**PE4.41 Effect of manufacturing with vegetable juice powder as source of nitrites of cooked loin 144.00**

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***Abstract*— The aim of this study was to investigate the addition of vegetable juice powder as alternative to the direct addition of nitrite in the manufacture process of cooked loin. In that way three batches of cooked pork loin were manufactured: Batch 1 (with nitrites added and without phosphates), Batch 2 (with vegetable juice powder and without phosphates) and Batch 3 (with vegetable juice powder and with phosphates). During the manufacture process (raw material, after injection, after tumbling and after heating) samples were taken to carry out microbiological, physicochemical and sensory analysis. The results obtained throughout manufacture process showed that the use of vegetable juice powder as source of nitrite might be an alternative method in order to manufacture cooked loin.**

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*Keywords*: vegetable juice powder, nitrate, nitrite, cooked loin, culture starters.

## I. INTRODUCTION

Due to the recent recommendation from the World Cancer Research Fund to avoid the intake of processed meat, it is necessary an urgent adaptation of meat processing industry in relation to the health value of processed meats. In this sense, alternatives for the use of nitrate and nitrite from meat processing have been proposed. So, meat products using vegetables juices as sources of nitrates and nitrites have been recently development. The aim of this study was to investigate the influence of this production system in cooked loin.

## II. MATERIALS AND METHODS

### MATERIALS

To achieve this objective three batches of cooked pork loin were manufactured:

-Batch 1: with nitrites added and without phosphates.

-Batch 2: with vegetable juice powder and without phosphates.

-Batch 3: with vegetable juice powder and with phosphates.

In that way, 9 loins were divided in three batches and each batch was pumped in a multi-needle injection machine with 20% brine containing the different additives depending of the batch. After brining, the meat was transferred to a tumbling machine and "massaged" in intervals of work and rest periods under vacuum during 5 hours and 20 minutes at 2ºC. After tumbling, the meat was introduced into elastic mesh and the pieces were cooked in an oven to a core temperature of 68ºC. During the cooked, a smoking step was applied to enhance the desired aroma and colour formation. After the heat treatment, the pieces were cooled in a chilling room to 2ºC.

The loins of each batch were sampled during the manufacture process in different sampling points: raw material, after injection, after tumbling, after heating (final product). Samples from each loin (a steak with 1 cm thickness) were taken aseptically to carry out the analysis.

In the raw material, the results for microbiological and physicochemical parameters were calculated as average of the values obtained in all loins analyzed. Besides, a sensory evaluation was carried out in the final product.

### METHODS

*Microbiological analysis*

The samples were analysed for aerobic mesophilic bacteria (3M Petrifilm Aerobic Count Plate (Bioser, Barcelona, Spain) at 30ºC for 48 h) *Micrococcaceae* (MSA (Scharlau, Spain) at 37ºC for 48 h).

*Physicochemical analysis*

Nitrite content was determined according to the ISO method 3091:1975 [3]. Nitrate content was determined by high performance liquid chromatography [4]. Phosphates content was measurement by spectrophotometric method [1].

*Instrumental colour measurement*

Objective measurements of colour were taken at the surface of loin using a reflectance spectrophotometer (CM-2600d/2500d (Konica Minolta, Aquateknia S.A., Valencia, España). Colour coordinates were determined in the CIE-LAB system and the results were expressed as lightness (L*), redness (a*) and yellowness (b*).

*Sensory analysis*

An acceptance sensory test was carried out by a trained eight-member test panel. The samples were reheated in an oven to reach a centre temperature of 68ºC. The samples were kept in a sand bath at 50ºC to present to the panellists one at a time. The sensory attributes evaluated (colour, odour, taste, springiness, juiciness and overall acceptability) were scored using a 5-point scale (5 = excellent, 4 = good, 3 = acceptable, 2 = fair and 1 = unacceptable).

