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QUALITY ASSESSMENT OF FERMENTED MEAT PRODUCT AFTER NATURAL EXTRACTS OF BLACKCURRANT (*RIBES NIGRUM*) AND KAMCHATKA HONEYSUCKLE (*LONICERA CAERULEA* VAR. *KAMTSCHATICA*) ADDITION

Miroslav Kročko, Adam Hanuska, Marek Bobko, Lukáš Jurčaga, Andrea Mesárošová*

Address(es):
Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Science, Institute of Food Science, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

*Corresponding author: xhanuska@uniag.sk

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ABSTRACT

The aim of this work was to analyse the effect of blackcurrant (*Ribes nigrum*) and kamchatka honeysuckle (*Lonicera caerulea* var. *Kamtschatica*) extracts on the physico-chemical properties, microbiological and sensory quality of fermented meat product. Analyses were performed after 5, 15, 30 and 45 days of ageing. The addition of blackcurrant and kamchatka honeysuckle extracts in quantities of 3 and 5 $ml.kg^{-1}$ did not adversely affect the ageing process of fermented meat product samples determined based on pH. After 45 days of ageing period, we found higher malondialdehyde (MDA) values in all experimental groups (except for the experimental group with the addition of 3 ml blackcurrant extract). The addition of the extracts in the tested quantities did not cause demonstrable differences in the intensity values of brightness (L^*), red (a^*) and yellow (b^*) colour throughout the ageing period. Microbial examination indicates that the addition of blackcurrant and kamchatka honeysuckle extracts did not inhibit the growth of starter culture. Bacteria of the genus *Lactobacillus* and *Staphylococcus* predominated in all experimental groups. Family Enterobacteriaceae was not detected after 45 days of ageing and storage. Moulds were detected only after 5 days of ageing and in the experimental groups with the addition of blackcurrant extracts. The counts of yeasts gradually increased with increasing ageing time in all experimental groups. Sensory analysis revealed a beneficial effect of kamchatka honeysuckle extract in the amount of 3 $ml.kg^{-1}$ after 30 days of fermented sausages ageing. On the other hand, blackcurrant extract in higher amount (5 $ml.kg^{-1}$) had a beneficial effect on sensory quality after 30th day. Traditional kamchatka honeysuckle aroma was probably transferred into the samples of meat product and caused lower sensory scores. Due to the known functional properties of black currant and kamchatka honeysuckle, we recommend carrying out their further analyses on the quality of fermented meat products.

Keywords: black currant, kamchatka honeysuckle, fermented meat product, quality

INTRODUCTION

An alternative to the common synthetic chemicals used to stabilise meat products is the use of plant-based ingredients as a source of antioxidants throughout the production process. Therefore, research into methods of creating and producing healthier meat products is receiving a lot of attention. Several well-known studies have examined the fruits and seeds of plants containing polyphenols to find compounds with antioxidant activity. These compounds can be used instead of artificial antioxidants to preserve the quality of meat products **(Munekata *et al.*, 2020). Munekata *et al.* (2020)** suggest that by halting or delaying the oxidation of fatty acids, proteins and meat pigments, plant extracts containing polyphenols can enhance the antioxidant capacity of meat products and preserve their sensory properties. In addition to their antioxidant properties, polyphenols have several other biological effects, including antibacterial, anticarcinogenic and anti-inflammatory properties. Fruits high in polyphenols include sea buckthorn, blackcurrants, rose hips and grape vine **(Ehsani *et al.*, 2017). Realini *et al.* (2015)**; **Van Cuong & Chin (2016)**; **García-Lomillo *et al.* (2017); Munekata *et al.* (2020)** identified the strong antioxidant content of pomegranates, strawberries, plums and acerola. Their antioxidant properties are associated with high concentrations of bioactive compounds including ascorbic acid, flavonoids, phenolic acids, anthocyanins and tannins. Their use in the meat sector is increasingly popular due to these properties **(Okatan, 2020).** According to **Lorenzo *et al.* (2018)**, plant extracts are added to meat in the form of extracts and powders to be used as antioxidants.

