PE4.44 Physico-chemical and sensory characteristics of cooked ham manufactured with vegetable juice powder vs sodium nitrite. 153.00

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Abstract*—Currently, consumers demand safe food with all of their nutritional and sensory properties without the use of chemical additives. Recent research has focused on the use of vegetable juices powder (natural resource of nitrate) and a starter culture containing *Staphylococcus s.p.* with nitrate-reductasa activity as an alternative to the use of nitrite in cooked products. The aim of this study was to evaluate the effects of using natural ingredients *v.s.* chemical additives on the physico-chemical and sensory characteristics of cooked ham. Three batches of cooked hams were manufactured using pork legs: batch *A*, with commercial vegetable juice powder A and starter culture, batch *B*, with commercial vegetable juice powder B and starter culture and batch *C* (control) with sodium nitrite. Physico-chemical (pH, a_w, water holding capacity, moisture, sodium nitrite content), CIE L* a* b* colour, texture profile analyse and sensory parameters were determined in each batch. The results obtained showed that cooked ham from batch B showed the highest value (p<0.05) of nitrites and for the value b*. No differences (p>0.05) were found among different batches for texture parameters (T.P.A.) and the results obtained were in agreement with the evaluation carry out by the trained panel. In the sensorial analyse, cooked ham from batch *A* showed the lowest value (p<0.05) for the juiciness, the quality of odour, the quality of taste and overall acceptance. The judges indicated that these hams (batch A) showed a strong vegetable odour and taste. No differences (p>0.05) were found for the quality of odour, and overall acceptance between batch *B* and batch *C* (control). By considering the results obtained, cooked ham manufactured with vegetable juice powder could have similar physico-chemical and sensory characterists than cooked ham manufactured with nitrites.

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***Index Terms*—cooked ham, nitrite, quality, vegetable juice powder.**

I. INTRODUCTION

Nowadays, increasing concerns about the potential health risk associated with the consumption of processed meat, have prompted consumers demand additives-free and healthy meat products, with sensory and quality attributes similar to conventional meat product. In the case of cooked meat product, such as cooked ham, nitrites play a crucial role for the development of ham colour. During the manufacture of cooked product, nitrites involve meat myoglobin reacts with nitric oxide to form nitric oxide myoglobin. Then, when heat is applied, the nitric oxide myoglobin becomes nitrosohemochrome, and the cooked ham takes on a typical, cured pink colour [8]. For this reason, nitrite is an ingredient for which there is no substitute. An alternative to the use of sodium nitrite (E-250) in cooked meat product is to use vegetable juice powder (with a high concentration on nitrate like a natural resource) and a starter culture containing *Staphylococcus s.p.* (with nitrate reductase activity).

The objective of this study was to determine the effect of using different natural ingredients *v.s.* chemical additives on physico-chemical and sensory characteristics of cooked ham.

II. MATERIALS AND METHODS

Three different batches of cooked hams were manufactured with different brine solution, using pork legs. The brine composition of each batch was:

-Batch *A*: commercial vegetable juice powder A, starter culture, salt, phosphates, mix of sugars and sodium ascorbate and natural antioxidants (clove, cinnamon and extract of olive).

-Batch *B*: commercial vegetable juice powder B, starter culture, salt, phosphates, dextrose and natural antioxidant (phenolics compounds).

-Batch *C* (control): sodium nitrite, salt, phosphates, dextrose and ascorbic acid.

Pork legs were deboned, and skin, tendons and fatty tissues were removed. The boneless hams were pumped to 120-130% of their green weight with different brine solution, using a multi-needle brine injector (Ogalsa CH-14). The injected hams were massaged in a meat tumbler (SM-Pulmax) at slow speed with cycles of time on and time off, at 2 ºC. Then, each ham were placed in pear-shaped ham moulds and they were steam cooked in an oven (Industrial Junior 1100, Verinox) using different stage of cooking cycles until to get a core temperature of 68 °C. Finally, hams were cooling with water and put them into a cooler at 2 ºC. The batches A and B were manufactured in accordance with their own specific in-house formulation.

