What are the risks of nitrite and nitrate exposure of consumer eating processed food?

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INTRODUCTION

Nitrite (NO_2) and nitrate (NO_3) salts are commonly used to preserve meat and other perishable products. Indeed, they to maintain the food freshness and to inhibit the growth of pathogens (Skibsted, 2011). Addition of NO_2 and NO_3 also gives their specific color and flavor to cured meat (Honikel, 2008). NO_3 are also naturally present in some vegetables, such as spinach or lettuce. NO_3 can also enter the food chain as an environmental contaminant in water therefore contributing to the exposure of people.

Among the existing processes for pork processed meat, dry fermented sausage and cooked ham were chosen. Reducing nitrite and nitrate in new formulation raises the challenge of maintaining the safety and organoleptic quality.

Recent eating habits encourage consumers towards new cured meat consumption patterns and consumers buy more and more ready to-eat meals of which processed meat. These new practices imply to consider the exposure to NO_2 and NO_3 from the first ages (cooked ham is introduced in the food of babies at 6 months of age) until older ages, since cooked ham stays easy to chew even for people with masticatory deficiencies.

AIM

Recently, EFSA has re-evaluated the safety of $NaNO_2$ and $NaNO_3$ as Acceptable Daily Intakes (ADI): 0.07mg $NaNO_2$/kg bw/day and 3.7mg $NaNO_3$/kg bw/day. This initiative goes hand in hand with ongoing research by manufacturers to reduce NO_2 and NO_3 inputs to processed meat. The objective is the **evaluation of NO_2 and NO_3 exposure** induced by dry fermented sausage and cooked ham consumption with different formulations.

METHOD

- Dry fermented sausages were manufactured by ADIV (meat technical center), with different formulations 0 ppm $NaNO_2$/$NaNO_3$, 80 ppm $NaNO_2$/$NaNO_3$, 200 ppm of $NaNO_3$ (200 NO_3), 120 ppm $NaNO_2$/ $NaNO_3$.
- Cooked ham was manufactured by IFIP (meat technical center) with brine containing 0, 40, 80 and 120 ppm of $NaNO_2$, and ascorbate.
- Residual nitrite and nitrate ion contents were determined using the procedure of Bonifacie et al. 2021 (Table 1 & 2).
- Nitrite and nitrate exposure calculations according to body weight: the calculation is based on NO_2 and NO_3 residual contents of the product. For dry fermented sausages an intake mean of 7.5g was used, for cooked ham 40g for adult and for an infant (1 y-old, 10kg) 10g.

RESULTS

Exposure

Table 1: Residual contents of nitrites and nitrates in dry fermented sausages

$NaNO_2$ / $NaNO_3$ (ppm)	0 / 0	80 / 80	0 / 200	120 / 120
Residual NO_2 (ppm)	$0,17^a \pm 0.17$	$3,64^b \pm 0.08$	$4,42^b \pm 0.33$	$8,43^b \pm 0.49$
Residual NO_3 (ppm)	$4,19^x \pm 0.25$	$6,85^x \pm 2.08$	$13,14^y \pm 0.64$	$21,30^y \pm 1.30$

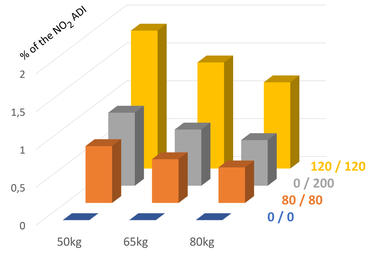

Fig 1: Acceptable daily intake of NO_2 based on 7.5 g consumption of dry fermented sausages, according to body weight (%)

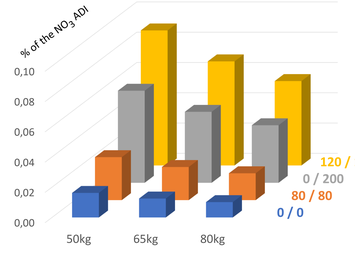

Fig 2: Acceptable daily intake of NO_3 based on 7.5 g consumption of dry fermented sausages, according to body weight (%)

The calculation of NO_2 and NO_3 exposition when consuming dry fermented sausages is based on a daily portion of 7.5g (Fig 1 & 2). For NO_2, the acceptable daily intake remains below 2% for the formulation with 120 NO_2/120 NO_3, for a body weight comprised between 50 and 80 kg.

