# EVALUATION OF NITRITE, COLOUR AND RANCIDITY IN PORCINE COOKED SAUASAGES WITH ROSE-HIP'S EXTRACTS

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*Abstract*— **The aim of this study was to evaluate the effect of the addition of rose-hips ("*Rosa canina* L.") extracts, on the nitrite content, colour, and rancidity of porcine cooked sausages. Four different groups of cooked sausages were elaborated as follows: Control sausages (basic recipe, R1) were elaborated with 70 % meat cuts from Iberian pigs (≈ 22 % fat), 28 % water, 1.5 % sodium chloride and 0.5 % sodium phosphate. Additional groups were produced following the same basic recipe plus: a mixture of sodium nitrite (100 ppm) and sodium ascorbate (500 ppm) (R2) and the same additives (nitrite/ascorbate) together with a rose-hip extract at 0.5 % and 1.5 % (R3 and R4, respectively). Freshly made sausages (n=5) were analyzed for the nitrite content and instrumental colour. The rancidity of the cooked sausages (n=5) was evaluated after 45 days of chilled storage (4ºC) by analysing volatile compounds and by an olfaction test carried out by non-trained panellists (n=10). As expected, R1 showed lower levels of residual nitrite than sausages from R2, 3 and 4. Sausages from R2, 3 and 4 were redder (higher a*-values) than those from R1. Cooked and chilled sausages from R3 and R4 had significantly lower amount of lipid-derived volatiles than those from R1. Additionally, sausages from R3 and R4 were found to be less rancid than those from R2 and were the most preferred by the non-trained panellists. Therefore, the presence of dog-rose extracts improved the oxidative stability and sensory quality of cooked sausages.**

*Keywords*—**nitrite, colour, rancidity cooked sausages.**

## I. INTRODUCTION

Lipid oxidation is the main cause of deterioration of cooked meat due to an acceleration of oxidative process during processing at high temperature. The oxidative degradation of lipids causes a decline of nutritional and sensory quality of meat and meat products and consequently in the consumer's acceptance (*1*).

During handling, processing and storage lipid oxidation occurs due to an autoxidative mechanism involving free radical formation. Primary lipid peroxidations are unstable and decompose to generate various secondary products, such as aldehydes that can contribute to food rancidity. Secondary and final oxidation products such as malondialdehyde and hexanal, are reliable indicators of oxidative deterioration in meat products (*2*).

Lipid oxidation in meat and meat products may be controlled using synthetic or natural antioxidants. In addition, some food additives, such ascorbic acids and phosphates, could increase the antioxidant protection of meat products. Synthetic antioxidants, such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG) and tertiary butyl hydroquinone (TBHQ) have been widely used in the food industry to control oxidative reactions. However, over the past few years the use of such synthetic substances has begun to be restricted because of their potential health risks.

Concomitantly, the interest in the development and use of natural antioxidants has increased markedly. In recent times, the usage of antioxidants from plant kingdom in the form of pure compounds, extracts and/or essential oils has spread out extensively in the meat industry (*3*). These natural substances are recognised as convenient options to reduce oxidative reactions in foods because they are generally well-accepted by consumers and their effectiveness in extending shelf-life of food products has been extensively documented (*4*).

A wide variety of wild Mediterranean fruits and berries are found in the Mediterranean forest such as arbutus-berries (*Arbutus unedo* L.), common hawthorns (*Crataegus monogyma* L.), rose hips (*Rosa canina* L.) or elm-leafblack-berries (*Rubus ulmifolius* Schott.), amongst others. These wild Mediterranean fruits contain phenolic compounds, namely, flavonoids and phenolic acids, which compose two large and heterogeneous groups of biologically active non-nutrients with antioxidant activity. Phenolic extracts derived from the fruits aforementioned have been reported to be effective enhancers of the oxidative stability of meat patties, particularly, those obtain from the rose hip (*4*).

The present study aimed to evaluate the effect of phenolic-rich extracts derived from rose hip on colour, nitrite content and rancidity in cooked sausages.

## II. MATERIALS AND METHODS

### *A. Fruits*

Samples of rose hip (*Rosa canina* L.) were collected at full ripeness in the Cáceres region, Spain, during the autumn of 2010. After hand-harvest, the samples were immediately transferred to the laboratory, cleaned and sorted to eliminate damaged and shrivelled fruits and then frozen at -80ºC.

