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Article for XIX European Meat Research Conference (1973)

THE INFLUENCE OF NITRITE ON CURED PORK FLAVOR

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The purpose of this project was to examine the effects of nitrite on the flavor of pork. Taste panel members were able to correctly differentiate samples with nitrite from samples without nitrite. Products with nitrite were preferred and they were evaluated as having more cured pork flavor. Nitrite had a significant effect on the composition of volatile compounds in the headspace samples. Samples containing nitrite had better shelf life (organoleptic and TBA rancidity) than samples without nitrite. It was concluded that nitrite is important in developing and maintaining palatability of cooked canned comminuted meat products.

Cette recherche a été entreprise dans le but d'étudier les effets du nitrite sur la saveur du porc. Les dégustateurs ont pu différencier correctement les échantillons de viande traités au nitrite des morceaux non-traités. La préférence est allée aux morceaux traités au nitrite qui ont été jugés comme ayant un goût de porc salé plus naturel. Le nitrite a eu un effet notable sur la composition des composés volatils dans les morceaux de la tête. Les échantillons traités au nitrite se sont avérés plus faciles à conserver (point de vue organoleptique et rancidité TBA) que les morceaux non-traités. On est arrivé à la conclusion que le nitrite joue un rôle important dans l'obtention et la préservation de la saveur des viandes cuites pulvérisées en boite.

Der Zweck dieses Projekts war, die Wirkungen von Nitrit auf das Geschmack von Schweinefleisch zu untersuchen. Die Teilnehmer der Kostproben konnten sich richtig zwischen Kostproben mit Nitrit und Kostproben ohne Nitrit unterscheiden. Sie hatten Schweinefleischprodukte mit Nitrit lieber als Produkte ohne Nitrit und der Meinung der Teilnehmer nach hatten die Produkte ein stärkeres Geschmack von geräuchertem Schweinefleisch. Das Nitrit hatte eine bedeutende Wirkung auf die Zusammensetzung der flüchtigen Verbindungen in den Proben von dem Raum zwischen dem Doseninhalt und dem Dosendeckel. Die Nitrit enthaltenden Proben hatten eine längere Lagerbeständigkeit (nach Ranzigkeit-Proben, die von den Teilnehmern der Kostproben und mit Thiobarbitursäure gemacht wurden) als die ohne Nitrit enthaltenden Proben. Es wurde beschlossen, dass das Nitrit wichtig in der Herstellung und Erhaltung von Schmackhaftigkeit in gekochten zerkleinerten Büchsenfleischprodukten ist.

Целью этого проекта являлось исследование влияния соли азотистой кислоты на вкус свинины. Члены комиссии дегустаторов были в состоянии правильно отличать пробы свинины с солью азотистой кислоты от проб без нее. Предпочтение было отдано продуктам с солью азотистой кислоты и было найдено, что они имеют лучший вкус заготовленной свинины. Соль азотистой кислоты имела значительное влияние на состав летучих составных частей, находящихся в пространстве между мясом и крышкой консервной банки. Пробы свинины с солью азотистой кислоты имели более продолжительный период сохранения (по вкусу и по измерению протухлости анализом тиобарбитуровой кислотой), чем пробы без этой соли. Заключение: соль азотистой кислоты важна для развития и сохранения вкуса вареной и порезаной на мелкие куски законсервированной свинины.

INTRODUCTION

Various reports have suggested that nitrite may contribute to cured flavor in a variety of meat products (Brooks et al. 1940, Cho and Bratzler 1970, Simon et al. 1972, Wasserman and Talley 1972, and Bailey 1973). This investigation was undertaken to further develop the present knowledge of the action of sodium nitrite in meat. The approach was to organoleptically and chemically compare cooked, canned, comminuted pork products with and without nitrite. The comparison was performed with 0 and 3 percent salt and at 3 levels of nitrite.

PROCEDURE

This investigation was divided into two phases. Phase I involved an organoleptic analysis using a triangle test for detecting differences in flavor between a product with nitrite and a product without nitrite. Panel members were then asked to state their preference (cured or uncured). This evaluation was immediately followed by a paired comparison to determine which sample exhibited the greatest cured flavor. Data relating to gas chromatography head space analysis, proximate analysis, and residual nitrite levels were collected on comparable samples at a later date.

