis) және тазартылған раушан жапырағы сығындысы (Rosa damescena Mill) сияқты биологиялық белсенді заттармен өңдеу қарастырылды зерттеді.). Сонымен қатар, ет матрицаларына кептірілген годжи жидектері (Lycium barbarum) және асқабақ (Cucurbita moschata) сияқты функционалды ингредиенттерді қосу талқыланады. Зерттеу осы функционалды ингредиенттердің липидтердің тотығуын тежеудегі, түсін сақтаудағы және ет өнімдерінің дәмін жақсартудағы әлеуетті артықшылықтарын көрсетеді. Өсімдіктерден алынған табиғи антиоксиданттар мен биоактивті қосылыстарды қосу синтетикалық қоспаларға перспективалы балама болып табылады. Сонымен қатар, ет өнімдеріндегі нитриттер сияқты ықтимал зиянды заттардың азаюына функционалды ингредиенттерді қосу арқылы қол жеткізіледі. Осы функционалды өңделген ет өнімдерінің сапасы мен қауіпсіздігін қамтамасыз ету үшін бақылау жүйесі ұсынылады. Бұл жүйе ингредиенттердің шығу тегін, өндіріс процесін және орау туралы ақпаратты құжаттауды қамтиды. Бақылау жүйесін енгізу арқылы өнімдердің бүкіл жеткізу тізбегі бойынша қозғалысы мен таралуын бақылауға болады, осылайша ингредиенттердің оң әсерін растайды және тұтынушылардың сенімін қамтамасыз етеді. Бұл мақаланың мақсаты-жаңа функционалды ингредиенттерді біріктіру және қадағалау жүйесін енгізу тұтынушылардың ет өнімдерінің сапасын, қауіпсіздігін және қолайлылығын арттыруға ықпал етеді. Бұл тәсілдер табиғи және жоғары сапалы азық-түлікке деген сұраныстың артуына сәйкес келеді, бұл ет өнеркәсібінде инновацияларға мүмкіндіктер ашады.

Негізгі сөздер: функционалды ингредиенттер, ет өнімдері, сапа, биологиялық белсенді заттар, бақылау.

Introduction

Recently, many products have emerged on the food market utilizing non-traditional raw materials, food additives, dietary supplements, and other components, the use of which enables the creation of products with new technological characteristics [1].

The demand for natural food products is increasing. At the same time, the industry is paying attention to the use of natural antioxidants

[2]. Synthetic antioxidants, which are used to inhibit lipid oxidation and enhance the quality and nutritional value of food products, are being replaced by naturally derived antioxidants.

The antioxidant and antibacterial properties of various plant extracts and preparations have been extensively studied, such as citrus extracts, tea catechins, and α-tocopherol, ethanolic extracts of rosemary (Rosmarinus officinalis), and others [3]. Furthermore, relatively new bioactive ingredients that are beneficial for human health have been discussed, including dihydroquercetin extracted from Siberian larch (Larix sibirica Ledeb), distilled extract of rosewood (Rosa damascena Mill.), dried fruits of goji berries (Lycium barbarum) and pumpkin (Cucurbita moschata), and pumpkin seed flour (Cucurbita pero L.), among others.

Another interesting by-product, which is a waste product during the production of Bulgarian rose oil and rose water, is distilled rose color extract. Distilled rose extract (Rosa Damascena Mill) possesses strong antioxidant properties as it is rich in flavonoids [4].

However, this category of products is not always flawless in terms of safety. Moreover, the abolition of mandatory certification of food products has led to a decrease in the number of products subject to safety and quality indicators control, which highlights the relevance of introducing new control schemes, one of which could be traceability.

The definition of traceability is provided in Technical Regulation 021/2011 "On Food Safety." Traceability of food products refers to the ability to establish, through documentation on paper or electronic media, the manufacturer and subsequent owners involved in the circulation of the food product, as well as the place of origin of the food product's raw materials [5]. In other words, traceability is the ability to trace the history of a product, including its production, movement, and current location.

