TOWARDS THE REDUCTION OF NITRITE IN CURED MEAT: ROLE OF ASCORBATE?

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I. OBJECTIVES

Nitrite and/or nitrate added in cured meat is involved in the formation of nitroso-compounds (nitrosamines, nitrosothiols, and nitrosylheme) and potentially mutagenic. Oxidation in meat affects health by formation of mutagenic aldehydes. An excessive consumption of cured meat is associated with an increased risk of colorectal cancer. Therefore, the objective of this study was to evaluate the role of ascorbate regarding the reduction of nitrites in cured meat.

II. MATERIALS AND METHODS

Cured meat was prepared with pork shoulder muscle, with different amounts of sodium nitrite (0 to 120 ppm) with or without ascorbate (300 ppm), and cooked at 68.5°C. A recooking at 180°C/7 min was also studied. The free iron content was measured by ferrozine assay. Nitrosylated heme iron was evaluated by extraction in acetone. Lipid oxidation was evaluated by measurement of the thiobarbituric acid reactive substances. To determine nitrosothiol and nitrosamine contents, the S-NO and N-NO bonds were cleaved, and the nitrite released was measured.

III. RESULTS

Addition of nitrite decreased significantly free iron level. This can be due to the oxidative cleavage of myoglobin heme by hydrogen peroxide (H_2O_2). Nitrite prevents this cleavage by neutralizing superoxide radical at the origin of H_2O_2 formation. In meat, free iron is implicated in oxidation via the formation of hydroxyl radical. Thus, by decreasing H_2O_2 and oxygenated free radicals, nitrite acts as a powerful antioxidant. For the uncured condition, lipid oxidation was significantly higher than in cured meat products, demonstrating again the efficiency of nitrite as antioxidant. Ascorbate did not show any significant effect. Reducing nitrite from 120 to 40 ppm did not affect nitrosylheme content. So, a nitrite decrease could be considered without major impact on color. The level of nitrosothiols increased in cured meat from 40 ppm of added nitrite. This effect was especially pronounced in the absence of ascorbate. Nitrosothiols can transfer NO group to heme iron. Nitrosamines were not detected in this model with the exception of a low level at 40 ppm of nitrite. However, with the recooking, mimicking a second cooking process in pizza for instance, an important production of nitrosamines was observed in absence of ascorbate. This demonstrated the necessity of adding ascorbate in this process in order to protect human health.

Table.

Effect of nitrite (NO_2) and ascorbate (AH) and of recooking on iron content, oxidation, nitrosation and nitrosylation in ham model ($n = 6$; superscripts differ if $P < 0.01$)

	0 ppm NO_2+AH	40 ppm NO_2+AH	80 ppm NO_2+AH	120 ppm NO_2+AH	120 ppm NO_2	120 ppm NO_2+AH 180°C/7 min	120 ppm NO_2 180°C/7 min
Free iron (µM)	82.1^a +/-1.7	28.4^b +/-1.6	26.6^b +/- 0.9	34.9^c +/- 1.2	35.5^c +/- 0.8	-	-
TBARS (mg MDA/kg)	1.37^a +/- 0.03	0.69^b +/- 0.06	0.72^b +/- 0.15	0.51^b +/- 0.03	0.51^b +/- 0.04	-	-
Nitrosylated heme iron (µM)	1.2^a +/- 0.1	83.1^b +/- 7.5	98.5^b +/- 0.9	89.1^b +/-6.1	82.2^b +/-1.6	-	-
Nitrosothiols (µM)	7.7^a +/- 2.2	30.6^{ab} +/- 2.0	63.0^b +/- 9.1	35.2^{ab} +/-14.1	207.4^c +/-15.4	-	-
Nitrosamines (µM)	0	6.1 +/- 3.2	0	0	0	188.2^a +/- 34.4	439^b +/- 41.5

IV. CONCLUSION

The protective effect of nitrite on lipid oxidation is counterbalanced by production of nitrosothiol and nitrosylheme. Ascorbate reduces nitrosamine formation due to recooking. In the future, we will examine the protective effect of some vegetable antioxidants against nitrosation and nitrosylation.

Keywords: cured meat, lipid oxidation, nitrite, nitrosamines, nitrosothiols, nitrosylheme