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# DETERMINATION OF SOME CONTROVERSY ADDITIVES IN FOODSTUFFS

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## ABSTRACT

Food additives have been implicated as aetiological factors in many different disease states. Therefore, a survey was carried out with the aim to evaluating the levels of food preservatives, nitrite and sulfites in various food items available on the Egyptian markets. The results of this survey showed that the average concentration detected could be exceeded than the maximum permitted limits for dried fruits and canned juices to sulphites and some processed meat products to nitrite. The effect of sausage culinary processing on the changes in the content of nitrite was determined. The results indicated that the sausage cooked in hot water exhibited the lowest residual nitrite levels. This study showed that water cooking might provide a promising method to process sausage with high yield and cooking efficiency. Results from the sensory panel members indicated that the frying sausage were preferred to roasted ones or those cooked in the microwave oven or in the hot water.

**Keywords:** Nitrite; Sulphite; Survey; Analytical determination & Culinary processes.

## INTRODUCTION

Food additives play a vital role in the modern food industry, and are generally used for maintaining food quality and characteristics as well as promoting food safety. Among them, nitrite, nitrate and sulfite which are widely used as food preservatives throughout the world. In recent years, concern about their safety in foods has been growing. An acceptable daily intake (ADI) for nitrate of 3.7 mg $kg^{-1}$ body weight while, nitrite has higher acute toxicity than nitrate and a lower ADI of 0 - 0.07 mg nitrite/kg body weight which would correspond to approximately 0.09 mg $kg^{-1}$ body weight for sodium nitrite (JECFA, 2002). The ADI for sulpher dioxide has been set at 0 - 0.7 mg $kg^{-1}$ of body weight (WHO, 2000).

The increasing incidence of various forms of cancer in the world has been attributed to the levels of certain chemicals in our foods and drinks. Among these chemical carcinogens are N-nitrosamines, nitrite and secondary amines. Nitrite and nitrate "saltpeter" were still, as the most widely used salts as food additives. It's a traditional agent for curing meat products and it has multifunctional: imparts the characteristic pink color to cooked cured meat products, contributes to the typical flavor of cured meat products, acts as an antioxidant and most importantly, it has a strong antimicrobial effect in retarding germination of spores and the formation of *Clostridium botulinum* toxin.Various levels of carcinogenic volatile N-nitrosamines, nitrites and secondary amines are present in a wide variety of foods such as cheese and cheese products, raw and processed meats, smoked fish, dried malt and beer (Cassens, 1997).

The occurrence of nitrites in foods and their effects on human health, remain the subject of controversy. Excess dietary intake has been associated with methaemoglobinaemia and the in-vivo production of the carcinogenic N-nitrosamines. It has been also reported that nitrate can be reduced in-vivo to nitrite which can react with secondary or tertiary amines to form N-nitroso compounds, some of which are known to be carcinogenic, teratogenic and mutagenic (Meah *et al*., 1994 and Eichholzer & Gutzwiller, 1998)

The directive 2006/52/EC of 5 July 2006 indicates ingoing amount of 150 mg nitrite/kg and 300 mg nitrate/kg were permitted in more or less all meat products. The residual amounts could be 50 mg nitrite/kg in non-heat treated meat products and 100 mg nitrite/kg in all other meat products except Wiltshire bacon and some other similar products to 175 mg nitrite/kg (Directive, 2006).

A wide range of analytical techniques have been employed to assess the quantitative determination of nitrite and nitrate. These include kinetic (Koupparis *et al.,* 1982 and Li *et al.,* 1994); Chromatographic (Butt *et al*., 2001 and Siu & Henshall, 1998); capillary electrophoresis (Otzekin *et al*., 2002) and spectrophotometry (AOAC, 2000 and Kawakami & Igrashi, 1996).

Sulphite is a term widely applied to a variety of sulphur-based compounds. The six sulphiting agents most commonly used by the food industry are: sulphur dioxide, sodium and potassium metabisulphite, sodium and potassium bisulphate and sodium sulphite. These sulphites compounds act as antimicrobial agents, enzyme inhibitors, and antioxidants in the control of enzymatic and non-enzymatic browning reactions with stabilizing and conditioning functions and for these characteristics they are widely used in foods such as dried fruits, dehydrated vegetables, biscuits, jellies, mustard and wine (Lyengar & McEvily, 1992; Kim, 1995 and Walker, 1985)

However, consumer awareness of the risks associated with sulphites has increased recently, and several adverse effects associated with the use of sulphites have been reported; these have been restricted, however, to animal studies. Sulphur dioxide has been shown to cause various physiological changes, such as polyneuritis, bleached incisors, visceral organ atrophy, bone marrow atrophy and spectacle eyes in rats. Human sulphite consumption of more than 50 mg $kg^{-1}$ body weight may result in headache, nausea and diarrhea. Sodium bisulphite damages the nervous system, reproductive organs, bone tissue, kidneys and other visceral organs in rats (Davidson and Juneja, 1996). Sulphites have also been implicated as initiators of asthmatic reactions in a small subset of sensitive individuals; asthmatic attacks can be serious, and the ingestion of foods containing sulphites is alleged to have caused several deaths in recent years (Fazio and Warner, 1990).