### *B. Preparation of fruit extracts for cooked sausages*

Fruits (30 g), including peel and pulp, were cut into pieces while the seeds were carefully removed. The fruit was ground, dispensed in a falcon tube and homogenized with 10 volumes (w/v) of absolute ethanol. The homogenates were centrifuged at 2600g for 10 min at 6 ºC. The supernatants were collected and the residue was re-extracted once more following the procedure previously described. The two supernatants were combined, evaporated using a rota-evaporator and redissolved using 250 g of distilled water. Water solutions from each fruit were prepared and stored under refrigeration until used for the manufacture of porcine burgers (less than 24 h). No insoluble fragments or residues were observed in the water solutions (*4*).

### *C. Manufacture of cooked sausages*

Four types of porcine cooked sausages were prepared with the addition of additives and rose hip's extracts including a negative control (no added extract). In the basic formulation (batch R1) the ingredients per percentage of sausage were as follows: 70 % meat cuts from Iberian pigs (≈ 22 % fat), 28 % distilled water, 1.5% sodium chloride and 0.5% sodium phosphate. Additional groups were produced following the same basic recipe plus: a mixture of sodium nitrite (100 ppm) and sodium ascorbate (500 ppm) (batch R2) and the same additives (nitrite/ascorbate) together with a rose-hip extract at 0.5 % and 1.5 % (batches R3 and R4, respectively).

Cooked sausages were manufactured in a pilot plant. Firstly, all ingredients were minced in cutter (Stephan UMC 5 Electronic) until a homogeneous raw batter was obtained. Subsequently, the mixture was stuffed into 18 mm diameter cellulose casings, hand linked at 10 cm intervals and given a thermal treatment in a hot water bath (80 ºC/30 min.). Finally cooked sausages were dispensed in polypropylene trays, wrapped with PVC film and then stored for 45 days at 4ºC. At sampling day 1, cooked sausages were taken out the refrigerator and analysed for nitrite content and instrumental colour measurements. At the end of the process was evaluated the rancidity of the porcine cooked sausages by analysing volatile compounds and by an olfaction test.

### *D. Colour measurements*

Instrumental colour (CIE L* a* b*, CIE, 1976) was measured in triplicate on the cross section of the porcine cooked sausages using a Minolta Chromameter CR-300 (Minolta Camera Corp., Meter Division, Ramsey, NJ) with illiminant $D_{65}$ and 0º standard observer. CIELAB L*, a*, b* values were determined as indicators of lightness, redness and yellowness, respectively. Chroma (C) and Hue angle (hº) values were obtained by using the following equations: C = (a*2 + b*2)0.5; Hº = arctg b*/a*.

### *E. Nitrite content*

Nitrite content was determined using official AOAC method.

### *F. Analysis of volatile compounds*

Volatile compounds were extracted by using the solidphase microextraction (SPME) (Supelco Bellefonte, PA) fibre coated divinylbenzene-carboxen-poly(dimethylxilosane) (DVB/CAR/PDMS) 50/30µm and subsequently analysed by gas chromatography coupled to mass spectrometry (GC-MS) (gas chromatograph Hewlett-Packer 5890 series II coupled to mass selective detector Hewlett-Packard HP-5973A). One gram of minced porcine cooked sausages was placed in 4-mL glass vials and sealed with a silicon cap. Before extraction, samples were pre-conditioned in a temperature-controlled water bath at 37 ºC for 30 min. After extraction, the SPME fibre was immediately transferred to the injector of the chromatograph, which was in splitless mode at 280 ºC. Volatiles were separated according to Estévez et al. (2005) (*5*). Subsequently, volatile compounds (5 ketones, 2 aldehydes and 1 alcohol) were either positively identified by comparing their linear retention indexes (LRI) with those from standard compounds (Sigma-Aldrich, Steinheim, Germany) or tentatively identified by comparing their mass spectra with those contained in the Wiley library and by comparison of their LRI with those reported in the scientific literature (*6*). Results are given in area units (AU).

