S7P34.WP

USE OF VACUUM OR NITROGEN GAS FLUSHING DURING CHOPPING TO IMPROVE CURED COLOUR OF COOKED SAUSAGE

G.M. STRØMSTAD*, O. SØRHEIM, T. HØYEM and P. LEA

MATFORSK, Norwegian Food Research Institute, Osloveien 1, N-1430 Ås, Norway
* Nord-Norges Salgslag, avd. Mosjøen, N-8651 Mosjøen, Norway

Please refer to Folio 58.

INTRODUCTION

Nitrite is responsible for the colour formation in cured meat products besides functioning as an antioxidant, as an antibotulinum agent and in the development of aroma. Factors that influence colour formation include the level of nitrite added, the presence of reducing substances temperature, pH and oxygen (Wirth, 1986). Much of the interest in the role of nitrite has arisen from a wish to reduce the level of free nitrite in the diet and so to minimize consumer exposure to the potential synthesis of nitrosamines (Cassens, 1990). In Norway, a temporary ban on the use of nitrite in most meat products was introduced in 1973 (Høyem, 1977). However, low levels (30 to 60ppm) of sodium nitrite ($NaNO_2$) can currently be added to various types of cooked emulsion sausages (Statensnæringsmiddeltilsyn, 1992). The low permitted levels of nitrite may lead to problems with formation of the characteristic cured colour of sausages. Therefore, processing conditions must be redesigned to assure satisfactory colour formation.

Discoloration of cooked emulsion sausages because of reactions involving oxygen can occur during the comminuting process. That has led to the development of chopping technologies which remove oxygen from sausage batters. Klettner and Ambrosiadis (1980) studied the colour of cooked sausages after chopping with continuous carbon dioxide treatment, nitrogen gas flushing, evacuation of combinations of those treatments. Compared to continuous open bowl chopping, those chopping methods all gave a more acceptable colour in sausages to which 80ppm $NaNO_2$ had been added. Tantikarnjathep *et al.* (1983) found that with the use of 40ppm $NaNO_2$, continuous vacuum chopping resulted in a more typical cured colour of cooked sausage that partial vacuum chopping.

The aim of our experiments was to study cured colour development in cooked emulsion sausages with low $NaNO_2$ addition (10 to 60ppm) which were prepared either by partly chopping with vacuum or nitrogen gas flushing, or by continuous chopping in an open bowl.

MATERIALS AND METHODS

Preparation of sausages

Sausages were produced using frozen/thawed lean beef (39%) and pork fat (16%), dried skim milk (3%), potato flour (5%), sodium chloride (1.4%), sodium nitrite (see later), spices (0.3%), sodium ascorbate, ascorbic acid (200ppm) and water (35%). All batter weighed six kilograms. The final products contained 10.3±0.1% protein, 17.6±0.2% fat and 62.0±0.2% water.

In experiment A, 16 separate batter were prepared. Six batters containing 10, 20, 30, 40, 50 and 60ppm $NaNO_2$ were vacuum chopped (V); five batter with 20, 30, 40, 50 and 60ppm $NaNO_2$ were chopped with nitrogen gas flushing (N); and five batters with 20, 30, 40, 50 and 60ppm $NaNO_2$ were chopped in an open bowl to obtain control (C) batters.

In experiment B, 30ppm $NaNO_2$ was added to 18 batters. Six replicate batter were each subjected to the V, H and C chopping methods.

The batters were all chopped for a total of 16 minutes. The final temperature of batters was 14°C. Vacuum (-1.0 bar) or nitrogen gas flushing were applied for the last 80 seconds of the chopping time after finishing the mixing of the ingredients in the bowl. Nitrogen was flushed over the bowl with a lid almost closed to displace air from the batters. The batters were vacuum stuffed into 35mm natural casings. The sausages were smoked and heated to an internal temperature of 75°C, water chilled for 10 minutes, air chilled, vacuum packaged (except for density measurements) and stored in the dark at 4°C.

