Assiut J. of Agric. Sci., 38 (2) (31-45)

EFFECT OF SOME ADDITIVES ON RESIDUAL NITRITE AND SOME QUALITY ATTRIBUTES IN BEEF SAUSAGE

Fardous A. A. W., Nadia M. Abdel-Bar and Hesham Ahmed H.

*Meat and Fish. Tech. Res. Dept., Food Tech. Res. Inst., A.R.C..

Abstract: Seven batches of beef sausage were produced. Sodium tripolyphosphate (STPP) was added to the sausage mixture at concentrations of 0.25 and 0.50%. Sodium lactate (SL) was added at concentrations of 0.75 and 1.5%. A combination of STPP + SL were added at concentrations of 0.125% STPP + 0.375% SL and 0.25% STPP + 0.75% SL. STPP and SL were replaced by starch in the control sample. It was found that the use of STPP resulted in a higher pH value and a higher residual nitrite level than the control group. It also improved WHC, cooking loss and texture. Addition of SL to the sausage mixture reduced pH value and residual nitrite level compared to the control sample. It also reduced microbial growth, TVN and TBA values, enhanced flavor scores and its cost was the cheapest among all samples. It is recommended not to use STPP in the sausage production; however, SL was advised to be used.

Key words: Sausage - Beef sausage – Residual nitrite – Ascorbic acid – Sodium tripolyphosphate (STPP) – Sodium lactate (SL).

Introduction

It had been known that sodium nitrite is highly beneficial in the manufacture of cured meat products (Sen and Baddoo, 1997; Heaton *et al.,* 2000). It enhanced flavor of cured products and it had antimicrobial effect towards lots of microorganisms (Bacus and Botrnbae, 1991). It also inhibited the growth of *Clostridium botulinum* (Asku *et al.,* 2005).

However, in recent years, there have been a serious concern about the human consumption of sodium nitrite (Bastian, 2005). There have been some fear about the possibility of sodium nitrite to encourage human cancer (Cassens, 1997; Cassens, 1998). This is because under conditions of high heat such as occurs during frying of sausage, residual nitrite may react with certain amines and amino acids to produce carcinogenic nitrosamines. Furthermore, among the numerous chemical carcinogens that had been detected in meat products, N-nitrosamines are distinguished by being very potent (Ahn *et al.,* 2002). Volatile N-nitrosamines induced tumors in a variety of organs, including the liver, lung, kidney, bladder, pancreas, esophagus and tongue, but not in the skin, brain, colon, or bone. For example, N-nitrosodimethylamine in the levels of 20 ppm could induce liver cancer in humans (Lijinsky, 1999). In addition, Francis (2000) reported that the formation of N-nitrosamines in foods occurs due to addition of nitrite, smoking, or drying with combustion gas; therefore, the nitrite in meat products is a primary problem in the formation of carcinogenic volatile N-nitrosamines under high-temperature condition. Moreover, Oliveira *et al.* (2004) reported that sodium nitrite is an important additive for the curing process in the meat industry. However, high nitrite concentrations are very serious for infants because it could lead to infant methaemoglobinaemia (Andrade *et al.,* 2003).

There had been lots of research work trying to find possible techniques to reduce the level of residual nitrite in the finished products. Among these techniques was investigating the effect of adding different substances to the cured meat products and test their effects on residual nitrite levels. One of these substances was sodium tripolyphosphate (STPP). It is known to improve water holding capacity (WHC) and increases cooking yield. In addition, sodium lactate had been known to have an antimicrobial effect towards several microorganisms. Furthermore, it enhances flavor and increases WHC.

The objective of the present study was to determine the effect of sodium tripolyphosphate and sodium lactate on residual nitrite level and on other quality attributes of beef sausage during refrigerated storage.

