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ASSESSMENT OF NITRITE AND SORBIC ACID SALTS LEVEL IN SOME MEAT PRODUCTS AND THEIR PUBLIC HEALTH SIGNIFICANCE

(With 8 Tables and One Figure)

By

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تقدير مستوي النيتريت وأملاح السوربيك في بعض منتجات اللحوم وتأثيرهما علي الصحة العامة

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في دراسة لتقدير مستوي النترات والنيتريت وأملاح السوربيك في بعض منتجات اللحوم تم جمع مائة وعشرون عينة بواقع ٣٠ عينة لكل من السجق ، البسطرمة، البلوبيف ، اللانشون المعلب من أسواق مدينة بورسعيد. وبقياس مستوي النيتريت في عينات منتجات اللحوم موضع الدراسة وجد أن متوسط مستوي النيترايت كان ١٢٠,٤٠±٧,٠٣، ١٤٢,١٥ ± ٩,١٣ ، ١٨٦,٢٧ ± ٤,٤٢ ، ١٥٩,٩٦ ± ٦,٧٣ جزء في المليون لعينات السجق ، البسطرمة، البلوبيف ، اللانشون المعلب علي التوالي.، بينما كان متوسط مستوي النترات وأملاح السوربيك ٧٣,٤٩ ± ٦,٤٦ ، ٦٢,٥٤ ± ١٩,٤٤، ٣٩,٨٢ ± ٩,٩٦ و ٢٨,٥٢ ± ١٠,٨٦، جزء في المليون و٠,٩٢ ± ٠,١١، ١,٢٥± ٠,١٢، ٠,٠ ، ٠,٠ جرام /كجم لعينات السجق ، البسطرمة، البلوبيف ، اللانشون المعلب علي التوالي. ووجد أن ١٠٠% من العينات موضع الدراسة تحتوي علي نيتريت، بينما ١٠٠%، ٣,٣٣%، ٤٣,٣٣%، ، ٢٦,٦٧ % من عينات السجق ، البسطرمة، البلوبيف ، اللانشون المعلب علي التوالي تحتوي علي النترات. وعلي الجانب الأخر وجد أن ١٠٠% من عينات السجق والبسطرمة تحتوي علي أملاح السوربيك بينما لم يستدل علي هذه الأملاح في عينات البلوبيف واللانشون المعلب. وبمقارنه النتائج بالحد المسموح للنيتريت حسب دستور منظمة الزراعة والأغذية ومنظمة الصحة العالمية في هذا الشأن وجد أن ٣ (١٠%)، ٧ (٢٣,٣٣%) ، ٤ (١٣,٣٣%) من عينات البسطرمة، البلوبيف ، اللانشون المعلب علي التوالي تعدت الحد المسموح به، بينما مستوي النترات في جميع العينات موضع الدراسة لم يتعد الحد المسموح. أيضا وجد أن ٢ (٦,٦٧%) من عينات السجق ، ٥ (١٦,٦٧%) من عينات البسطرمة تعدت الحد المسموح به لأملاح السوربيك. وتم مناقشة تأثير مستوي النترات والنيتريت وأملاح السوربيك علي الصحة العامة.

SUMMARY

One hundred twenty samples of some meat products (30 each of sausage, pastrami, corned beef and canned luncheon beef) were randomly purchased from Port-Said markets. The samples were examined for assessment the levels of nitrite, nitrate and sorbic acid salts. The obtained results revealed that the mean values of nitrite level in the examined meat products were 120.40 ± 7.03, 142.15 ± 9.13, 186.27 ± 4.42 and 159.96 ± 6.73 ppm for sausage, pastrami, corned beef and canned luncheon beef respectively. While that of nitrate and sorbic acid salts were 73.49 ± 6.46, 62.54 ±19.44, 39.82 ± 9.96 and 28.52 ±10.86 ppm and 0.92 ±0.11, 1.25 ±0.12, 0.00 and 0.00 g/kg for sausage, pastrami, corned beef and canned luncheon beef respectively. For all samples nitrite was detected in 100% of the examined samples, while nitrate was detected in 100, 3.33, 43.33 and 26.67% of the sausage, pastrami, corned beef and canned luncheon beef samples respectively. On the other hand sorbic acid salts was detected in 100% of sausage and pastrami samples and could not be detected in the corned beef and canned luncheon beef samples. For all specimens 3 (10%), 7 (23.33%) and 4 (13.33%) of pastrami, corned beef and canned luncheon beef samples exceeded the permissible limits of nitrite established by JECFA "FAO/WHO" (1974) respectively, while nitrate not exceed the permissible limits. In case of sorbic acid salts 2 (6.67%) of sausage and 5 (16.67%) of pastrami exceeded the permissible limits of sorbic acid salts. The effects of nitrite, nitrate and sorbic acid salts levels on public health significance were discussed.