Colour analyses

The colours of the sausages were analyzed both instrumentally and sensorially, two and 23 days after their production.

CIE colour values, L* (lightness), a* (redness) and b* (yellowness) were obtained using a Minolta Chroma Meter CR-200 (minolta Camera Co., Osaka, Japan) with an 8mm viewing port and illuminant D_{65}. Measurements were performed on the outer layer and fresh cross-sections of the sausages at a total of nine positions on three sausages from each batch.

Sensory evaluations were performed by a six member trained panel. Evaluations included the colour of the fresh cross-sections of the sausages (scale 1=0%, 2=1-25%, 3=26-50%, 4=51-75% and 5=76-100% of the area) and the colours of the worst spots on the fresh cross-sections (scale 1=red/pink; 5=grey/green).

Determination of nitrite

The residual nitrite in the sausages was determined two days after their production using Merckoquant 10007 test strips (merck, Darmstadt, Germany) after water extraction for two hours (experiment B only).

Sausage density

The densities of the sausages were determined as the weight of the product that displaced a measured volume of water (experiment B only).

Cooking and drip losses

Cooking losses were calculated by weighing the sausages both before and 30 minutes after heat processing. Drip losses from vacuum packaged sausages were determined by reweighing the sausages after 23 days of storage.

Statistical analysis

The analysis of variance employed Tukey's multiple comparisons test. The analysis was performed using a SYSTAT version 5.01 (Wilkinson, 1990). The colour data for sausages stored for two and 23 days was pooled for presentation.

RESULTS AND DISCUSSION

Colour

The best colour of the outer layers of the sausages were obtained with vacuum chopping (V). Nitrogen flush chopping (N) also improved colour of the outer layers compared to the controls prepared in an open bowl (C) but to a lesser extent than vacuum chopping. Sensory evaluations showed that the redness on the outer layers of the V sausages increased with increasing nitrite addition from 10 to 30ppm and then remained constant. A minimum of 50ppm nitrite was needed to stabilize the red colour of the outer layers of the N sausages (Figure 1). At a level of 30ppm nitrite, instrumental colour analyses revealed that the outer layers of the V sausages were darker, more red and less yellow than those of the N sausages ($P<0.05$) (Table 1).

The differences in colour observed for the outer layers of the sausages were supported by the data obtained from the fresh cross-sections. Instrumental analyses showed uniform redness of the fresh cross-sections of the V sausages to which nitrite had been added at 20ppm or more (Figure 1). With nitrite at 30ppm, the fresh cross-sections of the V sausages were darker and more red than those of the N and C sausages, but the V, N and C sausages did not differ in yellowness ($P>0.05$) (Table 1). Sensory analysis showed almost no discoloration of V sausages with 20ppm nitrite (Figure 2). An addition of 50ppm or higher nitrite was needed with the N sausages to avoid discoloration. The C sausages were 25 to 50% discoloured with 60ppm nitrite added and the discoloration increased with decreasing nitrite levels. When 30ppm nitrite was added, no discoloration of fresh cross-sections was found in the V sausages and the C sausages were more discoloured than the N sausages ($P<0.05$) (Table 1).

Studies of Tantikamjathep *et al.* (1983) and of Klettner and Ambrosiadis (1980) revealed that a stable cured colour of cooked sausages was obtained when they were chopped with continuous vacuum during the whole comminuting process and with the addition of either 40 or 80ppm $NaNO_2$. Klettner and Ambrosiadis (1980) achieved a similar cured colour by chopping with continuous nitrogen flushing. However, in our study, nitrogen flushing resulted in a less acceptable colour of the sausages than vacuum chopping. The nitrogen flushing time of 80 seconds possibly was too short to fully displace oxygen from the batters and so to allow the development of a uniform cured colour.

Addition of 30 to 50ppm nitrite is regarded as the minimum level for acceptable cured colour formation in meat products (Romminger *et al.*, 1982; Wirth, 1986). Our experiments showed that the colour of cooked sausages generally improved with increasing addition of nitrite from 10 to 60ppm. Moreover, the addition of 30ppm was sufficient only in combination with vacuum chopping. When only low concentration of nitrite are allowed in sausage production, vacuum chopping can be a useful aid for assuring cure colour formation.