*Statistical analysis*

Data sets were statistically analyzed using one-way variance analysis (ANOVA) in order to determine any significant differences during the manufacture process in each batch and between the different batches in each processed step. The means were separated by Tukey-honest significant difference test at 5% level. Data analyses were conducted using STATISTICA 7.0 statistical package.

## III. RESULTS AND DISCUSSION

The microbiological results (table 1) showed that the microorganisms numbers remained nearly constant in the batch 1 (in raw material, after injection, after tumbling). However, the aerobic mesophilic bacteria and *Micrococcaceae* counts increase after brining step and remained constant in the tumbling process in the batches 2 and 3. In the final product, these counts were under detection limit in all batches.

Considering batches, differences ($p<0.05$) were found between the batch 1 and the batches 2 and 3 at the injection and tumbling steps. The behaviour was expected taking into account that starter culture was added to the brines of the batches 2 and 3.

The results of the physicochemical analysis are showed in the table 2. The pH values increased during the manufacture process in the three batches. In the final product, no differences were found between batches and the values obtained were similar to those pointed by other authors in this product [2], [5].

The nitrate content in the batch 1 (without nitrate added) was under detection limit throughout manufacture process. However, the nitrate content increased after injection in the batches 2 and 3 (both with vegetables juice powder added) and decreased in the cooked product under detection limit.

The behaviour for the nitrite content was different in the three batches. After injection, the nitrite content decreased up to the final product in the batch 1 (with nitrite added). However, the nitrite content increased in the batches 2 and 3 due to the transformation to the nitrate into nitrite by the culture starter added, mainly during the cooked step. On the other hand, differences among batches were found in the final product. Higher nitrite values were found in the batches 2 and 3 and than those found in the batch 1.

No differences ($p>0.05$) were found for phosphates content during manufacture neither process between batches (data not showed).

Regarding colour results (table 3), although some differences were found during the manufacture process in the three batches, it did not allow establishing clear behaviour for L*, a*, b*.

In the final product, no differences ($p>0.05$) were found for parameter L* among batches. However, the cooked loins belong to the batch 3 presented the lowest a* values and the cooked loins belong to the batch 2 showed the highest b* values. These differences might be due to the differences in the raw material.

Finally, the results obtained for the sensory evaluation in the final product are showed in the table 4. In general, no clear differences were found in the parameters evaluated among batches and all scores obtained were between 4 and 5 in the scale used which correspond with a good or excellent product.

## IV. CONCLUSION

On the basis of the results obtained, it can be concluded that the use of vegetable juice powder instead of nitrite addition had not effects on manufacture process of cooked loin. Besides, the final product obtained with this different production style showed good or excellent sensory characteristics.

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**Table 1**. Microbiological counts (log cfu/g) obtained during the manufacture process of different cooked loin batches (Batch 1: with nitrites added and without phosphates, Batch 2: with vegetable juice powder and without phosphates and Batch 3: with vegetable juice powder and with phosphates).

| | | BATCH 1 | BATCH 2 | BATCH 3 |
|---|---|---|---|---|
| **Aerobic mesofic bacteria** | **RAW MATERIAL** | $^{A}3.81\pm0.09_{a}$ | $^{A}3.81\pm0.09_{a}$ | $^{A}3.81\pm0.09_{a}$ |
| | **AFTER INJECTION** | <1 | $^{A}7.41\pm0.10_{b}$ | $^{A}7.54\pm0.35_{b}$ |
| | **AFTER TUMBLING** | $^{A}3.26\pm0.35_{a}$ | $^{B}7.39\pm0.9_{b}$ | $^{B}7.52\pm0.35_{b}$ |
| | **COOKED PRODUCT** | <1 | <1 | <1 |
| ***Micrococcaceae*** | **RAW MATERIAL** | $^{A}2.36\pm0.31_{a}$ | $^{A}2.36\pm0.31_{a}$ | $^{A}2.36\pm0.31_{a}$ |
| | **AFTER INJECTION** | <2 | $^{A}6.92\pm0.16_{b}$ | $^{B}7.31\pm0.06_{b}$ |
| | **AFTER TUMBLING** | $^{A}2.98\pm0.35_{a}$ | $^{B}7.34\pm0.12_{b}$ | $^{B}7.15\pm0.34_{b}$ |
| | **COOKED PRODUCT** | <2 | <2 | <2 |

$^{A,B}$ Means with different letters in the same row indicate significant differences between batches (Tukey test: $p<0.05$).