### *G. Olfaction test*

A sensory detection of rancid odours was carried out at the end of the chilled storage. Approximately 10 g of each sample was placed in separate polystyrene tube and subsequently were held during 1 h at 21 ºC. Afterwards,

samples were randomly served and evaluated by a non-trained panel consisting of 10 members. The evaluation sessions were conducted in a sensory analysis room at constant temperature (24ºC) on three different sessions. Panelists were concentrated on detecting rancidity odours using a structured scale, from 1 (absolutely fresh) to 4 (very rancid).

### *H. Statistic analysis*

Data obtained from colour, nitrite and volatile content were evaluated by one-way Analysis of Variance (ANOVA). Tukey's test was performed when ANOVA revealed significant ($p< 0.05$) differences between formulations. SPSS (v. 12.0) software (1998) was used to carry out the statistic test. Data obtained from olfaction test was evaluated by Friedman test (non- parametric test). Wilconxon test was carried out when the differences between bathes were significant.

## III. RESULTS AND DISCUSSION

The nitrite content and the instrumental colour measurements of the experimental cooked sausages (R1, R2, R3 and R4 batches) after 1 day of their elaboration are shown in Table 1.

As expected, control cooked sausages (R1) showed a lower nitrite content compared to the counterparts ($p< 0.05$). However, no significant differences were found amongst nitrite-added batches (R2, R3 and R4). These results pointed out that the addition of rose hip's extracts did not affect the residual nitrite content in cooked sausages.

The addition of rose hip's extracts (R3 and R4) had a significant effect on the colour displayed by the cooked sausages (see Table 1). Thus, cooked sausages elaborated with rose hip's extract were darker (lower L*-value), and had a redder colour (higher a*-value), than R1 and R2. In addition, R3 and R4 batches displayed a more intense colour (higher saturation index), particularly R3. This fact was correlated to the red axis (lower hue angle value) found in the R2 batch. In general, rose hip's extracts plus sodium nitrite and sodium ascorbate had a significant effect of colour parameters, whereas the addition of these additives (R2 batch) led to increased the L* values and decreased a*, b*, saturation index and hue Angle. These results are in agreement with those found by Ganhão et al. (2010) (*4*), who also confirmed that the addition of phenolic extracts derived from rose hips improve the colour of meat patties with no apparent drawbacks.

The rancidity of the cooked sausages was evaluated after 45 days of chilled storage (4ºC) by analysing volatile compounds and by an olfaction test.

The content of lipid-derived volatiles from batches after chilled storage (45 days) is shown in figure 1. As can be seen, the addition of rose hip's extracts (R3 and R4 batches) significantly reduced the formation of volatile compounds derived from polyunsaturated fatty oxidation. Some of these compounds such as hexanal and other volatile aldehydes and ketones are indicators of lipid oxidation and contribute to the development of undesirable aromatic notes, such as rancid odours (*5*).

The sensory detection of rancid-odours was also used to evaluate the occurrence of rancidity in the experimental cooked sausages (see Figure 2)

Table 1. Means ± standard deviation of nitrite content and instrumental color measurements of porcine cooked sausages after 1 day of their elaboration.

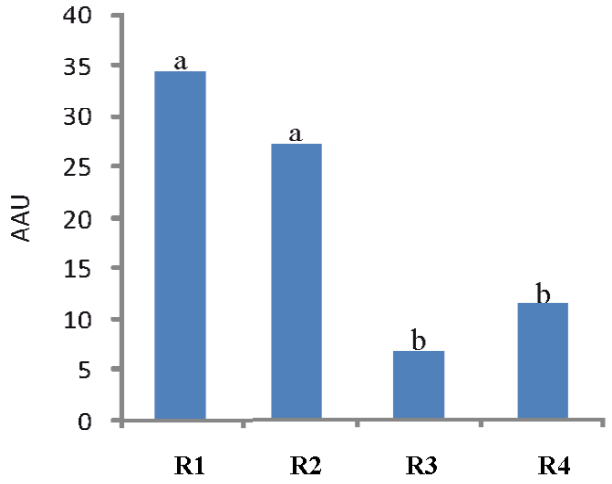
| Parameters | R1♣ | R2 | R3 | R4 |
|---|---|---|---|---|
| **Nitrite content♦** | $2.79^{b}$±0.44 | $22.21^{a}$±1.43 | $21.56^{a}$±0.01 | $23.39^{a}$±0.93 |
| **L*** | $73.13^{b}$±0.37 | $74.58^{a}$±0.12 | $72.25^{c}$±0.33 | $72.95^{bc}$±0.22 |
| **a*** | $6.22^{c}$±0.12 | $11.62^{b}$±0.02 | $12.94^{a}$±0.40 | $11.19^{b}$±0.02 |
| **b*** | $7.13^{b}$±0.18 | $5.7^{d}$±0.00 | $8.75^{a}$±0.16 | $6.63^{c}$±0.02 |
| **Saturation Index** | $9.46^{c}$±0.22 | $12.94^{b}$±0.02 | $15.62^{a}$±0.42 | $13.00^{b}$±0.01 |
| **Hue Angle** | $48.95^{a}$±0.18 | $26.15^{d}$±0.04 | $34.07^{b}$±0.32 | $30.65^{c}$±0.13 |