Phase II evaluated samples with and without nitrite at refrigerated and frozen storage temperatures using an odor evaluation panel, TBA analysis, and gas chromatography head space analysis.

Product Preparation

Individual emulsions were manufactured from boneless pork (16% fat) using normal industry practices. Four different treatments were prepared using the basic formulations shown in Table 1.

TABLE 1. PRODUCT TREATMENTS

TREATMENT	INGREDIENTS
1	Boneless pork
2	Boneless pork, sodium nitrite (20, 156, or 200 ppm)
3	Boneless pork, salt (2%)
4	Boneless pork, salt (2%), sodium nitrite (20, 156, or 200 ppm)

Sodium nitrite was added at 20, 156, and 200 ppm in Phase I and 156 ppm in Phase II. Four hundred and seventy gram portions of the emulsion were stuffed into number 2 cans (307 x 409). The cans were sealed and the product was cooked in a 74°C water bath until the internal temperature reached 71°C.

Taste Panel Evaluation

In Phase I, testing for differences in flavor between products with and without nitrite was performed by using a blindfolded untrained panel of 6 to 9 members. Comparisons were made between treatments 1 and 2 and between treatments 3 and 4 (Table 1). Significance was determined by the method of Amerine et al. 1965.

The aroma evaluation (rancid odor) in Phase II was performed by a blindfolded panel on products stored 0, 1, 3, and 5 weeks at refrigerated (3 ± 2°C) temperatures and on products stored 0, 1, 4, 8, and 14 weeks at frozen (-29 ± 2°C) temperatures.

Head Space Analysis

Duplicate head space samples were taken of the vapor above each product submitted to the taste panel. The samples were heated to 60°C and 4 ml of the head space gas was injected into a gas chromatography column packed with Carbowax 20 M. The peaks and peak areas for samples containing nitrite and those not containing nitrite were compared.

Chemical Analysis

Proximate analyses to insure uniformity of product and residual nitrite were determined on all products in Phase I.

In Phase II the 2-Thiobarbituric acid (TBA) method of Tarladgis et al. (1960) was used to periodically evaluate the 4 different products under refrigerated and frozen storage.

RESULTS AND DISCUSSION-PHASE I

Taste Panel

Table 2 shows the summarized results of the triangle evaluation. Each triangle test performed by the total panel is referred to as an attempt at differentiation. The numbers of statistically significant ($p < .05$ or higher) differentiations made by the panel out of the total number of panel attempts at differentiations for given treatments are shown. A significant differentiation (Amerine et al. 1965) occurred when a significant number of panel members correctly identified the odd sample in the triangle test.

TABLE 2. THE NUMBER OF STATISTICALLY SIGNIFICANT PANEL DIFFERENTIATIONS MADE IN TRIANGLE TEST

Nitrite (ppm)	Salt in Samples (%)	Significant Panels of $P \leq .05$	Total Number of Panels Conducted
20	0	2	10
	2	6	10
	total	8	20
156	0	4	6
	2	3	6
	total	7	12
200	0	2	6
	2	5	6
	total	7	12
Total		22	44

Panel members were able to distinguish between samples with nitrite and samples without nitrite at the levels of nitrite used (20, 156, 200 ppm) and could more easily distinguish between samples at the higher levels of nitrite (156 and 200 ppm). At 20 ppm nitrite, it was observed that there was a greater tendency to correctly identify the odd sample when salt was also in the samples.

The results of the preference test are presented in Table 3. The tabular values are the number of individual panel members preferring the sample with nitrite per total number of panelists in the preference test. At every level of nitrite the panel members indicated a preference ($p<0.5$, $p<.01$, or $p<.001$) for the sample containing nitrite.

TABLE 3. SUMMARIZED RESULTS OF PREFERENCE TEST MADE ON TRIANGLE TEST SAMPLES

Nitrite (ppm)	Salt (%)	Number of Panel Members Preferring Sample With Nitrite	Total Number of Panelists
20	0	31	43*
	2	34	57 NS
	total	65	100**
156	0	24	31**
	2	18	22**
	total	42	53***
200	0	21	32 NS
	2	26	40 NS
	total	47	72*
Total		154	225***

NS $p > 0.5$, * $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$

The results of the two sample test for detecting intensity of cured pork flavor are summarized in Table 4. At all levels of nitrite tested, panel members indicated that samples with nitrite had more cured pork flavor ($p < .001$).