The aim of this study is to summarize the application of new functional ingredients when incorporated into meat matrices, as well as to trace the quality of the resulting functional meat products.

Materials and research methods

Used Ingredients:

Natural antioxidants: Natural antioxidants used in the study included citrus extracts, tea catechins, α-tocopherol, ethanolic extracts of rosemary (Rosmarinus officinalis), and others.

Bioactive ingredients: Investigated bioactive ingredients included dihydroquercetin extracted from Siberian larch (Larix sibirica Ledeb), distilled extract of rosewood (Rosa damascena Mill.), dried fruits of goji berries (Lycium barbarum) and pumpkin (Cucurbita moschata), as well as pumpkin seed flour (Cucurbita pero L.) and other ingredients.

Meat matrices:

Specific meat matrices were selected for the study, such as minced meat or meat-based semi-finished products.

Research Methods:

Antioxidant properties evaluation: Specific methods were employed to measure the antioxidant activity in the ingredients and the resulting meat products, such as enzymatic or chemical analysis methods.

Product quality analysis: Organoleptic analysis was conducted, along with measurements of moisture, fat, protein content, as well as analysis of microbiological safety and the presence of pathogenic microorganisms according to relevant standards.

Statistical data analysis:

The obtained results were subjected to statistical analysis, including calculation of mean values, standard deviation, and hypothesis testing to determine the statistical significance of differences between samples.

Product traceability:

The implementation of a traceability system was carried out as part of the study. Documentation and the technological process was done on paper or electronic media.

Results and their discussion

Possibility of preserving meat quality through surface treatment with functional ingredients.

The potential of several bioactive components for improving the quality of chilled meat through surface treatment has been studied. This approach is relevant because the packaging used in recent years, such as modified atmosphere packaging (MAP) or vacuum packaging (VP), demonstrates quality deficiencies - rapid undesirable changes in meat color occur due to the oxidation of muscle pigments caused by the oxidation of muscle lipids.

Ivanov et al. (2010) investigated the effect of surface treatment of chilled beef (0+4°C) with a solution of taxifolin (1 g/L) on oxidative changes in the lipid fraction. According to the reported results, the combined use of taxifolin surface treatment and MAP effectively inhibits the formation and accumulation of secondary lipid oxidation products, with a reduction of 50-60% in hydroperoxide formation.

The antioxidant activity of dihydroquercetin solutions used for meat surface treatment has also been studied by Balev et al. (2010; 2011), Dragoev et al. (2014a; 2014b), and Staikov et al. (2013; 2015; 2016). The positive effect of surface introduction of dihydroquercetin solutions has been demonstrated through monitoring color changes (CIE L*, a*, b*) and lipid stability.

By combining modified atmosphere packaging and surface treatment with taxifolin, the attractive bright red color of beef can be maintained for up to 12 days of storage at 0°C (Balev et al., 2011). The quality of meat subjected to surface treatment can also be assessed based on lipid oxidation stability (oz) indicators (Staikov et al., 2015). Vacuum packaging of beef before surface treatment with natural antioxidant flavonol solutions significantly restores lipolytic processes (reducing AV by 26%) and lipid oxidation processes (reducing PV by 63%, conjugated dienes and trienes by 60% and 59%, respectively, and TBARS by 78%).

In the monitoring of the quality of surface-treated fish, Dragoev et al. (2014b) and Vlahova-Vangelova et al. (2022) found that bioactive components from distilled rose extract and dihydroquercetin successfully inhibit lipid oxidation and preserve the sensory characteristics of the meat.

Enhancing the quality and safety of meat products through the inclusion of functional ingredients.

Surface treatment is suitable for improving the quality of chilled meat. Another innovative approach in meat product production, such as meat and sausage products, is the formulation of meat product compositions to improve their oxidative stability (Abilmazhinova et al., 2020). Optimal levels of dihydroquercetin and L-ascorbic acid were determined through a full factorial experiment (Table 2). In quality monitoring, it was found that horse meat pulp exhibits the highest oxidative stability with the addition of 0.027-0.030% L-ascorbic acid and 0.024-0.035% dihydroquercetin.