Key words: *Meat products, preservatives, nitrate, nitrite, sorbic acid.*

INTRODUCTION

Meat and meat products are important component of diet for a large majority of people and considered the vital part of any balanced and nutritious diet. They have a highly nutritive value and palatability thus considered a highly perishable foods and an excellent environmental source for microbial growth (Garcia *et al.,* 1995; Kalalou *et al.,* 2004).

The potential of food contamination and spoilage makes it necessary to add preservatives to foods (Lindsay, 1985). Food preservation has become an increasingly important practice in modern food technology with the increase in the processed and convenience

foods (Saad *et al.*, 2005). These preservatives are added to stop or delay the nutritional losses and meat spoilage due to microbiological, enzymatic or chemical changes of foods and to prolong shelf life and quality of food (Mota *et al.*, 2003).

The most commonly used preservatives in meat processing are nitrite, nitrate and sorbic acid (Mihyar *et al.*, 1999). Sodium and potassium salts of nitrite and nitrate are widely used as preservatives in meat processing. The nitrite is either added as salts or produced from nitrate by microbial reduction. Nitrite and/or nitrate plays a crucial role in the curing process, which results in the typical sensory properties and an appealing pinkish reddish color to the meat products that is well know by consumers consequently prevent meat products from turning brown or grey colored. (Dahle, 1979; Noel *et al.*, 1990; Hyytia *et al.*, 1997). The coloring of the processed meat results from the conversion of nitrate to nitrite by chemical reaction that reacts with the myoglobin to form a bright red nitrosomyoglobin. This bright red color is converted into permanent pink pigment nitrosohemochrome under effect of cooking (Hyytia *et al.*, 1997). Generally, nitrite has antimicrobial properties that prevent pathogenic and non-pathogenic bacteria. Nitrite control or prevent the growth of spores particularly of *Clostridium botulinum,* these spores are a real concern in the food industry because they can survive normal heat processing under right conditions, they can produce vegetative cells which resulted in food poisoning by their lethal toxin (Olsman, 1977; Roberts and Ingram, 1977; Noel *et al.*, 1990; Hyytia *et al.*, 1997). Besides the coloring and antimicrobial effect of nitrite and nitrate, they have antioxidant properties and can preserve the taste and flavoring and prevent warmed over (undesirable flavors), off odors and rancidity of several meat and meat products during their storage (AMI, 1978; Dahle, 1979; Honikel, 2008).

The other most common used food preservatives were sorbic acid and its water-soluble salts specially potassium sorbate. The microbiological safety of food products was best ensured by addition of potassium sorbates (Shahidi *et al.*, 1988; Ferrand *et al.*, 2000 a). Sorbates are naturally occurring unsaturated fatty acid and considered the best antibacterials agents because their broad spectrum of action. They effectively inhibit certain bacteria and food born yeast and mold species (Sofos and Busta, 1993). The inhibitory effect of sorbates on microorganisms may be lethal or static. The mechanism by which sorbates inhibits microbial growth may be due to its effect on enzymes such as dehydrogenase involved in fatty acid oxidation and sulfhdryl

enzyme such as succinic dehydrogenase and yeast alcohol dehydrogenase (Davidson and Juneja, 1990; Sofos and Busta, 1993).

Many epidemiological studies have showed that diets plays a substantial role in the etiology of many forms of cancer and it has been estimated that as much as 40-60% of cancer cases may be attributed to factors associated with diets (Miller, 1985; Twombly, 1995). Thus, a specific attention has been focused on the possible role of nitrite and nitrate, in cancer (Jakszyn and Gonzalez, 2006). The potential health dangerous of nitrite referred to its ability to reacts with secondary amines and amides present in the meat products under acidic condition to form nitrosamine. This compound is strong mutagens and powerful carcinogenic in animals and potential in humans causing cancer in certain body organs and tissues e.g. stomach, urinary bladder and others organs (Lijinsky and Kovatch, 1982; Mirvish, 1995). Nitrosamine may be ingested directly with cured meat or may be formed in vivo in the stomach (Howe *et al.*, 1986; Nijinsky, 1999). Ingested nitrates can be reduced to nitrite in the saliva and thus these compounds are considered as potential precursor of endogenously formed nitrosamine (Shapiro *et al.*, 1991; Grosse *et al.*, 2006). Nitrites also have a vasodilator effect cause intravascular hemolysis in human specially that with glucose-6-phosphate dehydrogenase deficiency (Chan, 1996), headaches (Henderson and Raskins, 1972), hypotension, abdominal pain, acidosis (Gosselin *et al.*, 1984) and linked with triggering migraines (FDA, 1998). In infants, epidemiological evidence showed a relationship between consumption of cured meats and incidence of childhood leukemia, brain tumors, methaemoglobinaemia (blue baby syndrome) and cyanosis due to the reaction of nitrite with hemoglobin in the red blood cells. Some of these signs may appear also in young children and elder person (Sen and Baddoo, 1997).

