ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 13(3), 59-66
Received: 23.05.2022 Revised: 30.06.2022 Accepted: 21.07.2022

UDC 637.521:663.242
DOI: 10.31548/animal.13(3).2022.59-66

Influence of balsamic vinegar on the quality indicators of natural semi-finished pork meat products

Oksana Shtonda*, Viktoriia Kulyk

National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony str., Kyiv, Ukraine

Abstract. Lipid oxidation leads to an unpleasant smell and taste of semi-finished meat, which becomes tougher and less juicy due to the loss of intracellular fluid. The purpose of the study is to determine the effect of fruit and berry components of balsamic vinegar on organoleptic, structural, and mechanical parameters and changes in the pH level of semi-finished meat products. The paper presents the results of the influence of various types of balsamic vinegar on the quality indicators of semi-finished meat products. 5 varieties of balsamic vinegar were used: rowan, blackberry, currant, pomegranate, and grape. At the first stage of the study, the pH value was determined in samples of balsamic vinegar from fruit and berry raw materials. The next stage of the study was to determine the effect of balsamic vinegar on the structural and mechanical parameters, pH and organoleptic characteristics of meat during 7 days of storage of semi-finished pork products, which were injected with 5 types of balsamic vinegar in the amount of 15% to the weight of meat. Meat samples were evaluated by appearance, in-section appearance, taste, colour, consistency, and juiciness. Determination of penetration stress in the samples was carried out by measuring the immersion depth of a standard needle in each marinated meat semi-finished product and the control sample of pork meat. It was confirmed that the use of balsamic vinegar made from rowan, black currant, and pomegranate significantly affects the consistency of meat, making it more tender. When interacting with the components of raw materials, food acids affect the taste and aroma, and partially break down proteins and fats, making meat softer and tastier. It was found that in semi-finished pork meat products under the action of balsamic vinegar as one of the components of the marinade, the pH level decreases, which extends the shelf life and prevents the development of bacteria. Organoleptic characteristics and taste and aroma properties of the semi-finished product were improved and the appearance became more pleasant. The obtained results would allow extending the shelf life, enriching with biologically active substances, and improving the consumer properties of the semi-finished product

Keywords: fruit and berry raw materials, physical and chemical parameters, organoleptic evaluation, penetration stress

Introduction

According to the approved norms of physiological needs of the population of Ukraine in basic nutrients and energy, depending on gender, age, weight, and physical activity coefficient, the daily requirement for protein ranges from 68 g to 117 g for men and from 58 g to 87 g for women, of which 50% are of animal origin [1]. Therefore, it is necessary to create products that can be quickly prepared, and which at the same time will not lose their biological properties and nutritional value [2].

Ukrainian and foreign researchers have established that the use of derivatives of substances that include natural fruits and berries prevents lipid oxidation that leads to loss of product quality, and organoleptic parameters are regulated, such as appearance, colour, taste, smell, and consistency of semi-finished meat products. The goal of improving semi-finished meat products is not only to increase the range, but, above all, to provide the consumer with a product filled with vitamins, biologically active substances, antioxidants, and minerals.

Suggested Citation:
Shtonda, O., & Kulyk, V. (2022). Influence of balsamic vinegar on the quality indicators of natural semi-finished pork meat products. *Animal Science and Food Technology*, 13(3), 59-66.

**Corresponding author*

The needs of the human body for minerals for men are: calcium and phosphorus – 1,200 mg, zinc and iron – 15 mg, magnesium – 400 mg; for women: calcium – 110 mg, phosphorus – 1,200 mg, zinc – 12 mg, iron – 17 mg, magnesium – 500 mg. The required amount of vitamins for men: C – 80 mg, A – 1000 mg, E – 15 mg, B vitamins – from 1.6 mg to 3 mg; for women: C – 70 mg, A – 1,000 mg, E – 15 mg, B vitamins – from 1.3 mg to 3 mg [1]. Therefore, the addition of balsamic vinegar to the marinade for meat semi-finished products due to the mineral and vitamin composition, the presence of micro and macro elements, organic acids, and biologically active substances will not only satisfy the needs of the human body in nutrients.