The overall objective of this study was to monitor the concentrations of certain controversy food additives in various food categories sold in the local markets of Egypt and evaluate their compliance of the maximum permitted limits. And also, determine the effect of culinary processes on the residual nitrite levels in sausages.

## MATERIALS AND METHODS

### 1. Materials

All samples of food items purchased from several local markets in Egypt. Information on the different kinds of food products was collected for each sample and presented in Table (1 & 2).

## 2. Preparation of sausage

The main formula of Sausage was prepared by the following ingredients as according to the method described by (Shehata, 1989). The following thermal processes were used: hot water cooking (H); microwave oven cooking (M); frying cooking (F); roasted cooking (R). The obtained samples were cooled in a shock refrigerator until analysis.

| Ingredients of sausage | |
|---|---|
| Lean meat | 70.0 g |
| Fat tissues | 12.0 g |
| Sodium chloride | 2.3 g |
| Ice water | 9.295 g |
| Starch | 3.0 g |
| Spices mixture | 1.2 g |
| Sodium nitrite | 0.005 g |
| Garlic | 1.0 g |
| Onion | 1.2 g |

## 3. Physical and chemical analyses

Physical and chemical analyses were carried out on all treatment, the nitrite residual determined according to the aforementioned method described above. All weight losses were recorded before and after cooking, which were used to calculate the cooking loss and yield as follows:

Cooking yield = (cooked sausage weight / uncooked sausage weight) x 100

Cooking loss = [(raw weight – cooked weight)/raw weight] x 100

## 4. Determination of nitrite residue

Approximately 10 g of each meat product were homogenized in phosphate buffer solution (pH 7.4) and centrifuged at 4,000 rpm / 20 min. then the nitrite contents were determined by shimadzu, uv-1201 spectrophotometer at 540 nm, according to the method adopted by (Montgomery and Dymock, 1961) using nitric oxide assay kit obtained from Biodiagnostic Co., Egypt.

**5. Determination of sulfite residue**

Each of the real food samples were accurately weighed (for solid foods) or pipetted (for liquid foods), and measured according to the iodometric titration of sulfites. A back titration mode was used to avoid sulfites loss in the form of $SO_2$ in acidic environment (AOAC, 2000).

**6. Sensory evaluation**

Sausage with different cooking methods was evaluated for color, flavor, juiciness, tenderness and overall acceptability according to Sanz *et al*. (1998).

**7. Statistical analysis procedure**

The analysis was carried out using the PROC ANOVA procedure. Duncan multiple ranges at 5 % level of significance was used to compare between means. Results followed by different letters are significantly differed. All procedures were subjected using Statistical Analysis System program (SAS, 1996)

## RESULTS AND DISCUSSION

**1- Determination of nitrite residues in meat products**

Under optimal conditions for nitrite analysis, the described method was tested in several food ingredients with known amounts of nitrite added, and the average percentage recovery was found to be 98%. Table (1) shows a typical levels of nitrite in various meat products analyzed, which was ranged between not detected to 243.13 mg $kg^{-1}$ for ham and ranged from not detected to 60.78 mg $kg^{-1}$ for beef.

The levels of nitrite found in most meat samples access the maximum residual level except Luncheon, Basterma, Frankfurters and Beefy have nitrite concentration in the range of permitted limits. These results are in harmony with that reported by Directive (2006).

**Table 1: The level of nitrite in various meat products analyzed**

| Food types | Mean concentration (n = 10) of nitrite mg kg$^{-1}$ |
|---|---|
| **Raw meat:** | |
| Ham | n.d.[a] |
| Beef | n.d. |
| **Processed ham products:** | |
| Banie jambnuon | 243.13 |
| Mortadella | 178.41 |
| Sertella jambnuon | 177.98 |
| Salami | 225.66 |
| salami jambnoun | 197.02 |
| **Processed beef products:** | |
| Luncheon | 28.32 |
| Basterma | 36.42 |
| Frankfurters | 22.98 |
| Beefy | 34.98 |
| Sausage | 60.78 |

[a] n.d., not detected.

## 2. Determination of sulphur dioxide in food items

Sulphite levels of seven subcategories of foods are shown in Table (2). It could be noticed that sulphite concentration was ranged between 22.8 to 1178.6 ppm and the highest levels of sulphites were found in dried fruit and fruit juice which exceeded the maximum permitted levels of GSFE. The wide range of results indicates uncontrolled addition of sulphite to these products.