On the other hand, sorbates are low or non-toxic even in large quantities (Shahidi *et al.*, 1988; Ferrand *et al.*, 2000 a) and considered the lowest allergenic potential of all food preservatives. They do not accumulate in the body and being rapidly metabolized by pathway similar to those of other fatty acids through ß-oxidation to form CO_2 and H_2O (Lindsay, 1996; Walker, 1990). Sorbic acid act as a nucleophile and form complex with amino compounds under normal food processing conditions with the resulting adducts being devoid of genotoxic activity (Ferrand *et al.*, 2000 b). In human, few cases of idiosyncratic intolerance to sorbic acid have been reported such as non-immunological contact urticaria and pseudo-allergy (Safford *et al.*, 1990; Walker, 1990)

Therefore, the objective of the present study aimed to investigate the level of nitrite, nitrate and sorbic acid salts in sausage, pastrami, corned beef and canned luncheon beef that mostly consumed by people to evaluate the overall safety of these preservatives in such meat products.

MATERIALS and METHODS

1: Samples collection:

A total of 120 random samples of some meat products (30 each of sausage, pastrami, corned beef and canned luncheon beef) were purchased from Port-Said markets. Each individual sample was placed separately into sealed plastic bags, thoroughly identified and delivered to the laboratory. All specimens were processed for assessment the levels of the nitrite, nitrate and sorbic acid and its salts.

2: Chemical examination:

2-1: Preparation of the samples:

All specimens of sausage, pastrami, and the entire contents of the corned beef and canned luncheon beef meat, were separately passed rapidly three times through food chopper with plate opening equal to $1/8^{th}$ inch (3 mm), mixed thoroughly after each grinding to obtain a uniform mass and finally began all determinations promptly. The homogenate sample was transferred to a wide mouth glass or other suitable container with an airtight stopper. The analysis was carried out as soon as possible, if any delay, the sample was chilled to inhibit the decomposition (A.O.A.C., 2000).

2-2: Determination of nitrite and nitrate levels:

2-2-1: Reagents:

All reagents used were of analytical grade purchased from Merck (Merck, Darmstadt, Germany) and Sigma-Aldrich (Sigma, St. Louis, MO). Nitrite standard were obtained from Sigma-Aldrich.

2-2-2: Sample extraction:

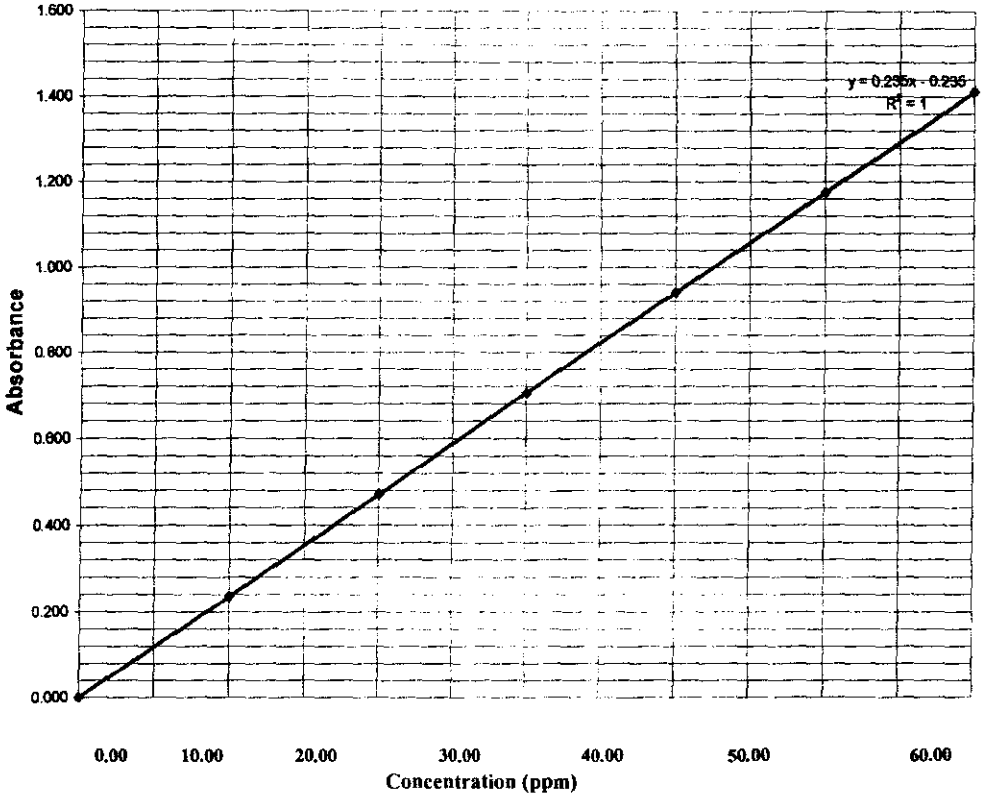
In 50 ml beaker, 5 gm of the prepared sample were weighed to which about 40 ml of heated water (at 80°C) were added and mixed thoroughly with glass rod then transferred to 500 ml volumetric flask. Beaker and glass rod were thoroughly washed with successive portions of hot water (at 80°C) and all washings water were added to flask. Enough hot water was added to bring volume to about 300 ml. The flask was put in steam bath and let stand for 2 hours with shaking occasionally. The samples were cooled to room temperature, diluted to volume with water and remixed then filtered (by free nitrite and nitrate

filter paper); if turbidity remained after filtration, centrifuging will usually clear the solution (I.S.O., 1975; A.O.A.C., 2000).