Moisture and nitrite content were analysed following official procedure ISO 1442:1997 [3] and ISO 2918:1975 [2], respectively. Water activity (a_w) was determined using hygrometer (Aqua-lab CX2 de Decagon, Washington, USA) and the pH values were determined with a Crison 2001 pH meter (Crison Instrument S.A, Barcelona, Spain) equipped with a punction electrode. The water holding capacity (WHC) was measured by a modified centrifugal procedure [4].

Surface colour of the cooked hams was measured using spectrophotometer (CM-2600d/2500d, Konica Minolta). Colour results were determined in the CIE-LAB system and the lightness (L*), redness (a*, red↔green) and yellowness (b*, yellow↔blue) were calculated. Instrumental Texture Profile Analysis (TPA) [1] was performed with a texture analyzer TA-XT2 (Stable Micro Systems, Haslemere, UK.) Ten ham cores (diam. 2.5 cm × ht. 2 cm) were taken from two 2 cm thick slices. Each core was compressed to 50% of its original height with a crosshead speed of 1 mm s^{-1}, and different attributes were calculated: hardness, cohesiveness, springiness, gumminess, chewiness.

Sensory evaluation was carried out on cooked ham from different batches, by an experienced 8 member sensory panel (UNE 87-024, 1995) [6]. The judges were previously trained in the sensory assessment of cooked meat products. The colour (homogeneity and intensity), odour (intensity and quality), hardness, chewiness, juiciness, flavour (intensity and quality) and the overall acceptance were evaluated on slices (1.5 mm thick) of cooked ham. These attributes were scored on a 5-point scale (1: minimum intensity, 5: maximum intensity).

Data analysed were conducting using the statistical package STATISTIC V 7.0. Data were statically analysed using a one-way analysis of variance (ANOVA) and means were separated by Tukey-honest significant difference at 5% level.

III. RESULTS AND DISCUSSION

Table 1 shows the results obtained for the pH, a_w, WHC, % of moisture and ppm of $NaN0_2$. No differences ($p>0.05$) were found for the pH and a_W among the different batches of cooked ham and the values for this parameters were the typical values for cooked ham. Respect to the WHC, cooked hams from batch *A* showed a higher WHC ($p<0.05$) than cooked ham from batch *B*. On the other hand, cooked ham from batch *C* showed a higher percentage of moisture ($p<0.05$) than cooked hams from batch *B*. These differences could be due to the different ways of manufacturing the hams. Regarding to nitrite content, cooked hams from batch *B* showed the highest ($p<0.05$) value. These differences can be attributable to a higher amount of nitrate (date no showed) in the commercial vegetable juice powder B (batch *B*).

Table 2 shows the result for the instrumental evaluation of colour. No differences ($p>0.05$) were found among any batch of cooked ham for L* and a*. Several authors have found similar results for these parameters [5], [7]. For b* value, batch *C* was lower ($p<0.05$) than batch *B*, probably due to the use of different natural antioxidant.

Respect to the instrumental measurement of texture (Table 3), no differences were found ($p>0.05$) for hardness, springiness, cohesiveness, gumminess, and chewiness and the results obtained were in agreement with the evaluation carry out by the trained panel.

For sensory attributes (Table 4) cooked ham from batch *A* showed the lowest value ($p<0.05$) for the juiciness, the quality of odour, the quality of taste and overall acceptance. The judges indicated that these hams (batch *A*) showed a strong vegetable odour and taste. The differences obtained for the juiciness may be due to the different ways of manufacturing hams or for the use of different kind of ingredients. Cooked hams manufactured with sodium nitrite (batch *C*), showed a higher value for the quality of taste than cooked ham manufactured with vegetable juice powder (batch *A* and *B*). However no differences were obtained for the quality of odour and for the overall acceptance between batch *B* (commercial vegetable juice powder B) and batch *C* (control with sodium nitrite).