Lorenzo *et al.* investigated antioxidants from black currant berries, blueberries, blackberries, cranberries, and grapes as a substitute for food additives to inhibit the oxidation of lipids and proteins in meat and meat products, since meat is very susceptible to oxidation [2]. Oxidation can be slowed down by synthetic antioxidants with a phenolic structure. Berries are a good source of phenolic compounds, especially anthocyanins, which can be used as a potential alternative to synthetic supplements. The study suggests that extracts of blueberries, blackberries, cranberries, and grapes can be used as substitutes for synthetic antioxidants in meat products. Their extracts contain polyphenols, antioxidants that have a positive effect on the stabilisation of meat products [2].

Ali Samet Babaoğlu *et al.* evaluated the physicochemical and microbiological properties and sensory parameters of beef patties with an aqueous extract of rowan, blackberries, red currants, and blueberries when stored in the refrigerator for 9 days. Treatment with berry pomace extract significantly reduced the amount of lipid oxidation by-products in the samples. The results show that water extract of chokeberry pomace can be a promising natural preservative among extracts of pomace of various berries to improve oxidative stability and improve the microbiological quality of beef patties when stored in the refrigerator [3].

The purpose of the study is to determine changes in organoleptic characteristics, pH level, structural and mechanical parameters, namely penetration stress of meat semi-finished products, to solve the problems of lipid oxidation, which will increase shelf life and improve consumer characteristics of semi-finished products.

Literature Review

Rowan berries contain sugar (up to 5%), malic, lemon, wine, and succinic acids (2.5%), tannins (0.5%) and pectin (0.5%) substances, sorbitol and sorbose, amino acids, essential oils, potassium, calcium, magnesium, and sodium. The presence of vitamin P (more than 2,500 mg%) provides rowan with the first place among other fruit plants. Rowan berries are also rich in vitamin C (up to 160 mg%) and beta-carotene (up to 5.6 mg%). The preparation of rowan berries reduces the content of fat in the liver and cholesterol in the blood, and powder from rowan berries increases the resistance of blood vessels. In scientific medicine, rowan berries are used as a multivitamin, diuretic, and haemostatic agent [4].

Blackberries are a real storehouse of microelements that are useful for the body. Berries contain glucose, sucrose, and fructose (5.1-13%), organic acids: malic, citric, salicylic, tartaric, etc. (0.5-1.5%), pectin (1.8%), fibre (2-4%), vitamins P, B, E, C, carotene, potassium, salt, manganese, copper, potassium, sodium, calcium, magnesium, phosphorus, iron, etc. [5].

Black currant berries contain various sugars; citric, malic, and succinic acids; pectin, nitrogen, tannins, dyes, and polyphenolic compounds. In terms of vitamin C content, black currant occupies one of the leading positions (about 400 mg%), its content practically does not decrease with proper fruit processing. In addition, berries contain vitamins A and P. Black currant berries are an excellent source of vitamin C, used to produce a variety of concentrates and vitamin C preparations. Currant fruits have a special spicy aroma and sweet and sour taste. The main advantage of fruits is that they are low in enzymes that break down ascorbic acid, so they are a valuable source of vitamins. Ascorbic acid is also stored in frozen berries [6].

Pomegranate has a rich chemical composition, contains manganese, phosphorus, magnesium, potassium, iron, zinc, aluminium, silicon, chromium, nickel, calcium, copper, iodine and other minerals, acids including citric acid, tartaric acid, oxalic acid, and malic acid, vitamins – C, E, B1, B2, B6, B12, P, niacin, folic acid, carbohydrates, protein, fibre, ash, catechins, tannins and colouring agents, flavonoids, amino acids, alkaloids, and oils. Pomegranate has antioxidant, antiseptic, anti-inflammatory, vulnerary, haemostatic, astringent, antihelmintic, and nutritional properties [7].