2-2-3: Standard curve of nitrite:

In 50 ml volumetric flask, 2.5 ml of sulphanilamide solution (0.5 gm of sulphanilamide were dissolved in 150 ml of 15% acetic acid (v/v) then filtered "by free nitrite and nitrate filter paper" and stored in a glass stoppered brown bottle) were added and thoroughly mixed with aliquot containing 5-50 µg $NaNO_2$ (was prepared by added 10, 20, 30, 40 ml of nitrite working solution). After 5 minutes, 2.5 ml NED reagent (0.2 gm N- "1 Napthyl" ethylenediamine dihydrochloride were dissolved in 150 ml of 15% (v/v) acetic acid), were added and diluted to volume with mixing and let color developed 15 minutes. A portion of the solution was transferred to photometer cell and determined absorbance at 540 nm against blank. Standard curve is straight line up to 1 ppm Na NO_2 in final solution according to A.O.A.C. (2000).

Standard Calibration Curve for Nitrite (5-50 µg)



2-2-4: Reduction of nitrate to nitrite:

The nitrate residue in the sample aliquot was reduced to nitrite by acid reduction technique according to Narayana and Sunil (2009). 5 ml concentrated HCl and 2 ml of Zn / NaCl granular mixture were added to 10 ml of the sample aliquot. The mixture was allowed to stand for 30 minutes with occasionally stirring to form nitrite and then filtered the solution to 100 ml volumetric flask using Whitman filter paper No. 41. The filtrate was diluted up to the mark and the reduced nitrate levels was assessed and calculated according to A.O.A.C. (2000).

2-2-5: Assessment of the sample for nitrate and nitrite levels:

In 50 ml volumetric flask, 2.5 ml of sulphanilamide solution were added and mixed with 45 ml of the sample filtrate. After 5 minutes, 2.5 ml NED reagent were added and diluted to volume with mixing and let color develop 15 minutes. A portion of sample solution was transferred to photometer cell and determined absorbance at 540 nm against blank of 45 ml water and 2.5ml sulphanilamide reagent and 2.5ml of NED reagent. Nitrite concentrations in the samples were determined by comparison with standard curve. All the estimations were carried out in duplicate for each of reduced and non reduced aliquot according to A.O.A.C. (2000).

2-2-6: Calculation (A.O.A.C., 2000):

$$\text{Nitrite content (expressed as } NaCO_2\text{) "Without reduced nitrate } NaCO_3\text{"} = \frac{C \times 500 \times 50}{M \times V}$$

$$\text{Nitrite content (expressed as } NaCO_2\text{) "With reduced nitrate } NaCO_3\text{"} = \frac{C \times 500 \times 50 \times 10}{M \times V}$$

$$\text{Nitrate content (expressed as } NaCO_3\text{)} = \text{Nitrite content with reduced nitrate} - \text{Nitrite content without reduced nitrate} \times 1.23$$

C = Concentration of sodium nitrite in µg/ml read from the calibration curve that corresponds with the absorption of the solution prepared from the sample.

M = Mass in gm of sample taken.

V= Volume in ml of aliquot portion of filtrate taken for test.

1.23= factor to convert nitrite to nitrate

2-3: Determination of Sorbic acid salts:

2-3-1: Reagent:

All reagents used were of analytical grade purchased from Merck (Merck, Darmstadt, Germany) and Sigma-Aldrich (Sigma, St. Louis, MO). Sorbic acids standard were obtained from Sigma-Aldrich.

