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Assessment of dietary exposure of nitrate and nitrite in France

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Disclaimer:

The findings and conclusions in this paper are the authors' own and do not necessarily represent the views of the French Food Safety Agency. The authors declare they have no conflict of interests.

Abstract

The aim of this study was to assess the dietary exposure of nitrate and nitrite in France. 13 657 concentration levels of nitrate and nitrite measured in food, representing 138 and 109 food items respectively and coming from French monitoring programs between 2000-2006, were used. Depending on the non-detected and non-quantified analysis treatment, lower and upper concentration mean estimates were calculated for each food item. These were combined with consumption data of 1474 adults and 1018 children from the French national individual consumption survey (INCA1), conducted in 1999 and based on a seven-day food record diary. 18% of spinaches, 6% of salads, 10% of cheeses, 8% of meat products and 6% of industrial meat products exceeded the European nitrate maximum level or maximum residual level. 0.4% of industrial meat products and 0.2% of meat products exceeded their European nitrite maximum level or maximum residual level. Nitrate dietary exposure averaged 40% of the Acceptable Daily Intake (ADI, $3.7 \text{ mg kg}^{-1} \text{ bw day}^{-1}$) for adults and 51 - 54% of the ADI for children with the major contributors being, for adults and children respectively, vegetables (24 and 27% ADI), potatoes (5 and 11% ADI) and water (5 and 5% ADI). The individual nitrate dietary intake of 1.4% (Confidence Interval (CI_{95th}) [0.8; 2.0]) to 1.5% (CI_{95th} [0.9; 2.1]) of adults and 7.9% (CI_{95th} [6.2; 9.6]) to 8.4% (CI_{95th} [6.7; 10.1]) of children were higher than the ADI. Nitrite dietary exposure averaged 33 - 67% of ADI ($0.06 \text{ mg kg}^{-1} \text{ bw day}^{-1}$) for adults and 67 - 133% of ADI for children, with contributions of additive food-vectors at 33% ADI for adults and 50 - 67% ADI for children. The individual nitrite dietary intake of 0.7% (CI_{95th} [0.3; 1.1]) to 16.4% (CI_{95th} [14.5; 18.3]) of adults and 10.5% (CI_{95th} [8.6; 12.4]) to 66.2% (CI_{95th} [63.3; 69.1]) of children were higher than the ADI.

Keywords: *Nitrate, Nitrite, Dietary exposure, foods additives, Acceptable Daily Intake (ADI), exposure assessment.*

Introduction

Nitrate and nitrite are ions naturally present in the environment. They are used increasingly as food additives to stabilize some meat products and cheeses. But nitrate is mainly used in agriculture as fertilizer. There are many published papers characterizing the presence of nitrate in plant foods such as lettuce and spinach for example or in water. Because of all these sources of nitrate (vegetables, water, meat products) and nitrite (food additives), humans can be exposed to these compounds, although it has been shown that nitrate is also produced endogenously. The human body absorbs the nitrate ingested very easily. However, it is not the nitrate itself that presents a health risk, but its reduction into nitrite (Hartman 1983; FAO/WHO 1998) for which a lot of studies have already shown the effects on human health. The best known health effect of nitrite or nitrate reduced into nitrite is methemoglobinemia in newborn babies, due to the fact that nitrite can prevent hemoglobin from being able to transport oxygen (Comly 1954; FAO/WHO 2002). Moreover, in 1987 Fan et al. showed that high doses of nitrite could have a toxic effect on reproduction (Fan et al. 1987). These observations have since been clearly confirmed (Fan and Steinberg 1996; Manassaram et al. 2006). Nitrite or its degradation compounds have also been shown to be mutagenic. A potential link with the emergence of chromosomal aberrations was demonstrated, as sodium nitrite would lead to an increase in the number of micronucleated polychromatic erythrocytes in vivo in mice (Luca et al. 1987). Finally, nitrite or nitrate reduced to nitrite, could interact with the amide compounds of the stomach to create N-nitroso compounds, which are very carcinogenic for animals in several target organs (Fraser 1985) and even for humans (Broitman et al. 1981). But according to the last conclusions of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) (FAO/WHO 2003), nitrite does not appear to be carcinogenic and the association between the nitrate ingested and an increased risk of cancer is still debated (Van Grinsven et al. 2006; Ward et al. 2005).

