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The effect of sodium nitrite on the organoleptic properties
of processed meat products.-----

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SUMMARY

Organoleptic analyses of three minced meat products, produced with and without the addition of sodium nitrite, were carried out. Smoked meat sausage (dinner sausage, to be boiled and served hot) was tested 3 days after production, while meat loaf (pressed minced meat sausage, served sliced and cold) was examined after 3, 11 and 17 days.

The taste panel succeeded in differentiating between products containing nitrite and products not containing it, but could not differentiate between products with different concentrations of nitrite. For the products investigated there is no evidence indicating that a taste panel prefers products containing nitrite to products not containing nitrite.

Wirckung von Natrium-Nitrit auf die sensorische Qualität von Fleischwaren.

ZUSAMMENFASSUNG

An drei geräucherten Füllfleischprodukten sind organoleptische Analysen durchgeführt worden. Die Waren wurden mit und ohne Zusatz von Natriumnitrit hergestellt.

Geräucherte Fleischwurst wurde 3 Tage nach Herstellung getestet. Wienerwurst wurde 3 und 11 Tage nach Herstellung getestet. Savelat wurde 3, 11 and 17 Tage nach Herstellung getestet.

Der Geschmackstafel gelang es, zwischen Ware mit und ohne Nitrit zu unterscheiden, schaffte es aber nicht, zwischen Waren mit verschiedenem Nitritniveau zu unterscheiden.

Für die Produkte untersucht hier, gab es kein Tendens dahin, dass Waren mit Nitritzusatz Waren ohne Nitrit vorgezogen würde.

Effets du nitrite de soude sur la qualité sensorielle de la charcuterie.

RÉSUMÉ

Des analyses organoléptiques ont été effectuées sur trois produits fumés farcis. Les marchandises ont été produites avec et sans addition de nitrite de soude.

Le saucisson fumé a été vérifié 3 jours après la production. La saucisse a été vérifiée 3 et 11 jours après la production. Le Cervelas le fut 3, 11 et 17 jours après la production.

La commission de goût a réussi à différencier les produits avec et sans nitrite, mais n'a pu différencier ces produits avec différents niveaux de nitrite. Au sujet du saucisson fumé et de la saucisse, il est apparu un désaccord parmi les juges. Il n'y a pas eu de tendance montrant que les produits contenant du nitrite aient été préférés à ceux n'en contenant pas.

Влияние азотистокислого натрия на органолептические свойства обработанных мясных изделий.

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РЕЗЮМЕ

Выполнились анализы фаршированных мясных изделий, произведенных как при примеси азотистокислого натрия, так и без примеси его. Копченая мясная колбаса (столовая колбаса, которая варится и подается в горячем виде) была подвергнута испытанию 3 дня после изготовления, пока "сервелатпельсе" (сжатая, фаршированная мясная колбаса, подаваемая ломтиками и в холодном виде) была исследована после 3, 11 и 17 дней.

Дегустаторам удалось различить между изделиями, содержащими нитрит, и изделиями не содержащими его, но нельзя было им различить между изделиями, имеющими различные уровни содержания нитрита. Касательно исследованных изделий, нет основания указывать, что дегустаторы предпочитают изделия, содержащие нитрит, изделиям не содержащим нитрита.

INTRODUCTION

The development of flavour in (salt) meat products is affected by a variety of factors, including salt, sugar and smoke. Some investigations also show that sodium nitrite affects the development of taste and aroma of meat and processed meat products. Brooks (1940) studied the effect of sodium nitrite on the curing of meat products, and discovered that sodium nitrite contributed to the development of their characteristic flavour. Barnett et al. (1965) found that sodium nitrite influenced the flavour of ham, but no comparison was made with ham not containing nitrite. Grau (1969) emphasises that the characteristic flavour of cured meat products is caused mainly by water-soluble substances. It was difficult to ascertain whether the formation of nitrose-myoglobin actually influences the development of taste and aroma, but it has been established that nitroso-myoglobin has no specific taste of its own. Cho and Bratzler (1970) investigated the effect of sodium nitrite in brine of the flavour of salted and heat-processed pork. For smoked and non-smoked products, the taste panel in a triangle test succeeded in differentiating between products with, and without, nitrite ($P < 0.05$). Wassermann & Talley (1972), studied the effect of sodium nitrite on the flavour of frankfurters. For non-smoked products, the taste panel was able to differentiate between those containing nitrite and those not containing nitrite ($P < 0.001$). After the smoking process greater difficulty was found in differentiating between products with and without nitrite, although significant differences ($P < 0.01$) were also obtained in a triangle test.