$^{a,b}$ Means with different letters in the same column for each microbial group indicate significant differences during the processing (Tukey test: $p<0.05$).

**Table 2**. Evolution of physicochemical parameters (means ± sd) during the manufacture process of different cooked loin batches (Batch 1: with nitrites added and without phosphates, Batch 2: with vegetable juice powder and without phosphates and Batch 3: with vegetable juice powder and with phosphates).

| | | BATCH 1 | BATCH 2 | BATCH 3 |
|---|---|---|---|---|
| PH | RAW MATERIAL | $^{A}5.56\pm0.04_{a}$ | $^{A}5.56\pm0.04_{a}$ | $^{A}5.56\pm0.04_{a}$ |
| | AFTER INJECTION | $^{B}5.69\pm0.03_{c}$ | $^{A}5.51\pm0.10_{a}$ | $^{AB}5.61\pm0.01_{a}$ |
| | AFTER TUMBLING | $^{B}5.64\pm0.01_{b}$ | $^{A}5.48\pm0.05_{a}$ | $^{B}5.59\pm0.03_{a}$ |
| | COOKED PRODUCT | $^{A}5.90\pm0.01_{d}$ | $^{A}5.81\pm0.06_{b}$ | $^{A}5.88\pm0.02_{b}$ |
| NITRATE | RAW MATERIAL | <50 | <50 | <50 |
| | AFTER INJECTION | <50 | $^{A}74.0\pm17.3$ | $^{B}104.3\pm11.5$ |
| | AFTER TUMBLING | - | - | - |
| | COOKED PRODUCT | <50 | <50 | <50 |
| NITRITE | RAW MATERIAL | $^{A}1.9\pm0.3_{a}$ | $^{A}1.9\pm0.3_{a}$ | $^{A}1.9\pm0.3_{a}$ |
| | AFTER INJECTION | $^{B}71.1\pm13.9_{c}$ | $^{A}1.7\pm1.1_{a}$ | $^{A}8.4\pm2.7_{a}$ |
| | AFTER TUMBLING | $^{B}40.7\pm5.7_{b}$ | $^{A}1.8\pm0.6_{a}$ | $^{A}4.8\pm1.3_{a}$ |
| | COOKED PRODUCT | $^{A}33.4\pm10.9_{b}$ | $^{B}109.2\pm24.9_{b}$ | $^{B}129.1\pm6.0_{b}$ |

$^{A,B}$ Means with different letters in the same row indicate significant differences between batches (Tukey test: $p<0.05$).

$^{a,b,c,d}$ Means with different letters in the same column for each parameter indicate significant differences during the processing (Tukey test: $p<0.05$).

**Table 3**. Evolution of the results obtained in the instrumental colour measurements (means ± sd) during the manufacture process of different cooked loin batches (Batch 1: with nitrites added and without phosphates, Batch 2: with vegetable juice powder and without phosphates and Batch 3: with vegetable juice powder and with phosphates).