Pomegranate peel contains the following macro- and microelements: potassium – 18.9 mg/g, calcium – 4.0 mg/g, magnesium – 0.5 mg/g, iron – 0.05 mg/g, manganese – 5.2 mcg/g, copper – 2.5 mcg/g, zinc – 3.8 mcg/g. Pomegranate peel is rich in tannins, anthocyanins, amino acids, vitamins and minerals, which, when used correctly, have a positive effect on the gastrointestinal tract. These substances can treat diseases such as dysentery, diarrhoea, abdominal pain, and increased acidity [8].

Grapes are a highly valuable food product due to the presence of a number of biologically active substances in it, among which vitamins occupy a special place. Their absence in humans causes various pathologies – obesity, cardiovascular, oncogenic, and respiratory diseases. One of the most important and most studied in grape berries is vitamin C (ascorbic acid) [9].

In the study by José M.Lorenzo *et al.*, four natural grape extracts (GRA) with potential antioxidant activity in pork patties were evaluated. During 20 days of storage in packages with a modified atmosphere at 2°C, the pH, colour, lipid oxidation, and microbial spoilage parameters of raw pork patties were studied and compared with a synthetic antioxidant and a control batch. Due to their high polyphenol content, grape extracts were the most effective antioxidants that prevent lipid oxidation and reduce colour degradation. In addition, natural grape extracts resulted in a decrease in the total number of viable cells and lactic acid bacteria, compared to the control [10].

Cranberries – the main active substance of this berry – organic acid, in addition to this acid, it contains quinic, citric, malic, benzoic ascorbic acid; macro- and microelements: Mo, Fe, Mn, I, Cu; flavonoids: anthocyanins, hesperidin, rutin, quercetin; sucrose (0.27-2.8%), sorbitol (2.1-2.3%), fructose (1-9.9%), tannins (0.1-4.9%), pectin

substances, riboflavin, carotene; catechins. Seeds contain fatty oils (16-28.12%), their hydrolysates contain acids: linoleic acid (36%), oleic acid (21%), palmitic acid (5%), stearic acid (1.5%) [6].

The healing properties of viburnum are conditioned by the high content of useful elements, including bioactive substances (tannins, phytoncides, essential compounds, glycosides, anthocyanins, coumarins), sugars, trace elements (magnesium, potassium, zinc, calcium, etc.); organic acids, vitamins (A, C, E, K, P). Tannins contained in the pulp and seeds give the pods astringency. The bitter taste of the fruit is given by the glycoside biburnin, in addition, it improves blood clotting, so viburnum is a remedy for bleeding, and also reduces the risk of diabetes and prevents circulatory diseases. About 30% sugar, but tasteless. Berries have a characteristic sourness due to the content of organic acid (2%). Viburnum berries have the following effect on the human body: they increase the body's defences, promote faster recovery from seasonal colds, relieve swelling, and increase vitality [11].

In berries made from organic acids, succinic, malic, citric, and acetic are most often found. Peshuk & Ishchenko studied the effect of a solution of lactic and orthophosphoric acids in the marinade on the meat properties. The results of studies have shown that when marinating for up to 48 hours, the process of extracting macro and microelements from meat raw materials into the marinade occurs [12]. G.P. Khomych, Yu.G. Nakonechna, L.B. Oliinyk investigated the effect of Chaenomeles juice on the quality of marinated semi-finished products [13]. But the research data needs to be clarified.

Ascorbic acid (AC) is a multifunctional compound that participates in many biochemical processes (synthesis of collagen, catecholamine, bile acids), affects cholesterol metabolism, increases the body's resistance to colds, and has antioxidant properties. Vitamin C is not synthesised in the human body, so it is necessary to constantly get it with food [9].

Ascorbic acid is involved in various biochemical processes in the human body. It is part of the redox system necessary for protein synthesis. This vitamin is involved in the synthesis of collagen, an important component of ligaments that provide mechanical connections to various organs of the tooth, cartilage, bone, and dentin. Ascorbic acid is essential for the proper functioning of nervous tissue, it promotes the absorption of iron in the digestive tract and the subsequent synthesis of haemoglobin, and also supports the active form of vitamin B_9 in the cells of the body necessary for the synthesis of proteins and nucleic acids [14].