**Table 2: Number of analysis, maximum limits and average concentration of sulphites in food.**

| Food types | GSFE MPLs (Codex Alimentarius Commission, 2006) mg $kg^{-1}$ | Sulphites levels (n = 10) mg $kg^{-1}$ |
|---|---|---|
| Malt beverages | 50 | 22.8 |
| Fruit juice | 50 | 63.4 |
| Canned mushrooms | 100 | 35.5 |
| **Dried fruits** | 1000 | |
| Greengages | | 1064.2 |
| Tin | | 1043.3 |
| Apricot | | 1112.7 |
| Raisin | | 1278.6 |

## 3. Physical and chemical analyses of sausage

The weight loss of sausage with different cooking processes can be observed from Table (3). Microwave oven cooking had highest cooking loss (38.38%), while the hot water cooking (22.63%) exhibited the lowest cooking loss. The frying (34.94%) and roasted (31.83%) treatments are not significantly different from each other ($p>0.05$) and frying was similar to roasted. The same results were observed by Dzudie *et al.* (2000), who found that the water-bath cooking method reduced cooking loss. Cheng *et al.* (2005) proposed that because samples cooked in water were surrounded by the water and little evaporation occurred, water cooking had the lowest cooking loss.

The residual nitrite levels of the sausage were dependent on treatment Table (3). The highest residual nitrite levels were found in the sausage cooked with microwave, while the lowest residual nitrite levels were found in sausage cooked in the hot water. From a healthy point of view this fact is very interesting since it has been demonstrated that the applying a thermal processing method could reduce the residual of nitrite levels (Mozolewski and Smoczyński 2004).

**Table 3: Effect of different cooking methods on physico-chemical composition of sausage*.**

| Tests | Treatment | | | |
|---|---|---|---|---|
| | H | M | F | R |
| **Cooking yield (%)** | 72.37$^{a}$ | 61.62$^{b}$ | 65.06$^{ab}$ | 68.17$^{ab}$ |
| **Cooking loss (%)** | 27.63$^{b}$ | 38.38$^{a}$ | 34.94$^{ab}$ | 31.83$^{ab}$ |
| **NaNO2 (ppm)** | 91.51$^{e}$ | 117.21$^{b}$ | 107.34$^{c}$ | 101.19$^{d}$ |

H, hot water cooking; M, microwave oven cooking; F, frying cooking; R, roasted cooking
*Means with different letters in the same raw are significantly differ at $P<0.05$.

### 4. Sensory evaluation

The fried sausage received higher scores for color and flavor desirability than those cooked by hot water or in the microwave (Table 4). Juiciness and tenderness was also affected by treatment ($P< 0.05$). The juiciness scores were significantly higher for the frying cooked than for the microwave cooking, hot water and roasted chops. These results agree with the data obtained by Dzudie *et al.* (2000).

**Table 4: Sensory characteristics of the sausage with different cooking methods*.**

| Characteristics | Treatment | | | |
|---|---|---|---|---|
| | H | M | F | R |
| **Color** | 7.0$^{b}$ | 6.9$^{b}$ | 8.3$^{a}$ | 8.0$^{a}$ |
| **Flavor** | 7.3$^{b}$ | 6.7$^{b}$ | 8.4$^{a}$ | 7.4$^{ab}$ |
| **Juiciness** | 7.6$^{b}$ | 6.1$^{c}$ | 8.6$^{a}$ | 7.6$^{b}$ |
| **Tenderness** | 7.7$^{ab}$ | 6.1$^{c}$ | 8.7$^{a}$ | 7.6$^{b}$ |
| **Overall acceptability** | 7.7$^{b}$ | 6.4$^{c}$ | 8.6$^{a}$ | 7.6$^{b}$ |

H, hot water cooking; M, microwave oven cooking; F, frying cooking; R, roasted cooking
*Means with different letters in the same raw are significantly differ at $P<0.05$.

## Conclusions

Results of this study showed most meat products under investigation contained higher levels of nitrite excess the permissible limit due to uncontrolled addition. Also, the sulphite concentration is higher in dried fruit and fruit juice which are one of the foodstuffs that most commonly present this additive and the asthmatics may have adverse reactions to sulphites. Also, nitrite contents in sausage are significantly reduced during culinary processes. The majority losses of nitrite were observed in hot water cooking method. This procedure has been shown to be capable of reducing cooking losses. Sensory results showed that consumers preferred frying sausage, probably because of the better flavor developed by the chops when using this method of cooking.

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## تقدير بعض المضافات المثيرة للجدل فى المواد الغذائية

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تورطت المواد المضافة كمسبب لمختلف الحالات المرضية، ولذلك أجرى دراسة إستكشافية بهدف تقييم مستويات المواد الحافظة، أملاح النتريت والكبرتيت فى المواد الغذائية المتوفرة فى الأسواق المصرية. ولقد أظهرت نتائج هذه الدراسة أن متوسط التركيزات المقدرة تجاوز الحدود القصوى المسموح بها من أملاح الكبرتيتات بالنسبة للفاكهة المجففة والعصائر المعلبة ومن أملاح النتريت فى منتجات اللحوم المصنعة.

كما تم دراسة تأثير عمليات التصنيع على مستوى النتريت فى السجق وقد أظهرت النتائج أن السجق المطهى فى الماء الساخن أبدى أقل مستوى متبقى من النتريت. كما أظهرت الدراسة أن الطبخ فى الماء أظهر عائد طبخ مرتفع، وأوضحت نتائج التحكيم الحسى أن السجق المقلي كان أفضل حسياً مقارنة بطرق الطبخ الأخرى.