Materials and Methods

Materials:

The beef meat and the constituents of sausage were purchased from the local market. The cost (in Egyptian pounds) per Kg of each sausage ingredient was as follows:

Ingredient	Cost (LE/Kg)	Ingredient	Cost (LE/Kg)
Beef meat	27.00	Sodium nitrite	15.00
Fat	16.00	Ascorbic acid	95.00
Powdered milk	20.00	Spices	24.70
Starch	4.00	Garlic	5.00
Sodium chloride	1.10	STPP	100.00
Sodium glutamate	150.00	SL	120.00

Sausage preparation :

The sausage was formulated according to the ingredients of samples (Table, 1). From Table (1), samples T_1 and T_2 contained 0.25% and 0.50% STPP, respectively. Samples T_3 and T_4 contained 0.75% and 1.5% SL, respectively. Samples T_5 and T_6 contained (0.125% STPP + 0.375% SL) and (0.25% STPP +

0.75% SL), respectively. Finally, the control sample contained neither STPP nor SL; but they were replaced by 1.5% starch.

Minced meat was mixed with all ingredients except fat and half of the ice flakes. The mixture was blended for 2 minutes in a meat chopper then fat and remaining ice were added and mixed for 15 minutes (for emulsification). The sausage was stuffed in natural casings, then the casings were closed and clipped. The sausage was steam cooked after 10 min to an internal temperature of 70°C. It was immersed in an ice water for 30 min. The sausage was stored in the refrigerator (4°C) for 22 days. Analysis were carried out at 1, 8, 15 and 22 days.

Table(1): Formulation of each beef sausage batch

Ingredients	Concentration (%)						
	C	T_1	T_2	T_3	T_4	T_5	T_6
Meat	68	68	68	68	68	68	68
Fat	15	15	15	15	15	15	15
P. Milk	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Starch	1.50	1.25	1	0.75	---	1	0.50
Sodium chloride	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Sodium glutamate	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Sodium nitrite	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Ascorbic acid	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Spices	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Ground garlic	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Water ice	10	10	10	10	10	10	10
STPP	---	0.25	0.50	---	---	0.125	0.25
SL	---	---	---	0.75	1.50	0.375	0.75

Analytical methods :

The gross chemical composition (protein, moisture, fat and ash) was determined according to A.O.A.C. (1995) methods. Carbohydrate was calculated by difference. pH Value was measured using the pH-meter (Alken *et al.,* 1962). The water holding capacity (WHC) was measured using the Press method, and was presented as cm^2 according to Soloviev (1966). Cooking loss and cooking yield were calculated as (El-Nemr, 1979).

% cooking loss was calculated as follows : [(Fresh sample weight – cooked sample weight)/fresh sample weight] × 100

Cooking yield was calculated as follows : 100 - % cooking loss.

Thiobarbituric acid (TBA) was

determined according to the method of Pearson (1991). Total volatile nitrogen (TVN) was estimated by the method of Winton and Winton (1958). Nitrite concentration was determined in the Central Lab., Horticultural Research Inst., Agric. Research Center according to Pearson and Tauber (1984).

Microbiological determination :

Total plate count (TPC) and psychrophilic count were determined using the nutrient agar according to Difco Manual (1984). Petri plates were incubated at 37°C/48 h and 4°C/ 10 d, for TPC and psychrophilic count, respectively.

Sensory evaluation :

Organoleptic evaluation was conducted at day 1 and day 22. Samples were heated by boiled for 2 min.

Organoleptic evaluation was carried out according to Watts *et al.* (1989) by aid of 10 panelists. Judging scale was as follows :

Very good	8-9
Good	6-7
Fair	4-5
Poor	2-3
Very poor	0-1

Data of organoleptic evaluation were analyzed statistically by determining the least significant difference (LSD).

Results and Discussion

Table (2) presents the gross chemical composition, pH value and total plate count (TPC) of raw beef meat. The data revealed that, the pH value was 5.79 which indicated high quality of meat. This pH is favorable for attaining low cooking loss, high water holding capacity (WHC) and protein gel formation. In addition; from Table (2), it is clear that the fresh meat had a TPC of 4.2×10^4 cfu/g, which indicated good sanitation conditions in slaughtering and transportation processes because the upper safe limit for beef meat is 1.0×10^6 cfu/g (Egyptian Standards, 1991).