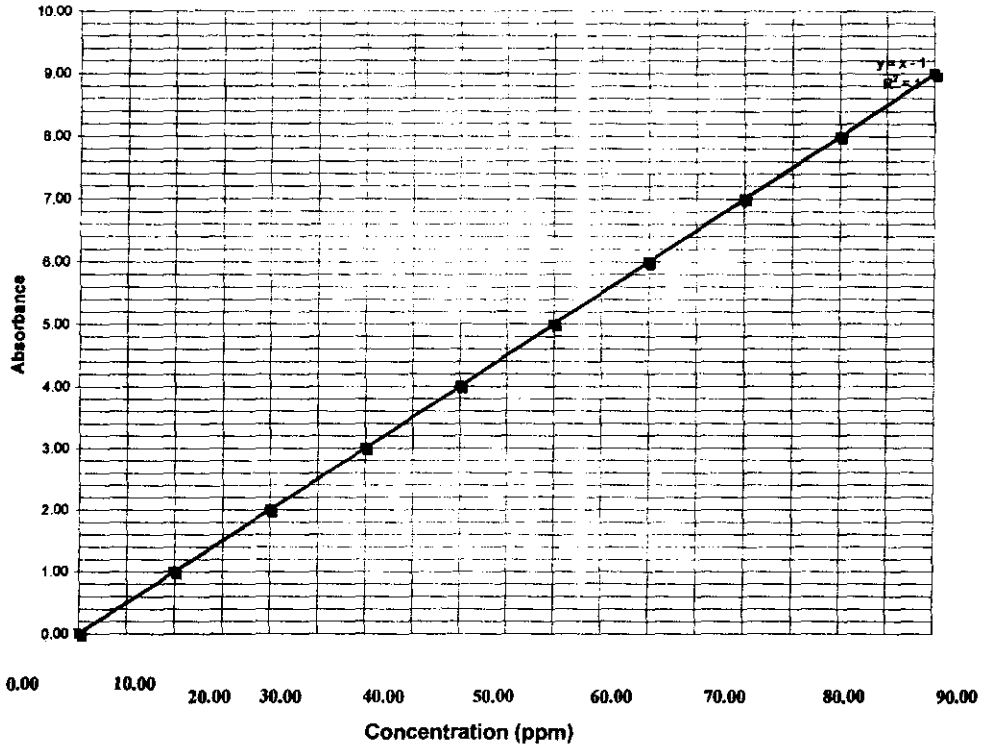
2-3-2: Sample extraction (oxidation methods):

In one liter steam distillation flask, 50 gm of the prepared sample were weighed and 100 gm of magnesium sulphate hexahydrate and 100 ml 1N sulphuric acid were added. Rapidly the prepared sample (do not heat the distilling flask) was steam distilled and the distillates were received in the receiving flask containing 10 ml of 1N NaOH. About 450 ml of distillate were collected in about 30 minutes, cooled and transferred to a 500 ml volumetric flask. 15 ml 1N sulphuric acid were added to the sample aliquot, then diluted to the volume with water and mixed well.

2-3-3: Standard curve of sorbic:

In 500 ml volumetric flask, 25 ml of the standard sorbic acid stock solution (1.0 gm of sorbic acid was dissolved in a small volume of 1N NaOH and diluted to 1 liter with water "1 mg/ml") were pipetted and diluted to volume with water (50 μg/ml). Next 0.0, 10.0, 20.0, 50.0 and 80.0 ml of this solution were pipetted into five 100 ml volumetric flasks and diluted to volume with water (range 0, 5, 10, 25, and 40 μg/ml respectively). Then 2 ml of each of the working standards and blank were pipetted into 5 test tubes and 2 ml of dichromate solution (freshly prepared solution of equal volumes of 0.3 N sulphuric acid mixed with a solution of 0.5 gm potassium dichromate in 1 liter of water) were added, followed by heating in a boiling water bath for 5 minutes. After cooling, 2 ml of 0.5% TBA solution (0.5 gm of thiobarbituric acid was dissolve in 25 ml water + 20 ml 0.5 N NaOH then added 11 ml 1 N HCL and diluted to 100 ml with water) were added and heated in a boiling water bath for 10 minutes. The mixture was cooled rapidly, transferred to 50 ml volumetric flask and diluted to the volume with water. The absorbance of the solution was measured at 532 nm against blank using 1 cm cuvette. All the estimations were carried out in duplicate and the mean of the duplicate was taken. Plot absorbance μg sorbic acid for a standard curve (μg sorbic acid = 0, 10, 20, 50, 80 in 2 ml aliquots) according to FAO (1986).

Standard Calibration Curve for Sorbic Acid (5-50 µg)



2-3-4: Assessment of the sample levels:

Two ml of the aliquots sample were pipetted into a test tube and 2 ml of dichromate solution were added, followed by heating in a boiling water bath for 5 minutes. After cooling 2 ml of 0.5% TBA solution (0.5 gm of thiobarbituric acid was dissolve in 25 ml water + 20 ml 0.5 N NaOH then, added 11 ml 1 N HCl and diluted to 100 ml with water) were added and heated in a boiling water bath for 10 minutes, then cooled rapidly and transferred to 50 ml volumetric flask and diluted to the volume with water. The absorbance of the solution was measured at 532 nm using 1 cm cuvette. All the estimations were carried out in duplicate and taken the mean of the duplicate according to FAO (1986).

2-3-5: Calculation (FAO, 1986):

$$\text{Sorbic acid (ppm)} = \frac{A}{S} \times \frac{500}{2}$$

Where A = µg sorbic acid corresponding to sample absorbance, taken from the standard curve

S = sample weight in gm

3: Statistical methods

Minimum, maximum, mean, standard error and standard deviation of mean as well as frequency distribution were used to describe data. One-Way ANOA test was used to compare the mean of the nitrite, nitrate and sorbic acid salts levels in sausage, pastrami, corned beef and canned luncheon beef. P value was considered significant if less than 0.05 and 0.01 at 95% and 99% respectively. These tests were analyzed using the Statistical Package for Social Scientists (SPSS) for windows 16.0 (SPSS Inc., Chicago, IL, and USA).

