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CHANGES IN THE SENSORY PROFILE OF NITRITE-FREE SALAMI FORMULATED WITH THE ADDITION OF FRUIT POWDER MIXTURES

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Abstract

This study evaluated the effects of incorporating fruit powder mixtures, consisting of sour cherries powder (SCP), blackcurrants powder (BCP) and cranberries powder (CP), as natural sodium nitrite substitutes on the sensory attributes of nitrite-free salami. Four powder mixtures (SCP+BCP, BCP+CP, CP+SCP and BCP+CP+SCP) have been included in the salami formulas at a dose to provide a total phenol content (TPC) of 90, 200 and 300 mg gallic acid equivalent (GAE)/kg meat, with the minimum dose set according to the level of nitrite content per kg of processed meat (90 mg nitrite/kg). Before use, the fruits were slowly convective dehydrated at a temperature of 60°C. The results revealed that the addition of fruit powder mixtures impacted on the appearance of sample, while other sensory characteristics did not show any significant change. The highest overall acceptability was recorded for sample with BCP+CP+SCP in a dose that provided a TPC of 300 GAE/kg meat. Thus, fruit powders could become an attractive option in the formulation of nitrite-free meat products due to their high total phenol content.

Key words*: fruit powder mixtures, nitrite-free salami, sensory profile, sodium nitrite substitute.*

INTRODUCTION

An important part in human diet are meat and meat products, therefore their quality and safety are very important (Custură et al., 2012; Lelieveld, 2015). The meat industry has been seriously affected by the discovery of carcinogenic and genotoxic N-nitroso compounds (NOCs) in processed meat products. Nitrite is used to improve flavor and color and to prevent lipid oxidation in the curing of various meat products (Savu & Petcu, 2002; Petcu, 2006; Sebranek & Bacus, 2007).

Currently, there is a noticeable concern for methods to reduce the use of nitrites and nitrates in meat or meat products (Cadariu et al., 2022; Lee et al., 2020; Zhang et al., 2023).

To improve the health benefits and shelf life of meat products, the meat industry is keen to find cost-effective natural additives (Abd El-Khalek et al., 2013; Marin et al., 2015; Abdel-Naeem et al., 2022; Bariya et al., 2020). Nowadays, consumers are becoming increasingly aware of what they eat and the possible health implications of using synthetic additives, which has led them to set restrictive requirements for their food, which should be nutritious, high quality and free of any antioxidants or chemical preservatives (Aziz & Karboune, 2018; Manihuruk et al., 2017; Sharma & Yadav, 2020).

As an alternative to using synthetic additives, the meat industry has been encouraged to use plant-based additives in meat systems (Grispoldi et al., 2022; Munekata et al., 2020; Shah et al., 2014). Therefore, one of the most common alternatives is the use of fruits, vegetables, herbs and other plant extracts or powders as natural preservatives to improve the quality of meat products and extend their shelf life (Beya et al., 2021; Manessis et al., 2020; Nikmaram et al., 2018; Reddy et al., 2018).

Natural nitrate is considered to be more functional for this purpose for two reasons: first of all, the amount of nitrate that enters and

remains can be lower than that of its synthetic counterparts, and secondly, it can be approved for biological use (Nicorescu et al., 2018; Pennisi et al., 2020).

In the meat processing, nitrite is considered to be a multifunctional food additive (Petcu, 2013). Due to its potential carcinogenic effects in humans, several studies have suggested that nitrite intake should be limited. On the other hand, some studies have demonstrated the favorable effects of nitrite on human health, if legal requirements and food safety are implemented (Mitrea et al., 2003; Goncearov et al., 2004; Petcu et al., 2007; Ianițchi et al., 2007). Nevertheless, consumer interest in natural or nitrite-free meat products remains significant (Cadariu et al., 2022).