Ribes nigrum, or blackcurrants, are members of the Grossulariaceae family, which consists of approximately 150 species. This plant can survive in a variety of soil types and does not require any special growing conditions **(Wójciak *et al.*, 2023).** This plant, which is native to northern and central Europe, produces dark purple fruits. Vitamin C and several polyphenolic chemicals, especially anthocyanins, are abundant in the fruits of this plant **(Kerner *et al.*, 2023).** On the other hand, the leaves mainly contain quercetin-3-O, myricetin and kaempferol derivatives along with neochlorogenic, caffeic, gallic, chlorogenic and catechinic acids. However, compared to fruits, leaves have a higher concentration of polyphenols **(Wójciak *et al.*, 2023).** In addition, compared to other berries including gooseberries, strawberries, redcurrants, raspberries and white currants, blackcurrants have a higher polyphenol content **(Alzahrani *et al.*, 2023).** The chemical composition and antioxidant activity of extracts from these raw materials depend on the type of soil and the time of harvest. Nevertheless, blackcurrant leaves and fruits have various biological effects, including the ability to inhibit cell proliferation, and have antibacterial, antihypertensive, antimutagenic, antidiabetic, analgesic and anti-inflammatory properties. In natural medicine, blackcurrant leaves are used as a diuretic and to treat inflammatory conditions in the form of extracts. They have also been used as an infusion to control kidney function **(Wójciak *et al.*, 2023).**

The unique characteristics of kamchatka honeysuckle berries (*Lonicera caerulea* var. *kamtschatica*) are their elliptical cylindrical shape, the blue-purple colour of the skin and their juicy, sweet and sour taste with a waxy coating. They are mainly cultivated by northern European nations, China, Japan and Russia (Kamchatka and Siberia). Honeysuckle varieties, agrotechnical conditions and the timing of harvesting influence the chemical composition of the berries. Honeysuckle berries are rich in organic acids (mainly citric acid, with smaller amounts of malic and phytic acid) and carbohydrates (mainly fructose and glucose), as well as minerals (K, P, Ca, Fe). Honeysuckle berries contain a high concentration of physiologically active substances with strong antioxidant activity, such as polyphenols, the main representatives of which are ferulic, caffeic and chlorogenic acids. Honeysuckle berries are also an important source of vitamin C **(Belcar *et al.*, 2023).**

There are many physiologically active substances in the honeysuckle berries. These berries belong to the category of so-called superfruits. This berry bush is deciduous and can reach a height of 1.5 to 2 metres. Its honey-coloured, pale yellow flowers offer a delicate, pleasant scent. The berries are dark purple, oblong and elliptic or cylindrical. In Asia, kamchatka honeysuckle plants have long been used for their medicinal properties. Positive characteristics of honeysuckle include its early ripening (it can ripen up to two weeks before strawberries), remarkable hardiness, it does not require special soil and climatic conditions and is minimally susceptible to pests and diseases. This plant was originally mentioned in Russian literature in the 17th century. It is now cultivated in Japan, China, Russia, Poland, the Czech Republic, Slovenia, Slovakia, Canada and the USA. Based on existing research, honeysuckle berries are rich in vitamins, minerals and secondary metabolites that are essential for maintaining human health. The medicinal effects of honeysuckle include preventive effects against osteoporosis, type 2 diabetes, cardiovascular and neurological diseases and anaemia **(Bieniek *et al.*, 2021).**

Honeysuckle berries are healthier than other berries that are often eaten, according to a new study. The study also showed that adding honeysuckle berries to apple juice improved its antioxidant activity and influenced the amount of vitamin C, polyphenols and anthocyanins. Apple juice and honeysuckle berry extract were also combined in the present study **(Waszkiewicz *et al*., 2023).** Honeysuckle berries are rich in chemicals that make them useful for the treatment of eye diseases (due to the concentration of anthocyanins). They also have antibacterial, anticancer, detoxifying and anti-inflammatory properties. According to **Belcar *et al*. (2023)**, honeysuckle berries are used in food processing as natural colouring agents, as well as in the production of frozen meals, jams, juices, tinctures, wines and desserts.

The aim of this work was to analyse the effect of the addition of blackcurrant (*Ribes nigrum*) and kamchatka honeysuckle (*Lonicera caerulea* var. *Kamtschatica*) extracts on the quality properties of fermented meat product.

MATERIAL AND METHODS

Extract preparation

Fruit (blackcurrant and kamchatka honeysuckle) for the preparation of the extracts was procured from the Botanical Garden of the Slovak University of Agriculture in Nitra, Slovakia. The preparation of the extract was conducted according to **Shirahigue *et al*. (2010).** The fruit, which was dried and homogenized (20 g), was combined with 100 ml of 80% ethanol in a shaker and allowed to rest at room temperature in the dark for 24 hours. The filtrate was made up to 100 ml with ethanol. The liquid part was then evaporated to dryness at 65 °C in a vacuum rotary evaporator. The weighed dry residue was redissolved in 50 ml of water. The final extract was stored at 4 °C in the dark.