Ukrainian researchers V.M. Pasichnyi, & T.R. Mykhavko have proved that the use of an additive based on citrus and pepper extract has the following properties: preservation of the natural red-pink colour of meat products; preservation of organoleptic properties and extend the shelf life; elimination of rancidity; improvement of the product quality; increase in the safety of the product, especially against the following pathogens: *Listeria*, *Listeria monocytogenes* bacteria, *Escherichia coli* H157, and *Clostridium* [15].

Materials and Methods

The study was conducted in the laboratory of the Department of Meat, Fish, and Marine Products of the National University of Life and Environmental Sciences of Ukraine in November 2021. Pork meat of grades 1 and 2, and balsamic vinegar made from rowan, blackberries, grapes, pomegranate, and black currant were investigated Vinegar was added to the samples by injection in an amount of 15% to the portion weight of meat not less than 90 g and not more than 150 g. 6 samples were examined: 5 samples with the addition of balsamic vinegar and 1 control sample without the addition of balsamic vinegar.

To obtain reliable experimental data, all studies were performed at least five times, two repetitions for each experiment. Sampling for sensory and physicochemical parameters and preparation for analysis were carried out in accordance with DSTU 4823.2:2007 [4]. Determination of the main organoleptic properties of natural marinated meat semi-finished products was carried out appearance, in-section appearance, colour, aroma, taste, consistency, and juiciness according to DSTU 4823.2: 2007 Meat products. Organoleptic evaluation of quality indicators. Part 2. General requirements [4].

Organoleptic evaluation was carried out according to the developed five-point scale (Table 1), considering DSTU 2925-94 Product quality. Quality assessment. Terms and definitions [16], where 1 – very bad, 2 – bad, 3 – satisfactory, 4 – good, and 5 – excellent.

Table 1. *Scale of organoleptic evaluation of semi-finished products*

Indicator	Characteristics	Points
Appearance, surface colour	The surface is dry, sticky, with obvious signs of spoilage	1
	The surface is dry, sticky, and unpleasant	2
	The surface is moist, sticky	3
	The surface is moist, slightly sticky	4
	The surface is moist, without stickiness, pleasant colour	5
Muscles in-section appearance	Dry, do not leave stains on filter paper, with signs of spoilage	1
	Dry, leave no stains on filter paper	2
	Barely moist, leave no stains on filter paper	3
	Moist, leave a barely noticeable stain on filter paper	4
	Moist, leave a noticeable stain on filter paper	5

Table 1, Continued

Indicator	Characteristics	Points
Consistency	In-section, the meat is flabby, the hole formed when pressed with a finger not evens out	1
	In-section, the meat is flabby, the hole formed when pressed with a finger evens out slowly	2
	In-section, the meat is less dense, not elastic, the hole formed when pressed with a finger evens out slowly	3
	In-section, the meat is less dense and less elastic, the hole formed when pressed with a finger evens out slowly	4
	In-section, the meat is dense, elastic, the hole formed when pressed with a finger evens out quickly	5
Smell	Sharp, sour, musty, smell of spoiled meat, repulsive	1
	Unpleasant, slightly sour	2
	Neutral, characteristic of this type of meat	3
	Pleasant, too pronounced fruit and berry aroma	4
	Pleasant, with a light fruit and berry aroma	5

Physical and chemical parameters were determined by commonly known methods: the pH of meat was determined by measuring the electrical potential difference between a glass electrode and a comparison electrode placed in a sample of meat or meat products according to DSTU ISO 2917-2001 [17]. Determination of penetration stress in samples consists in measuring the depth of penetration of a standard needle in the test sample. Determination of the needle penetration depth to approximately 330×0.1 mm is performed at a test temperature of 25°C, an applied load of 100 g for 5 seconds on an Ulab 3-31 M penetrometer according to DSTU EN 1426:201X [18].