Table(2): Gross chemical composition, pH and total plate count of raw (fresh) beef meat

Characteristics	Values
Moisture	63.96%
Protein	18.25%
Fat	16.75%
Ash	0.92%
Carbohydrate	0.12%
pH	5.79
TPC	4.2×10^4 cfu/g*

*cfu/g = Colony forming unit per gram of sample

Effect of STPP and SL on chemical composition of beef sausage:

Table (3) presents the chemical composition of the 7 batches of sausage as described in Table (1). It is obvious that at the first day of refrigerated storage, the highest moisture content was for sample T_6

which had STPP + SL added at concentrations of 0.25% + 0.75%, respectively; in comparison to T_2 or T_4samples which had STPP or SL added at concentrations of 0.5% or 1.5%, respectively. This probably indicated some synergistic effect in sample 6 between STPP and SL in cooking yield and WHC. This resulted in the highest moisture content for sample T_6.

Protein and ash contents recorded the same pattern of moisture content, at the first day of storage, as they were the highest in concentration in T_6. This was a result of T_6 being the highest in WHC and cooking yield. Hence, during cooking, T_6 lost the least amount of small peptides, amino acids, vitamins and minerals in the drip that came out of the sausage mixture (Fouda *et al.,* 2000; Sharaf, 2002).

Concerning fat content, at the first day of storage, it was the highest in sample T_4 followed by sample T_3, then the control. The lowest fat content was in sample T_5 followed by T_6.

In addition, in the first day of storage, the carbohydrate content was the highest in the control, as a result of having the highest content of starch (Table, 1). The lowest carbohydrate level was in sample T_4 which had zero starch content.

Table(3): Effect of STPP and SL on the chemical composition of beef sausage during refrigerated storage (4°C), on dry weight.

Constituents	Storage time (d)	Concentration (%)						
		C	T_1	T_2	T_3	T_4	T_5	T_6
Moisture	1	55.29	55.87	55.97	55.68	55.88	56.71	56.83
	8	54.86	55.45	55.56	55.25	55.47	56.30	56.41
	15	54.03	54.34	54.46	54.10	54.31	55.19	55.30
	22	52.87	53.15	53.27	53.03	53.25	54.00	54.09
Protein	1	31.38	32.14	32.16	31.81	32.00	32.96	33.15
	8	30.86	31.56	31.66	31.33	31.51	32.45	32.92
	15	29.61	30.18	30.32	30.02	30.16	30.91	31.05
	22	28.43	31.18	29.32	28.78	28.98	29.63	29.88
Fat	1	58.15	58.03	58.33	59.21	60.40	57.33	57.91
	8	58.97	58.54	59.00	59.84	61.04	58.08	59.21
	15	60.50	60.23	60.61	61.46	62.64	59.90	60.45
	22	62.00	61.64	61.87	62.91	64.04	61.46	61.90
Ash	1	3.79	3.74	3.77	3.68	3.72	3.86	3.91
	8	3.52	3.68	3.69	3.60	3.68	3.75	3.87
	15	3.41	3.58	3.58	3.51	3.50	3.64	3.71
	22	3.31	3.44	3.47	3.36	3.40	3.54	3.59
Carbohydrate	1	6.73	6.31	5.75	5.30	3.88	5.84	5.03
	8	6.65	6.21	5.65	5.23	5.61	5.72	4.98
	15	6.48	6.05	5.49	5.07	3.70	5.56	4.79
	22	6.26	5.87	5.35	4.94	3.57	5.37	4.62

With prolonged storage, sausage drip took place which resulted in a loss of moisture, protein, ash and carbohydrate for all samples, which resulted in higher concentrations of fat.

Effect of STPP and SL on pH value of beef sausage:

Table (4) presents the pH values of the 7 batches of sausage as described in Table (1). It is obvious that at first day of refrigerated storage, the highest pH value was for sample T_2 (6.6). It was clear that addition of STPP to sausage mixture resulted in raising the pH value. On the contrary, SL resulted in producing the lowest pH of the beef sausage mixture at the first day of storage (T_4, pH = 5.4). Hence, STPP is expected to have a good effect on the physical properties of sausage as outlined in Table (5).

With prolonged refrigerated storage, the pH values of most samples decreased. Probably, that was due to the activity of some members of lactic acid bacteria which produced organic acids (Wally *et al*., 2004).