Preparation of the shelf-life fermented meat product

The production of the shelf-life fermented meat product was conducted in a small-scale production facility, ensuring minimal secondary contamination of raw materials as well as tools. For the preparation of the meat product samples, 5 kg of pork meat was used, which was ground on a grinder through a cutting board with 6 mm holes. For the preparation of the fermented meat product, 70% lean meat and 30% back fat were used.

The prepared meat mass mixed with spices and starter culture was evenly divided into 5 experimental groups. The first group did not contain the addition of plant extracts, but only starter culture. To the second group was added kamchatka extract at 3 $ml.kg^{-1}$ and to the third group, the same extract was added but at 5 $ml.kg^{-1}$. To the fourth group was added blackcurrant extract at 3 $ml.kg^{-1}$ and to the fifth group, the same extract was added but at 5 $ml.kg^{-1}$. The starter culture contained the following species of microorganisms: *Staphylococcus xylosus*, *Lactobacillus curvatus*, *Lactobacillus rhamnosus* (Clerici Sacco, Italy). Addition of starter culture to each group was in an amount of 0.2 $g.kg^{-1}$. The prepared experimental groups were labelled as follows:

- **Sample 1 - sausages with starter culture (C),**
- **Sample 2 - starter culture + 3 ml blackcurrant extract (BE3),**
- **Sample 3 - starter culture + 3 ml kamchatka extract (KE3),**
- **Sample 4 - starter culture + 5 ml blackcurrant extract (BE5),**
- **Sample 5 - starter culture + 5 ml kamchatka extract (KE5).**

After mixing, each group of the meat part was stuffed into pig intestines with a diameter of 36-38 mm. The products were then dried and lightly coloured in a climate-controlled chamber for 10 hours. The first stage was followed by cold smoking, also for 10 hours. After smoking, the products were returned to the climate chamber, where the relative humidity was gradually changed from 90% to 75%, the temperature from 18 to 16 °C and the air flow. The sausages were aged and stored in the climate-controlled chamber. Analyses were performed after 5, 15, 30 and 45 days of ageing and storage.

pH

The pH values were determined using an Orion Star™ A211 Benchtop pH meter (China).

Oxidative stability

According to **Grau *et al.* (2000)**, the malondialdehyde (MDA) content was measured using the thiobarbiturate test with a 2-thiobarbituric acid (TBA) solution to determine the oxidative stability of the fermented meat product.

Colour determination

The sample of fermented meat product was homogenised with a Heidolph DIAX 900 (Germany). After that, a spectrophotometer (CM 2600D, Konica Minolta, Japan) was used to determine the CIELAB colour space where L* means brightness intensity, a* intensity of red colour and b* intensity of yellow colour. Colour was measured on six randomly selected locations of each sample.

Microbial examination

- Bacteria of Enterobacteriaceae family (ETB) were determined on VRBG medium by cultivation in a Biological Thermostat BT 120 at 37 ± 1 °C. Counts of ETB were found out after 24 hours of cultivation **(STN ISO 21528-2, 2017).**
- Bacteria of genus *Lactobacillus* (*Lb.*) were determined on MRS medium by cultivation in a Biological Thermostat BT 120 at 37 ± 1 °C. Counts of *Lb.* bacteria were found out after 5 days of cultivation **(STN ISO 15214, 2002).**
- Moulds and yeasts were determined on DG 18 and DRBC medium by cultivation in a Biological Thermostat BT 120 at 25 ± 1 °C. Their counts were found out after 5 days of cultivation **(STN ISO 21527-1 & STN ISO 21527-2, 2010).**
- *Staphylococcus* (*Sc.*) bacteria were determined on MSA medium by cultivation in a Biological Thermostat BT 120 at 37 ± 1 °C. Counts of *Sc.* bacteria were found out after 5 days of cultivation **(STN EN ISO 6888-1:2001/A1).**

The colony-forming unit (CFU) were determined by the plate counting method and expressed as log $CFU.g^{-1}$.

Sensory analysis

The sensory quality of the fermented meat product was conducted after 15 and 30 days of ageing and storage. Five panelists from the Institute of Food Science participated in the sensory evaluation. The sensory quality was evaluated using a 5-point system, namely colour on the cut, aroma, taste and acidity. In the evaluation, 5 points represented the highest quality, and 1 point represented the lowest quality of the monitored descriptor.

