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# Influence of polyphenols on sensory properties of fermented sausages

A Nikolic<sup>1</sup>, N Grkovic<sup>2</sup>, S Djuric<sup>2</sup>, J Jovanovic<sup>1</sup>, V Djordjevic<sup>1</sup>, D Trbovic<sup>1</sup> and D Vasilev<sup>2</sup>

<sup>1</sup> Institute of Meat Hygiene and Technology, Kačanskog 13, 11040 Belgrade, Republic of Serbia

<sup>2</sup> Faculty of Veterinary Medicine, University of Belgrade, Bulevar Oslobođenja 18, 11000 Belgrade, Republic of Serbia

Email: [aleksandra.nikolic@inmes.rs](mailto:aleksandra.nikolic@inmes.rs)

**Abstract.** In the current research, the use of polyphenols in the production of fermented sausages as a natural preservative and their influence on the sensory characteristics of these products were investigated. Polyphenols could have antimicrobial and antioxidant roles in meat products, but also a range of positive biological effects on consumers. The results of the research showed that the addition of polyphenols did not significantly affect the sensory properties (colour, cross-section appearance, consistency, odour and flavour) of the three groups of sausages (control fermented sausage and two sausage variants, one with nitrite and one without nitrite), and that sausages were highly rated during most of the storage period. In addition, all tested sausages were evaluated as acceptable until the end of the entire storage period, i.e., throughout the 280-day period after sausage production.

## 1. Introduction

Polyphenols are secondary metabolites of plants that play physiological roles in leaves by protecting them from microorganisms and ultraviolet irradiation. These compounds include flavonoids (anthocyanidins, flavonols, flavanols, isoflavonoids, flavones and flavanones) and phenolic acids. It has been proven that polyphenols can exert a range of positive biological effects on consumers including antioxidative, anticarcinogenic, anti-inflammatory and antimicrobial ones, so they could play an important role as a functional ingredient in meat products, providing them the properties of functional food. Furthermore, some recent research indicates polyphenols could be used as natural preservatives in meat products [1]. Fermented sausages are meat products which, after being stuffed into casings, are preserved by fermentation and drying, i.e., ripening, with or without smoking. Salts, spices, additives etc. can be added to the stuffing of these sausages [2]. Since the fermented sausages are not heat treated during production, so their nutritive and bioactive ingredients keep mainly unchanged during production, they have great potential to be designed as functional foods [3] and to be carriers of polyphenols as a functional ingredient.

As prescribed by Serbian Regulation [2], the sensory properties of fermented sausages must meet certain criteria: the surface of sausages must not be deformed, the casing should fit well with the filling, the texture should be firm, the cross section should have the appearance of a mosaic composed of pieces



of meat and fat which are evenly distributed and well connected, the presence of cavities is not allowed on the cross sections, the colour should be stable, and the odour and flavour pleasant and characteristic. Sensory properties of fermented sausages are influenced by the quantity and quality of meat, but also by other ingredients incorporated in the stuffing [4]. The colour is a very important characteristic of meat products and is frequently a deciding factor for consumers when purchasing fermented sausages [5]. The typical aroma of dried fermented sausages results from the accumulation of volatile substances, such as alcohols, ketones, aldehydes, esters, terpenes, aliphatic hydrocarbons and furans, as well as non-volatile substances such as amino acids, peptides, sugars and nucleotides, which come from the basic ingredients of sausages (meat, spices and additives) or are formed by their enzymatic degradation during ripening [6].

In this study, the influence of polyphenols, added during the production of fermented sausages, on the sensory properties of fermented sausages during the entire storage period was examined.

## 2. Materials and methods

Three groups of fermented sausages were produced. The first group, control (C), comprised sausages of the usual composition: 35 % beef, 35 % pork and 27 % fatty tissue in which 2.2 % nitrite curing salt was added as a preservative. The second group of sausages (N+P) was of the same basic composition as the first one, but with 0.17 % added polyphenol preparation (grape skins and seeds powder), and the third group (P) was produced without the addition of nitrite, but with 0.17 % added polyphenol preparation as a natural preservative. All sausages also contained added: 0.2 % sugar, 0.2 % spice mix and starter culture.

