28 **Effect of nitrate level on the chemical and microbiological properties of sausage during storage**

Fawzi A.Salem[1] Mohamed M.Abd El-Baki[2] Hussien K.El-Manawaty[3]
Amani A.El-Dashlouty[3] Ahmed A.Askar[2] Afaf I.Khazbak[3]

1. Dept. of Food Sci, Faculty of Agric, Zagazig Univ. Egypt.
2. Dept.of Food Sci,Faculty of Agric, Suez Canal Univ.
3. Dept.of Food Tech, Horticultural Res. Institute, Giza, Egypt.

Introduction

Sodium nitrate is widely used in sausage making to enhance color, flavor and keeping quality. On the other hand, nitrite reacts with secondary and tertiary amines to form toxic nitrose-amines (Sugimura et al.,1981). Nitrate is not considered so toxic since it is involved in conversion reactions by reducing bacteria (Jensen and Hess, 1940 and Sokolov 1965). This work was conducted to determine the lowest effective dose of nitrate which leads to the lowest possible residual nitrite in sausage. Also, the keeping quality of such sausage was studied.

Materials and Methods

Sausage sample with additions of 0 ,10,20 and 30 mg. nitrate/100 gm were prepared. Sausage ingreddients were minced lean meat 64.66%, cattle fat 20.05%, water (as ice flakes) 10.03%, salt (NaCl) 3.0%, black pepper 0.50%, red pepper 0.25%. Sausage in mutton casings was stored at 4°C. Samples were analyzed after 1,10,20 and 30 days. Spoilage was detected by the development of off odors. Effect of boiling sausages for 15 minutes in water was also examined.

The moisture content was determined according to the A.O.A.C. (1970). Nitrite content was estimated according to the method suggested by Graon and Mira (1957). Total volatile nitrogen (TVN) and thiobarbituric acid (TBA) value were measured according to Pearson (1970). Ammonia was estimated using the method described by Winton and Winton (1958). Total bacterial count was carried out by the plate count method reported by Fraizer and Foster (1950). The red color intensity was colorimeterically measured by the method of Husaini et al.,(1950). Sensory evaluation of cooked and uncooked sausage was applied according to the method described by Sorour (1978).

Results and Discussions

a. As shown in Table (1), moisture content, decreased during cooking and storage. This was to be expected, since cooking and storage were found to decrease the water holding capacity and consequently the moisture content which is lost as drip (Ameen 1968 and Abd El-Salam 1978).

b. Results in Table (2) show a residual nitrite (8.2 mg/kg) of fresh sausage in uncooked control samples after 1 day storage, which indicates that the added salts and or spices were responsible for this residual nitrite. Futhermore, the higher the added nitrate, the higher the residual nitrite formed by bacterial reduction of nitrate. Generally, the residual nitrite in the different treatments did not exceed the permitted limit of the Egyptian food standard organization. Whensamples were cooked a decrease in the residual nitrite content occured, which was evidently due to leaching in the

Table(1) Moistrue content (%) in sausage.

Time of storage in days	0.Omg % nitrate control		10 mg % nitrate		20 mg % nitrate		30 mg % nitrate	
	BC	AC	BC	AC	BC	AC	BC	AC
1	58.99	50.52	59.03	49.97	58.53	49.89	58.66	49.75
10	57.82	49.95	57.18	49.85	57.91	49.94	57.40	50.12
20	57.75	48.87	57.30	48.43	57.68	49.75	57.22	48.51
30	57.57	47.42	56.85	47.72	57.05	47.88	56.90	47.22

BC = Before cooking AC = After cooking

Table (2) Residul nitrite content in sausage (mg/kg)

Time of storage in days	0.Omg % nitrate				10 mg %				20 mg %				30 mg %			
	BC		AC		BC		AC		BC		AC		BC		AC	
	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW
1	8.20	20	8.14	17	43.02	105	43.53	87	87.09	120	90.20	180	127.33	308	143.21	285
10	6.75	16	6.61	13	33.83	79	32.60	65	67.34	160	62.07	124	83.07	195	84.80	170
20	5.92	14	5.62	11	25.62	60	25.27	49	55.02	130	50.75	100	73.15	171	78.60	141
30	4.24	10	4.21	8	20.71	48	20.39	39	49.82	116	49.51	95	69.82	162	69.67	132

WW = Wet weight basis WD= Dry weight basis BC = before cooking AC = after cooking

3.