In the meat-processing industry, fruit and vegetable powders can replace sodium nitrite. Liang et al. (2023) investigated the effects of different addition levels and marinating times on the properties of roast beef patties using Chinese cabbage, celery and cranberry powders. With regard to the different marinating times using cranberry powder on the properties of roasted beef patties, the marinating time of 12 hours showed the best effect. The analysis of this study revealed a possible solution for the replacement of nitrites in roast beef meatballs, also the research results indicated that cranberry powder could effectively increase the redness in roast beef meatballs and could potentially replace and reduce the number of synthetic nitrites.

The use of tomato processing by-products in smoked and burnt sausages compared to smoked and dried sausages was also analyzed as a nitrite replacement. Results analyzed it was noted a stronger inhibitory effect against lipid oxidation, with the addition of tomato processing byproduct as a natural antioxidant in reformulated nitrite-free sausages.

Abdel-Naeem et al. (2022) highlighted the effect of fruit powder specifically fruit peels namely lemon, orange, grapefruit, and banana (1% each), on the oxidative stability, microbial quality, physicochemical properties and sensory attributes of chicken meatballs during storage. As a result, in comparison with control samples all fruit peel powders showed significant antioxidant and antibacterial activities. The sensory characteristics were also improved in all samples analyzed; therefore, this study shows once again that the use of fruit peel powders can be used as a natural source of antioxidants.

Nour (2022) used fruit mixes such as sour cherries and plums in the form of marinades, used with pork pulp, to study the effect of fruit on quality characteristics and oxidative stability. Following the results, it was found that cherry and plum juice can be used as a marinating ingredient, as it increases the sensory properties and improves the storage stability of pork pulp.

In another study, the sensory evaluation, residual nitrite and oxidation levels of Chinese-style sausages were investigated, which were produced by both the reduction of nitrite levels and the addition of tomato powder (0%, 2% and 4%). Analysis of the results showed that nitrite reduction increased and oxidation levels decreased with the addition of 2% tomato powder, a result that suggests a potential solution for replacing nitrite in meat products (Xu et al., 2013).

The high content of bioactive compounds in fruits and fruit processing by-products has led them to be seen as an attractive possibility to slow down or inhibit lipid oxidation reactions, acting in the direction of preventing the formation of free radicals or as scavengers of free radicals (Doaa & Refaat, 2017; Shui & Leong, 2006). A recent study on the replacement of nitrates with a natural additive addressed the use of cranberry powder in the manufacturing process of fermented sausages, leading to improved quality characteristics (Yang et al., 2023).

Research on the effect of incorporating fruit powder (sour cherries, blackcurrants and cranberries) into salami formulas on sensory characteristics was conducted by Moraru Manea et al. (2022). Based on the observed findings, the research was continued by incorporating fruit powders into salami in the form of SCP+BCP, BCP+CP, CP+SCP and BCP+CP+SCP mixtures, following the impact of their addition on the sensory properties of the designed nitrite-free salami formulations.

MATERIALS AND METHODS

Fruit powder production

Three species of fruits were used, such as: sour cherries (SC), blackcurrants (BC) and cranberries (C), which were incorporated as powder in the manufacturing recipe of salami

formulas. For this purpose, the fruits were dehydrated and ground. The dehydration process lasted 15 hours (5 h per day, 3 days in a row) at a moderate temperature of 55-60°C in a forced-air oven (Froilabo AC60/France, 1000 W) to preserve the bioactive compounds of the fruits. Dehydrated fruits were ground with a laboratory mill (Grindomix Retsch GM 2000). The fruit powders obtained (SCP, BCP and CP), in the form of mixtures, two-by-two and all three, were used to replace sodium nitrite in salami formulas.

Determination of total phenolic content of fruits powder

Since the doses of fruit powder in the form of mixtures were calculated according to their total phenolic content (TPC), the corresponding TPC was determined by Folin-Ciocalteu colorimetric method (Singleton et al., 1999). The results were expressed in mg gallic acid equivalents (GAE)/g dry weight (d.w).

