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

V. SANTE-LHOUELLER¹, A. BONIFACIE^{1,2}, E. KEULEYAN¹, V. FERRARO¹, P. GATELLIER¹, A. PROMEYRAT³, G. NASSY³, L. PICGIRARD⁴ & L. THERON¹

¹ Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE), UR370 Qualité des Produits Animaux, F-63122 Saint Genès-Champagnelle, France

² IFIP – Institut du Porc, 7 Avenue du Général De Gaulle, F-94700 Maisons Alfort, France

³ IFIP – Institut du Porc, La motte au Vicomte, BP 35104, F-35561 Le Rheu Cedex, France

⁴ Association Pour le Développement de l'Industrie de la Viande (ADIV), 10, Rue Jacqueline Auriol, F-63039 Clermont-Ferrand, France

INTRODUCTION

Nitrite (NO₂) and nitrate (NO₃) 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 NO₂ and NO₃ also gives their specific color and flavor to cured meat (Honikel, 2008). NO₃ are also naturally present in some vegetables, such as spinach or lettuce. NO₃ 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 NO₂ and NO₃ 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 NaNO₂ and NaNO₃ as Acceptable Daily Intakes (ADI): 0.07mg NaNO₂/kg bw/day and 3.7mg NaNO₃/kg bw/day. This initiative goes hand in hand with ongoing research by manufacturers to reduce NO₂ and NO₃ inputs to processed meat. The objective is the **evaluation of NO₂ and NO₃ 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 NaNO₂/NaNO₃, 80 ppm NaNO₂/NaNO₃, 200 ppm of NaNO₃ (200 NO₃), 120 ppm NaNO₂/ NaNO₃.
- Cooked ham was manufactured by IFIP (meat technical center) with brine containing 0, 40, 80 and 120 ppm of NaNO₂, 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 NO₂ and NO₃ 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



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 ± 0.17	3,64 ^b ± 0.08	4,42 ^b ± 0.33	8,43 ^b ± 0.49
Residual NO ₃ (ppm)	4,19 ^x ± 0.25	6,85 ^x ± 2.08	13,14 ^y ± 0.64	21,30 ^y ± 1.30