In a preliminary investigation, it was found that meat products such as boiled ham, salt meat etc., were difficult to produce uniformly, and these products were not particularly suitable for organoleptic testing.

It was therefore decided to carry out the tests using three minced meat products: Smoked meat sausage (dinner sausage, to be boiled and served hot), frankfurter and meat loaf (pressed minced meat sausage, served sliced and cold). These products are easy to

produce uniformly, and furthermore, they are of special interest in view of the new regulations on the addition of nitrite to meat products in Norway. From January 1st., 1973 the addition of nitrite/nitrate to smoked meat sausage and frankfurter is no longer permitted, whereas meat loaf belongs to a product group which is exempt from the new regulations until December 31st., 1973.

This investigation was undertaken to elucidate the effects of sodium nitrite on the flavours of these products. The chemical investigations were limited to determination of sodium nitrite, fat, water and protein content of the products. The microbiological investigations comprised determination of viable counts, and were made only to ensure that the raw materials were of good hygienic quality.

It was also necessary to check the growth of bacteria in the products during the storage periods in order to ensure that the organoleptic investigations would not be affected by excessive bacterial growth.

MATERIALS AND METHODS

The meat products were produced at the Meat Division of the National Institute of Technology. The raw materials used were of standard quality, and supplied by the Norwegian Meat Trade Association.

All three products were produced in 3 lots, one without the addition of nitrite, and two with different nitrite levels corresponding to 50% and 100% of the amount normally added to meat products (80 mg/kg = 80 ppm). Smoked meat sausage and meat loaf were produced with the addition of 0.3 g ascorbic acid per kg of product.

Frankfurter was produced both with and without ascorbic acid, giving a total of 6 series of frankfurter, 3 series of meat loaf, and 3 series of smoked meat sausage.

Product	Serial number	Amount of sodium nitrite added to product as percentage of normal quantity added	Ascorbic acid
Smoked meat sausage	1	0	Added
	2	50	"
	3	100	"
Meat loaf	4	0	"
	5	50	"
	6	100	"
Frankfurter	7	0	"
	8	50	"
	9	100	"
Frankfurter	10	0	Not added
	11	50	"
	12	100	"

Recipé: Smoked meat sausage.

	Series 1	Series 2	Series 3
Beef II	2.5 kg	2.5 kg	2.5 kg
Pork II	2.5 "	2.5 "	2.5 "
Pork trimmings	2.5 "	2.5 "	2.5 "
Water	5.0 "	5.0 "	5.0 "
Sodium Chloride	208 g	104 g	-
Saltmixture*	-	104 "	208 g
Potato flour	500 "	500 "	500 "
Dried milk powder	300 "	300 "	300 "
Mixed spices	25 "	25 "	25 "
Ascorbic acid	2.5 "	2.5 "	2.5 "

*Saltmixture: In Norway the addition of nitrite to meat products is only permitted in the form of a salt/nitrite mixture called Lakesalt. The nitrite concentration in the mixture is limited to 0.5 per cent (99.5% NaCl + 0.5% NaNO₂).

Recipé: Meat loaf.