Residual nitrite

In accordance with the colour results, the concentrations of residual nitrite were higher in the V than in the N and C sausages. However, the N and C sausages did not differ in the amounts of residual nitrite ($P>0.05$) (Table 1).

Density

The highest density was measured in the V sausages followed by the C and N sausages ($P<0.05$) (Table 1). The V sausages had a compact structure without small air/gas pockets which were observed in the N and C sausages. The C sausages were notably discoloured in many areas with many air pockets. Tantikamjathep *et al.* (1983) also found that vacuum chopping resulted in increased densities of cooked sausages and that the density was higher when continuous rather than partial vacuum chopping was used.

Cooking and drip loss

The mean cooking loss, of 9.3%, did not differ for the V, N and C sausages ($P>0.05$). The V sausages had a drip loss after storage of 0.7% while the N and C sausages had no measurable purge.

ACKNOWLEDGEMENT

Bjørn Sæther is thanked for skilful technical assistance with the sausage production.

REFERENCES

CASSENS, R.G. 1990. Nitrite-cured meat - a food safety issue in perspective. *Food and Nutrition Press.* Inc. Trumbull, CON.

HØYEM, T. 1977. Experiences with nitrite and nitrate ban in Norway. In: TINBERGEN, B.J., and KROL, B. Proc. 2nd Int. Symp. Nitrite Meat Products. Pudoc, Wageningen, The Netherlands. pp.293-297.

KLETTNER, P.-G., and AMBROSIADIS, J. 1980. Einfluß verschiedener Kutter und Fulltechniken auf Qualitatsparameter bei Bruhwurst. *Fleischwirtsch.* 60:1950-1956.

ROMMINGER, G., JESCHKE, G., and PILLING, H. 1982. Zum Problem der Umrotung von Fleisch. II. Einfluß der Roduzeirung des Nitrizusatses auf die Qualitatsmerkmale von Bruhwurstchen. *Fleisch.* 36:215-217.

STATENS NÆRINGSMIDDELTILSYN. 1992. Forskrift om tilsetningsstoffer til næringsmidler (Regulation of additives for food products). Oslo, Norway. pp.25-26.

TANTIKARNJATHEP, K., SEBRANEK, J., TOPEL, D.G., and RUST, R.L. 1983. Use of vacuum during formation of meat emulsions. *J. Food Sci.* 48:1039-1041, 1052.

WILKINSON, L. 1990. *SYSTAT: The system for statistics.* SYSTAT Inc., Evanston, IL.

WIRTH, F. 1986. Curing: colour formation and colour retention in frankfurter-type sausages. *Fleischwirtsch.* 66:354-358.

Table 1. Analyses of sausages produced with 30ppm sodium nitrite addition and chopping was partly vacuum (V), partly nitrogen gas flushing (N) or a continuously open bowl (C) (experiment B). Each value is the mean of six replicates.

	Chopping method		
Analysis:	V	N	C
Outer layer			
Colour[1]	1.9b	3.4a	3.4a
L*	55.4b	57.8a	58.0a
a*	15.4a	9.3b	9.5b
b*	18.6c	20.5b	21.2a
Fresh cross-sections			
Discoloration[2]	1.0c	2.3b	3.3a
Worst spot colour[3]	1.7b	3.7a	4.2a
L*	60.3b	60.9a	61.2a
a*	15.6a	14.1b	12.3c
b*	10.3a	10.8a	11.3a
Residual nitrite (ppm)	10a	3b	4b
density	1.064a	0.996c	1.004b

a,b,c Values in a line without a common letter are different ($P<0.05$).

1 Scale: 1=red; 5=brown.

2 Scale: 1=0%; 5=76-100% of the area.

3 Scale: 1=red/pink; 5=grey/green.