Table(4): Effect of STPP and SL on the pH values of beef sausage during refrigerated storage (4°C).

Storage time (d)	pH values						
	C	T_1	T_2	T_3	T_4	T_5	T_6
1	6.3	6.4	6.6	5.8	5.4	5.9	6.2
8	6.4	6.6	6.8	5.9	5.5	5.9	6.3
15	6.2	6.5	6.7	5.8	5.3	5.8	6.1
22	6.1	6.5	6.6	5.6	5.2	5.7	6.0

Effect of STPP and SL on physical properties of beef sausage:

Table (5) presents the values of WHC, cooking loss and cooking yield of sausage. It was clear that at the first day of storage, WHC was the best for T_6 (WHC = 0.30) and it was the worst for the control sample (WHC = 1.25). In addition, STPP produced a better WHC compared to SL (T_1 and T_2 = 0.78 and 0.67 vs T_3 and T_4 = 0.95 and 0.84, respectively). Furthermore; probably, there was some synergistic effect between STPP and SL resulted in the WHC for T_5 and T_6 (contained a combination of both STPP and SL) which were better than the WHC for either STPP or SL alone.

Table(5): Effect of STPP and SL on the physical properties of beef sausage during refrigerated storage (4^{o}C), based on wet weight

Constituents	Storage time (d)	Concentration (%)						
		C	T_1	T_2	T_3	T_4	T_5	T_6
W.H.C. (cm^2)	1	1.25	0.78	0.67	0.95	0.84	0.56	0.30
	8	1.27	0.79	0.68	0.98	0.87	0.57	0.32
	15	1.28	0.81	0.69	1.02	0.89	0.58	0.33
	22	1.30	0.83	0.71	1.04	0.93	0.60	0.35
Cooking loss (%)	1	40.26	37.25	36.98	38.37	37.84	33.63	32.51
	8	40.65	37.64	37.37	38.70	38.23	34.27	32.88
	15	41.06	38.50	37.77	39.16	38.63	34.42	33.31
	22	41.45	38.81	38.11	39.55	39.05	34.80	33.68
Cooking yield (%)	1	59.74	62.75	63.02	61.63	62.16	66.37	67.49
	8	59.35	62.36	62.63	61.24	61.77	65.73	67.12
	15	58.94	61.50	62.23	60.84	61.37	65.58	66.69
	22	58.55	61.19	61.89	60.45	60.95	65.20	66.32

Cooking loss recorded the same trend of WHC; as the lowest cooking loss value was for sample T_6, at the first day of storage, and the highest cooking loss was for the control sample.

During storage, WHC, cooking loss and cooking yield deteriorated due to the loss of protein molecules as (Sharaf, 2002).

Effect of STPP and SL on total plate count and psychrophilic count of beef sausage:

From Table (6), it is clear that at day 1, TPC for all samples were much lower than the count of the fresh meat (Table, 2). That was due to the addition of sodium nitrite, salt and spices, and due to the cooking process. In addition, the lowest TPC was for sample T_4 and the highest TPC was for the control sample. Knowing that T_4 contained 1.5% SL, it is obvious that SL exerted an antimicrobial effect which resulted in a low microbial count.

Table(6): Effect of STPP and SL on total plate count and psychrophilic count of beef sausage during refrigerated storage (4°C).

Micro-biological evaluation	Storage time (d)	Microbial count (cfu/g)*						
		C	T_1	T_2	T_3	T_4	T_5	T_6
TPC	1	3.7×10^3	3.2×10^3	3.0×10^3	7.6×10^2	6.3×10^2	9.1×10^2	8.5×10^2
	8	9.2×10^3	8.0×10^3	7.5×10^3	8.2×10^2	7.1×10^2	3.0×10^3	2.3×10^3
	15	1.9×10^4	1.0×10^4	9.1×10^3	1.7×10^3	9.3×10^2	6.2×10^3	5.1×10^3
	22	8.3×10^4	7.9×10^4	6.8×10^4	4.1×10^3	2.0×10^3	2.9×10^4	2.3×10^4
Psychrophiles	1	9.5×10^2	8.7×10^2	8.0×10^2	3.1×10^2	2.2×10^2	6.8×10^2	5.9×10^2
	8	5.1×10^3	4.6×10^3	2.8×10^3	4.0×10^2	3.1×10^2	1.9×10^3	8.7×10^2
	15	7.6×10^3	6.9×10^3	4.5×10^3	8.2×10^2	5.9×10^2	6.7×10^3	4.0×10^3
	22	3.7×10^4	2.2×10^4	1.3×10^4	2.1×10^3	1.0×10^3	1.3×10^4	9.6×10^3