At the first stage of research, the task was to determine the pH value of a sample of balsamic vinegar of Ukrainian production from fruit and berry raw materials. The pH-150 MI measuring device was used, designed to measure the activity of hydrogen ions, redox potential, and temperature of aqueous solutions, and directly measure meat and meat products. The second stage of research was to determine the effect of balsamic vinegar on the quality indicators of natural semi-finished products. Organoleptic evaluation of the samples was performed on Day 1 and Day 7 of storage. 5 varieties of balsamic vinegar were used: No. 1 – rowan vinegar, No. 2 – blackberry vinegar, No. 3 – currant vinegar, No. 4 – Narsarab (pomegranate) vinegar, No. 5 – grape vinegar, sample No. 6 (control) – pork meat without balsamic vinegar. Each test sample was treated with balsamic vinegar in an amount of 15% by weight of meat. The results were processed using Microsoft Excel.

Results and Discussion

Samples of balsamic vinegar were examined: rowan – No. 1, blackberry – No. 2, black currant – No. 3, pomegranate – No. 4, grape – No. 5 (Fig. 1).

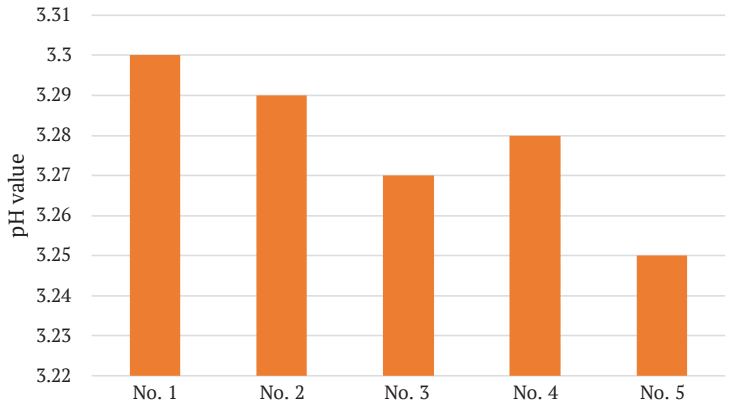

Figure 1. Changes in the pH of balsamic vinegar from fruit and berry raw materials

The pH values of the samples under study were in the range of 3.22-3.3. Such results are associated with the presence of organic acids in the composition of balsamic vinegar. Comparing the obtained indicators with the pH of table vinegar (9%), the latter has a pH value of 2 [19]. The results of the study of the effect of the corresponding samples of balsamic vinegar on the organoleptic evaluation of semi-finished meat products are shown in Table 2.

Table 2. *Organoleptic evaluation of injected semi-finished pork products on Day 7 of storage*

Sample	Indicator			
	Appearance, surface colour	Muscle in-section appearance	Consistency	Smell
No. 1	The skin is moist, without stickiness, red in colour	Wet, leave a barely noticeable stain on the filter paper, red in colour	At the cross-section, the meat pulp is less dense and has poor elasticity, the hole slowly evens out after pressing with a finger (up to 1 min)	Characteristic of this type of meat with a light aroma of rowan
No. 2	The skin is moist, without stickiness, pink in colour with a purple tinge	Wet, leave a barely noticeable stain on the filter paper, dark red in colour	At the cross-section, the meat pulp is less dense and has a flexible elasticity, the hole slowly evens out after pressing with a finger (up to 1 min)	Typical of this type of meat with blackberry aroma
No. 3	The skin is moist, without stickiness, dark red in colour	Wet, leave a barely noticeable stain on the filter paper, dark red in colour	At the cross-section, the meat pulp is less dense and has a flexible elasticity, the hole slowly evens out after pressing with a finger (up to 1 min)	Characteristic of this type of meat with a light aroma of black currant
No. 4	The skin is moist, without stickiness, red in colour	Wet, leave a barely noticeable stain on the filter paper, red in colour	At the cross-section, the meat pulp is less dense and has a flexible elasticity, the hole slowly evens out after pressing with a finger (up to 1 min)	Characteristic of this type of meat with a pleasant hint of pomegranate aroma
No. 5	The skin is moist, without stickiness, purple in colour	Wet, leave a barely noticeable spot on the filter paper, dark red with a purple tinge	At the cross-section, the meat pulp is less dense and has a flexible elasticity, the hole slowly evens out after pressing with a finger (up to 1 min)	Characteristic of this type of meat with a pronounced aroma of grapes
No. 6	The skin is sometimes moist, slightly sticky, darkened, greyish-pink in colour	Wet, leave a barely noticeable spot on the filter paper, dark red with a purple tinge	At the cross-section, the meat pulp is less dense and has a flexible elasticity, the hole slowly evens out after pressing with a finger (up to 2 minutes)	Slightly sour with a hint of mustiness