Because of the effects of nitrate and nitrite on health, European standards have been established. Nitrate and nitrite could be present in food items as a natural constituent or due to an intentional addition as additive. So, European standards and this study distinguished between additive foods-vectors contributions, food items for which nitrate and nitrite uses are

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3 authorized and other food items, food items for which nitrate and nitrite are natural constituents.
4 Besides, French monitoring Program distinguished 'unprepared' from 'pre-prepared' meat
5 products like chicken wings coated with bread-crumbs or ready-to-eat curried chicken, which
6 are food items obtained by specific food industry processes and called industrial prepared meat
7 products in this study. Concerning agricultural uses of nitrate, the European Commission has
8 established Maximal Levels (MLs) for lettuces (2500 - 3500 mg kg⁻¹ for summer salad and 4000
9 - 4500 mg kg⁻¹ for winter salad) and spinaches (2500 mg kg⁻¹ for summer spinach, 3000 mg kg⁻¹
10 for winter spinach, 2000 mg kg⁻¹ for frozen spinach) (Commission Regulation (EC) No
11 1881/2006). Concerning the use of nitrate as an additive, Maximal residual Level (MrLs) have
12 been established for meat products (250 mg kg⁻¹), cheeses and canned foie gras (50 mg kg⁻¹)
13 (Directive 2006/52/EC). Concerning nitrite uses, the European Commission has established
14 several MrLs (Directive 2006/52/EC) for dry cured meat products as bacon (175 mg kg⁻¹), for
15 dry non-heat-treated meat products (50 mg kg⁻¹) and for others dry cured meat products as dry
16 cured ham (100 mg kg⁻¹). For water, Directive 2003/40/EC also lays down a Maximum Limit for
17 nitrate (50 mg L⁻¹) and nitrite (0.1 mg L⁻¹).
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Some studies have already estimated dietary exposure of nitrate and nitrite, which generally does not exceed the ADI in the Netherlands, United Kingdom, Korea or New Zealand (Lee et al. 2006; Thomson et al. 2007; Vaessen and Schothorst 1999; Ysart et al. 1999). The main contributors are often potatoes, green vegetables and other vegetables at 33%, 21% and 15% respectively of total exposure (Ysart et al. 1999). None of these studies are comparable, however, because some are conducted on the general population and others on adults only. Moreover, some studies are focused on additive food-vectors only (Lee et al. 2006; Verger et al. 1998) and do not take account of the whole diet or the actual levels of nitrate and nitrite found in food items.

Some studies are available in France. A French national duplicate study was first conducted in 1990 (DGS 1992) to estimate nitrate dietary exposure. Meals eaten outside of the home were analyzed and nitrate intake was in average 147.8 and 84.4 mg/day respectively for adults and children. Water contributed to 22% of the total exposure, some vegetables either consumed in large quantity or highly contaminated contributed to 48% of the total intake.