RESULTS

Table 1: Statistical analytical results of the nitrite levels (expressed as ppm of $NaCO_2$) recovered from the examined meat products (n=30 of each).

			Meat Products			
			Sausage	Pastrami	Corned beef	Canned luncheon beef
Samples	Total	No.	30	30	30	30
		%	100	100	100	100
	(ND)	No.	0.00	0.00	0.00	0.00
		%	0.00	0.00	0.00	0.00
	(D)	No.	30	30	30	30
		%	100	100	100	100
Statistic for nitrite levels of (D) samples		Min.	52.01	70.92	132.38	70.92
		Max.	193.84	264.76	236.39	245.84
		Mean	120.40	142.15	186.27	159.96
		S.E.	7.03	9.13	4.42	6.73
		S.D.	38.52	50.02	24.19	36.88

ND = Non-Detectable. D = Detectable. Min. = Minimum. Max. = Maximum.
SE = Standard Error SD = Standard Deviation.

Table 2: Statistical analytical results of the nitrate levels (expressed as ppm of $NaCO_3$) recovered from the examined meat products (n=30 of each).

			Meat Products			
			Sausage	Pastrami	Corned beef	Canned luncheon beef
Samples	Total	No.	30	30	30	30
		%	100	100	100	100
	(ND)	No.	٠,٠٠	20	17	22
		%	٠,٠٠	66.67	56.67	73.33
	(D)	No.	30	10	13	8
		%	100	33.33	43.33	26.67
Statistic for nitrate levels of (D) samples		Min.	26.29	٠,٠٠	٠,٠٠	٠,٠٠
		Max.	161.55	367.19	182.02	209.58
		Mean	73.49	62.54	39.82	28.52
		S.E.	6.46	19.44	9.96	10.86
		S.D.	35.40	106.46	54.55	59.48

ND= Non-Detectable. D= Detectable. Min. = Minimum. Max. = Maximum.
SE = Standard Error SD = Standard Deviation.

Table 3: Statistical analytical results of the sorbic acid salts levels (expressed as ppm of sorbic acid) recovered from the examined meat products (n=30 of each).

			Meat Products			
			Sausage	Pastrami	Corned beef	Canned luncheon beef
Samples	Total	No.	30	30	30	30
		%	100	100	100	100
	(ND)	No.	٠,٠٠	٠,٠٠	30	30
		%	٠,٠٠	٠,٠٠	100	100
	(D)	No.	30	30	٠,٠٠	٠,٠٠
		%	100	100	٠,٠٠	٠,٠٠
Statistic for sorbic acid salts levels of (D) samples		Min.	0.10	0.15	٠,٠٠	٠,٠٠
		Max.	2.35	2.50	٠,٠٠	٠,٠٠
		Mean	0.92	1.25	٠,٠٠	٠,٠٠
		S.E.	0.11	0.12	٠,٠٠	٠,٠٠
		S.D.	0.58	0.64	٠,٠٠	٠,٠٠

ND= Non-Detectable. D= Detectable. Min. = Minimum. Max. = Maximum.
SE = Standard Error SD = Standard Deviation.

Table 4: Frequency distribution of the examined meat products based on their nitrite levels (n=30 of each)

Levels range	Type of samples							
	Sausage		Pastrami		Corned beef		Canned luncheon beef	
	No.	%	No.	%	No.	%	No.	%
0 (ND)	0	0	0	0	0	0	0	0
> 0 – 50	0	0	0	0	0	0	0	0
> 50-100	10	33.33	9	30.00	0	0	1	3.33
> 100-150	11	36.67	6	20.00	2	6.67	10	33.33
> 150-200	9	30.00	12	40.00	21	70.00	15	50.00
> 200-250	0	0	2	6.67	7	23.33	4	13.33
> 250-300	0	0	1	3.33	0	0	0	0
Total	30.00	100.00	30.00	100.00	30.00	100.00	30.00	100.00

ND = Non detectable level.

Table 5: Frequency distribution of the examined meat products based on their nitrate levels (n=30 of each).

Levels range	Type of samples							
	Sausage		Pastrami		Corned beef		Canned luncheon beef	
	No.	%	No.	%	No.	%	No.	%
0 (ND)	0	0	20	66.67	17	56.67	22	73.33
> 0 - 50	10	33.33	0	0	1	3.33	1	3.33
> 50-100	13	43.33	2	6.67	7	23.33	4	13.33
> 100-150	6	20.00	2	6.67	3	10.00	0	0
> 150-200	1	3.33	2	6.67	2	6.67	2	6.67
> 200-250	0	0	1	3.33	0	0	1	3.33
> 250-300	0	0	2	6.67	0	0	0	0
> 300-350	0	0	•	•	0	0	0	0
> 350-400	0	0	1	3.33	0	0	0	0
Total	30.00	100.00	30.00	100.00	30.00	100.00	30.00	100.00

ND = Non detectable level.