Salami formulas preparation

The stages of the salami manufacturing process are as follows: weighing of raw material, weighing of auxiliary material, mixing of raw material by adding auxiliary material, filling of membranes, heat treatment and storage. In order to replace sodium nitrite, the mixture fruits powder is used in three doses, to ensure a level of total phenolic content (TPC) of 90, 200, 300 mg GAE/kg in salami recipe in the mixing stage with raw material and other auxiliary materials. The added nitrite content in 1 kg of raw minced meat is 90 mg/kg, from this value was chosen a minimum dose of total phenolic compounds from dehydrated fruit powder. The amounts of powder from each fruit in the mixtures were calculated to make an equal contribution to the TPC doses. Nitrite-free salami formulations were analyzed in comparison with control salami samples prepared with added nitrite and without nitrite, respectively.

Heat treatment of salami samples with the addition of fruit powder mixes takes place in a smoking cell with closed smoke flap, the samples are smoked with beech sawdust and steamed until they have reached 62°C in the technological center of the product. The last step in the technological process of salami manufacturing is the storage of the product at 2-4°C. After 21 days of storage, the sensory analysis is performed.

The sample were labeled, as follows:

- SC: Salami control sample;
- SCN: Nitrite-free Salami;
- S(SCP+BCP)90: Salami formula with mixture of SCP and BCP to ensure a TPC of 90 GAE/kg of raw processed meat;
- S(SCP+BCP)200: Salami formula with mixture of SCP and BCP to ensure a TPC of 200 GAE/kg of raw processed meat;
- S(SCP+BCP)300: Salami formula with mixture of SCP and BCP to ensure a TPC of 300 GAE/kg of raw processed meat;
- S(BCP+CP)90: Salami formula with mixture of BCP and CP to ensure a TPC of 90 GAE/kg of raw processed meat;
- S(BCP+CP)200: Salami formula with mixture of BCP and CP to ensure a TPC of 200 GAE/kg of raw processed meat;
- S(BCP+CP)300: Salami formula with mixture of BCP and CP to ensure a TPC of 300 GAE/kg of raw processed meat;
- S(CP+SCP)90: Salami formula with mixture of CP and SCP to ensure a TPC of 90 GAE/kg of raw processed meat;
- S(CP+SCP)200: Salami formula with mixture of CP and SCP to ensure a TPC of 200 GAE/kg of raw processed meat;
- S(CP+SCP)300: Salami formula with mixture of CP and SCP to ensure a TPC of 300 GAE/kg of raw processed meat;
- S(BCP+CP+SCP)90: Salami formula with mixture of BCP, CP and SCP to ensure a TPC of 90 GAE/kg of raw processed meat;
- S(BCP+CP+SCP)200: Salami formula with mixture of BCP, CP and SCP to ensure a TPC of 200 GAE/kg of raw processed meat;
- S(BCP+CP+SCP)300: Salami formula with mixture of BCP, CP and SCP to ensure a TPC of 300 GAE/kg of raw processed meat.

Sensory characteristics evaluation

Sensory analysis of the designed salami formulas was carried out using the hedonic scale method (STAS 12656-88) by a group of 20 tasters (10 men and 10 women) which were recruited from the staff and students of the University of Life Sciences “King Mihai I” from Timisoara, Romania.

The evaluators, aged between 20 and 50, were regular consumers of meat products. The participation of evaluators in this study was voluntary.

Prior to the sensory analysis, panel members were trained to identify the characteristics that will be assessed. Evaluators assessed the sensory attributes of salami samples including appearance, flavor, texture, taste and overall acceptability according to their rating and awarded points according to the five-point hedonic scale as follows: 5 - highly appreciated; 4 - moderately appreciated; 3 - neither liked nor disliked; 2 - slightly disliked; 1 - extremely disliked (Cadariu et al., 2023).

By adding up the maximum points allowed for each sensory attribute, a maximum of 20 points can be achieved. Each taster assigns a score to one sensory characteristic of a sample. The average score is then calculated. The sum of the average scores of the 4 sensory attributes analyzed for a test will result in the overall average score. Each sample has an overall average score, which helps us to identify which concentration level of the added fruit powder is more effective to ensure an optimal level of natural antioxidant, but also which is the best fruit powder among the three analyzed (SCP, CP, BCP) as a substitute for sodium nitrite.

