Occurrence and dietary exposure of volatile and non-volatile N-Nitrosamines in processed meat products

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Introduction

Nitrite and nitrate have for many decades been used for preservation of meat. However, nitrite can react with secondary amines in meat to form N-Nitrosamines (NAs), many of which have been shown to be genotoxic1. The use of nitrite therefore ought to be limited as much as possible. To maintain a high level of consumer protection Denmark obtains National low limits of the nitrite use in meat products. An estimation of the dietary exposure to volatile NAs (VNA) and non-volatile NAs (NVNA) is necessary when performing a risk assessment of the use of nitrite and nitrate for meat preservation.

Methods

We have examined the occurrence of volatile NVNA and five NVNA in processed meat products sampled on the Danish market (n=70) and the Belgium market (n=20). A recently developed sensitive, selective and generic LC-(APCI/ESI)-MS/MS method was used for the nitrosamine determinations2. The estimates of the dietary exposure to NVNA and VNA are based on analytical results and consumption data from the Danish National dietary survey3 to obtain the intake.

Results

NVNA were detected in most samples (Table 1). Especially NTCA and NMTCA were frequently found at levels up to 4030 µg/kg and 39 µg/kg, respectively. VNA were also detected in several of the samples, though at lower levels. Only N-nitrosodibutyramine was not detected. N-nitrosodibenzylamine, a VNA, and N-nitrosodihydroxyproline, a NVNA, were detected in two and at about 40% of the samples, respectively. However, these two NAs could not be quantified with enough certainty using the developed method and are therefore not presented.

The 4 to 5 year old children have a high consumption of processed meat and therefore also the highest exposure of NVNA and VNA, i.e. 129 and 1.8 ng/kg bw/day, respectively (Table 1). NTCA and NPYR accounted for 91% (118 ng/kg bw/day) and 51% (0.93 ng/kg bw/day) of the exposure to NVNA and VNA, respectively (Fig. 1). The classical VNA accounted for >90% of the exposure to NVAs. The NA exposure was lower for the 6-14 year olds and adults, but otherwise the results were similar. Salami was found to be the primary source of both the NVNA and VNA (Fig. 2), partly because of a high Danish consumption of the use of nitrite and nitrate for meat preservation.

Conclusion

NVNA and VNA were found in nitrite/nitrate preserved meat products on the Danish and Belgian market. The exposure to VNA was low, whereas the exposure to NVNA was considerably higher. NTCA accounted for 91% of the NVNA exposure. The toxicological activity of NTCA is not very well studied and needs to be examined before the risk assessment associated with the NA exposure can be performed.

Table 1: Levels of NAs in nitrite/nitrate preserved meat products from the Danish and Belgian market and estimates of dietary exposure. In the columns colored grey and red are the results for NVNA and VNA, respectively.

<table>
<thead>
<tr>
<th>Compound name</th>
<th>NVNA</th>
<th>NPYR</th>
<th>NMTCA</th>
<th>NMTOR</th>
<th>NPRO</th>
<th>NMA</th>
<th>NSAR</th>
<th>NTCA</th>
<th>NDMA</th>
<th>NMOR</th>
<th>NMEA</th>
<th>NPYR</th>
<th>NDPA</th>
<th>NPIP</th>
<th>NDPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abreviation</td>
<td>N0A</td>
<td>N0M</td>
<td>N0N</td>
<td>N0O</td>
<td>N0P</td>
<td>N0Q</td>
<td>N0R</td>
<td>N0S</td>
<td>N0T</td>
<td>N0U</td>
<td>N0V</td>
<td>N0W</td>
<td>N0X</td>
<td>N0Y</td>
<td>N0Z</td>
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<tr>
<td>Product group</td>
<td>N0A</td>
<td>N0M</td>
<td>N0N</td>
<td>N0O</td>
<td>N0P</td>
<td>N0Q</td>
<td>N0R</td>
<td>N0S</td>
<td>N0T</td>
<td>N0U</td>
<td>N0V</td>
<td>N0W</td>
<td>N0X</td>
<td>N0Y</td>
<td>N0Z</td>
</tr>
<tr>
<td>Mean content, positives (all products)</td>
<td>90%</td>
<td>107</td>
<td>81.8</td>
<td>4.3</td>
<td>75.3</td>
<td>0.4</td>
<td>1.1</td>
<td>90.1</td>
<td>430.0</td>
<td>7.5</td>
<td>9.2</td>
<td>1.3</td>
<td>1.2</td>
<td>0.4</td>
<td>0.2</td>
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<tr>
<td>Mean content (incl. also no contents)</td>
<td>90%</td>
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References

2. Herrmann et al. Submitted to Journal of Chromatography A