	Series 4	Series 5	Series 6
Beef II	3.5 kg	3.5 kg	3.5 kg
Pork II	2.0 "	2.0 "	2.0 "
Fat	2.0 "	2.0 "	2.0 "
Water	5.0 "	5.0 "	5.0 "
Sodium chloride	250 g	125 g	-
Lakesalt	-	125 "	250 g
Potato flour	500 "	500 "	500 "
Dried milk powder	300 "	300 "	300 "
Ascorbic acid	2.5 "	2.5 "	2.5 "
Mixed spices	36 "	36 "	36 "

Recipé: Frankfurter

	Series 7	Series 8	Series 9	Series 10	Series 11	Series 12
Beef II	2.0 kg	2.0 kg	2.0 kg	2.0 kg	2.0 kg	2.0 kg
Pork II	3.0 "	3.0 "	3.0 "	3.0 "	3.0 "	3.0 "
Pork trimming	2.5 "	2.5 "	2.5 "	2.5 "	2.5 "	2.5 "
Water	5.0 "	5.0 "	5.0 "	5.0 "	5.0 "	5.0 "
Dried milk powder	0.5 "	0.5 "	0.5 "	0.5 "	0.5 "	0.5 "
Potato flour	0.5 "	0.5 "	0.5 "	0.5 "	0.5 "	0.5 "
Sodium chloride	208 g	104 g	-	208 g	104 g	-
Lakesalt	-	104 "	208 g	-	104 "	208 g
Mixed spices	40 "	40 "	40 "	40 "	40 "	40 "
Ascorbic acid	2.5 "	2.5 "	2.5 "	-	-	-

The technological operations in the production chain were standardised so that the manner of processing was, as far as possible, the same for all series. After stuffing, the sausage were left at room temperature for 4 hours and were then boiled.

Subsequent to smoking and boiling, the sausages were left overnight in the refrigerator, and then vacuum-packed. The products were then stored in the refrigerator until sampling for chemical, bacteriological, and organoleptic testing.

Organoleptic Tests

The three products were investigated by a trained test panel consisting of 10 testers (judges). This test was carried out at the State Institute of Consumer Research. Red lighting was used in the room in order to minimize colour differences between samples containing nitrite and those not containing it. The test panel was asked to answer three questions in connection with the tasting of the different products:

- (1) Which sample differs from the other two? (Triangle test)
- (2) Is there a distinct difference in flavour between the two identical samples and the odd sample?
- (3) Which sample has best flavour (preference test)?

Smoked meat sausage was tested once (3 days after production), frankfurter was tested twice (3 days and 11 days after production), and meat loaf was tested three times (3 days, 11 days and 17 days after production).

The meat loaf was sliced immediately prior to the organoleptic test. The smoked meat sausage was put in lukewarm water and heated until the water reached boiling point, before being served to the taste panel. The frankfurters were heated in boiling water for 3 minutes before being served to the taste panel.

Microbiological Tests

10 g test material was mixed with 90 ml 0.1% peptone water and homogenised for 60 seconds. Peptone water also used for subsequent ten-fold dilution of the samples. Viable counts were registered by pouring in "Plate count agar" (Difco 1966) and incubated aerobically at 30°C for 72 hours.

Chemical Tests

The methods used for determination of water content, fat content, and nitrite content are all found in the methods published by the Nordic committee on food analysis.

RESULTS

Chemical Tests

Table 1 gives the amounts of nitrite found in the different samples. The figures 0, 50 and 100 in the text and in the Table refer to products containing 0 nitrite, and 50% and 100 % of the amount of nitrite normally added to meat products.

Table 1

Nitrite content of cold-stored meat products to which varying amounts of nitrite were added (Nitrite level is expressed in ppm.).

Product	Nitrite added (ppm)	Time in storage		
		3 days	11 days	17 days
Smoked meat sausage 50	40	16.7		
Smoked meat sausage 100	80	43.0		
Frankfurter 50 + ascorbic acid	40	25.3	23.3	
Frankfurter 50 ÷ "	40	33.3	31.0	
" 100 + "	80	55.0	55.0	
" 100 ÷ "	80	69.8	70.0	
Meat loaf 50	40	31.0	24.7	22.0
Meat loaf 100	80	68.7	57.3	56.3

Table II

Content of water, fat and protein of the products (expressed as percentages).

Product	Water (per cent)	Fat (per cent)	Protein(per cent)
Smoked meat sausage	62	21	11.0
Frankfurter	60	21	11.7
Meat loaf	62	22	11.2

Organoleptic Tests

The results of the organoleptic analyses are presented in Tables III-V. Column 4 in Tables III-V lists the number of tasters (judges) who replied "yes" or "no" respectively in the triangle test to the question as to whether there was a distinct difference in taste between the two similar samples and the odd one.

