PRESENCE OF VOLATILE N-NITROSAMINES IN A TURKISH MEAT PRODUCT KAVURMA PREPARED WITH NITRITE

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Background

Kavurma is a traditionally cooked meat product and produced to extend the shelf life six to nine months. In the past, this technology was used only to conserve meat, but currently it is preferred as a processed meat variety; although some people living in many places in Turkey and the Middle-East are processing kavurma for preservation. In traditional processing, the meat from beef or mutton is diced (approximately 4x5x6 cm) and mixed with 2.0 to 5.0 % salt, and then fried or cooked in animal fat using a steam cauldron. After the cooking process, it is kept in almost anaerobic conditions which is provided by solidified animal fat in a container (Anon., 1983). Recently, it has also become available in vacuum packaged forms in modern meat processing plants and sold in department stores and markets.

There has been little research publication reported on kavurma; therefore, there has been very little information available on its properties. However, some researchers have suggested the utilization of nitrite in the kavurma formulations to improve color and other properties such as better protection against *Clostridium botulinum* and fat rancidity (Gokalp *et al.*, 1994). In a recent research, Gungor (2000) reported that 100 ppm of nitrite had positive effects on the inhibition of *C. sporogenes* and fat rancidity of Kavurma during six months of storage.

It is well documented that nitrite is a meat additive responsible for producing a desirable red color, and flavor, antioxidation properties and has antimicrobial properties for *C. botulinum.* This bacteria has the potential of producing heat stable spores and potentially toxin in the cooked meat products (Pearson and Tauber, 1984; Cassens, 1995). Despite these desirable properties, nitrite has been questioned since it can react with amines or amino acids which would produce N-nitroso compounds in the cured meat products (NAS, 1982; Shahidi *et al.*, 1994; Cassens, 1995). Most of the N-Nitrosamines such as N-nitrosopyrrolidine (NPYR), N-nitrosodiethylamine (NEMA) and N-nitrosodimethylamine (NDMA) are known as potential animal carcinogens (Druckrey *et al.*, 1967) and they could consistently be formed in frying meat and meat products (Tricker, 1991). Additionally, N-nitrosopiperidine (NPIP) might be a problem for products which have pepper in their recipe. Therefore, over the last decades, hundreds of publications on the occurrence of N-Nitroso compounds in foodstuffs have been published since the presence of these compounds is regarded as an ecological risk factor for humans (Mirvish, 1995; Mitacek *et al.*, 1999) and have been shown to be direct acting mutagens in vitro (Walker, 1990). Most of the dietary surveys indicate that NPYR, NDEA, and NDMA are commonly found in some foods like cured meats especially in fried bacon, oriental fish, and malt based beverages (Beatriz *et al.*, 1997). Therefore, reduction of the use of nitrite (NAS, 1982; Walker, 1990; Shahidi *et al.*, 1994) might be desirable.

Objectives

The use of nitrite has been questioned because of its residual problems and the possible production of carcinogenic N-nitroso compounds in cured meat products. Therefore, the objective of this research was to determine the occurrence/absence of the volatile nitrosamines in the fat part and meat chunks of Kavurma which is a traditional cooked meat product that is prepared with different levels of nitrite.

Materials and Methods

A traditional type of Kavurma was prepared with different nitrite levels (Table 1) in the presence of salt as described by Gungor (2000). In the cooking process, a steam jacketed cauldron was used and the internal temperature of the meat-fat mixture was approximately 98°C during cooking for approximately 1.5 hours. Then, the Kavurma samples were subjected to residual nitrite and volatile N-Nitrosamine analysis. Nitrite analysis was conducted as described by Gungor (2000), and the results were expressed as ppm residual nitrite. For the analysis of N-nitrosamines, approximately 20 g sample was subjected to homogenization, distillation, extraction, concentration, and Gas Chromatography Thermal Energy Analysis (GC-TEA) procedure as described by Egan *et al.* (1983) and The German Toxicology and Chemotheraphy Institute (Anon., 1987). The GC utilized was a Hewlett Packard 5700 equipped with 50 m, 0.53 mm i.d. FS-OV-1701-CB-1 capillary column, and the GC was coupled to a model 502 Thermal Energy Analyzer (TEA Thermo Electron, Co. Whalther, MA). The temperature of the injection port was 225 °C and the column oven temperature was programmed from 140 °C to 240 °C with an 8 °C/min increase in temperature. The carrier gas was helium at a flow rate of ca 5 ml/min. The solutions of 1 ppm NPYR, NDEA, and NDMA, NMOR were used as standards, and NPDA was the internal standard during the analysis. For safety, the N-nitrosamines used as standards were handled with appropriate safety precautions for their potential carcinogenity.