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3 Concerning nitrite exposure in France, it was shown in 1998 that the Theoretical Maximum Daily
4 Intake of nitrite was on average $0.31 \text{ mg kg}^{-1} \text{ bw day}^{-1}$ (Verger et al. 1998). Another study was
5 conducted in 2005 (Bemrah-Aouachria et al. 2007) to integrate nitrite uses in meat products
6 declared by industries. For high consumers, nitrite dietary exposure was between 0.093 and
7 0.134 $\text{mg kg}^{-1} \text{ bw day}^{-1}$ for adults and between 0.165 and 0.250 $\text{mg kg}^{-1} \text{ bw day}^{-1}$ for children.
8 These French studies are either theoretical or based on old data and present contrasting
9 results. A new assessment of dietary exposure of nitrate and nitrite was therefore required for
10 the French population.
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17 This study is the first one to estimate dietary intake of nitrate and nitrite in French adults
18 and children, based on individual consumption data and on concentrations measured in several
19 food items and water. This paper reports the levels of nitrate and nitrite present in several
20 French food items, available on the market between 2000 and 2006, and the level of dietary
21 exposure of nitrate and nitrite with a lower and upper estimate, depending on the non-detected
22 and non-quantified analyses treatment. As recommended by the Joint FAO/WHO Expert
23 Committee on Food Additives (FAO/WHO 2003), all nitrate and nitrite food sources and not only
24 just additive food-vectors were considered in this study. As a result, food groups and food items
25 contributing to dietary exposure were also identified.
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33 **Methodology**

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36 The chronic dietary exposure assessment of nitrate and nitrite in France was conducted by
37 comparing the Acceptable Daily Intake (ADI, $\text{mg kg}^{-1} \text{ bw day}^{-1}$) with the dietary exposure
38 calculated as the sum of all concentration levels (mg kg^{-1}), multiplied by the food consumption
39 (g day^{-1}) and divided by the individual body weight (kg bw).
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43 *Individual consumption data*

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46 French individual consumption data came from the *Enquête Individuelle et Nationale de*
47 *Consommation Alimentaire* (INCA 1) conducted between August 1998 and June 1999. This
48 French study was based on a sample of 1474 healthy adults (aged 15 and over) and 1018
49 children (between 3 and 14 years old), representative of the French population through
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3 stratification (region of residence, size of urban area) and use of the quota method (age,
4 gender, household size, individual occupation and socio-professional status) (Volatier 2000). All
5 subjects were asked to complete a seven-day food record diary (consecutive days) as well as
6 other questionnaires on anthropometrical and socio-economical factors. Participants could
7 estimate portion sizes by comparing the amount they were eating with photographs compiled in
8 a manual adapted from the SuViMax picture booklet (Deheeger 1994). Food records were
9 subsequently coded into 895 food items (INCA classification). Adults identified as under-
10 reporters according to the ratio of energy intake to estimated basal metabolic rate were
11 excluded, as were those for whom no individual body weight was given. Briefly, according to
12 Schofield (Schofield 1985; Schofield et al. 1985) and Goldberg et al (Goldberg et al. 1991),
13 identification of the individuals' reporting status was based on fundamental principles of energy
14 physiology. Basal metabolic rate (BMR) was first estimated using gender-age-weight specific
15 equations computed by Schofield (1985). Dietary reporting status was then assessed as
16 suggested by Goldberg et al. (1991) by computing a ratio of reported energy intake (EI) to
17 estimated basal metabolic rate (BMR). Tabulated cut-off limits for this EI/BMR ratio have been
18 derived by Goldberg et al. (1991) from whole-body calorimeter and doubly labelled water
19 measurements in a wide range of healthy adults. Among our study sample, ratios falling below
20 the 1.1 limit were recognized as being incompatible with long-term maintenance of energy
21 balance and therefore with long-term survival.
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36 *Nitrate and nitrite concentration data*