The triangle test shows that all tasters (judges) in the taste panel were able to differentiate between smoked meat sausage containing nitrite and smoked meat sausage without nitrite ($P < 0.001$). However, panel of tasters was unable to differentiate between meat sausage containing the standard amount of nitrite, and meat sausage with a nitrite level of half that amount.

In the case of frankfurter without ascorbic acid, the taste panel was able to differentiate between sausage containing nitrite and sausage not containing nitrite after 3 days storage ($P < 0.1$ and $P < 0.5$), but unable to differentiate between sausage with different nitrite levels. After 11 days' storage, significant differences in the triangle test were obtained for the test pair 0/100 only ($P < 0.001$). Results for frankfurter with ascorbic acid were similar. The panel of tasters was able to differentiate between sausages containing nitrite and sausages not containing nitrite, but were unable to differentiate between different nitrite levels.

Frankfurters with and without ascorbic acid were also tested against each other, for similar nitrite levels, but the results obtained were ambiguous.

In the case of meat loaf significant differences for one test pair were obtained throughout the entire storage period, the test pair being sausage not containing nitrite and sausage with the standard content of nitrite. (After 3 days and 11 days $P < 0.001$, after 17 days $P < 0.5$).

Significant preferences were not obtained for any of the test samples. In the case of smoked meat sausage and of frankfurter, approximately equal numbers of tasters (judges) preferred sausage not containing nitrite, and sausage containing nitrite, respectively. The same occurred in the case of meat loaf after

Table III

Organoleptic analysis of smoked meat sausage without nitrite, and with addition of varying amounts of nitrite.

Time in storage after production	Tested in triangle test	Number of correct choises / Number of judges	Distinct difference in flavour.	
			Number of judges Yes	Number of judges No
3 days	Meat sausage 0 / Meat sausage 50	10 / 10 +++	9	1
	" " 0 / " " 100	10 / 10 +++	10	0
	" " 50 / " " 100	5 / 10 NS		

0 = product without nitrite

50 = product with 50% of normal nitrite content

100 = product with normal nitrite content (100%)

NS = not significant

+ P = 0.05

++ P = 0.01

+++ P = 0.001

Table IV

Organoleptic analysis of frankfurter without nitrite, and with addition of varying amounts of nitrite.

Time in storage after production	Tested in triangle test	Number of correct choices / Number of judges	Distinct difference in flavour?	
			Number of judges Yes	No
3 days	Frankfurter 0÷/Frankfurter 50÷	8 / 10 ++	4	4
	" 0÷/ " 100÷	7 / 10 +	4	3
	" 50÷/ " 100÷	6 / 10 NS		
	Frankfurter 0÷/Frankfurter 0+	7 / 10 +	4	3
	" 50÷/ " 50+	5 / 10 NS		
	" 100÷/ " 100+	6 / 10 NS		
	Frankfurter 0+/Frankfurter 50+	7 / 10 +		
	" 0+/ " 100+	9 / 10 +++	6	3
	" 50+/ " 100+	6 / 10 NS		
" 50+/ " 100÷	5 / 10 NS			
11 days	Frankfurter 0÷/Frankfurter 50÷	6 / 10 NS		
	" 0÷/ " 100÷	10 / 10 +++	6	4
	" 50÷/ " 100÷	5 / 10 NS		
	Frankfurter 0÷/Frankfurter 0+	5 / 10 NS		
	" 50÷/ " 50+	4 / 10 NS		
	" 100÷/ " 100+	10 / 10 +++	7	3
	Frankfurter 0+/Frankfurter 50+	8 / 10 ++	6	2
	" 0+/ " 100+	10 / 10 +++	8	2
	" 50+/ " 100+	6 / 10 NS		
" 50+/ " 100÷	5 / 10 NS			

NS = not significant
 +P = 0.05
 ++P = 0.01
 +++P = 0.001
 +) = with ascorbic acid
 ÷) = without ascorbic acid

0 = product without nitrite
 50 = product with 50% of normal nitrite content
 100 = product with normal nitrite content (100%)

Table V

Organoleptic analysis of meat loaf without nitrite, and with varying amounts of nitrite.