Statistical analysis

The data obtained were subjected to analysis of variance (ANOVA) using SAS software (version 9.3, Enterprise Guide 4.2, USA). Tables show the results as the mean **(SAS, 2008)**.

RESULTS AND DISCUSSION

pH

According to **Decree No. 83 Coll. (2016)** valid in Slovakia, at the end of the ageing period, thermally unprocessed shelf-life meat products are classified according to pH and water activity (a_w) as follows:

- fermented and dried uncooked shelf-life meat product - pH < 5.5 and a_w < 0.93,
- dried shelf-life uncooked meat product - pH 5.5-6.2 and a_w < 0.89,
- dried meat - a_w 0.9 or less.

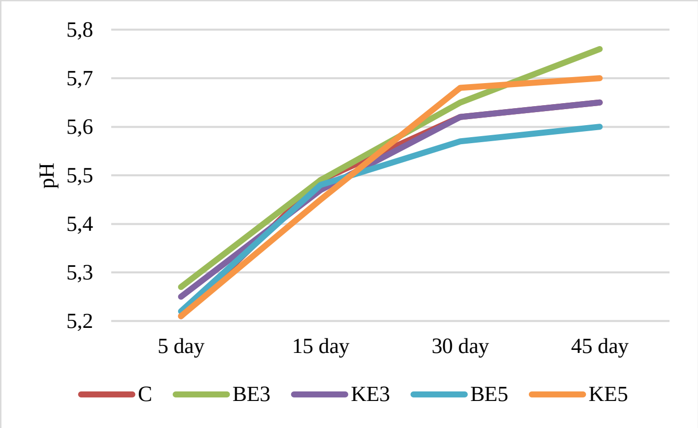

Figure 1 pH values determined in fermented meat products during 45 days of ageing and storage

Note: C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

Based on the abovementioned Decree, the samples evaluated can be considered as fermented and dried meat products until 15 days of ageing. During next storage period were considered as dried shelf-life uncooked meat product. This is because the a_w of samples was lower than 0.89 and pH value was between 5.5 and 6.2

(Figure 1). The ageing process of fermented meat products was not significantly influenced by the addition of natural extracts, however **Tamkutė *et al*. (2021)** observed a decrease value of pH after the addition of chokeberry extract to burgers.

Oxidative stability

Lipid oxidation is one of the main causes associated with shortened shelf-life of meat products. In fermented meat product samples after 15 and 30 days of ageing, lower MDA values were found in the experimental groups with the addition of kamchatka honeysuckle extracts (KE3, KE5). However, after 45 days of ageing of the samples, considerably higher MDA levels were found in the samples KE3, BE5, KE5 (**Figure 2).**
Fernández-López *et al*. (2006) produced and investigated dry sausages containing orange fibre. In all samples, thiobarbituric acid reactive substances (TBARS) levels increased during the drying process, with a smaller increase in the treated samples than in the control samples.

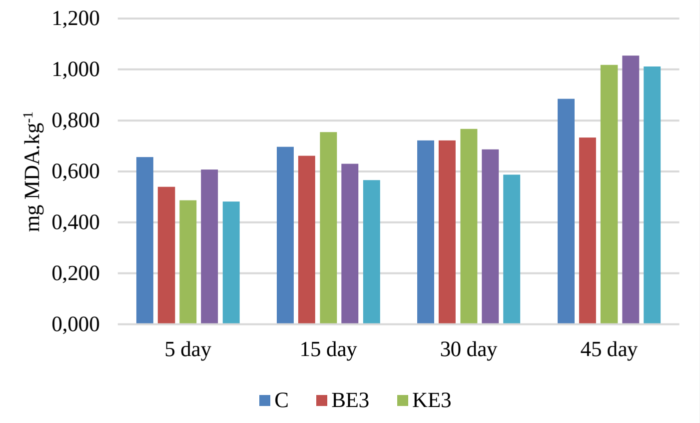

Figure 2 Oxidative stability of fermented meat products during 45 days of ageing and storage
Note: C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

According to a study by **Sayari *et al*. (2015)**, extract of *Citrus paradisi* (*C. paradisi*) proved antioxidant and antibacterial properties in turkey sausages stored at 4 °C for 13 days. The addition of 2.5 $g.kg^{-1}$ of extract of *C. paradisi* significantly delayed lipid oxidation and reduced microbial growth. The use of *C. paradisi* extract could preserve the higher quality characteristics of turkey sausages.