On Day 1, the condition of all the studied samples corresponded to the indicators of fresh meat, pale pink colour, the muscles on the incision are slightly moist, the colour is characteristic of pork meat, the consistency is dense and elastic, the smell is specific, inherent in this species. Organoleptic evaluation was performed on a five-point scale (Fig. 2).

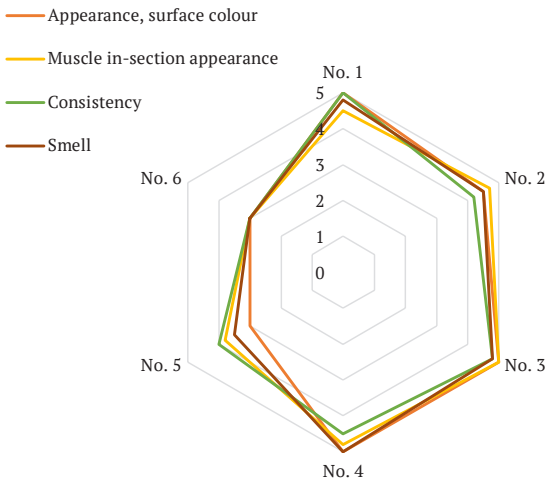

Figure 2. Organoleptic evaluation of semi-finished pork products treated with balsamic vinegar on Day 7 of storage

As a result of the organoleptic evaluation (Fig. 2) of marinated semi-finished pork products, it was found that on Day 7 of storage, samples injected with balsamic vinegar had moist skin, without stickiness, samples No. 1, No. 4 had a red surface colour, sample No. 2 had a pink colour with a purple tint, sample No. 3 had a dark red surface colour, and sample No. 5 had a purple colour. The skin of the control sample is sometimes moist, sticky, darkened, and greyish-pink in colour.

The muscles in-section of the test samples were moist, red to dark red in colour, leaving a barely noticeable spot on the filter paper. The consistency became less dense and less elastic, the hole from pressing with a finger evens out more slowly. The smell of samples injected with

balsamic vinegar is pleasant, characteristic of each type of vinegar, the control sample had a slightly sour smell with a hint of mustiness. As a result of the organoleptic evaluation of marinated semi-finished pork products, the best indicators were observed in samples No. 1, No. 3, and No. 4 treated with balsamic vinegar from rowan, currant, and pomegranate, respectively.

Changes in the pH values of marinated pork meat were studied over 7 days. Resistance of meat to spoilage during storage depending on pH, most bacteria will not develop in an acidic nutrient medium. Below pH 6.2, the development of bacteria slows down, and sufficiently mature meat with low pH is not as sensitive as meat with high pH to the effect of bacterial decomposition. Thus, according to the pH indicator, a conclusion can be drawn about the storage conditions of meat and semi-finished products from it (Fig. 3).