The sausage stuffing was packed into collagen casings with a diameter of 55 mm, after which the sausages were subjected to the processes of smoking, drying and ripening, under the following conditions: tempering at room temperature for 12 hours; two days of fermentation at 26°C and relative air humidity (RH) 90 %; smoking occasionally for three days at 22°C to 24°C; drying and ripening at 15°C and RH which gradually decreased from 90 % to 75 % over 35 days. After ripening, the products were stored at 15°C. The sensory properties of all the produced fermented sausages were assessed using a quantitative descriptive test (ISO 8586-2: 2008 [7]; ISO 6564: 1985 [8]), by the evaluation of the following properties: colour, cross-section appearance, texture, odour and flavour. These parameters were evaluated on 0, 30, 70, 100, 130, 190, 220, 250 and 280 days of storage, according to a five-point score system in which 5 points meant 'excellent' and 1 point denoted 'unacceptable'. Scores were grouped according to sausage types and average scores were calculated. Sausages with scores of 2.0 and higher for each test trait were considered acceptable.

## 3. Results and discussion

The results of the sensory test showed that the cross-section appearance of all products was very similarly evaluated. In the first 70 days of storage, the cross-section appearance of P sausages received slightly lower grades ( $4.8 \pm 0.3$ ) than C sausages and N+P sausages (5.0 for both) did; this difference was not statistically significant ( $P=0.15$ ). From day 100 until the end of storage, the ratings for the appearance of the cross-section reduced, so that at the end of the storage period, P sausages were rated with an average grade of  $3.3 \pm 0.3$ , and C and N+P sausages  $3.0 \pm 0.0$  ( $P=0.03$ ).

During the storage, the average colour grade of P sausages was significantly lower during the first 30 days ( $4.4 \pm 0.5$ ), compared to the other two groups ( $5.0 \pm 0.0$  in both) ( $P=0.03$ ) because of a weaker developed red colour in the central parts of the sausage as well as the presence of a 5-10 mm wide peripheral ring. In this case it was not a "dry edge" as a consequence of over drying of the sausage surface, but the colouring of peripheral parts of sausages due to migration of diluted grape polyphenol pigments together with moisture which diffuses towards the periphery of the sausage during drying [9]. In the further stages of ripening and storage, this ring gradually disappeared, most likely as a consequence of the equalization of the colour of the sausage in the cross-section during the formation of stable forms of reduced myoglobin in the mature product, as stated by other authors [10]. Based on the above, the appearance of a darker coloured ring in sausages with polyphenols can be considered a

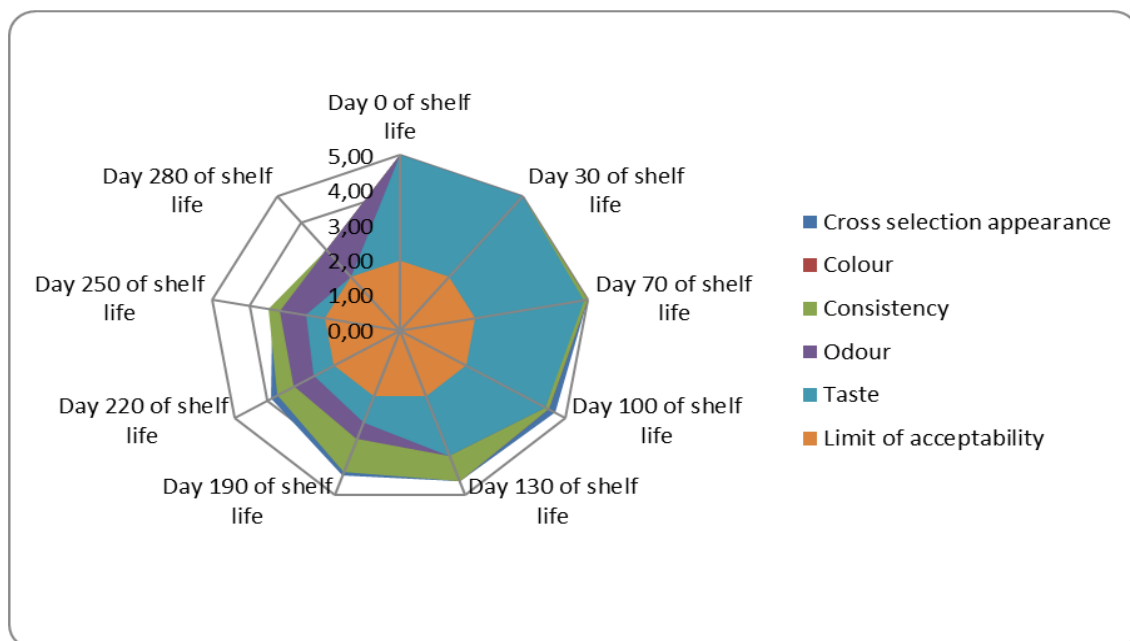
normal transient phenomenon, as also shown by colour ratings in the period between days 70 and 130, where the colour of P sausages was given better scores ( $4.5 \pm 0.3$  to  $4.6 \pm 0.3$ ) than at the beginning of storage and there were no statistically significant differences ( $P=0.83$ ) in colour grades between the three groups of sausages ( $C=4.6 \pm 0.2$  and  $N+P=4.6 \pm 0.2$ ). After 130 days of storage, the average colour grades of all sausage groups gradually decreased, so that on day 280 the average grade was 3.0 in all of them.