Table 6: Frequency distribution of the examined meat products based on their sorbic acid salts levels (n=30 of each)

Levels range	Type of samples							
	Sausage		Pastrami		Corned beef		Canned luncheon beef	
	No.	%	No.	%	No.	%	No.	%
0 (ND)	0	0	0	0	30	100.00	30	100.00
> 0 – 0.5	7	23.33	3	10.00	0	0	0	0
> 0.5 – 1.0	9	30.00	10	33.33	0	0	0	0
> 1.0 – 1.5	10	33.33	6	20.00	0	0	0	0
> 1.5 - 2	2	6.67	6	20.00	0	0	0	0
> 2 – 2.5	2	6.67	5	16.67	0	0	0	0
Total	30.00	100.00	30.00	100.00	30.00	100.00	30.00	100.00

ND = Non detectable level.

Table 7: Correlation between the different mean values of nitrite, nitrate and sorbic acid salts levels in the examined meat products samples (at p = 0.05 "95%" and p = 0.01 "99 %").

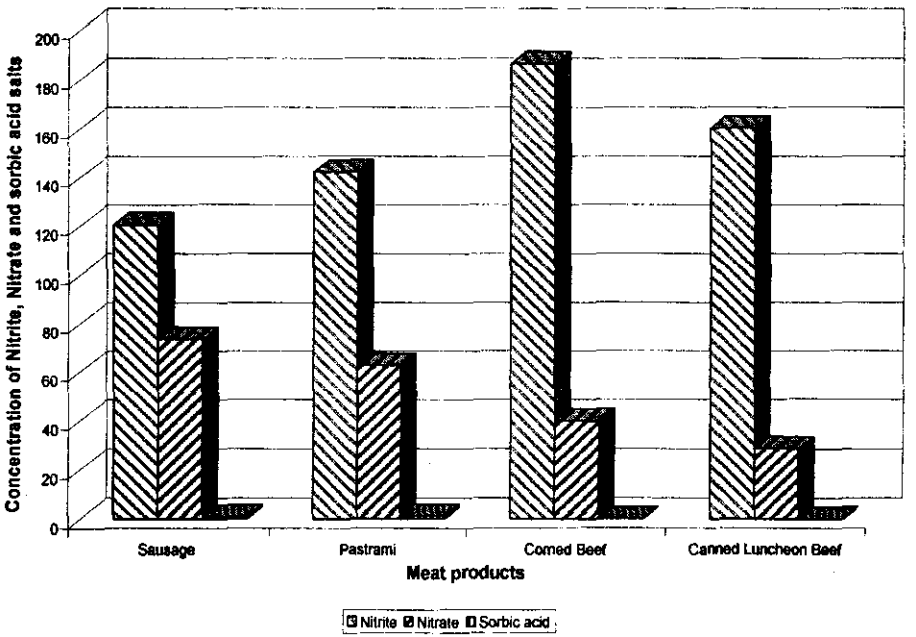
	Nitrite	Nitrate	Sorbic acid salts
Nitrite	---------- --	0.023 (*)	0.000 (**)
Nitrate	0.023 (*)	----------	0.055
Sorbic acid salts	0.000 (**)	0.055	----------

(**) = Highly significant relationship at 0.01 (99%).
(*) = Significant relationship at 0.05 (95%).

Table 8: Comparison between the mean values of nitrite, nitrate and sorbic acid salts with the permissible limits of each in the examined meat products.

Meat products	Nitrite					Nitrate					Sorbic acid salts				
	Results				Permissible limits	Results				Permissible limits	Results				Permissible limits
	Allowed		Not allowed			Allowed		Not allowed			Allowed		Not allowed		
	No.	%	No.	%		No.	%	No.	%		No.	%	No.	%	
Sausage	30	100	0	0	200 ppm	30	100	0	0	500 ppm	28	93.33	2	6.67	2.0 g/kg
Pastrami	27	90	3	10		30	100	0	0		25	83.33	5	16.67	
Corned beef	23	76.67	7	23.33		30	100	0	0		30	100	0	0	
Canned luncheon beef	26	86.67	4	13.33		30	100	0	0		30	100	0	0	

Fig. (1): The mean levels of nitrite, ntrate and sorbic acid salts in some meat products



DISCUSSION

The importance of the various preservatives, which added to meat products during processing are to extend the shelf life and enhanced food safety. They have always been a health safety issues to consumers. Thus, their determination is essential for legislative purpose and consumer's health (Capillas and Colmenero, 2008).