Exposure

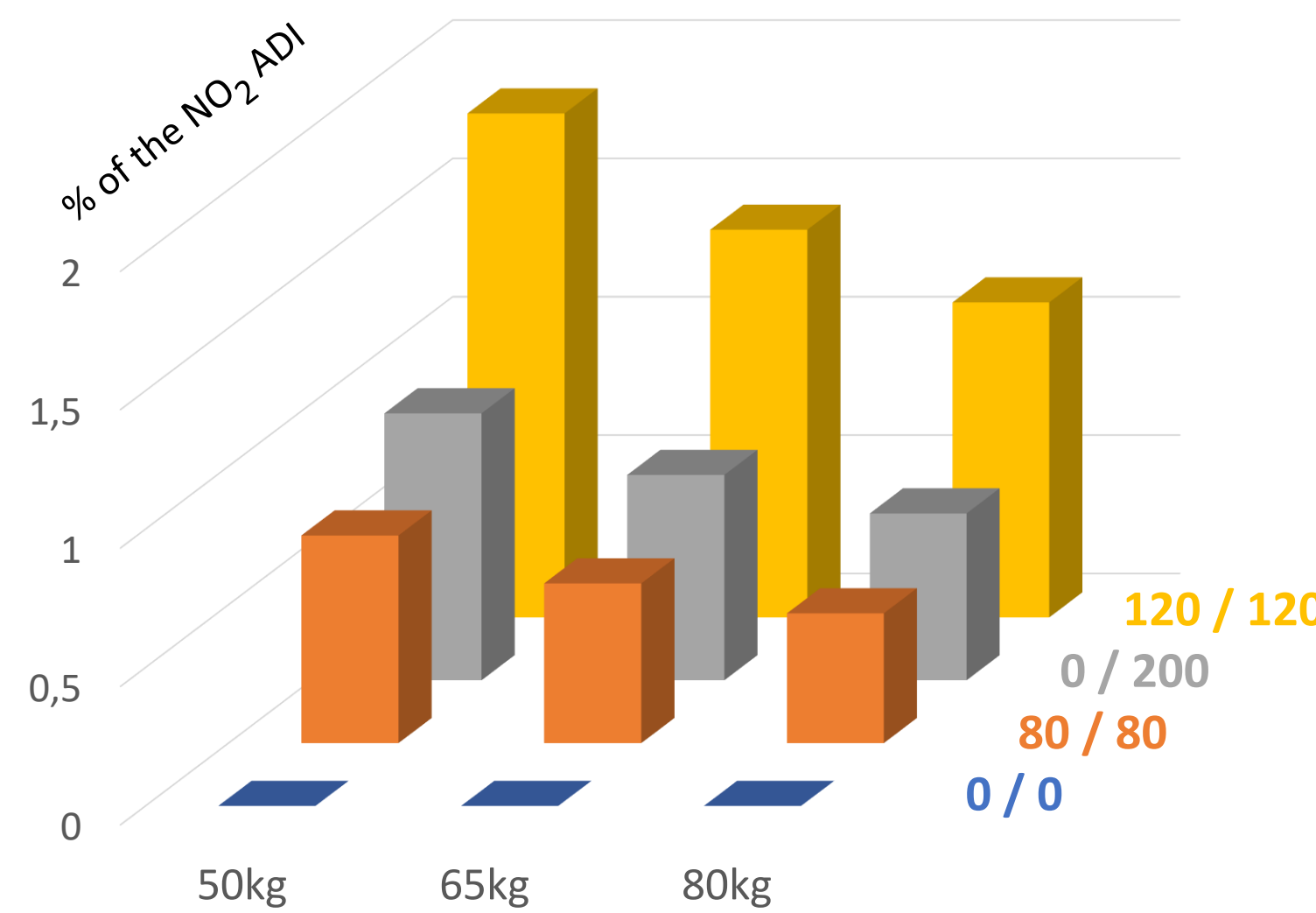


Fig 1: Acceptable daily intake of NO₂ based on 7.5 g consumption of dry fermented sausages, according to body weight (%)