IV. CONCLUSION

The results obtained, clearly show that the use of vegetable juice powder (commercial vegetable juice powder B), could generates an acceptable cooked ham with similar physico-chemical, and sensorial characteristics than the cooked ham manufactured with nitrites added.

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Table 1. pH, aw, water holding capacity (WHC), % moisture and sodium nitrite content (ppm NaN02) of cooked ham manufactured with vegetable juice powder (*batch A*, *batch B*), and with sodium nitrite (control, *batch C*).

	Batch A	*Batch B*	*Batch C*
pH	6.15 ± 0.03	6.04 ± 0.08	6.20 ± 0.10
a_W	0.976 ± 0.002	0.975 ±0.002	0.977 ± 0.001
WHC	^{b}90.04 ± 0,59	^{a}88.73 ± 0.35	^{ab}89.76 ± 0.36
% Moisture	^{ab}72.91 ± 1.56	^{a}72.15 ± 1.22	^{b}75.47 ± 1.08
$NaN0_2$ ppm	^{a}4.48 ± 0.18	^{b}24.69 ± 5.01	^{a}8.00 ± 0.47

a,b,c. Value (means ± deviation standard) in the same row indicates significant differences ($p<0.05$).

Table 2. Instrumental colour parameters (L*, a*, b*) of cooked ham manufactured with vegetable juice powder (*batch A, batch B*), and with sodium nitrite (control, *batch C).*

	Batch A	*Batch B*	*Batch C*
L*(lightness)	60.03 ± 2.22	62.47 ± 3.15	60.92 ± 1.30
a*(redness)	7.72 ± 1.47	8.42 ± 0.80	8.67 ± 0.76
b*(yelloness)	^{ab}8.01 ± 0.02	^{b}8.88 ± 0.51	^{a}7.56 ± 0.67

a,b,c. Value (means ± deviation standard) in the same row indicates significant differences ($p<0.05$).

Table 3. Instrumental textural mesurement (T.P.A) of cooked ham manufactured with vegetable juice powder *(batch A, batch B*), and with sodium nitrite (control, *batch C).*

	Batch A	*Batch B*	*Batch C*
Hardness (N)	56.2 ± 3.0	51.9 ± 8.5	51.4 ± 3.4
Springiness	0.8 ± 0.0	0.8 ± 0.1	08 ± 0.1
Cohesiveness	0.6 ± 0.0	0.5 ± 0.0	0.5 ± 0.0
Gumminess	31.0 ± 1.1	18.9 ± 10.5	24.7 ± 4.5
Chewiness (N)	25.3 ± 1.5	22.1 ± 4.1	20.8 ± 2.4

Table 4. Sensory parameters scored on a 5-point scale (1: minimum intensity, 5: maximum intensity), of cooked ham manufactured with vegetable juice powder (*batch A, batch B*), and with sodium nitrite (control, *batch C).*

	Batch A	*Batch B*	*Batch C*
Homogeneity of colour	2.9 ± 0.3	3.1 ± 0.5	3.6 ± 0.1
Intensity of colour	2.8 ± 0.7	3.5 ± 0.3	3.1 ± 0.2
Intensity of odour	3.5 ± 0.1	3.6 ± 0.5	3.4 ± 0.1
Quality of odour	^{a}1.9 ± 0.3	^{b}3.9 ± 0.3	^{b}4.4 ± 0.0
Hardness	2.5 ± 0.1	2.0 ± 0.2	2.0 ± 0.4
Chewiness	2.2 ± 0.3	1.9 ± 0.1	1.9 ± 0.3
Juiciness	^{a}2.6 ± 0.4	^{b}3.6 ± 0.1	^{b}3.3 ± 0.2
Intensity of taste	3.1 ± 0.3	3.7 ± 0.3	3.8 ± 0.3
Quality of taste	^{a}2.5 ± 0.3	^{b}3.8 ± 0.2	^{c}5.0 ± 0.0
Overall acceptance	^{a}3.1 ± 0.2	^{b}4.2 ± 0.1	^{b}4.2 ± 0.1

a,b,c. Value (means ± deviation standard) in the same row indicates significant differences ($p<0.05$).