By analysing the average total score of each salami sample, it is possible to identify which concentration of fruit mixture powder has a similar effect on sensory characteristics as the nitrite dose, in order to be recommended as its substitute.

RESULTS AND DISCUSSIONS

Total phenolic compound of fruit powder

The results obtained from the analysis of total phenolic compounds (TPC) were presented in Table 1.

Table 1. Total phenolic content of fruits powder

Fruits powder	Total phenolic content (mg GAE)/g d.w)
BCP	14.68
CP	11.49
SCP	9.55

Based on the values obtained, the amounts of fruit powder providing particular levels of TPC in the designed salami formulas were determined.

Sensory characteristics of salami formulas

Sensory evaluation of the salami formulas was carried out to identify the acceptability of the designed products. Figure 1 shows the salami formulations obtained by adding the SCP+BCP mixture to ensure a TPC level of 90, 200 and 300 GAE/kg processed raw meat, compared to the SCN and SC control samples.

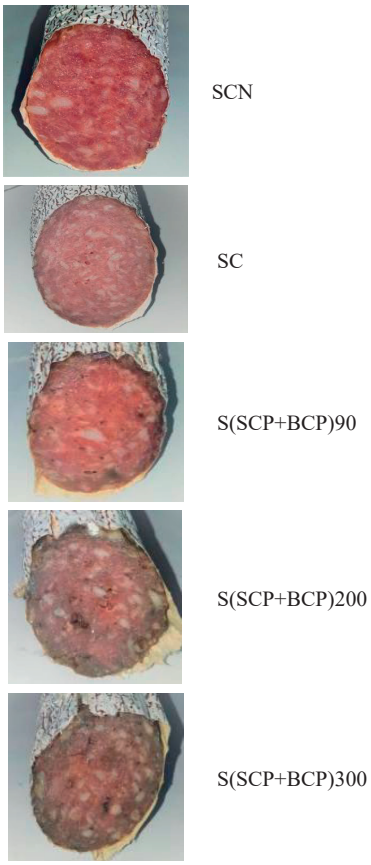

Figure 1. Control samples and salami formulas with addition of SCP+BCP mixture (own source)

Figure 2 shows the results obtained from the sensory analysis of salami formulations. It can be observed that the sample with the highest score was S(SCP+BCP)300 with 21.8 points on the total average score, followed by S(SCP+BCP)200 with 18.8 points and S(SCP+BCP)90 with 16.9 points, which is the lowest total average score of the salami samples. In terms of appearance, the average scores awarded by assessors increased in the order S(SCP+BCP)300 > S(SCP+BCP)200 >

S(SCP+BCP)90 suggesting that the addition of fruit powder mixture in a dose to provide a TPC of 300 GAE/ kg of raw processed meat with mixture of SC powder and BC powder is the most appreciated sample by the evaluators.

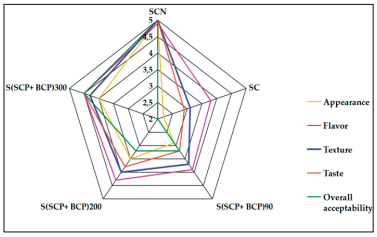

Figure 2. Sensory evaluation scores of salami with SCP+BCP mixture versus control samples

The mixtures contain sour cherry powder which slightly influences the taste that had decreasing values, the other sensory characteristics flavor texture did not change significantly.
The salami formulas with BCP+CP mixture are presented in Figure 3.