Colour determination

The colour of fermented meat products is a very important characteristic that influences consumer acceptability and ultimately relates to the quality of the products when they are purchased. It is important to remember that when trying to incorporate a new ingredient into a traditional product, consumers may reject the product if it does not retain its original characteristics **(Lau, 2019).** No significant differences in brightness intensity (L^*) were found between the control group (C) and the samples with the addition of black currant extract. However, lower ($P \geq 0.05$) values of both brightness intensity (L^*) and yellow colour intensity (b^*) were found in the samples with the addition of kamchatka honeysuckle extract. No significant differences were found in the red colour intensity (a^*) values between the samples after 5 as well as 45 days of ageing and storage of the fermented meat product samples. After 45 days of ageing and storage, the value of the intensity of brightness (L^*) decreased in comparison with the values found after 5 days of ageing and storage in all the samples studied. The red (a^*) and yellow (b^*) colour intensity values determined after 45 days of ageing and storage did not change significantly ($P \geq 0.05$) when compared with the findings after 5 days of ageing and storage (**Figure 3, Figure 4).**

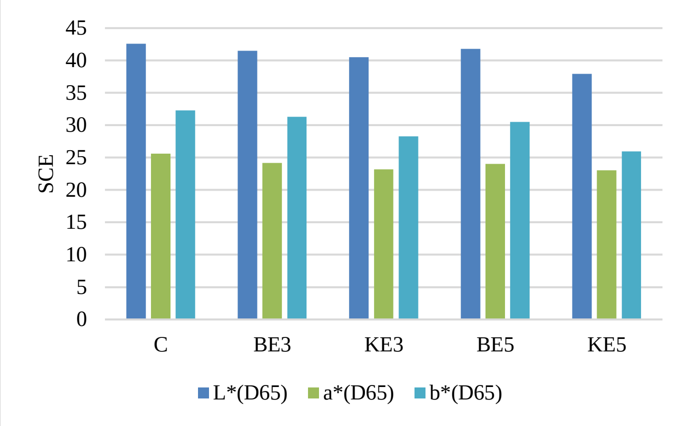

Figure 3 Colour determination fermented meat products after 5 days of ageing and storage
Note: C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

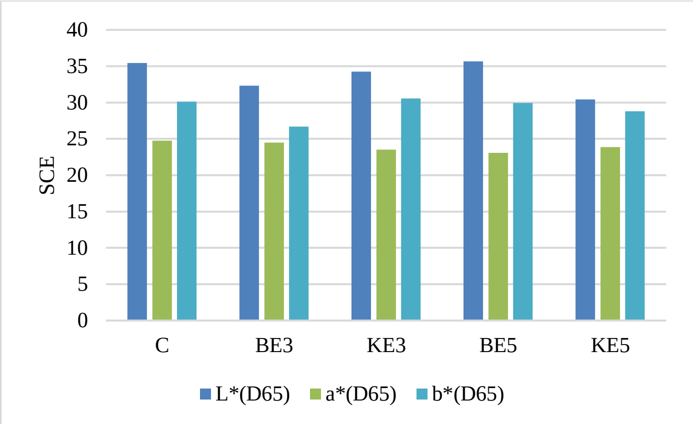

Figure 4 Colour determination of fermented meat products after 45 days of ageing and storage
Note: C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

The decrease in L* value can be attributed to moisture loss, as expected in dry-ageing of sausages **(Bozkurt & Bayram, 2006; Lorenzo *et al*. 2012). Lorenzo *et al*. (2013)** obtained the same results when investigating the colour of dry fermented sausages using grape seed extract and chestnut leaf extract, where the L* value also decreased throughout the ageing period with values ranging from 43.8% to 30.5%. **Ganhão *et al*. (2010)** found that blackberries, which are rich in anthocyanins, improved the colour of cooked hamburger patties, while other fruits containing small amounts of anthocyanins had no effect on colour. The results according to **Nowak *et al*. (2016)** suggest that blackcurrant and sour cherry extracts have no significant effect on colour changes (L*, a*, b* values) in vacuum-packed pork products during refrigerated storage.