Results and Discussion

The residual nitrite analysis was conducted about two days after Kavurma production, and the results indicated that all of the nitrite added samples had residual nitrite with an increasing level parallel to the addition of the nitrite (Table 2). The reason for increment of the residual NO_2 level with the addition level would be related to the fate of nitrite in a meat system in which 5-10% of the NO_2 remains in the product while the rest is lost or bound to proteins or reacts with the other compounds in the system (Tricker, 1991). As can be seen in Table 2, the treatment of 200 ppm nitrite plus 1.0% paprika added samples had a lower residual nitrite value than that of the sample with only 200 ppm $NaNO_2$. This is probably related to the binding behaviors of nitrite with paprika in the product.

The N-nitrosamines analysis were conducted approximately 15 days after the Kavurma production, and the results were presented in Table 2. In this study, all known possible volatile N-nitrosamines (VNA), which would be present in a meat product, were tested but none of them were detected in the cooked meat product, Kavurma. The detection limit of the N-nitroso compounds with the TEA analysis was 0.1 ppb. This indicates that any one of these N-nitrosamines might be present, but at the levels less than 0.1 ppb (the detection threshold of the TEA procedure used in this research). Despite several attempts, in this study, the recovery of the standard NPDA did not exceed 40%. It is not known the reason for this loss, but it could be caused by the high fat content of the product. Nevertheless, no traces of N-nitrosamines could be detected in the Kavurma, so if present, the levels would have to be very low. In the literature, it has been reported that heated products like pizza and toasts with a mixture of higher levels of amines from cheese and nitrite from cured meat in raw sausages (Wiegler *et al.*, 1994) showed no significant increase in their content of N-nitrosamines (NA) like NPYR which is formed by decarboxylation, preferably, at temperatures above 180°C. It

might be suggested that the remaining water in the Kavurma would be helpful in preventing the formation of NPYR, because where there is water, the temperature could not exceed 100°C, and water-vapor would transport VNA's out of the product. Hence the absence of any VNA in Kavurma may not be a surprising fact.

The effects of $NaNO_2$ on the Nitrosamine (NA) formation was presented in Table 2. As stated previously, no measurable amounts of NA was detected in any of the treatments or samples. It was concluded that neither nitrite, nor cooking conditions has an effect on N-nitrosamine formation in this product. Again, a possible reason for not detecting any VNA could be the cooking temperature used to prepare the Kavurma samples. It is generally accepted that Nitrosamines are usually formed at frying temperatures (generally 160-200°C), not at the temperatures where the sample still contains moisture (Hotchkiss and Vecchio, 1985). The Nitrite Safety Council (1980) has also concluded that the cooking processes does not cause VNA formation in cured sausages, and that most fried dry-cure hams are free of nitrosamines. Additionally, Fazio *et al.* (1973) reported that cured meat products, other than bacon, usually do not contain detectable levels of VNA after frying or cooking. They also suggested that VNA's could be volatilized in vapor during the cooking process; whereas, with bacon the NAs would be solublized in the cooking fat.

Conclusions

From this study, it can be concluded that even with the cooking process utilized for Kavurma, which possibly could be a problem, and result only in the formation of VNA's at very low levels, or below current detection limits (0.1 ppb). The low cooking temperatures utilized to manufacture this product would not promote the formation of VNA's by decarboxylation and most of these volatiles, if formed, would be carried out with water vapor resulting in undetectable amounts in the edible portions of the product. Consequently, this study would recommend using $NaNO_2$ up to 200 ppm plus paprika in Kavurma. Therefore, the production of Kavurma can be successfully employed in order to produce better organoleptical properties and protection from microorganisms. However, this study warrants further research with an emphasis on non-volatile and volatile N-nitrosamines in the Kavurma prepared with nitrite at higher cooking temperatures than those used in the present study.

Table 1. Curing ingredients for the Kavurma treatments studied in this research.

Sample	Ingredients
1	2.5 % NaCl only (control)
2	2.5 % NaCl + 50 ppm $NaNO_2$
3	2.5 % NaCl + 100 ppm $NaNO_2$
4	2.5 % NaCl + 200 ppm $NaNO_2$
5	2.5 % NaCl + 200 ppm $NaNO_2$ + 1.0 % Paprika

Table 2. Residual nitrite and N-nitrosamine contents of the Kavurma samples.

Treatments*	Residual Nitrite (ppm)	N-nitrosamine (ppb)
1	0	ND**
2	7.62	ND**
3	10.46	ND**
4	12.01	ND**
5	10.94	ND**

*: The recipe of the treatments (samples) were given in Table 1.
**: ND means less than 0.1 ppb, which is the detection threshold of the TEA procedure used in this research.

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