*cfu/g = Colony forming unit/gram

Effect of STPP and SL on freshness indices of beef sausage:

Table (7) shows the freshness indices, total volatile nitrogen and thiobarbaturic acid and TBA, of the beef sausage. It is obvious that at the first day of storage, the lowest TVN value was for sample T_4 which had the higher concentration of SL (Table, 1). It is well known that the microbial growth leads to proteolysis which results in the production of nitrogenous compounds. The latter leads to raising the TVN value. Furthermore; during refrigerated storage, there was a continuous increase in TVN values for all samples. That was due to the increase in microbial growth. However, TVN for all samples after 22 days of refrigerated storage were lower than the upper safe limit (20 mg/100g, Egyptian Standards, 1991).

Table(7): Effect of STPP and SL on freshness indices of beef sausage during refrigerated storage (4°C), based on wet weight

Micro-biological evaluation	Storage time (d)	Sample no.						
		C	T_1	T_2	T_3	T_4	T_5	T_6
TVN mg/100g	1	12.70	12.25	12.10	11.90	11.80	12.05	11.98
	8	12.95	12.49	12.38	11.99	12.01	12.19	12.15
	15	13.30	12.77	12.68	12.32	12.24	12.57	12.49
	22	14.28	13.81	13.73	13.31	13.29	13.60	13.50
TBA (mg/Kg)	1	0.51	0.42	0.39	0.28	0.27	0.35	0.33
	8	0.54	0.44	0.40	0.28	0.27	0.36	0.33
	15	0.57	0.47	0.42	0.31	0.29	0.38	0.35
	22	0.61	0.50	0.45	0.35	0.32	0.42	0.41

Concerning TBA values, the data showed that the lowest and highest values of TBA were for samples T_4 and C, respectively. These samples contained the lowest and highest microbial counts, respectively (Table, 6). It is well established that the microbial activity would lead to fat oxidation raising TBA values (Vasavada and Cornforth, 2005). The TBA values for all samples after 22 days of refrigerated storage were lower than the upper safe limit (0.9 mg/Kg, Egyptian Standards, 1991).

Effect of STPP and SL on residual nitrite level of beef sausage:

From Table (8), it is clear that at day 1, the highest residual nitrite level was for sample T_2. The latter contained 0.50% STPP, and had a pH value of 6.6. Hence, the effect of STPP in raising the residual nitrite level might have been due to raising the pH of the sausage mixture. This results are coincided with Sebranek (1979) and Fox (1974) who reported that the effect of pH might be taken into account when considering the use of phosphates in curing, particularly for products such as bacon. They added that alkaline phosphates resulted in a higher ultimate pH in the tissue and would probably also result in raising residual nitrite due to the effect of pH. Furthermore, Krause *et al.* (1978) found a higher residual nitrite in tumbled than non-tumbled hams; this might have been caused by slightly higher pH levels in tumbled products (Addis and Schanus, 1979).

Table(8): Effect of STPP and SL on residual nitrite level of beef sausage during refrigerated storage (4°C), based on wet weight

Storage time (d)	Residual nitrite levels (ppm)						
	C	T_1	T_2	T_3	T_4	T_5	T_6
1	0.233	0.260	0.365	0.168	0.129	0.141	0.230
8	0.230	0.255	0.360	0.129	0.125	0.135	0.229
15	0.224	0.232	0.245	0.122	0.115	0.118	0.150
22	0.100	0.111	0.234	0.102	0.095	0.112	0.143