TABLE 4. RESULTS FOR A TWO SAMPLE TEST FOR MORE CURED PORK FLAVOR

Nitrite (ppm)	Salt (%)	Nitrite Samples Were Selected as Having More Cured Pork Flavor	Total Number of Responses
20	0	32	41**
	2	29	42*
	total	61	83***
156	0	18	21***
	2	19	21***
	total	37	42***
200	0	12	17 NS
	2	15	17**
	total	27	34***
Total		125	159***

NS $p > 0.5$, * $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$

In evaluating individual panel member response to the triangle test, it was noted that wide variations occurred in the ability of an individual to detect differences in the flavor caused by nitrite. Most panel members were usually successful at distinguishing the odd sample but a few had practically no success at differentiation.

Head Space Analysis

Panel members found a noticeable difference in aroma between samples treated with nitrite and those with no nitrite. Gas chromatography analysis of the head space vapors revealed four major compounds were separated by the Carbowax 20 M Column. Figure 1 shows sample chromatograms for the products evaluated in this experiment. All 4 peaks were found in each product examined in this experiment with peaks 3 and 4 much less predominant in the samples containing nitrite than in the samples without nitrite. This would suggest that nitrite is reducing the quantity of some of the major volatile compounds.

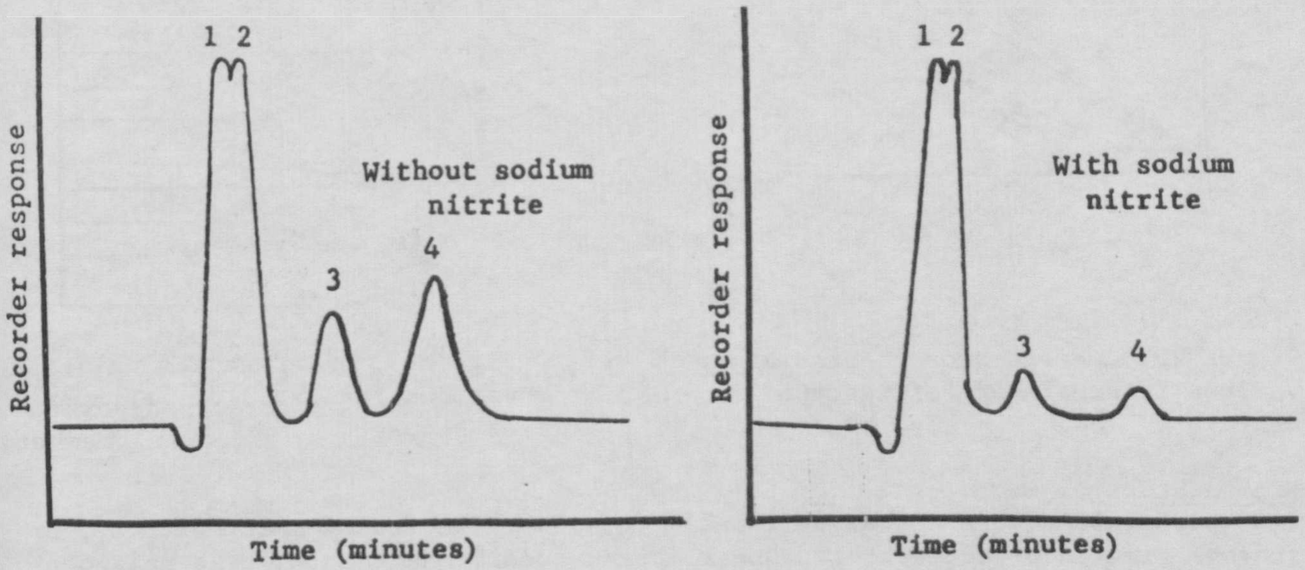

Figure 1. Chromatograms of head space vapors from samples with and without sodium nitrite.

RESULTS AND DISCUSSION-PHASE II

Products stored under refrigeration and frozen conditions were evaluated (analysis of variance) periodically for aroma (panel) and the extent of lipid oxidation (TBA evaluation).

Refrigerated Storage

Storage time had a highly significant ($p<.01$) effect on both aroma scores and TBA values of refrigerated products. Figure 2 shows the changes in aroma scores with storage time. Both the rate and final development of rancid odors were observed to be the greatest in products without nitrite. In addition, the non-nitrited product containing salt exhibited the most pronounced rancid odor.