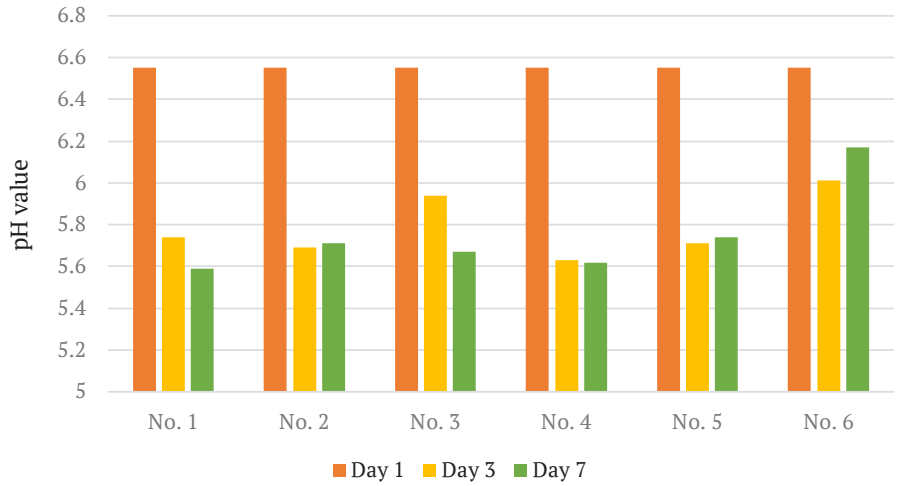

Figure 3. Changes in the pH of injected pork meat during storage

In the control meat sample, the pH value was 6.17, while in the test samples, the PH on Day 3 ranged from 5.63 to 5.94, on Day 7 – from 5.59 to 5.74, which indicates inhibition of bacterial development in samples using balsamic vinegar. Penetration stress studies were performed (Fig. 4) on Day 1 and Day 7 of sample storage.

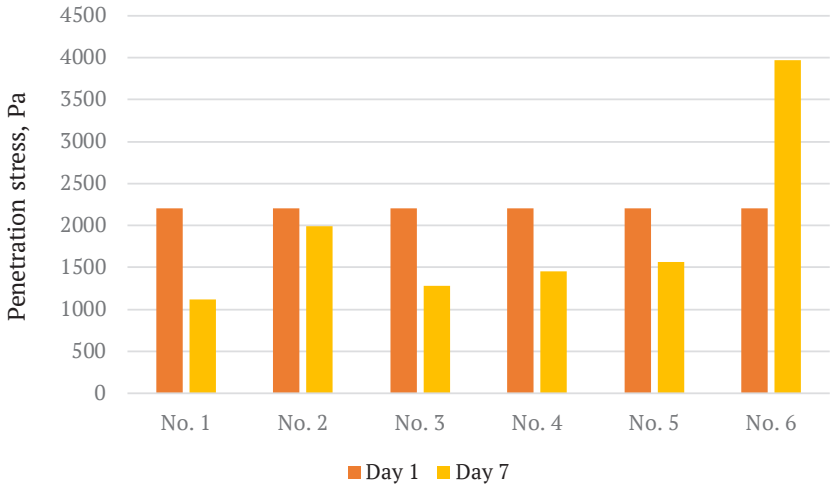

Figure 4. Change in penetration stress of injected pork meat depending on the storage time

It was found that samples injected with balsamic vinegar No. 1 – from rowan, No. 3 – from black currant, No. 4 – from pomegranate, had the softest consistency, samples No. 2 – from blackberries, No. 5 – from grapes had no significant effect, while the control sample became much tougher.

Previous studies have established that the addition of fruit and berry products has a positive effect on the stability of semi-finished meat products due to the presence of polyphenols and antioxidants. It is also proved that fruit and berry components act as natural preservatives, increasing the oxidative resistance of lipids and improving microbial quality during cold storage of semi-finished products. They prevent colour deterioration and reduce the total number of viable cells and lactic acid bacteria. Natural components contribute to the preservation of the natural reddish-pink colour of meat products, their organoleptic properties, and extend the shelf life, eliminate rancidity,

which improves the quality and safety of the product, especially against pathogenic microorganisms. Thus, studies confirm a positive effect on the quality characteristics of semi-finished meat products [2; 6].