In functional meat products, it is desirable, in addition to incorporating bioactive components, to reduce the content of substances that may have potential negative effects on consumer health. Nitrites are such potentially hazardous substances in cooked meat products. The addition of goji berries and pumpkin to meat cheesecake can partially reduce the nitrite content. In beef fillet quality control, these antioxidants stabilize the technological and sensory characteristics of the product (Serikkaisai et al., 2014).

Monitoring the color characteristics of sausages with added natural ingredients, such as dried goji berries, shows significant stabilization of color brightness, as observed dynamically (Bulambaeva et al., 2014). The inclusion of dried pumpkin in sausage formulations positively affects the stability of the red color component, which can be traced dynamically. The strong antioxidant activity of dried goji berries slows down the lipid oxidation process in the tested sausage samples (Vlahova-Vangelova et al., 2014).

The addition of bioactive components from goji berries, pumpkin, and rosewood (Rosa damascena) has been reported in the production of meat products (Table 2).

Monitoring the quality of sausages with reduced sodium nitrite content after 60 minutes of air exposure showed that rose petal extract successfully inhibits pigment oxidation (Balev et al., 2014). These results were confirmed by Kolev et al. (2022d) and Kolev & Balev (2022).

The addition of three investigated bioactive substances (sodium L-ascorbate, dihydroquercetin, and freeze-dried extract of dry distilled rose (Rosa damascena Mill.) petals) stabilizes the color and improves the sensory characteristics, enhancing the quality of low-fat cooked sausages. Based on the obtained results, an optimal three-component aperture was developed, containing: 0.100 g FDRPE; 0.091 g dihydroquercetin, and 0.100 g sodium L-ascorbate (Kolev et al., 2022).

Hydrolytic and oxidative changes in the lipid and protein fractions of a model sausage system with a 50% reduction in sodium nitrite content are slowed down by the inclusion of a three-component complex of bioactive substances (Kolev et al., 2022).

Abbreviations: Modified atmosphere packaging (MAP); Butylated hydroxytoluene (BHT); Peroxide value (PV); 2-thiobarbituric acid reactive substances (TBARS); Fatty acids methyl esters (FAMEs); Acid value (AV); Free amino nitrogen (FAN); Vacuum package (VP); Free fatty acids (FFA); Dry distilled rose petals extract (DDRPE). Abbreviations: Vacuum package (VP); Acid value (AV); Peroxide value (PV); 2-thiobarbituric acid reactive substances (TBARS); Free amino nitrogen (FAN); Rose petals extract (RPE); Freeze-dried distilled rose petals extract (FDRPE).

Table 1. Reported application of superficial treatment with functional ingredients used for preserving the quality of meat

Product	**Treatment**	**Storage**	**Evaluated parameters**	**Reference**
Chilled beef	Taxifolin solution (dihydroquercetin) - 1 g/l + MAP (80% O_2/ 20% CO_2)	18 days (0 – 4 °C)	PV; TBARS; FAMEs composition	Ivanov et al. (2010)
			Color characteristics and Sensory profile	Balev et al. (2011)
			AV; FAN and Microbiological status	Balev et al. (2010)
Chilled veal	Dihydroquercetin solution - 0.02%; BHT solution – 0.02% + MAP (80% O_2/ 20% CO_2)	8 days (0 ± 0.5 °C)	FAN; FFA; PV; TBARS; FAMEs composition and Microbiological status	Dragoev et al. (2014)[a]
			Conjugated dienes and trienes; Color characteristics and Sensory profile	Staykov et al. (2013)
Chilled beef m. *Semimembranosus*	Ternary antioxidant blend – Dihydroquercetin (10 g/l), Rosemary extracts (5 g/l) and L-ascorbic acid (1 g/l) + MAP (80% O_2/ 20% CO_2); VP	28 days (0 ± 0.5 °C)	AV; PV; TBARS; Conjugated dienes and trienes and FAMEs composition	Staykov et al. (2015)
			FAN; Color characteristics; Sensory profile and Microbiological status	Staykov et al. (2016)
Atlantic salmon (*Salmo salar)*	Dihydroquercetin solution - 1 g/l	11 days (0 ± 1 °C)	FFA; PV; TBARS and FAMEs composition	Dragoev et al. (2014)[b]
Paddlefish (*Polyodon spathula)*	DDRPE solution - 2 and 4%; L-ascorbic acid solution – 2%; Alginate coating with 2 and 4% DDRPE or 2% L-ascorbic acid	7 days (0 – 4 °C)	Color characteristics; Sensory profile; AV; PV and TBARS	Vlahova-Vangelova et al. (2022)