Microbial examination

Plant extracts high in polyphenols have been shown to reduce oxidation of meat in both raw and cooked forms, but do not show a clear antibacterial effect **(Libera *et al*., 2020).** This is a significant finding as it opens the possibility of combining probiotic and starter bacterial strains with these organic ingredients in fermented meat product technology. Moreover, polyphenols stimulate the growth of probiotic strains while reducing the growth of harmful bacteria **(Pacheco-Ordaz *et al*., 2017).** Furthermore, this opens the possibility of using natural substances in connection with probiotic and starter cultures to replace the antibacterial effect of curing salt. Strains of the genus *Lactobacillus* are among the probiotic bacteria used in the production of fermented meat products. According to **Wójciak *et al.* (2016)**, several metabolites of these bacterial strains are known to accelerate the oxidative changes that occur in meat products during ageing and storage. Consequently, it is essential to investigate the potential of combining probiotic bacterial strains and starter cultures using polyphenol-rich plant extracts. In addition to lactobacilli, the genera *Staphylococcus* and *Kocuria* are also important in the production of fermented meat products because they contribute to flavour development, stabilise colour and reduce oxidative effects **(Cocconcelli & Fontana, 2014).**

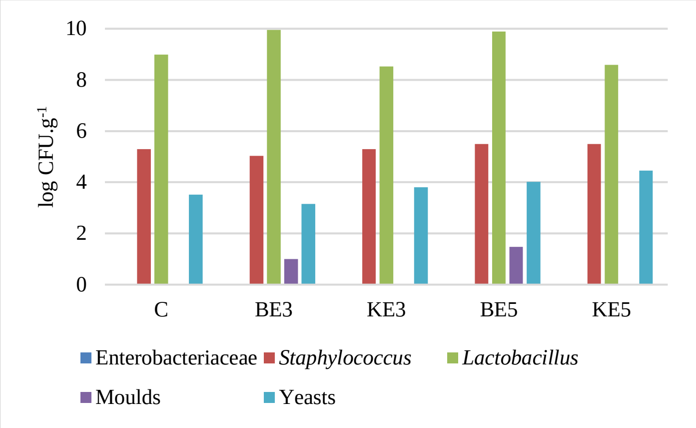

Figure 5 Counts of selected groups of microorganisms in samples of fermented meat products after 5 days of ageing and storage **Note:** C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

Of all monitored groups of microorganisms, the highest counts of the genera *Lactobacillus* and *Staphylococcus* were determined after 5 days of ageing and storage. The occurrence of moulds in the experimental groups was found to be 1 and 1.48 log CFU.g^{-1} in samples with addition of blackcurrant extract (BE3, BE5) **(Figure 5).**

Fermented sausages contain large amounts of salt **(Santos *et al*., 2015).** Salt affects microbiological stability because a reduction in initial water activity promotes the development of starter cultures and reduces contamination of the microbiota **(Fontán *et al*., 2007). Puupponen-Pimiä *et al*. (2001)** observed that blackcurrants have limited antibacterial properties. They found that blackcurrant was the least effective fruit extract they used against gram-negative bacteria.

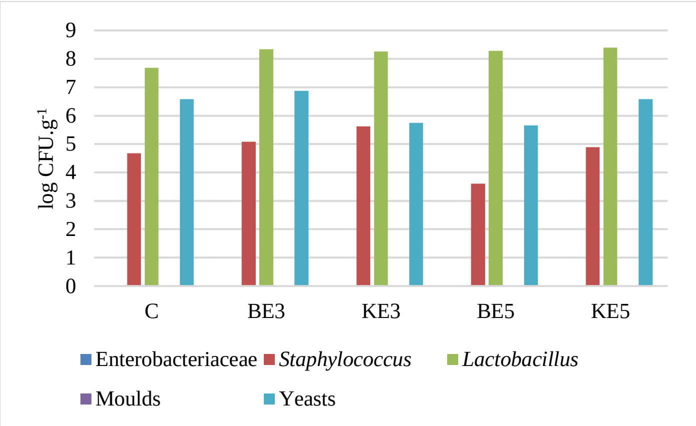

Figure 6 Counts of selected groups of microorganisms in samples of fermented meat products after 45 days of ageing and storage **Note:** C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

Compared to the findings after 5 days of ageing and storage, moulds were no longer been detected after 45 days of ageing and storage of the fermented meat product samples **(Figure 6)**. Significant increase in yeasts counts was detected in all experimental groups. Higher yeast counts were found in the control group (C), in the experimental group with the addition of 3 ml of black currant extract (BE3) and in the experimental group with the addition of 5 ml of kamchatka honeysuckle extract (KE5). The effect of *Lactobacillus sakei* bacteria on the quality characteristics of dry-fermented sausages was investigated by **Ameer *et al*. (2021).** From an initial count of 7.47 log CFU.g^{-1} to 8.30 log CFU.g^{-1} on day 7, they found that the counts of *Lactobacillus* spp. increased rapidly during the study period. After 21 days, their counts dropped dramatically ($P < 0.05$) to 6.18-7.25 CFU.g^{-1}. It is possible that the reason for this slight decrease in the counts of lactic acid bacteria (LAB) is due to the decrease in water and fermentable carbohydrate activity during ageing.