. boiling water. Upon prolonged storage (10-30 days) samples of both cooked and uncooked sausage containing 30 mg nitrate; had a lower residual nitrite than that permitted by the Egyptian food standard organization.

c. As for total count of bacteria; results in Table (3) show that one day storage of sausage; the total count was very low, although differences between treatments were not marked. It could be noticed that the higher the amount of nitrate, the less the total count found. Sokolov (1965); reported that the effect of nitrate on the production of toxin by Cl.botulinum was slight. Storage at 4°C was more effective in inhibiting toxin production, while cooking reduced the total count. Such thermal reduction was less marked when the storage period was prolonged. In general, the total count after storage (20 days) was lower than the permitted limit of the Egyptian food standard for sausages (10 X 10^8 /gm). Prolongation of storage (30 days) caused the development of off order and increased the total count more than the permitted limit.

Table (3) Total bacterial count in sausage (count X10^6/gm).

Time of storage in days	0.0 mg% nitrate		10 mg% nitrate		20 mg% nitrate		30 mg% nitrate	
	BC	AC	BC	AC	BC	AC	BC	AC
1	0.007	0.005	0.006	0.003	0.005	0.002	0.004	0.001
10	4.33	3.30	4.17	2.19	3.12	1.19	3.03	1.00
20	7.20	5.40	7.01	4.30	6.36	3.07	4.70	1.52
30 S	16.96	14.50	14.58	11.30	10.54	8.17	10.00	5.20

S = spoiled BC = before cooking AC= after cooking

d. The changes in total volatile nitrogen (T.V.N.) and ammonia (NH_3) are shown in Table (4). The T.V.N. as well as NH_3 contents were affected by nitrate level. Increasing the nitrate level caused a decrease in T.V.N. and NH_3 level in sausage. Cooking also lowered the level of these two consituents.

e. The thiobarbituric acid value (TBA) is shown in Table (5). Results show that oxidation of lipids was to some extent checked by increasing the nitrate level. Although, nitrate and nitrosmyglobin accelerate lipid oxidation (Pavolovski and Palmin, 1963); the decrease observed in the present study with increasing nitrate level may be attributed to the decrease occuring in microbial load. Moreover, cooking resulted in a decrease in TBA value; which may be due to the leaching of some malonaldehyde from sausage whereas storage increased such companent.

f. Color intensity. With increasing nitrate level (Table 6), via ntirate conversion to nitrite and afterwards to nitric oxide; resulting in the formation of nitrosmyglobin and nitroshaemochromogen which acquire a desirable red color in both cooked and uncooked samples. Color was considerably improved by increasing the nitrate dose. Sample containing 30 mg nitrate showed a better color than that containing 10 mg nitrate. On the other hand, cooking

Table (5) Thiobarbituric acid value of sausage, (mg malonaldehyde /kg)

Time of storage in days	0mg % nitrate (control)		10 mg% nitrate		20 mg% nitrate		30 mg % nitrate	
	BC	AC	BC	AC	BC	AC	BC	AC
1	1.56	0.65	1.48	0.25	1.37	0.25	1.25	0.25
10	4.85	0.86	4.45	0.75	4.03	0.64	3.72	0.56
20	7.74	1.31	6.95	1.18	6.33	1.01	5.82	0.87
30 S	10.85	1.85	9.75	1.65	9.13	1.46	8.87	1.33

BC = before cooking AC = after cooking S= spoiled

Table (6) color intensity of sausage, (absorbance at 542 um).

Time of storage in days	O mg% nitrate		10 mg % nitrate		20 mg% nitrate		30 mg% nitrate	
	BC	AC	BC	AC	BC	AC	BC	AC
1	0.95	0.25	0.95	0.25	0.97	0.30	1.00	0.40
10	0.85	0.20	0.87	0.25	0.90	0.30	0.95	0.35
20	0.70	0.15	0.72	0.25	0.77	0.30	0.90	0.30
30 S	0.55	0.16	0.55	0.20	0.65	0.25	0.75	0.30

BC = before cooking AC = after cooking S= spoiled

and storage decreased slightly the color intensity due to pigment leaching during cooking or to oxidation especially by the action of microorganisms (Pavlovski and Palmin 1963 and Abd El-Salem 1978).