Conclusions

Studies have shown that balsamic vinegar has a downward effect on the pH of meat, which prevents the growth of bacteria and spoilage of meat during long-term storage. The use of balsamic vinegar gives a pleasant aroma, helps to soften the consistency of meat, which has a positive effect on organoleptic parameters, taste and aroma properties. As a result of the study, it was found that semi-finished meat products treated with balsamic vinegar from pomegranate, currant and rowan have the best organoleptic characteristics. Due to injection with balsamic vinegar, the semi-finished product is enriched with micro-and macronutrients, vitamins, and biologically active substances that are part of the fruit and berry raw materials from which balsamic vinegar is made, and which are also necessary for the normal functioning of the human body. The results obtained show the feasibility of using balsamic vinegar in the production of semi-finished products.

The possibility of using vinegar in berry and fruit raw materials in meat production is not fully investigated. This area requires the development of methods for these ingredients, the study of their functional properties and mechanisms of interaction with the meat system, and the formulation of recipes for meat products containing ingredients of plant origin, the development of technology and methods for their introduction.

For the production of semi-finished meat products, structural and mechanical properties and pH values are important indicators of raw materials, they directly affect the organoleptic characteristics of the semi-finished product and the finished product. By adjusting these indicators, adding balsamic vinegar to the base of the marinade at the initial stage, it is possible to significantly improve the initial characteristics of raw materials.

Further study is aimed at a more detailed investigation of changes in the indicators of natural semi-finished meat products subjected to marinating with the use of balsamic vinegar.

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Вплив бальзамічного оцту на показники якості м'ясних натуральних напівфабрикатів із свинини

Оксана Анатоліївна Штонда, Вікторія Костянтинівна Кулик

Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна

Анотація. Окислення ліпідів призводить до неприємного запаху та смаку м'ясного напівфабрикату, який стає жорсткішим та менш соковитим у зв'язку із втратою внутрішньоклітинної рідини. Дослідження має на меті визначення впливу фруктово-ягідних складових бальзамічного оцту на органолептичні, структурно-механічні показники та зміни рівня pH м'ясного напівфабрикату. У статті представлено результати впливу різних видів бальзамічного оцту на показники якості м'ясних напівфабрикатів. Використовували 5 різновидів бальзамічного оцту: горобиновий, ожиновий, смородиновий, гранатовий та виноградний. На першому етапі досліджень визначали величину pH у зразках бальзамічного оцту з фруктово-ягідної сировини. Подальшим етапом дослідження було визначення впливу бальзамічного оцту на структурно-механічні показники, pH та органолептичні характеристики м'яса під час 7 днів зберігання напівфабрикатів із м'яса свинини, які ін'єктували 5 видами бальзамічного оцту у кількості 15 % до маси м'яса. Зразки м'яса оцінювали за зовнішнім виглядом, виглядом на розрізі, ароматом, кольором, консистенцією та соковитістю. Визначення пенетраційної напруги в зразках проводили методом вимірюванні глибини занурення стандартної голки в кожному досліджуваному м'ясному маринованого напівфабрикату та контрольному зразку з м'яса свинини. Підтверджено, що використання бальзамічного оцту з горобини, чорної смородини та гранату значно впливають на консистенцію м'яса, роблячи її більш ніжною. Харчові кислоти, при взаємодії з компонентами сировини, впливають на смак і аромат, частково розщеплюють білки і жири, що робить його більш м'яким і смачним. Встановлено, що у м'ясні напівфабрикати зі свинини під дією бальзамічного оцту як одного з компонентів маринаду, знижується рівень pH, що подовжує терміни зберігання та запобігає розвитку бактерій. Органолептичні характеристики та смако-ароматичні властивості напівфабрикату покращуються, зовнішній вигляд стає привабливішим. Отримані результати досліджень дозволять продовжити терміни зберігання, збагатити біологічно-активними речовинами та покращити споживчі властивості напівфабрикату

Ключові слова: фруктово-ягідна сировина, фізико-хімічні показники, органолептична оцінка, пенетраційна напруга