Lau *et al*. (2021) investigated the effect of adding cranberry pomace (CP) on *Salmonella enterica* inactivation, starter culture population and physicochemical properties of sausages to produce dry fermented sausages (DFS). Typical fermentation and drying conditions were applied to sausages carrying a cocktail of five *S. enterica* serovar strains at 7 log CFU.g^{-1}, with varying amounts of CP (control, 0%; low, 0.55%; medium, 1.70%; high, 2.25% w/w) or liquid lactic acid (0.33% w/w, LA). The findings showed that the level and rate of *Salmonella* inactivation in fermented meat matrix are concentration dependent and that CP has a significant effect on this process. Overall, moderate to high CP concentrations increased the development of LAB, although the growth of *Staphylococcus* species was inversely proportional to the degree of CP. The addition of low concentrations of CP resulted in better inactivation of *Salmonella* as well as DFS, which resembled standard DFS in terms of physicochemical, colour and textural properties. Sausages made from DFS combined with medium and high CP content had a finer texture and a redder, duller, and darker hue. The increase in CP content results in immediate acidification of the meat matrix to pH 5.2 (i.e., before fermentation occurs) and adversely affects the texture, making it unpleasant to customers.

Sensory analysis

Sensory analysis **(Figure 7)** revealed a beneficial effect of kamchatka honeysuckle extract in the amount of 3 ml.kg^{-1} (KE3) on taste and acidity after 15 days of fermented sausages ageing. Higher addition of kamchatka honeysuckle extract (KE5) resulted in lower sensory quality compared to lower addition of this extract (KE3). Blackcurrant extract in the amount of 5 ml.kg^{-1} (BE5) had no beneficial effect on taste in comparison with other tested samples until 15th days of ageing. It was probably due to higher value of acidity.

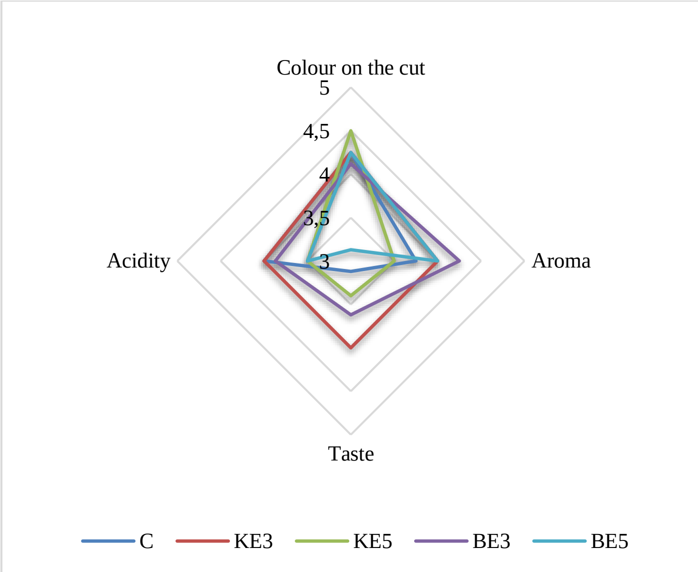

Figure 7 Sensory quality of fermented meat products after 15 days of ageing **Note:** C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

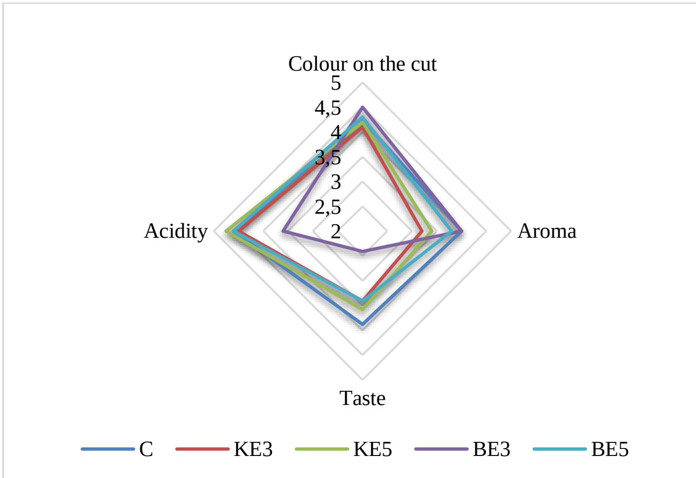

Figure 8 Sensory quality of fermented meat products after 30 days of ageing **Note:** C - sausages with starter culture, BE3 - starter culture + 3 ml blackcurrant extract, KE3 - starter culture + 3 ml kamchatka extract, BE5 - starter culture + 5 ml blackcurrant extract, KE5 - starter culture + 5 ml kamchatka extract.