The obtained results in Tables 1-3 and Fig. 1 showed that the mean values of nitrite and nitrate levels in the examined meat products were 120.40 ± 7.03, 142.15 ± 9.13, 186.27 ± 4.42 and 159.96 ± 6.73 and 73.49 ± 6.46, 62.54 ±19.44, 39.82 ± 9.96 and 28.52 ±10.86 ppm for sausage, pastrami, corned beef and canned luncheon beef respectively, while that of sorbic acid salts were 0.92 ±0.11, 1.25 ± 0.12, 0.00 and 0.00 g/kg respectively. These results were lower or approximately agree with the nitrite level results recorded by Vlascici *et al.* (2006), but higher than that reported by Babji *et al.* (1984); Sen and Baddoo (1997); Hamano *et al.* (1998); Olmos *et al.* (1998). In case of sorbic acid salts, our results were higher than that recorded by Kim *et al.* (1986) Song (1995); Do and Cho (2001). The variation between our results and the

results of other authors may be attributed to the variation in the concentration of the preservative added to the raw meat during meat processing (Mirvish *et al.*, 1995), the difference between the nitrite content of raw meat before processing (JECFA "FAO/WHO", 1974), and the variation in the content of ascorbic acid added to the meat products whereas adding 500 ppm sodium ascorbate decrease the nitrite residue in the meat products (Zhukova, 1999).

Regarding the frequency distribution of the examined meat products samples presented in Tables 4-6, it is evident that nitrite was detected in 100% of the examined samples, while nitrate was detected in 100%, 3.33%, 43.33% and 26.67% of the examined sausage, pastrami, corned beef and canned luncheon beef respectively. On the other hand sorbic acid salts was detected in 100% of sausage and pastrami samples only.

In addition, Tables 4-6 showed that most of the examined sausage (100%), pastrami (90%), corned beef (76.67%) and canned luncheon beef (86.66%) had nitrite levels ranged from >50-200 ppm, while 100%, 20%, 43.33% 23.33% of the examined sausage, pastrami, corned beef and canned luncheon beef respectively had nitrate levels ranged from >0-200 ppm. The most of sorbic acid salts levels ranged from >0-2 g/kg with a percentage of 93.33% and 83.33% for sausage and pastrami samples respectively. The non-detected levels of nitrate were found in samples of pastrami, corned beef and canned luncheon beef in a percentage of 66.67, 56.67 and 73.33 respectively, meanwhile that of sorbic acid salts were 100% for each of corned beef and canned luncheon beef. The recorded high incidence of nitrite, nitrate and sorbic acid salts in the examined meat product samples than that of other authors may be attributed to the ability, rate and amount of the conversion of nitrate to nitrite (Shemshadi *et al.*, 2006), high amount of preservative added (Mirvish *et al.*, 1995), high levels of nitrite in raw meat (JECFA "FAO/WHO", 1974), and low amount of ascorbic acid added to the meat (Zhukova, 1999).

Statistically by using One-Way ANOVA test to compare the means values of the nitrite, nitrate and sorbic acid salts in the examined meat products samples (Table 7), showed a significant relationship between the mean values of nitrite and nitrate but a highly significance relationship between the mean values of nitrite and sorbic acid salts. The relation between Nitrate and sorbic acid salts was non-significance. This indicates that nitrite and nitrate levels related to each other during the meat processing according to Lundberg *et al.* (2004).

In comparison with the permissible limits of the nitrite, nitrate and sorbic acid salts in the examined meat products samples, Table 8 showed that 10% (3), 23.33% (7) and 13.33% (4) of pastrami, corned beef and canned luncheon beef samples exceeded the permissible limits of nitrite established by JECFA "FAO/WHO" (1974 and 2005) respectively, while nitrate not exceed the permissible limits. In case of sorbic acid salts, 6.67% (2) of sausage and 16.67% (5) of pastrami were exceeding the permissible limits of sorbic acid salts. The recorded high permissible limits in a few of the examined meat products samples may be regarded to an error in the processing of these meat products samples concerning the extension of the shelf life is the more important aim for economic income than the adverse effect of the used preservative on consumer's health, although cured meat color can be obtained with 50 ppm nitrite or 100 ppm nitrate in the cure mixture (Zaika *et al.*, 1976).

Concerning the toxic effect of the preservatives exposure and the high consumption of meat products by large majority of people (Walker, 1990; Kalalou *et al.*, 2004; Jakszyn and Gonzalez, 2006), the overcome of these hazardous effects with the elongation of the shelf life and maintenance of the quality of the meat products are the main goal. Thus, in conclusion, we implemented to reduce the use of preservatives with the maintenance of their benefits action. The addition of nitrite should be limit to a few special food products where *Clostridium botulinum* really represents a hazardous to human health e.g. canned meat; some cure meat and fermented products, this mean nitrite should be permitted only for meat products were it exerts a clear beneficial function. Nitrite should not be used for products that have been traditionally manufactured without them e.g. that cooking by final consumers or the preparation of minced meat. Nitrosamine inhibiting agents as ascorbate, alpha tocopherol or both during the processing of meat products should be added to reduce the hazardous effects. Periodic monitoring of nitrite, nitrate and nitrosamine in the meat products in the plant before marketing and in the market should be permitted as a role of the authorities for local and imported meat products. A combination of a lower level of potassium sorbate with sodium nitrite should be used to reduce the nitrosamine formation, provide a safe antibotulinal and long shelf life of the products depending up on their synergistic action. Strict law enforcement should be under taken by the authorities and the modern food technologist regarding a control on the different sources of nitrite contaminants for food animals and environment (Nitrite free raw meat).

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