On the contrary, SL decreased the residual nitrite levels of sausage at day 1. The lowest residual nitrite level was for sample T_4 which had a SL concentration of 1.5% and a pH of 5.4. This was supported by Zaika *et al.* (1976) who reported that a reduction in pH will drastically lower residual nitrite levels. In addition, according to Goodfellow (1979) and Sebranek (1979), the idea of utilizing a low pH to reduce residual nitrite and thus potential nitrosamine formation has been applied in several instances with chemical acidulants. They added that acid compounds such as sodium acid pyrophosphate will lower the pH and also the residual nitrite. The same authors suggested another approach for increasing acidity for bacon which was to incorporate a lactic acid starter culture into the curing pickel for injection. They added that this procedure not only reduced nitrosamine formation upon frying, but also contributed some additional protection against *Clostridium botulinum* in storage because of the lowered pH (Gonzalez and Diez, 2002). Furthermore, Sink and Hsu (1977) showed a lowering of residual nitrite in a liquid smoke dip process for frankfurters when the pH also was lowered.

Further research is needed to elucidate if the change in residual nitrite levels due to the addition of either STPP or SL to the sausage mixture, was totally because of the change in pH of the product or there might have been other factors.

With refrigerated storage, residual nitrite levels were reduced as a result of pH change and exudate drip. The final result after a 3-week cold storage was (similar to the result at day 1) that the highest and lowest residual nitrite levels were for samples T_2 and T_4, respectively. Hence, after storage; STPP and SL resulted in the highest and lowest residual nitrite levels, respectively.

Effect of STPP and SL on the sensory evaluation of beef sausage:

Table (9) presents the sensory evaluation of the different samples at day 1 and 22 of refrigerated storage. LSD* was determined to compare among the different samples at day 1. Furthermore, LSD** was determined to compare between any sample at day 1 and the same sample at day 22.

It is obvious that at the first day of storage, the control sample was significantly better than all other samples concerning color evaluation. Probably that was due to its lowest moisture content which lead to a more color intensity. However, the colors of the treatment samples were still acceptable.

Odor and taste were significantly better for samples T_3 and T_4 in comparison to other samples, in the first day of storage. Knowing that SL provides flavor characteristics, it would be understandable that T_3 and T_4 (contained SL) got the best scores.

Concerning the texture, it was significantly better for sample T_6 than samples C, T_1, T_2, T_3 and T_4, in the first day of storage. This sample

had the best WHC score (Table, 5) which lead to the best texture (Desrosier, 1984).

At 22 days of storage, all samples significantly deteriorated in comparison to the same samples at day 1, except for the odor of sample T_5. Probably, that was due to the loss of some pigment and protein contents which led to a lower evaluation of the color and texture, respectively. Furthermore, with storage, fat oxidation took place which adversely affected aroma and taste (Vasavada and Cornforth, 2005). However, in spite of these significant deteriorations, still the evaluation (after the 22-day-storage) was acceptable.

Effect of STPP and SL on the cost of beef sausage:

From Table (10), it is clear that samples T_1 and T_2 (which contained STPP) had costs very close to the control sample. However, since STPP was proven to increase the residual nitrite level, it is not recommended to be added to the sausage mixture.

Concerning samples T_3 and T_4 (which contained SL), they were a little more expensive than the control. Their costs were 0.87 and 1.75 LE more than the control, respectively. However; since SL was proven to decrease the residual nitrite level; hence, this extra cost is negligible, and it is recommended to be added to the sausage mixture to decrease the residual nitrite level, and to improve its characteristics.

Conclusion

STPP addition to sausage mixture raised the pH of the finished product. Furthermore, it resulted in a higher residual nitrite level which might had been due to the higher pH value. Also, it improved WHC, cooking loss and texture. Addition of SL reduced pH value and residual nitrite level of the finished product. Moreover, it reduced microbial growth, TVN and TBA values and improved flavor score of the resulting sausage. It is recommended not to use STPP in cured sausage; however, the use of SL is advisable.

References

Addis, P.B. and E.S. Schanus (1979). Massaging and tumbling in the manufacture of meat products. Food Technol., 33 (4): 36-40.

Ahn, H.J.; H.S. Yook; M.S. Rhee; C.H. Lee; Y.I. Cho and M.W. Byun (2002). Application of gamma irradiation on breakdown of hazardous volatile N-nitrosamines. J. of Food Sci., 67: 596-599.