Sensory analysis revealed a beneficial effect of kamchatka honeysuckle extract in the amount of 3 ml.kg^{-1} (KE3) after 30 days of fermented sausages ageing. On the other hand, blackcurrant extract in higher amount (BE5) had a beneficial effect on sensory quality after 30th day. Traditional kamchatka honeysuckle aroma was probably transferred into the samples of meat product and caused lower sensory scores.

Walczycka & Migdał (2007) improved the properties of model comminuted sausages by using dried powders of black currant, black chokeberry, and carrot. The model fillings consisted of 80% pork and 20% fat, 30% water and 2% salt for curing. Two different amounts of blackcurrants, black chokeberries, and carrots (3% and 7%) were added. The sensory panel approved the sausages with the addition of black chokeberry, indicating that this addition may be beneficial for commercial fillings. The blackcurrant ingredient may be used in a burger recipe, but not more than 3% of the total batch. Compared to the control sausages, the flavour of the model sausages was improved by the addition of carrot powder, which also improved the sensory evaluation. The potential use of polyphenolic extracts from blackcurrant and cherry leaves as natural antibacterial agents in meat products was assessed by **Nowak *et al*. (2016).** The extracts dramatically reduced the formation of MDA after 14 and 28 days of refrigeration of sausages, suggesting an antioxidant effect. After 28 days of storage, colour changes were noticeable in all treatments with and without polyphenols. The shelf-life of vacuum-packed sausages was prolonged using blackcurrant and cherry leaf extracts. After 14 days of refrigeration, the microbiological quality of the pork sausages improved with both extracts. Polyphenols found in sour cherry leaves were more effective against almost all studied groups of microorganisms. **Mandić *et al*. (2018)** evaluated the effect of vacuum-packed Kranjska sausages on the quality of natural casing treatment using ethanol or aqueous extract of the blackthorn fruits (*Prunus spinosa* L.). Three experimental groups of sausages were produced. First, a traditional sausage was stuffed into a natural casing, then a sausage was stuffed into a natural casing that had been previously immersed in an ethanol extract of blackthorn, and finally a sausage was stuffed into a natural casing that had been previously immersed in an aqueous extract of blackthorn. The sensory quality and chemical composition of the different sausages were not significantly different ($P \geq 0.05$). This study showed that vacuum-packed Kranjska sausages stored for 60 days at 4 °C had less LAB on the outside when blackthorn extract was added to the natural casing before filling. Since the herbal extracts did not diffuse into the filling and were present in amounts small enough to significantly affect the changes in TBARS values or the decrease in acid and peroxide counts, the sausages with treated casings did not show significantly better oxidative stability during storage.

CONCLUSION

The addition of blackcurrant and kamchatka honeysuckle extracts in quantities of 3 and 5 ml.kg^{-1} did not adversely affect the ageing process of fermented meat product samples determined based on pH. After 45 days of ageing period, we found higher malondialdehyde (MDA) values in all experimental groups (except for the experimental group with the addition of 3 ml blackcurrant extract). The addition of the extracts in the tested quantities did not cause demonstrable differences in the intensity values of brightness (L^*), red (a^*) and yellow (b^*) colour throughout the ageing period. Microbial examination indicates that the addition of blackcurrant and kamchatka honeysuckle extracts did not inhibit the growth of starter culture. Bacteria of the genus *Lactobacillus* and *Staphylococcus* predominated in all experimental groups. Family Enterobacteriaceae was not detected after 45 days of ageing and storage. Moulds were detected only after 5 days of ageing and in the experimental groups with the addition of blackcurrant extracts. The counts of yeasts gradually increased with increasing ageing time in all experimental groups. Sensory analysis revealed a beneficial effect of kamchatka honeysuckle extract in the amount of 3 ml.kg^{-1} after 30 days of fermented sausages ageing. On the other hand, blackcurrant extract in higher amount (5 ml.kg^{-1}) had a beneficial effect on sensory quality after 30th day. Traditional kamchatka honeysuckle aroma was probably transferred into the samples of meat product and caused lower sensory scores. Due to the known functional properties of black currant and kamchatka honeysuckle, we recommend carrying out their further analyses on the quality of fermented meat products.

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