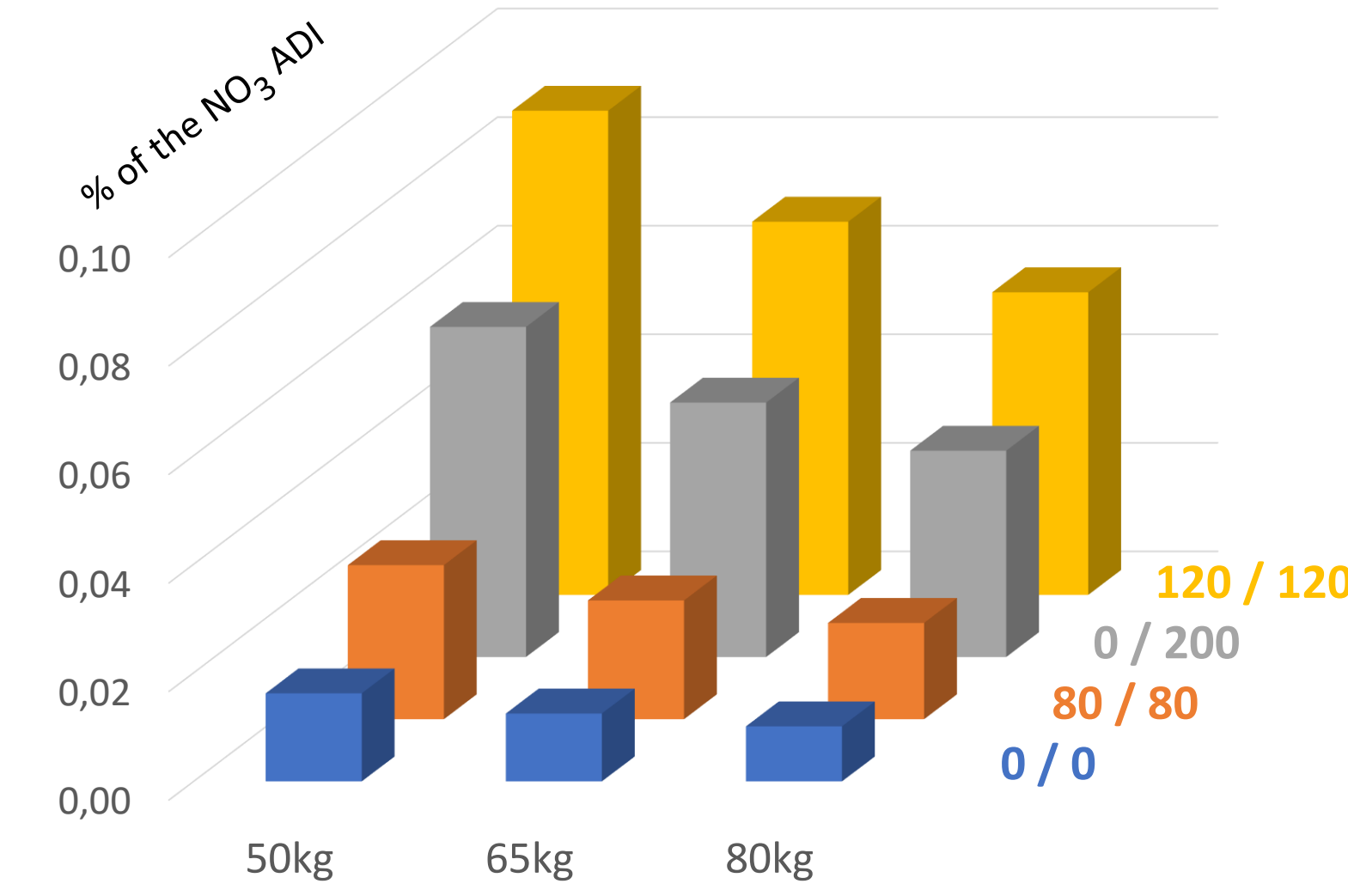


Fig 2: Acceptable daily intake of NO₃ based on 7.5 g consumption of dry fermented sausages, according to body weight (%)

The calculation of NO₂ and NO₃ exposition when consuming dry fermented sausages is based on a daily portion of 7.5g (Fig 1 & 2). For NO₂, the acceptable daily intake remains below 2% for the formulation with 120 NO₂/120 NO₃, for a body weight comprised between 50 and 80 kg.

In the same line, the exposition to NO₃ due to dry fermented sausages is under 0.1%. The calculation is based on an 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 NO₂ or nitrates will be far under the acceptable daily intake prone by EFSA (20% for NO₂ and 1% for NO₃).



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 ± 0.00	7.74 ^b ± 0.16	18.33 ^c ± 0.64	34.28 ^e ± 1.75
Residual NO ₃ (ppm)	45.68 ^a ± 14.04	61.60 ^a ± 3.87	47.52 ^a ± 7.55	120.86 ^c ± 6.78