TBA values for the various products stored for different intervals under refrigerated temperatures are shown in Figure 3. The products without nitrite developed TBA rancidity values faster ($p<.01$) and to a greater extent than comparable products with nitrite.

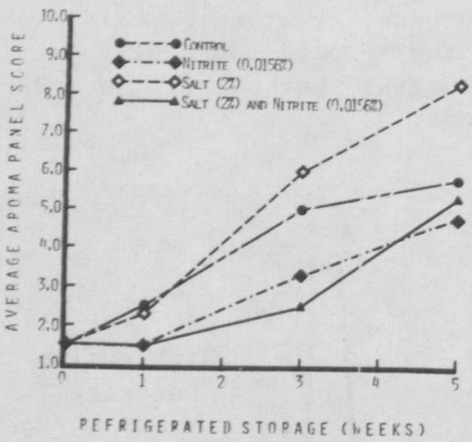

Figure 2. Average aroma scores at various intervals of refrigerated storage.

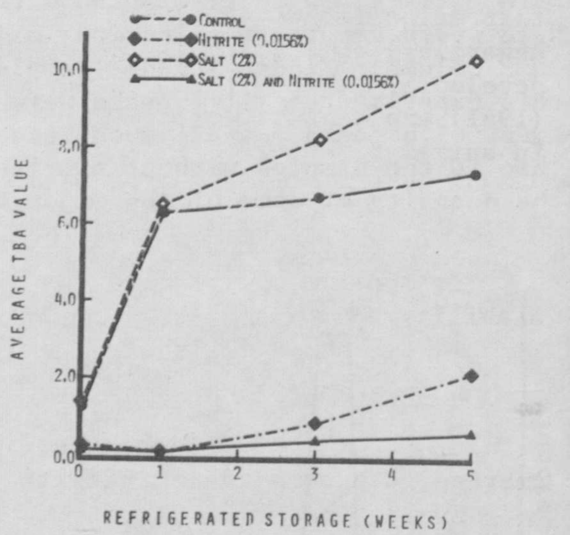

Figure 3. Average TBA values at various intervals of refrigerated storage.

Frozen Storage

Odor values were not significantly ($p > .05$) affected by salt, nitrite, or storage time in products stored under frozen conditions for 14 weeks as shown in Figure 4.

TBA values for frozen products were significantly ($p < .01$) affected by both nitrite and time but not ($p > .05$) by salt (Figure 5).

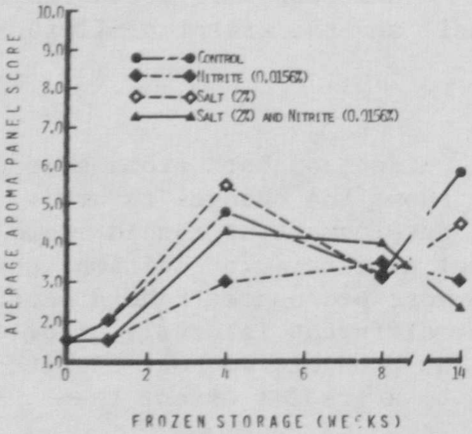

Figure 4. Average aroma scores at various intervals of frozen storage.

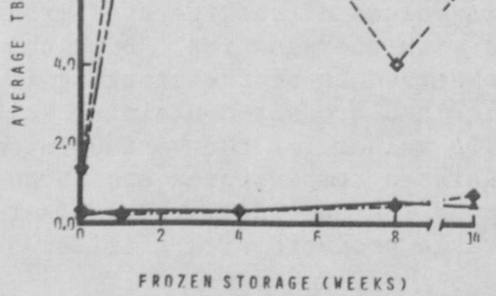

Figure 5. Average TBA values at various intervals of frozen storage.

In products without nitrite the TBA values increased with time and then began to decline which is in agreement with Tarladgis and Watts (1960) who found that malonaldehyde does not accumulate as a stable end-product of oxidation. Regardless of storage temperature it appears that products cured with nitrite develop TBA rancidity at a slower rate than products without nitrite. Tarladgis (1961) explained this occurrence by the theory of heme catalyzed lipid oxidation in animal tissue.

CONCLUSION

It appears that nitrite is effective in maintaining typical cured pork palatability during storage in cooked, canned, comminuted meat products.

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