Time in storage after production	Tested in triangle test	Number of correct choices	Number of judges	Distinct difference in flavour?	
				Number of judges Yes	No
3 days	Meat loaf 0/Meat loaf 50	6 / 10	NS		
	" " 0/ " " 100	10 / 10	+++	8	2
	" " 50/ " " 100	5 / 10	NS		
11 days	Meat loaf 0/Meat loaf 50	9 / 10	+++	4	5
	" " 0/ " " 100	10 / 10	+++	7	3
	" " 50/ " " 100	8 / 10	++	7	1
17 days	Meat loaf 0/Meat loaf 50	5 / 10	NS		
	" " 0/ " " 100	7 / 10	+	6	1
	" " 50/ " " 100	6 / 10	NS		

0 = product without nitrite

50 = product with 50% of normal nitrite content

100 = product with normal nitrite content (100%)

NS = not significant

+P = 0.05

++P = 0.01

+++P = 0.001

3 days and 11 days, but after 17 days, the majority of tasters preferred meat loaf containing nitrite (six of seven judges).

DISCUSSION

From Table 1 it can be seen that only 50-60% of the amount of added nitrite can be shown to be present in the boiled products, and that the amount of nitrite decreases during storage. This is well known from earlier investigations (Haugum et al. 1968). One of the reasons why frankfurter containing ascorbic acid has a lower nitrite content than frankfurter not containing ascorbic acid, is that ascorbic acid catalyses the formation of nitroso-myoglobin.

The results of the triangle test show that a panel of trained tasters are able to differentiate between products containing nitrite, and products not containing nitrite, but that the tasters are not able to differentiate between products of varying nitrite content. This would indicate that there is a distinct difference in flavour between products containing nitrite and products not containing nitrite. The results correspond to earlier investigations (Cho and Bratzler, 1970; Wassermann and Talley, 1972).

The results for the question as to whether there is a distinct difference in flavour between the odd sample and the two similar ones, show that difference in flavour between products containing nitrite, and products not containing nitrite, is greater in the case of meat sausage than in the cases of the two other products.

Special mention should be made of the preference test, because the results of a test of this kind have certain limitations. Significant results of preference test are very difficult to achieve with such a small number of judges, as was the case in this investigation. In addition, a panel of trained tasters (judges) is unsuitable for preference testing, because the results represent nothing but the preferences of that group of specialists who compose the taste panel. The primary object is

to give an indication of consumer preferences, and experience shows that these rarely correspond to the preferences of panel of trained tasters.

The preference test does not permit any conclusions to be drawn as to which products have the best flavour (not significant preferences). What the reference test did show was that about one half of the members of a panel of trained testers preferred sausages without nitrite, and this would appear to indicate that taste and aroma of products without nitrite are satisfactory. This diverges from earlier investigations, in which it was asserted that the addition of nitrate or nitrite is necessary for obtaining an acceptable product. Brooks (1940) asserts that the only way of producing satisfactory bacon is to add nitrite. The services of a test panel were not used in that investigation, and only little weight can, therefore, be attached to the results. Wassermann & Talley (1972) carried out a scoring test for smoked and non-smoked frankfurters, with and without the addition of nitrite. The results of the scoring test for smoked sausages showed that equally good grades were obtained by sausages containing nitrite, and sausages not containing nitrite, and this corresponds to the results obtained in this study.

The results of the bacteriological investigations showed that the raw materials were hygienically of good quality. During the entire test period, the bacterial levels of the products were so low that it may be assumed they did not have any influence on flavour.

CONCLUSION

This investigation shows that a trained test panel can differentiate between products containing nitrite, and products not containing nitrite, in the case of the three products smoked meat sausage, frankfurter and meat loaf; but that the same panel are not able to differentiate between products with varying nitrite levels.

For the products investigated, there is no evidence indicating that the taste panel prefer products containing nitrite to products not containing nitrite.

The results indicate that products without the addition of nitrite were of good organoleptic quality.

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