The traceability system is an important aspect of ensuring the safety and quality of meat products. In the context of this study, based on the use of functional ingredients and surface treatment, the following traceability system can be proposed:

Documenting the original ingredients:

Development of documentation specifying the initial ingredients used in the production of functional ingredients. This includes information about the origin of the ingredients, their quality and compliance with safety standards.

Documentation of the production process:

Formation of documentation describing the production process of functional ingredients and their use in the surface treatment of meat products. This documentation specifies the stages of production, processing conditions, time and temperature parameters, as well as quality control measures.

Marking and identification of packaging:

The packaging of meat products subjected to surface treatment using functional ingredients must be clearly identified and labeled. This includes information about the composition of the product, the date of manufacture, expiration date and storage method.

Traceability system:

Development of a traceability system that allows monitoring the movement and distribution of functionally processed meat products at all stages of the supply chain. Important elements of this system are accounting and labeling of batches of products, documentation on transportation and storage, as well as control measures to detect and respond to possible safety or quality problems.

Taking into account the data presented and the sources indicated, a traceability system can be developed and implemented to ensure the safety and quality of functionally processed meat products.

Table 2. Reported incorporation of functional ingredients in processing of meat products

Product	Treatment	Storage	Evaluated parameters	Reference
Minced horse meat	Dihydroquercetin - 0.01, 0.03 and 0.05%; L-ascorbic acid - 0.01, 0.03 and 0.05% + VP	2 days (0 – 4 ℃)	AV, PV, TBARS	Abilmazhinova et al. (2020)
Cooked and smoked beef striploin	Dried Goji Berry - 5 and 10 g/kg; Butternut Pumpkin powder - 5 and 10 g/kg + partial nitrites reduction	6 days (0 – 4 ℃)	FAN; Protein carbonyls; AV; TBARS; pH, Color characteristics and Sensory profile	Serikkaisai et al. (2014)
Cooked sausages Beef/ Horse/ Lamb – 50/20/20	Dried Goji Berry - 5 and 10 g/kg; Butternut Pumpkin powder - 5 and 10 g/kg + partial nitrites reduction	6 days (0 – 4 ℃)	Sensory profile; Color characteristics; FAN; Protein carbonyls; AV, TBARS and pH	Bulambaeva et al. (2014)
Cooked sausages Beef/ Pork - 50/ 50	Dried Goji Berry - 5 and 10 g/kg; butternut Pumpkin powder - 5 and 10 g/kg; RPE – 0.05 and 0.1% + partial nitrites reduction	6 days (0 – 4 ℃)	AV; TBARS; FAN and Protein carbonyls	Vlahova-Vangelova et al. (2014)
	RPE – 0.01, 0.03 and 0.05% + partial nitrites reduction	6 days (0 – 4 ℃)	pH; Sensory profile; Color characteristics and Dynamics of changes of color at exposure to air	Balev et al. (2014)
	FDRPE – 0.05 and 0.1 g/kg; Dihydroquercetin – 0.05 and 0.1 g/kg; Sodium L-ascorbate – 0.05 and 0.1 g/kg	7 days (0 – 4 ℃)	pH, PV, Microbiological status and Sensor profile	Kolev et al. (2022)[a]
			DDPH, FRAP, Color characteristics, TBARS, Protein carbonyls	Kolev et al. (2022)[b]
	Three-component antioxidant blend – FDRPE – 0.1 g/kg; Dihydroquercetin – 0.09 g/kg and Sodium L-ascorbate – 0.1 g/kg + partial nitrites reduction	7 days (0 – 4 ℃)	Residual nitrites; DPPH, FRAP, AV, PV, TBARS, FAN and Protein carbonyls	Kolev et al. (2022)[c]
			pH, Color characteristics, Microbiological status and Sensory profile	Kolev & Baleva (2022)
			Dynamics of changes of color at exposure to air	Kolev et al. (2022)[d]
Dry fermented sausages Beef/ Pork – 60/ 40	DDRPE - 1.140 and 2.280 g/kg + partial nitrate reduction	18 days of processing (10 – 12 ℃)	Color characteristics; pH; AV; PV, TBARS an Sensory profile	Balev et al. (2022)