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38 *Food items.* Concentration levels of nitrate and nitrite in foods came from the French national
39 monitoring programs carried out between 2000 and 2006. Monitoring programs are essentially
40 performed on individual composite samples according to sampling guidelines for official control
41 (Commission Regulation (EC) No 1882/2006). These samples are collected on the market and
42 often concern items which are supposed to contribute to dietary exposure. 13 657 samples
43 representing 138 commodities for nitrate and 109 commodities for nitrite were analyzed. All
44 concentration levels and mean estimates were compared to the Maximum Level (ML) or the
45 Maximum residual Level (MrL) currently in force for nitrates (Commission Regulation (EC) No
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3 1881/2006, Directive 2006/52/EC) and for nitrites (Directive 2006/52/EC). All analytical methods
4 were validated according to standards NF EN 12014-2 for plants and drinks, NF EN 12014-4 for
5 nitrates in meat products, NF V 04-409 for nitrites in meat products, and the French decree of
6 February 5, 1980 for cheese. Analytical limits of the eight French laboratories in charge of the
7 French National Monitoring Program analysis were also obtained, Limits Of Detection (LOD)
8 were between 0.2 and 20 mg kg⁻¹ for nitrate and between 0.03 and 5 mg kg⁻¹ for nitrite and
9 Limits Of Quantification (LOQ) were between 0.5 and 70 mg kg⁻¹ for nitrate and 0.1 and 10 mg
10 kg⁻¹ for nitrite.
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18 *Water.* For tap water, a distribution of nitrate concentrations was obtained from the French
19 database Sise-eaux 2005 (French Ministry of Health – DDASS-SISE-EAUX). To estimate a
20 nitrate concentration mean in tap water, a distribution was recreated using the “Best Fit”
21 function of @Risk, and the estimated mean was obtained. Because there is no nitrite residue in
22 tap water due to the presence of chlorate, two scenarios were conducted: the first considering
23 the nitrite concentration in tap water to be null and the second considering it to be the Maximum
24 Limit (ML) fixed at 0.1 mg L⁻¹, (Directive 2003/40/EC). The nitrate and nitrite concentration
25 means obtained for tap water were also attributed to boiled water (coffee, tea, soup). For water
26 of source origin, data (2732 and 2721 analyses for nitrate and nitrite respectively) from the
27 French database Sise-eaux 2004-2006 (French Ministry of Health – DDASS-SISE-EAUX) was
28 used. For mineral and sparkling mineral water, data (957 and 460 analyses for nitrate and nitrite
29 respectively) from the French database of the AFSSA-LERH-EMN 2004-2007 (National Mineral
30 Water Database of the Hydrology Laboratory of French Food Safety Agency) was used.
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41 *Toxicological Reference Values*

42 ADIs, toxicological reference values established over an entire lifetime, for nitrate and nitrite
43 have been discussed for years. The Joint FAO/WHO Expert Committee on Food Additives
44 (JECFA) (FAO/WHO 2003) and the Scientific Committee on Food (SCF 1995) of the European
45 Commission conducted several assessments. The nitrate ADI used in this study was 3.7 mg kg⁻¹
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1 bw day⁻¹ (SCF 1995, FAO/WHO 2003). For nitrite, because the difference between the

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3 European ($0.06 \text{ mg kg}^{-1} \text{ bw day}^{-1}$) (SCF 1995) and international ($0.07 \text{ mg kg}^{-1} \text{ bw day}^{-1}$)
4 (FAO/WHO 2003) ADI was very low, the European ADI was used in this study to be consistent
5 with the European MRLs and MLs.
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8 9 *Assessment of dietary exposure*