| | | BATCH 1 | BATCH 2 | BATCH 3 |
|---|---|---|---|---|
| L* | RAW MATERIAL | $^{A}42.07\pm1.34_{a}$ | $^{B}49.11\pm0.28_{b}$ | $^{B}50.20\pm2.01_{b}$ |
| | AFTER INJECTION | $^{B}56.29\pm1.82_{c}$ | $^{A}44.10\pm1.36_{a}$ | $^{A}42.62\pm2.05_{a}$ |
| | AFTER TUMBLING | $^{B}49.18\pm1.57_{b}$ | $^{A}43.89\pm1.79_{a}$ | $^{AB}45.12\pm2.06_{a}$ |
| | COOKED PRODUCT | $^{A}72.99\pm0.43_{d}$ | $^{A}70.51\pm2.35_{c}$ | $^{A}69.35\pm1.38_{c}$ |
| a* | RAW MATERIAL | $^{B}5.11\pm0.89_{a}$ | $^{B}3.89\pm0.62_{a}$ | $^{A}1.12\pm0.63_{a}$ |
| | AFTER INJECTION | $^{B}5.52\pm0.69_{a}$ | $^{B}6.60\pm0.22_{b}$ | $^{A}2.12\pm0.32_{b}$ |
| | AFTER TUMBLING | $^{B}5.32\pm0.78_{a}$ | $^{AB}4.31\pm0.36_{a}$ | $^{A}2.97\pm0.50_{b}$ |
| | COOKED PRODUCT | $^{B}5.84\pm0.53_{a}$ | $^{B}5.93\pm0.54_{b}$ | $^{A}4.34\pm0.54_{c}$ |
| b* | RAW MATERIAL | $^{AB}11.62\pm0.53_{b}$ | $^{B}12.51\pm0.22_{b}$ | $^{A}11.16\pm0.52_{ab}$ |
| | AFTER INJECTION | $^{B}11.09\pm0.20_{b}$ | $^{C}14.37\pm0.42_{c}$ | $^{A}9.95\pm0.14_{a}$ |
| | AFTER TUMBLING | $^{A}11.36\pm0.35_{b}$ | $^{A}10.95\pm0.91_{a}$ | $^{A}11.98\pm1.93_{b}$ |
| | COOKED PRODUCT | $^{A}8.60\pm0.34_{a}$ | $^{B}10.56\pm0.30_{a}$ | $^{A}8.68\pm0.60_{a}$ |

$^{A,B}$ Means with different letters in the same row indicate significant differences between batches (Tukey test: $p<0.05$).

$^{a,b,c,d}$ Means with different letters in the same column for each parameter indicate significant differences during the processing (Tukey test: $p<0.05$).

**Table 4**. Scores obtained in the sensory evaluation of the final product of the three different cooked loin batches manufactured (Batch 1: with nitrites added and without phosphates, Batch 2: with vegetable juice powder and without phosphates and Batch 3: with vegetable juice powder and with phosphates).

| PARAMETERS | BATCH 1 | BATCH 2 | BATCH 3 |
|---|---|---|---|
| **COLOUR** | $4.7\pm0.4_{a}$ | $4.8\pm0.4_{a}$ | $4.5\pm0.5_{a}$ |
| **ODOUR** | $4.9\pm0.2_{b}$ | $4.5\pm0.5_{a}$ | $4.5\pm0.5_{ab}$ |
| **TASTE** | $4.9\pm0.3_{a}$ | $4.8\pm0.4_{a}$ | $4.8\pm0.5_{a}$ |
| **SPRINGINESS** | $4.5\pm0.5_{a}$ | $4.7\pm0.5_{a}$ | $4.6\pm0.5_{a}$ |
| **JUICENESS** | $4.3\pm0.5_{a}$ | $4.9\pm0.3_{b}$ | $4.5\pm0.7_{ab}$ |
| **OVERALL ACEPTABILITY** | $4.7\pm0.2_{a}$ | $4.8\pm0.3_{a}$ | $4.6\pm0.4_{a}$ |

[a,b] Means with different letters in the same row indicate significant differences between batches (Tukey test: $p<0.05$).

Values rated on a 5 point scale: 5 = excellent, 4 = good, 3 = acceptable, 2 = fair and 1 = unacceptable.