A Research Note

Loss of Cured Pigment in Dehydrating Fermented Sausage

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ABSTRACT

An increase (P < 0.01) in the content of total heme pigment found during dehydration of a fermented sausage resulted from a concentrating effect due to the moisture loss from sausages. The percent of the total pigment converted to the “cured” nitric oxide heme pigment decreased (P < 0.01) during dehydration, indicating possible nitric oxide dissociation from the heme pigment.

In the production of fermented dry sausage, sausage is generally held to dry for extended periods after processing to attain desired moisture levels, texture, flavor, and color. A brownish discoloration on the surface of hams and sausage has often been associated with dehydration (1,3). In fresh meats (5) dehydration increased the concentration of pigments at the meat surface. Changes in the percent of total heme pigment existing as the cured nitric oxide heme pigment in ham (6, 9) and frankfurters (3, 10) have been followed using Hornsey’s (4) analytical method.

The moisture content found among dried sausage products as a group varied from 58.9 to 26.4% and was dependent upon the specific type or style of sausage manufactured (1). Percent conversion of total heme pigments to nitric oxide heme pigments was greater in sausage products containing 45 to 60% moisture than in those containing 25 to 30% moisture (12). The objective of this study was to determine the stability of the nitric oxide heme pigment during the dehydration phase of fermented, dry sausage preparation.

MATERIALS AND METHODS

A sausage mix was prepared using a blend of fresh boneless beef and beef fat adjusted to approximately 25% fat. Ingredient quantities per kg meat were as follows: 0.078 g of NaNO₂, 0.156 g of NaNO₃, 0.47 g of sodium erythorbate, 30.0 g of NaCl, 10.61 g of seasoning mix, 5.05 ml of Pediococci acidilacticii suspension (LACTACE), 7.51 g of dextrose, and 25.0 ml of water. The starter culture yielded an approximate level of 2 × 10⁹ cells/g of mix. Sausages were stuffed into 32-mm diameter collagen casings and fermented for 24 h at 38°C and 95% relative humidity. Heat processing was done at 71°C for 45 min followed by heating at 82°C until an internal temperature of 65.5°C was attained (2.5-h total). The sausage links (of approximately 125 g each) were cooled to 20°C by a cold water spray and placed in a 7.5 ± 2°C drying room having 20 to 25 air changes/h. Drying room humidity ranged from 80 to 85%. Two sausage links were removed at random for analysis over an 11-day period.

The methods for nitric oxide heme pigment and total heme pigments as described by Hornsey (4) were used with a modification in extraction technique. A Tri-R homogenizer with teflon pestle was used to homogenize 4 g of sample with an acetone-water volume calculated (including sample moisture) to yield 80% acetone in 20 ml of total extractant. Samples were homogenized for 2 min, kept in the dark for 13 min, and then filtered through Whatman #4 paper into 1-cm spectrophotometer tubes. The filtrates were collected and read immediately at 540 nm. The concentration of nitric oxide heme pigments was calculated using the absorption coefficient given by Hornsey (4).

Total heme pigments were determined using the above procedure except that 1 ml of concentrated HCl was substituted for 1 ml of water in the acetone-water extracting solution. After homogenization, samples were allowed to sit for 60 min before filtering. The filtrates were read at 640 nm and the total heme pigment concentration calculated from the absorption coefficient of Hornsey (4).

Results were analyzed statistically by analysis of variance and the significance of means tested by the least significant difference (LSD) method (8).

RESULTS AND DISCUSSION

At the beginning of the dehydration phase fermented sausage contained 59.9% moisture (Table 1). Of the total

<table>
<thead>
<tr>
<th>Moisture in sausage (%)</th>
<th>Total heme pigment (ppm)</th>
<th>NO heme pigment (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.0²</td>
<td>217.6²</td>
<td>79.3²</td>
</tr>
<tr>
<td>54.8²</td>
<td>251.6²</td>
<td>73.8²</td>
</tr>
<tr>
<td>48.0²</td>
<td>265.9bc</td>
<td>70.8b</td>
</tr>
<tr>
<td>46.1d</td>
<td>278.1bc</td>
<td>66.2c</td>
</tr>
<tr>
<td>43.2e</td>
<td>290.4c</td>
<td>64.7e</td>
</tr>
<tr>
<td>34.5f</td>
<td>361.1d</td>
<td>56.9d</td>
</tr>
</tbody>
</table>

*²Means in columns having the same superscript(s) are not significantly different (P < 0.05).

heme pigment content, 79.3% existed as the nitric oxide heme pigment. This maximum conversion to the cured pigment form agrees well with findings for other cured
products. Simon et al. (10) reported 71 to 76% pigment conversion in frankfurters formulated with 78 ppm of nitrite and 83 to 88% conversion when 156 ppm of nitrite was utilized. For frankfurters heated to 60 to 66 °C and processed with a combined cure of 154 ppm of nitrite and 1248 ppm of nitrate, Fox et al. (3) reported a conversion of 80 to 85%. A cure blend of 78 ppm of nitrite and 156 ppm of nitrate was used in the current study. The recommended level of nitrite for fermented sausage employing frozen concentrate starter cultures of \textit{P. acidilactici} is 78 ppm of nitrite with nitrate (up to 156 ppm) as an additional optional ingredient (7).

As the sausage moisture content began to decrease during drying, the quantity of total heme pigment increased (\(P < 0.01\)) as a result of a concentrating effect. If calculated on a sample dry weight basis, the total heme pigment quantity remained relatively constant and within experimental error. Thus, no destruction of the total heme pigment was indicated nor was there any apparent decrease in the extraction efficiency for the total pigment. A highly significant (\(P < 0.01\)) correlation coefficient (\(r\)) between moisture content and total heme pigment was indicated nor was there any apparent decrease in the extraction efficiency for the total pigment. A highly significant (\(P < 0.01\)) correlation coefficient (\(r\)) between moisture content and total heme pigment was obtained.

Dissociation of the nitric oxide from the nitric oxide heme pigment may have occurred during dehydration. The percent of total pigment converted to the cured pigment form decreased (\(P < 0.01\)) with moisture loss. The results in Table 1 are in agreement with Townsend's (12) findings of lower conversion percentages for sausages of the lower moisture contents. Other studies (6, 11) have shown that the dissociation is light-accelerated. The dissociated nitric oxide may be oxidized by air and the free pigment oxidized by excess nitrite, if present, to form metmyoglobin (2). In addition the cured pigment, once formed, is more stable at higher pH values near 6.0 (2). The sausage fermented in this study had a pH of 4.7.

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Reference to a firm or trade name does not imply endorsement over firms or products not mentioned.

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**REFERENCES**