Asku, MI.; M. Kaya and H.W. Ockerman (2005). Effect of modified atmosphere packaging, storage period and storage temperature on the residual nitrate of sliced-pastirma, dry meat product, produced from fresh meat and frozen/thawed meat. Food Chemistry, 93: 237-242.

Alken, A.; J.C. Casey; L.F. Penny and C.A. Voyle (1962). Effect of drying temperature in the accelerated freeze-drying of pork. J. Sci. Food Agric., 13: 439-442.

Andrade, R.; C.O. Viana and S.G. Guadagnin (2003). Spectrophotometric method for nitrate and nitrite determination through nitric oxide generation. Food Chemistry, 80 : 597-602.

A.O.A.C. (1995). Official Methods of Analysis, 16th ed. "Association of Official Analytical Chemists". Arlington, Virginia, U.S.A.

Bacus, J. and E. Bontenbal (1991). Controlling Listeria. Meat & Poultry, 37 (6): 64, 66, 69.

Bastian, E. (2005). Personal communication. Twin Falls, Idaho: Glanbia Foods.

Cassens, R.G. (1997). Residual nitrite in cured meat. Food Technol., 51 (2): 53-55.

Cassens, R.G. (1998). Nitrite issue. Reciprocal Meat Conference Proceedings, Am. Meat Sci. Assoc., Savory, IL, USA, 51: 162-163.

Desrosier, N.M. (1984). Elements of Food Technology. AVI Publishing Company, Inc., Westport, Connecticut, U.S.A.

Difco Manual (1984). Dehydrated Culture Media and Reagents for Microbiology. 10th Ed., Difco laboratories, Detroit, Michigan 48232, U.S.A.

Egyptian Standards (E.S.) (1991). Egyptian Organization for Standardization and Quality Control. No. 637. 523. I, 664. 8037.

El-Nemr, S.E.A. (1979). Studies on meat substitutes. M.Sc. Thesis, Faculty of Agric., Zagazig Univ.

Fox, J.B.Jr. (1974). Role of cure accelerators. In Proc. Meat Ind. Res. Conf., p. 17. Am. Meat Inst. Found., Washington D.C., U.S.A.

Fouda, Z.M.; H.A. Abdel-Aziz and N.M. Abdel Bar (2000). Some processed products from underutilized tuna "Taban" fish. Egypt. J. Appl. Sci., 15 (3): 202-212.

Francis, F.L. (2000). Encyclopedia of Food Sci. & Tech., New York; John Wiley & Sons, Inc. p 1707-1715.

Gonzalez, B. and V. Diez (2002). The effect of nitrite and starter culture on microbiological quality of "choriza"- a Spanish dry cured sausage. Meat Sci., 60: 295-298.

Goodfellow, S.J. (1979). Update on developments in meat curing. Acidulants. In Proc. Meat Ind. Res. Conf. P. 1150-1156. Am. Meat Inst. Found., Washington D.C., U.S.A.

Heaton, K.M.; D.P. Cornfourth; I.V.

Moiseev; W.R. Egbert and C.E. Carpenter (2000). Minimum sodium nitrite levels for pinking of various cooked meats as related to use of direct or indirect-dried soy isolates in poultry rolls. Meat Sci., 55: 321-329.

Krause, R.J.; R.F. Plimpton; H.W. Ockerman and V.R. Cahill (1978). Influence of tumbling and sodium tripolyphosphate on salt and nitrite distribution in porcine muscle. J. Food Sci., 43: 190-196.

Lijinsky, W. (1999). N-nitroso compounds in the diet. Mutat. Res., 443: 129-138.

Oliveira, S.M.; T.I. Lopes and A.O. Rangel (2004). Spectrophotometric determination of nitrite and nitrate in cured meat by sequential injection analysis. J. of Food Sci., 69 (9): C690-C695.

Pearson, A.M. and F.W. Tauber (1984). Processed Meat. 2nd ed. AVI Publishing Company, Inc. Westport, Connecticut, U.S.A.