G. Sensory evaluation :a. color : samples containing a higher dose of nitrate had a higher score than those containing a lower nitrate dose (Tables 6 &7). Increasing the storage period reduced these scores. Samples containing 20 and 30 mg nitrate showed similar scores. Cooked samples did not show significant differences than uncooked ones which indicated that cooking did not affect the color appeal till 20 days storage especially in high nitrate doses, (20 and 30 mg).

b. Odor : The scores in Table (7) show that odor became more clearly pronounced by increasing the nitrate dose. Cooked samples scored higher than the uncooked ones containing 20 or 30 mg nitrate. It thus appears that 20 mg of nitrate is enough for odor enhancement and improvement.

Table (7) color, aroma and taste of sausage.

Time of storage in days	0.0 mg% nitrate (control)					10 mg% nitrate					20 mg % nitrate					30 mg % nitrate				
	BC		AC			BC		AC			BC		AC			BC		AC		
	c	a	c	a	t	c	a	c	a	t	c	a	c	a	t	a	c	a	c	t
0	6	7	6	8	9	8	8	8	9	9	9	9	9	9	9	9	8	9	9	9
10	5	6	4	7	8	7	8	7	9	8	8	8	8	9	9	9	8	9	9	9
20	5	5	4	6	7	6	7	5	8	7	8	8	8	9	8	8	8	8	9	8
30 S	4	1	3	1	-	4	1	3	2	-	6	2	5	3	-	7	2	5	3	-

BC = before cooking AC= after cooking S = spoiled

c = color a = aroma t = taste

c. Taste : results obtained (Table 7) showed that cooked sausage containing 20 and 30 mg of nitrate scored a very full taste (9); while the untreated sample or that containing 10 mg nitrate scored a full taste (8) after 10 days storage.

From the previous results it could be concluded that addition of 20 mg of nitrate is quite satisfactory for production of sausage with acceptable color, odor, taste and low residual nitrite. If salt and spices are free of nitrite 30 mg of nitrate can be recommended.

REFERENCES

1. Abd El-Salam, N.N. 1978 Chemical and technological studies on some Egyptian meats. M.Sc. theis. Faculty of Agric. Al-Azhar University, Cairo, Egypt.
2. Ameen, A.A. 1968. Chemical and technological studies on some spiced meat in the local market. M.Sc. thesis. Faculty of Agric. , Al-Azhar University, Cairo, Egypt.
3. A.O.A.C. 1970 Official methods of analysis, 11th Ed. Association of official argiculture chemists Washington, D.C.

4. Fraizer, W.C. and Foster, E.N. (1950). Laboratory manual for food microbiology, Burgess publishing co. Minnesota.
5. Groau, R. and Mirna, A. 1957. Uber die bestimmuny von Nitrate, nitrite, in fleischwaren and Kaken, 2. Analyt. Chem., 158, 182.
6. Husaini, S.A. Deatherage, F.E. and Kunkle, L.E. 1950. Studies on meat; II observations on relation of biochemical factors to changes in tenderness, food technology, 4,561.
7. Jensen, L.B. and Hess, W.R. 1940. Study of the effect of Na NO3 on bacteria in meat, food manufacture, 16,157.
8. Pavlovski, P.E. and Palmin, V.V. 1963. Biochemistry of meat and meat products, food industry pub. (in rus.)
9. Pearson, D.1970. The chemical analysis of foods, chem. pub. company, Inc. New York.
10. Sokolov, A.A. 1965. Physico-chemical and biochemical basis of meat products technology, food industry pub. (in rus.)
11. Sorour, A.A.E. 1978. Utilization of aged buffalue meat for processing of some kinds of sausage. M.Sc. thesis, faculty of agriculture, Cairo, University, Egypt.
12. Sugimura, T. Kawachi, T.Nageo, M. and Yahgi, T. 1981. Mutagens in food as causes cancer progress. ins. Cancer research and Therepay 17.,59.
13. Winton, A.L. and Winton, R.B. 1958. The analysis of food, tohn witely, New York Chapman, & Hull, London.