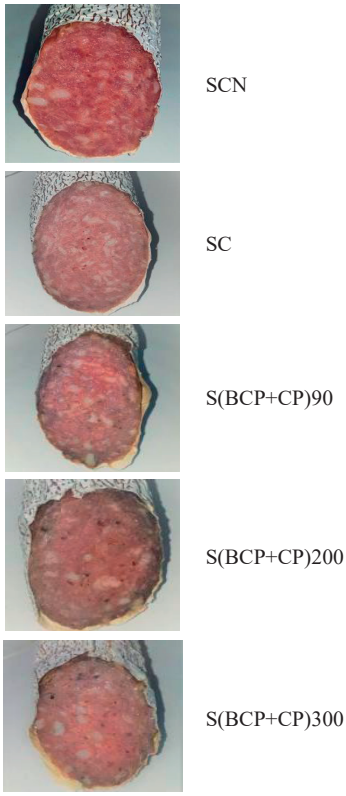

Figure 3. Salami control samples and salami formulas with addition of BCP+CP mixture (own source)

From the results of sensory analysis depicted in Figure 4, it can be seen that the highest scores have been registered for salami sample S(BCP+CP)300 with 23.4 points for overall acceptability, followed by S(BCP+CP)200 with 22.7 points and S(BCP+CP)90 with 20 points.

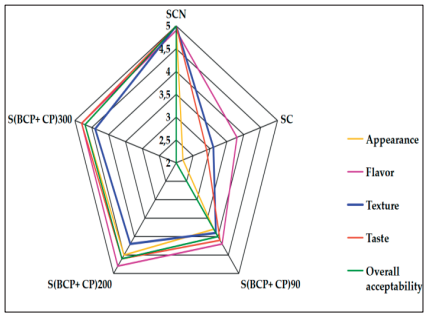

Figure 4. Sensory evaluation scores of salami with BCP+CP mixture versus control samples

As regard the appearance, the highest value was registered for the salami sample S(BCP+CP)300 (4.7) respectively S(BCP+CP)200 (4.5) and the lowest value for sample S(BCP+CP)90 (3.8) as it can be observed in Figure 5. The other sensory features did not undergo significant changes.
The salami formulas obtained by incorporating the CP+SCP mixture are shown in Figure 5, and the results of the sensory analysis of the developed formulas against SC (control sample) and SCN (nitrite-free sample) are shown in Figure 6.
The sensory ratings of salami formulations containing a mixture of CP and SCP with different TPC levels increased in the following order: S(CP+SCP)90 with 20 points, S(CP+SCP)200 with 21.7 points and S(CP+SCP)300 with 22.7 points.
A sensory characteristic that has undergone slight changes is the appearance, with 3.9 points for S(CP+SCP)90 sample, 4.2 points for S(CP+SCP)200 sample and 4.4 points for S(CP+SCP)300 sample the highest scores. No significant changes were observed for other characteristics.

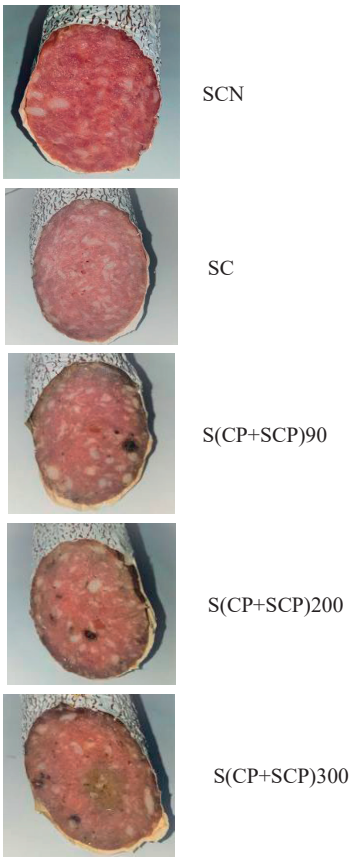

Figure 5. Salami control samples and salami formulas with addition of CP+SCP mixture (own source)

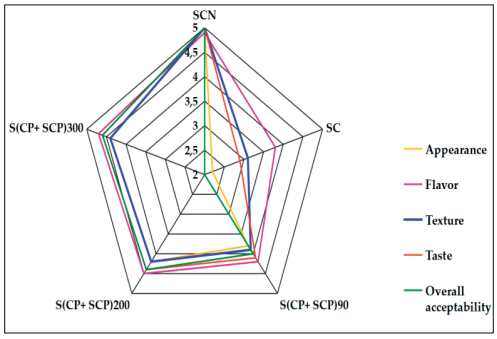

Figure 6. Sensory evaluation scores of salami with CP+SCP mixture versus control samples

The fourth fruit powder blend consists of all three fruit powders (BCP, CP and SCP). This blend is incorporated as a natural substitute for sodium nitrite in the salami recipe to provide the three levels of TPC. The obtained salami formulations are presented in Figure 7.