In terms of texture, all product groups were evaluated identically ( $P>0.99$ ). By day 70 of storage, the texture of all products was given 5.0 points, after which the grades gradually reduced so that on day 190, they averaged  $4.3 \pm 0.3$  and at the end of storage, they were 3.0 in all groups of sausages.

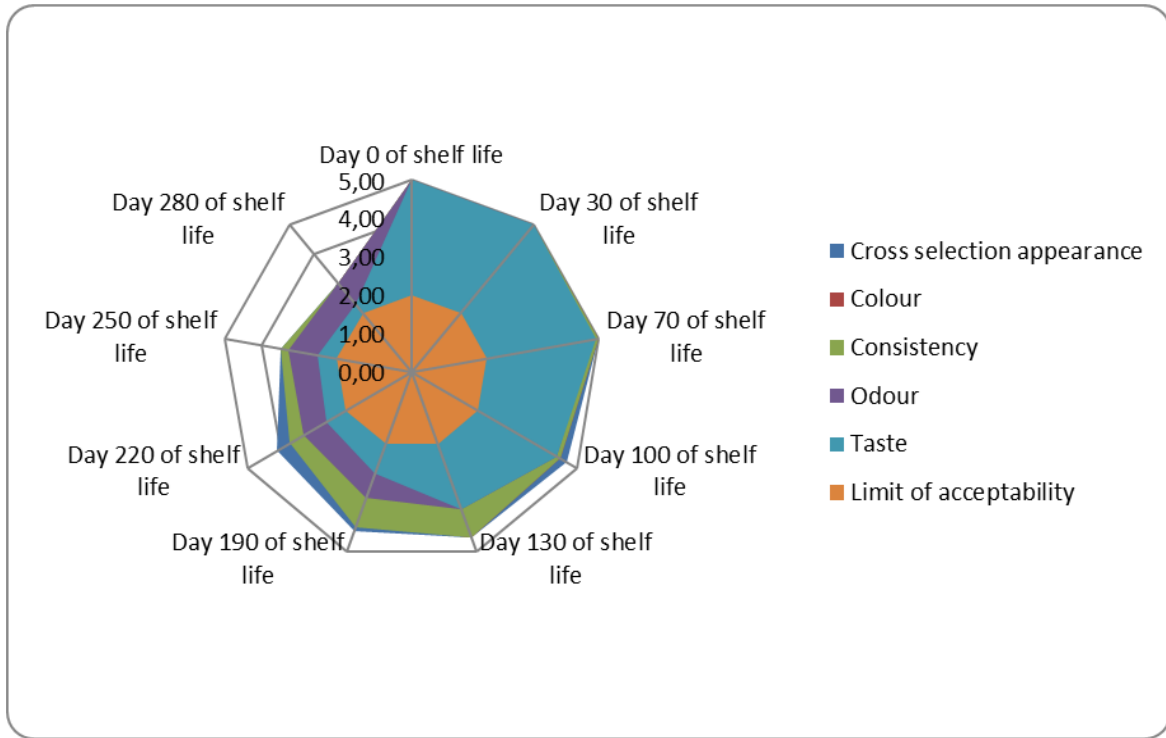
The odour of all groups of sausages was evaluated with an average grade of 5.0 until day 30, regardless of the method of storage (Figures 1, 2 and 3), after which odour grades gradually decreased so that on day 100 the average grade was  $4.3 \pm 0.6$  in P sausages, and  $4.4 \pm 0.5$  in C and N+P sausages, whereby these differences were not statistically significant ( $P=0.95$ ). The odour of P sausages was again slightly worse (3.0) on days 220 and 250 than of C ( $3.2 \pm 0.3$ ) and N+P sausages ( $3.3 \pm 0.3$ ), but this difference was not statistically significant ( $P=0.4$  and  $P=0.7$ , respectively). At the end of storage, the odour of all sausages was evaluated with the same average grades (3.0). The acceptable odour of sausages with polyphenols at the end of storage can be attributed to the antioxidant role of polyphenols, described by some other authors [1] and confirmed by lower lipid oxidation parameters we determined (data not shown).