Exposure

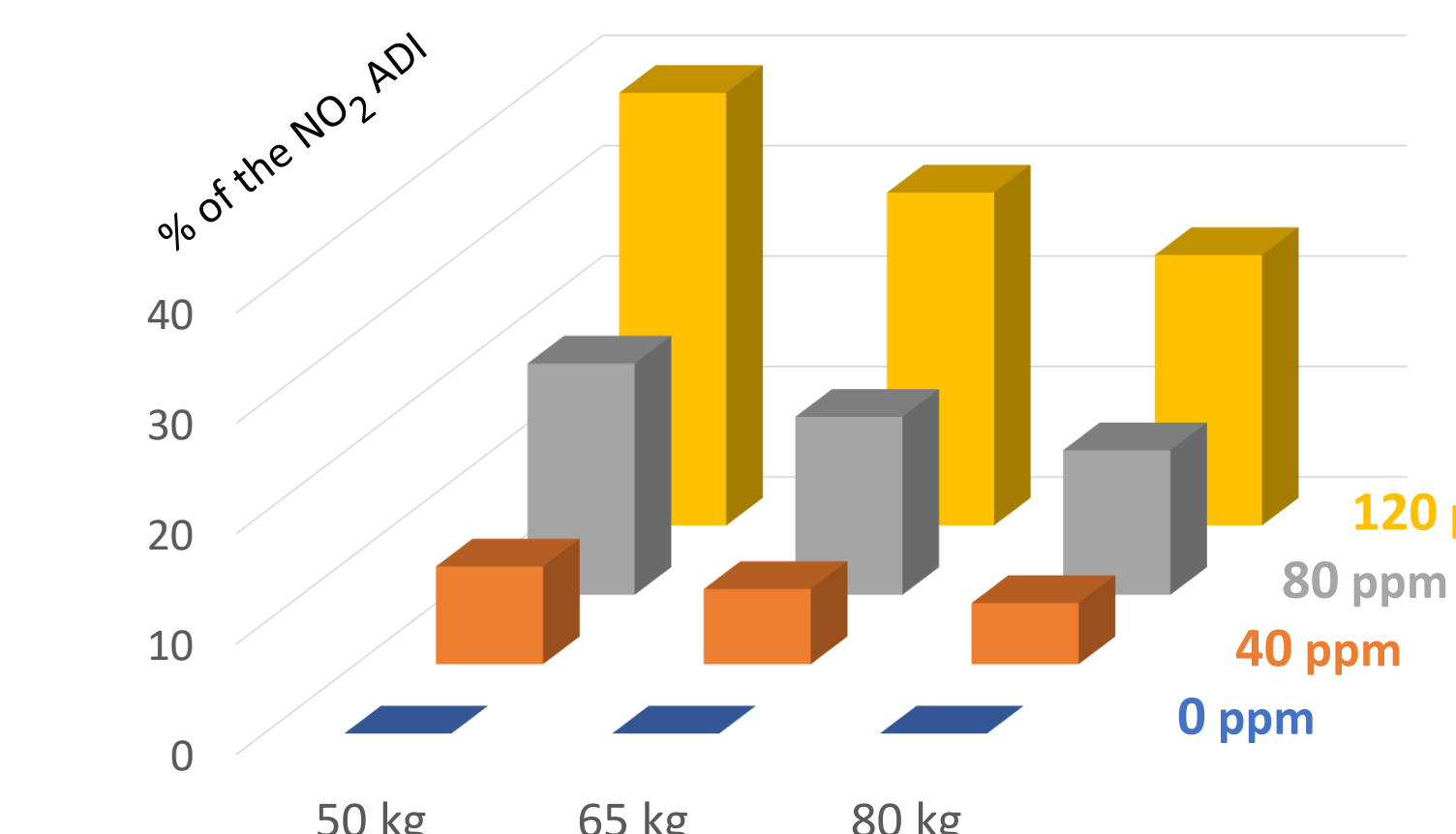


Fig 3: Acceptable daily intake of NO₂ based on a slice of 40 g cooked ham, according to body weight (%)