♣ R1: control; R2: sodium nitrite (100 ppm) and sodium ascorbate (500 ppm); R3 and R4: the same formulation than R2 plus rose-hip's extract at 0.5 % 1.5 %, respectively.

♦[b] Expressed as mg/Kg of porcine cooked sausage

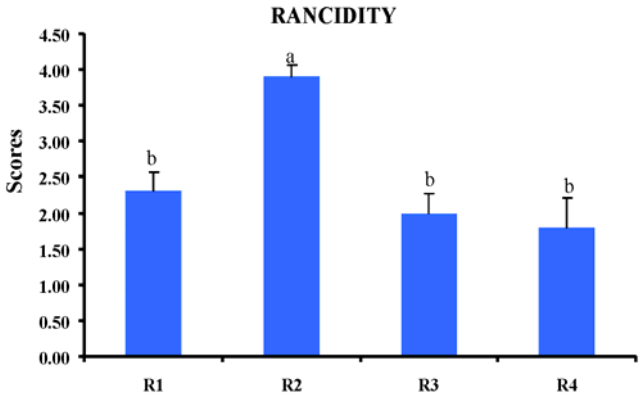
Values with a different letter [(a-d)] within the same row are significantly different ($p< 0.05$).

Figure 1. Content of lipid-derived volatiles from the oxidation of lipid in cooked sausages (R1, R2, R3 and R4) after chilled strorage.




R1: control; R2: sodium nitrite (100 ppm) and sodium ascorbate (500 ppm); R3 and R4: the same formulation than R2 plus rose-hip's extract at 0.5 % 1.5 %, respectively. Different letters on the bars denote statistical differences amongst batches.

Figure 2. Mean scores in each batch (R1, R2, R3 and R4) with respect rancid-odours by the non-trained panel.




R1: control; R2: sodium nitrite (100 ppm) and sodium ascorbate (500 ppm); R3 and R4: the same formulation than R2 plus rose-hip's extract at 0.5 % 1.5 %, respectively. Different letters on the bars denote statistical differences amongst batches.

The experimental cooked sausages from R2 batch received higher scores for rancidity by the non-trained panel compared to the counterparts. The presence of phenolic extracts derived from rose hip plus sodium nitrite significantly reduced the occurrence of rancid-odours compared to R2. Hence, taken together, both lipid oxidation determinations indicated that the addition of rose hip's extracts improved the sensory quality of the cooked sausages respect to the development of rancid-odours. These results are in accordance with Ganhão et al. (2010) (*4*), who also found a protective effect of rose hip's extract against lipid oxidation in meat patties.

## IV. CONCLUSIONS

This study has shown the suitability of the use of rose hip's extracts plus sodium nitrite and sodium ascorbate to reduce lipid oxidation and colour changes in cooked sausages. Therefore, rose hip's extracts could be used in cooked meat production to improve the oxidative stability and sensory quality of the final product.

## ACKNOWLEDGMENT

This work was supported by the CDTI (IDI 20090264) of Spain. Postdoctoral Fellowships (Action D) from Universidad de Extremadura to M. Armenteros is also acknowledged. We thank the owners, managers and staff of Consorcio de Jabugo, S.A.

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