The taste of P sausages ( $4.80 \pm 0.4$ ) was worse in the first 30 days compared to C and N+P sausages (5.0), but this difference was not statistically significant ( $P=0.46$ ). From day 70, the grades gradually reduced, and all sausages were identically rated for taste. At the end of sausage storage, the taste of C sausages (2.0) was evaluated as the worst in comparison with N+P ( $2.3 \pm 0.4$ ) and P ( $2.4 \pm 0.4$ ) sausages, without statistically significant differences ( $P=0.2$  and  $P=0.4$ , respectively).

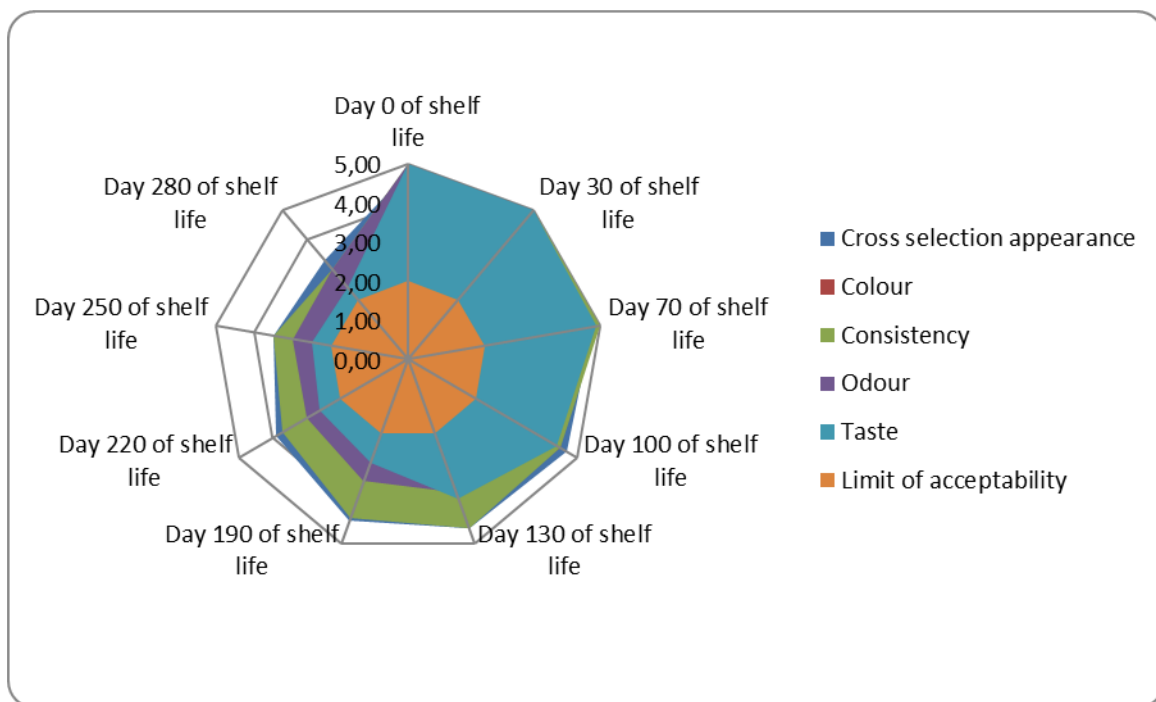
Sausages enriched with polyphenols were acceptable throughout the entire storage period of 280 days, with an average score of 3.0 for all the tested sensory properties, with control sausages being the lowest rated due to a poor and slightly rancid aroma, which received a score of 2.0. Moreover, all sausage groups were rated very highly even on day 190 of storage, which is important given that fermented sausages, according to some authors [11], are usually stored for no longer than 180 days.



**Figure 1.** Ratings of cross-section appearance, colour, consistency, odour and taste of sausages in the control sasusages (C) during storage



**Figure 2.** Ratings of cross-section appearance, colour, consistency, odour and taste of sausages with added nitrites and polyphenols (group N+P) during storage



**Figure 3.** Ratings of cross-section appearance, colour, consistency, odour and taste of sausages with added polyphenols, but without nitrites (group P) during storage

#### 4. Conclusion

The sensory characteristics of all the three groups of fermented sausages were evaluated as approximately the same, in all phases of storage. The decrease in grades for all parameters, especially after day 130 of storage, can be attributed to oxidative changes that endangered primarily the smell, taste, colour and appearance of the sausage cross-sections. Thus, this study confirms the possibility of achieving a prolonged shelf life for fermented sausages enriched with polyphenols, even those produced without nitrite.

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