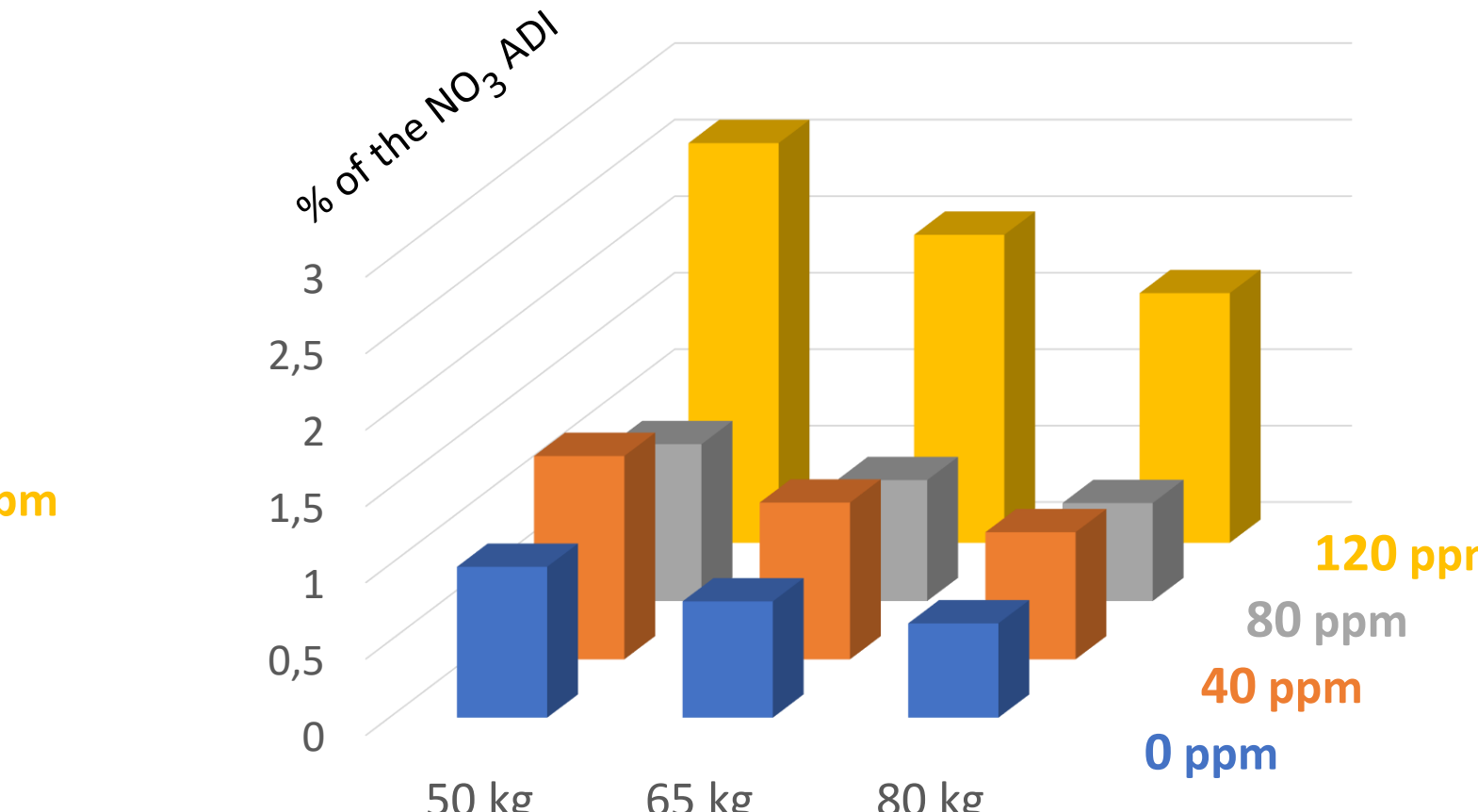


Fig 4: Acceptable daily intake of NO₃ based on a slice of 40 g cooked ham according to body weight (%)

The calculation of nitrite and nitrate exposition when consuming cooked ham is based on a daily portion of 40g slice (Fig 3 & 4). For NO₂, the acceptable daily intake remains below 40%, for the formulation with the maximum of NO₂ (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%.