Conclusion

In conclusion, the studies discussed in this material provide insights into the application of new biologically active components in meat matrices and the surface treatment of chilled meat to enhance product quality. The inclusion of natural antioxidants and bioactive ingredients derived from plants has shown promising results in inhibiting lipid oxidation and preserving the color, flavor, and nutritional value of meat products.

In addition, innovative technological approaches, such as modifying the composition of low-tonnage sausages by incorporating dried fruits or extracts and reducing nitrite content, have been investigated. These approaches aim to improve the functional characteristics of meat products while addressing potential safety concerns associated with certain additives.

The implementation of a traceability system emerges as a crucial aspect of ensuring the quality and safety of functionally processed meat products. By documenting the origin of ingredients, production processes, and packaging information, along with establishing a system for tracking product movement throughout the supply chain, it becomes possible to verify the positive effects of the ingredients and technologies used.

Overall, the integration of new functional ingredients and traceability systems can contribute to enhancing the quality, safety, and consumer acceptance of meat products. These approaches align with the increasing demand for natural and

high-quality food options, providing opportunities for innovation in the meat industry.

REFERENCES

1. Proslezhivaemost tovarov kak instrument prodovolstvennoy bezopasnosti [Traceability of goods as a tool of food security] / Samchenko O.N., Merkusheva M.A. //Proceedings of the Far Eastern Federal University. Economics and management. – 2016. – №. 3 (79). – Pp. 101-111.

2. Serikkaisai, M. S., Vlahova-Vangelova, D. B., Dragoev, S. G., Uzakov, Y. M., & Balev, D. K. (2014). Effect of dry goji berry and pumpkin powder on quality of cooked and smoked beef with reduced nitrite content.

3. Staykov, A.S., Dragoev, S.G., Balev, D.K., Vlahova-Vangelova, D.B., & Pavlova, M.R. (2016). Preserving the quality and prolongation the shelf-life of beef packed under vacuum or modified atmosphere using ternary antioxidant blend. // *Journal of Microbiology, Biotechnology and Food Sciences, 2016*, 617-622.

4. Balev, D., Vlahova-Vangelova, D., Dragoev S., Baleva, L., Dimitrova, M. & Kolev, N. (2022). Antioxidative effect of dry distilled rose petals extract in traditional Bulgarian dry fermented sausages with reduced nitrate content.// *Food Science and Applied Biotechnology*,*5*(2), 173-180.

5. Tehnicheskiy reglament 021/2011 "O bezopasnosti pischevyih produktov" [Elektronnyiy resurs] [Technical Regulation 021 / 2011 "On food safety" [Electronic resource]: URL: https://adilet.zan.kz/rus/docs/H11T0000880.