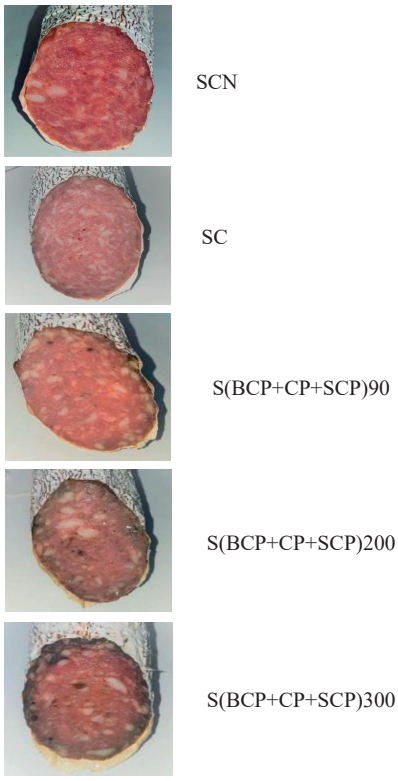

Figure 7. Salami control samples and salami formulas with addition of BCP+CP+SCP mixture (own source)

Results obtained from the sensory analysis of the salami formulas with addition of BCP+CP+SCP mixture are shown in Figure 8.

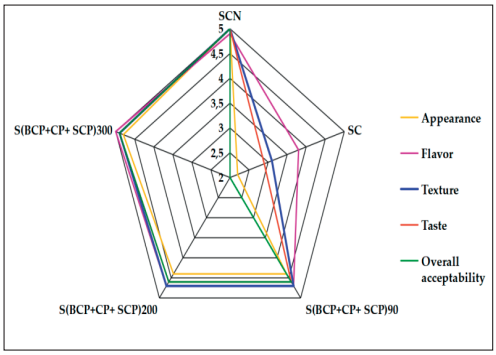

Figure 8. Sensory evaluation scores of salami with BCP+CP+SCP mixture versus control samples

It can be seen that in terms of appearance of the samples, the score increased significantly as the level of TPC provided by the fruit powder mixture increases from 4.4 points S(BCP+CP+SCP)90 sample, to 4.7 points

S(BCP+CP+SCP)200 sample, to the highest score of 4.8 points S(BCP+CP+SCP)300 sample. The other sensory characteristics did not change significantly. The data represented in Figure 8 revealed that the highest value for overall acceptability was obtained for salami formulas S(BCP+CP+SCP)300, with 24.5 points, followed by S(BCP+CP+SCP)200 sample with 23.4 points, while the lowest value with 23 points was obtained for sample S(BCP+CP+SCP)90.

CONCLUSIONS

Fruit powder, as a natural antioxidant, is used as a substitute for sodium nitrite in salami formulas.

In order to determine the most favorable fruit powder mixture, as well as the dose that does not impair sensory attributes, an analysis of the sensory characteristics of nitrite-free salami formulas was presented.

The results showed that, compared to control samples with or without added sodium nitrite, there were changes in the appearance of salami formulas with added fruit powder mixtures, while other sensory characteristics did not show a significant influence.

Higher scores were obtained for all salami formulas than for the nitrite-free control sample, but the highest overall acceptability was recorded for the salami formula with BCP+CP+SCP, which provided a total phenol content of 300 GAE/kg raw meat with 4.9 points, and an average total score of 24.5 points.

Analyzing the changes in the sensory profile of salami formulas without nitrites but with the addition of fruit powder blends, it can be concluded that fruit powders can successfully replace nitrites in boiled and smoked salami formulas, therefore being recommended as a natural additive for this purpose.

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