In the same line, the exposition to NO_3 due to dry fermented sausages is under 0.1%. The calculation is based on a average consumption. If we consider a compulsive desire for dry and cured sausage, let's say a 10-fold amount – 75g, the exposition for residual NO_2 or nitrates will be far under the acceptable daily intake prone by EFSA (20% for NO_2 and 1% for NO_3).

Exposure

Table 2: Residual contents of nitrites and nitrates in a model of cooked ham

$NaNO_2$ (ppm)	0	40	80	120
Residual NO_2 (ppm)	$0.00^a \pm 0.00$	$7.74^b \pm 0.16$	$18.33^c \pm 0.64$	$34.28^e \pm 1.75$
Residual NO_3 (ppm)	$45.68^a \pm 14.04$	$61.60^a \pm 3.87$	$47.52^a \pm 7.55$	$120.86^c \pm 6.78$

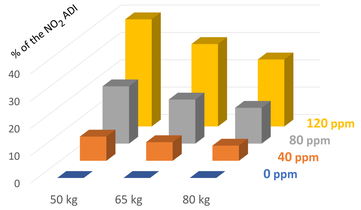

Fig 3: Acceptable daily intake of NO_2 based on a slice of 40 g cooked ham, according to body weight (%)

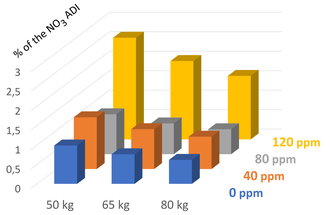

Fig 4: Acceptable daily intake of NO_3 based on a slice of 40 g cooked ham according to body weight (%)

Exposure

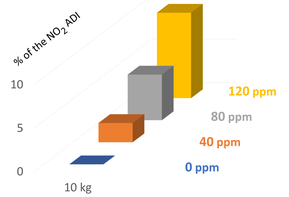

Fig 5: Acceptable daily intake in % of NO_2 based on a portion of 10 g cooked ham according to a body weight of an infant of 1 year old (10 kg)

The calculation of nitrite and nitrate exposition when consuming cooked ham is based on a daily portion of 40g slice (Fig 3 & 4). For NO_2, the acceptable daily intake remains below 40%, for the formulation with the maximum of NO_2 (120 ppm).

Interestingly, decreasing the nitrite addition by one third in the formulation of cooked ham would reduce by 2 the exposition for a body weight comprised between 50 and 80 kg. The exposition to nitrates due to cooked ham ingestion is under 3%.

As infant menus include generally 10g of grounded cooked ham, the risk of NO_2 and NO_3 exposition was evaluated. Again, NO_2 and nitrate exposition remained under the ADI, less than 10% for NO_2 (Fig 5) and 1% for NO_3 (data not shown), under the acceptable daily intake prone by EFSA.

CONCLUSIONS

- It is clearly established that the risk of nitrite and nitrate exposure remained far from the ADI.
- It is possible to decrease this risk by a formulation using less nitrite and nitrate.
- Neither nitrate nor nitrite *per se* is the active inhibitory principle for pathogens, they have to be converted to reactive intermediate compounds such as NO°, N_2O_3, $ONOO^-$, NO_2°, RS-NO.
- Substantial effort in research must be made on the reactivity of the above compounds in the products and during digestion.

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https://adduits.ifip.asso.fr/

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Method Article
Determination of nitroso-compounds in food products
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