Exposure

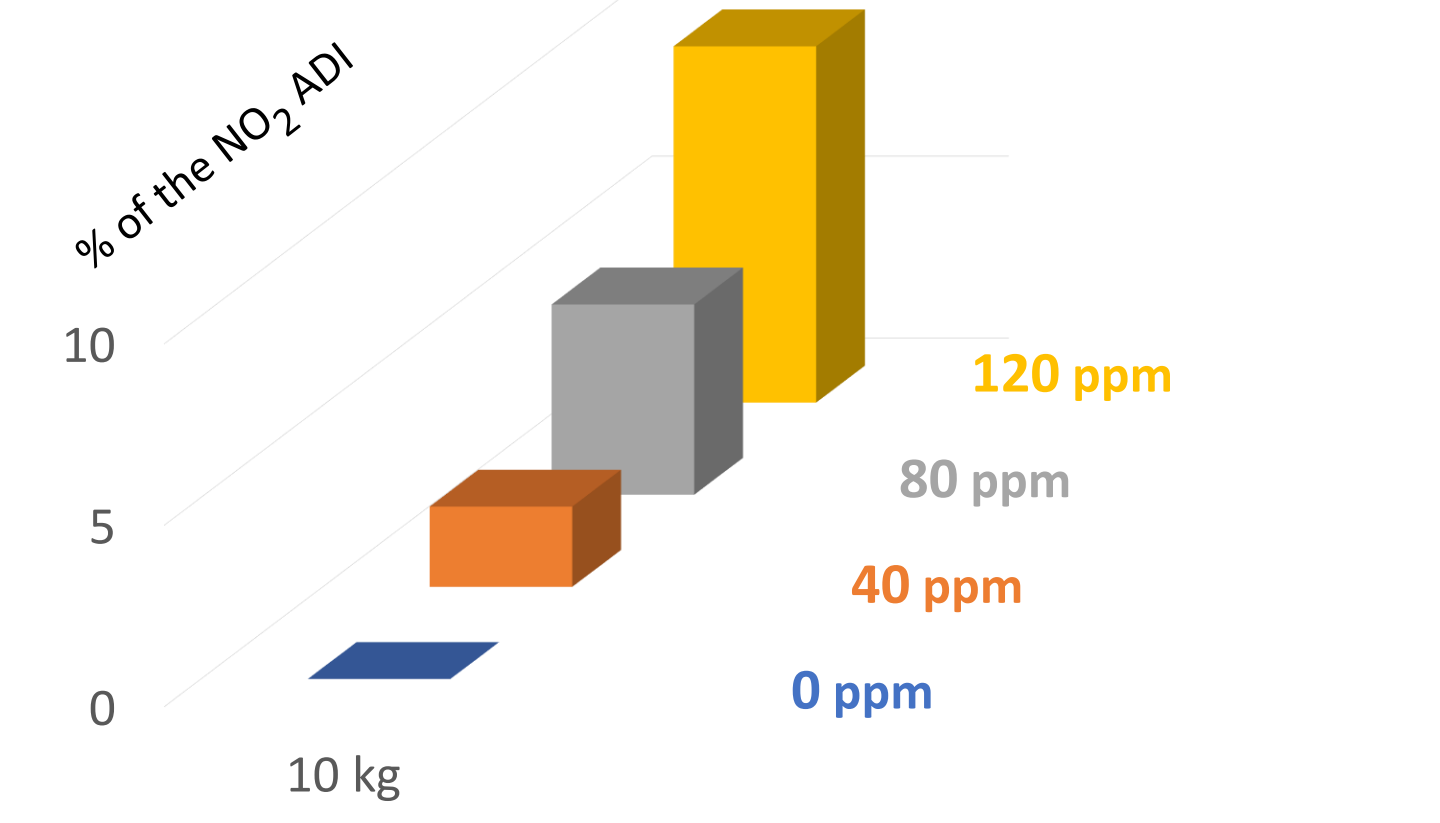


Fig 5: Acceptable daily intake in % of NO₂ based on a portion of 10 g cooked ham according to a body weight of an infant of 1 year old (10 kg)

As infant menus include generally 10g of grounded cooked ham, the risk of NO₂ and NO₃ exposition was evaluated. Again, NO₂ and nitrate exposition remained under the ADI, less than 10% for NO₂ (Fig 5) and 1% for NO₃ (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^o, N₂O₃, ONOO⁻, NO₂^o, 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/>



REFERENCES

European Food Safety Authority. 2017. EFSA Journal published by John Wiley and Sons Ltd on behalf of European Food Safety Authority

Bonifacie, A., Aubry, L., Gatellier, P., Santé-Lhoutellier, V., & Théron, L. (2021). Determination of nitroso-compounds in food products. *MethodsX*, 101289.



Method Article
Determination of nitroso-compounds in food products
Alain Bonifacie^{1,2}, Laurent Aubry¹, Philippe Gatellier¹, Veronique Santé-Lhoutellier¹, Laetitia Theron¹

De Mey, E., De Maere, H., Paelinck, H., & Fraeye, I. (2017). Volatile N-nitrosamines in meat products: potential precursors, influence of processing, and mitigation strategies. *Critical Reviews in food science and nutrition*, 57(13), 2909-2923.
Honikel, K. O. (2008). The use and control of nitrate and nitrite for the processing of meat products. *Meat Science*, 78(1-2), 68-76.
Skibsted, L. H. (2011). Nitric oxide and quality and safety of muscle based foods. *Nitric Oxide*, 24(4), 176-183.
van Maanen, J. M., van Geel, A. A., & Kleinjans, J. C. (1996). Modulation of nitrate-nitrite conversion in the oral cavity. *Cancer detection and prevention*, 20(6), 590-596.

CONTACT INFORMATION

veronique.sante-lhoutellier@inrae.fr ; laetitia.theron@inrae.fr