6.Ivanov, G.Y., Staykov, A.S., Balev, D.K., Dragoev, S.G., Filizov, E.H., Vassilev, K.P., & Grozdeva, T.G. (2010). Effect of treatment with natural antioxidant on the chilled beef lipid oxidation. *//Advance Journal of Food Science and Technology*, *2*(4), 213-218.

7. Balev, D.K., Staykov, A.S., Ivanov, G.Y., Dragoev, S.G., & Filizov, E.H. (2011). Color stability improvement of chilled beef by natural antioxidant treatment and modified atmosphere packaging. *//American Journal of Food Technology*, *6*(2), 117-128.

8. Balev, D.K., Staykov, A.S., Ivanov, G.Y., Dragoev, S.G., Filizov, E.H., Vassilev, K.P., & Grozdeva, T.G. (2010). Effect of natural antioxidant treatment and modified atmosphere packaging on the quality and shelf-life of chilled beef.//*Agriculture and biology journal of North America*, *1*(4), 451-457.

9. Dragoev, S.G., Staykov, A.S., Vassilev, K.P., Balev, D.K., & Vlahova-Vangelova, D.B. (2014a). Improvement of the quality and the shelf life of the high oxygen modified atmosphere packaged veal by superficial spraying with dihydroquercetisolution.//*International Journal of Food Science*, *2014*.

10. Staykov, A., Vassilev, K., Dragoev, S., Balev, D., Vlahova-Vangelova, D., Valeva, A., & Rustemova, F. (2015). Inhibition of lipid oxidation in different types packaged beef by a composition of natural antioxidants.//*Oxidation Communications*, *38*(2), 666-676.

11. Staykov, A., Balev, D., Vasilev, K., Dragoev, S, & Vlahova-Vangelova, D. (2013). Stabilisation of sensory properties, colour and conjugated lipid products in modifi ed atmosphere packaged veal, treated with dihydroqercetin. //*Food Processing Industry Magazine*, *13*(1), 37-42. [in Bulgarian]

12. Dragoev, S., Balev, D., Ivanov, G., Nikolova-Damyanova, B., Grozdeva, T., Filizov, E., & Vassilev, K. (2014b). Effect of superficial treatment with new natural antioxidant on salmon (Salmo salar) lipid oxidation.//*Acta Alimentaria*, *43*(1), 1-8.

13. Vlahova-Vangelova, D., Balev, D., Kolev, N., Nikolova, L. & Dragoev, S., (2022). Preservation of fish freshness by edible alginate coating and surface treatment with dry distilled rose petals extract or L-ascorbic acid. //*Food Science and Applied Biotechnology*,*5*(2), 181-189.

14. Kolev, N.D., Vlahova-Vangelova, D.B., Balev, D.K. & Dragoev, S.G. (2022a). Quality changes of cooked sausages influenced by the incorporation of a three-component natural antioxidant blend. In *BIO Web of Conferences (Vol. 45)*, 01006. EDP Sciences.

15. Kolev, N., Vlahova-Vangelova, D., Balev, D., Dragoev, S. (2022b). Stabilization of oxidative processes in cooked sausages by optimization of incorporated biologically active substances. //*Carpathian Journal of Food Science and Technology*, *14*(4), 180-188.

16. Kolev, N.D., Vlahova-Vangelova, D.B., Balev, D.K. & Dragoev, S.G. (2022c). Effect of three-component antioxidant blend on oxidative stability and nitrite reduction of cooked sausages.//*Acta Scientiarum Polonorum Technologia Alimentaria*, *21*(2), 205-212.

17. Kolev, N.D., Vlahova-Vangelova, D.B., Balev, D.K. & Dragoev, S.G. (2022d). Color dynamics of cooked sausages after nitrite reduction and incorporation of biologically active substances.//*The Journal of Almaty Technological University*, 2022(3):130-137.

18. Kolev, N.D. & Baleva, L.D. (2022). Possibilities for Reducing Nitrites in Cooked Sausages Via Biologically Active Substances. //*Journal of Mountain Agriculture on the Balkans*, *25*(1), 94-112.