Pearson, D. (1991). The chemical Analysis of Food, Churchill, New York, London, pp. 374.

Sebranek, J.G. (1979). Advances in the technology of nitrite use and consideration of alternatives. Food Technol., 33 (7): 58-61.

Sen, N.P. and P.A. Baddoo (1997). Trend in the levels of residual nitrite in Canadian cured meat products over the past 25 years. J. Agric. Food Chem., 45 (12): 4714-4718.

Sharaf, S.M. (2002). Technological studies on some poultry wastes and by-products for dietary uses. Ph. Dissertation, Dept. of Food Sci. and Technol., Fac. of Agric., Cairo Univ.

Sink, J.D. and I.A. Hsu (1977). Chemical effects of smoke process on frankfurter manufacture and storage characteristics. J. Food Sci., 42: 1489-1492.

Soloviev, V.E. (1966). Meat Aging, Food Industry Pub. 53-164. (Moscow) (In Russian).

Vasavada, M.N. and D.P. Cornfourth (2005). Evaluation of milk mineral antioxidant activity in beef meatballs and nitrite-cured sausage. J. of Food Sci., 70 (4): C250-C253.

Wally, F.A.; N.M. Abdel-Bar and S.A. Hussein (2004). Preparation and evaluation of different types of sauce fortified with processed meat products. Bull. Fac. Agric., Cairo Univ., 55: 301-314.

Watts, B.M.; G.L. Yamaki; L.E. Jeffrey and L.G. Elias (1989). "Basic Sensory Methods for Food Evaluation". 1st Ed. The International Development Research Center Pub., Ontario, Canada.

Winton, A.L. and R.B. Winton (1958). Okoloff Magnesium Oxide Distillation Volumetric Method. The analysis of Food, 848, John

Wiley, New York and Hull, London.

Zaika, L.L.; T.E. Zell; J.L. Smith; S.A. Palumbo and J.C. Kissinger (1976). The role of nitrite and nitrate in Lebanon Bologna, a fermented sausage. J. Food Sci., 41: 1457-1461.

تاثير بعض الإضافات علي تركيز النيتريت المتبقي في السجق البقري وعلي بعض خصائص الجودة الأخرى

فردوس أحمد أحمد والي – نادية مختار عبد البر – هشام أحمد

* قسم بحوث تكنولوجيا اللحوم والأسماك – معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة

لقد تم تصنيع ٧ خلطات من السجق البقري . وتم إضافة تراي بولي فوسفات الصوديوم بتركيز ٠,٢٥% ، ٠,٥٠% وإضافة لاكتات الصوديوم بتركيز ٠,٧٥% ، ١,٥% كما تم إضافة خليط من تراي بولي فوسفات الصوديوم + لاكتات الصوديوم بتركيز ٠,١٢٥% تراي بولي فوسفات الصوديوم + ٠,٣٧٥% لاكتات الصوديوم وأيضاً بتركيز ٠,٢٥% تراي بولي فوسفات الصوديوم + ٠,٧٥% لاكتات الصوديوم. وبالنسبة لعينة الكونترول فقد تم إستبدال تراي بولي فوسفات الصوديوم و لاكتات الصوديوم بالنشا بتركيز ١,٥% .

لقد وجد أن تراي بولي فوسفات الصوديوم أدي إلي زيادة رقم الـــ pH وزيادة تركيز النيتريت المتبقي بالمقارنة بعينة الكونترول. هذا وقد أدى إضافة تراي بولي فوسفات الصوديوم إلى تحسين القدرة علي إمساك الماء ، الفقد بالطبخ والقوام.

إضافة لاكتات الصوديوم إلي خلطة السجق أدي إلي تقليل قيمة الـ pH وتركيز النيتريت المتبقي. كذلك أدي إلي تقليل النمو الميكروبي ، قيمة النيتروجين الكلي المتطاير وقيمة حمض الثيوباربيتيوريك ، وإلي تحسين الطعم والرائحة .

ويمكن التوصية بعدم إضافة تراي بولي فوسفات الصوديوم إلي خلطة السجق حيث أن لاكتات الصوديوم تعتبر مادة مفيدة وينصح بإستخدامها في تصنيع السجق.