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11 As recommended by the international guidelines (FAO/WHO 1985; FAO/WHO 2000), the use of
12 a residue level mean when calculating dietary exposure is a realistic and appropriate estimation
13 of chronic exposure to be compared to the Acceptable Daily Intake (ADI), a toxicological
14 reference value established over an entire lifetime. Nitrate and nitrite concentration means were
15 therefore calculated for each food item. When less 60% of the results were censored, i.e. below
16 the LOD or the LOQ, means per food were calculated by setting all non-detected results to the
17 LOD/2 and all non-quantified results to the $(\text{LOD}+\text{LOQ})/2$. When more than 60% of the results
18 were censored, two mean estimates were calculated, as recommended by the international
19 guidelines (FAO/WHO 1995):
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- 22 - A lower bound one calculated by setting all non-detected results to 0 and all non-
23 quantified results to the LOD,
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- 25 - An upper bound one calculated by setting all non-detected results to the LOD and all
26 non-quantified results to the LOQ.
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29 So when more 60% of results were censored, concentration means were obtained by lower
30 and upper bound estimates. When less 60% of results were censored, concentrations means
31 were obtained by a middle bound estimate.
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34 Contamination and consumption data were linked. Consumption of some specific foods
35 analysed in the nitrite national monitoring program was not declared in the INCA survey. In fact,
36 the INCA survey does not distinguish unprepared meat products from industrial prepared meat
37 products obtained by specific industrial processes (coated with bread-crumbs or curried):
38 industrial prepared meat products based on beef, boar, chicken, duck, hare, pork, poultry, quail,
39 rabbit, turkey, veal or lamb, which are new food items less consumed than the corresponding
40 unprepared meat product. In order to be protective and to take account of the potential
41 contribution of these specific food items in the total intake, these industrial prepared meat
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3 products were assumed to be consumed at equivalent amounts to the corresponding meat. For
4 example, consumption of the industrial prepared poultry-based meat products was supposed to
5 be equal to the consumption of poultry. So, estimation of nitrite dietary exposure distinguished
6 meat products from industrial prepared meat products contributions and separated additive
7 food-vectors from the other food items contributions..
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11 Dietary exposure of nitrate and nitrite was expressed as a percentage of the ADI
12 established at $3.7 \text{ mg kg}^{-1} \text{ bw day}^{-1}$ and $0.06 \text{ mg kg}^{-1} \text{ bw day}^{-1}$ for nitrate and nitrite respectively
13 (SCF 1995). A risk may occur when the dietary exposure exceeds the ADI. Dietary exposure
14 means were calculated for adults and children. The number and percentage of individual dietary
15 exposure levels exceeding the ADI were also calculated with the respective 95% Confidence
16 Interval (CI_{95th}), considering the normal approximation to the binomial distribution of the
17 probability of an exposure exceeding the ADI. For nitrite, dietary exposure due to additive food-
18 vectors (meat products and industrial meat products) and other foods (the rest of the diet) was
19 calculated separately. Foods were identified as major contributors when the food intake
20 exceeded 5-10% of the ADI (Codex Alimentarius Commission 2005).
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30 Results

31 *Mean of nitrate concentrations*

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33 *Food items.* Nitrate monitoring data concerns 138 foods (Table 1). Only some of these have
34 MLs (Commission Regulation (EC) No 1881/2006), or MrLs. (Directive 2006/52/EC).
35 Concerning salads, 6.2% of salad concentrations exceeded their ML with 23 winter lettuces
36 (4%) and 10 other winter salads (2%) above 4000 mg kg^{-1} and 16 summer lettuces (3%), 4
37 summer green salads (14%) and 10 other summer salads (2%) above 2500 mg kg^{-1} . But the
38 mean concentration was 1974 mg kg^{-1} for lettuces, 1975 mg kg^{-1} for corn salads and 1783 mg
39 kg^{-1} for other salads. Concerning spinach, 18% of spinach concentrations exceeded their ML
40 with 27 winter spinaches (10%) above 3000 mg kg^{-1} and 21 summer spinaches (8%) above
41 2500 mg kg^{-1} . But the mean concentration in spinach was 1682 mg kg^{-1} . For additive food-
42 vectors, 6.3% of industrial prepared meat product concentrations exceeded 250 mg kg^{-1} with 2
43 turkey-based products (4%), 1 rabbit-based product (2%), 25 pork-based products (16%), 1
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3 boar-based product (3%) and 1 veal-based product (5%). But the mean concentration in
4 industrial prepared meat products was below 250 mg kg⁻¹. Concerning unprepared meat
5 products, 311 concentrations (8%) exceeded 250 mg kg⁻¹ but the mean concentration was
6 below 250 mg kg⁻¹ except in Coppa (mean = 394.2 mg kg⁻¹). The mean concentration in canned
7 foie gras exceeded 50 mg kg⁻¹ with 12% of the analysis above 50 mg kg⁻¹. Concerning cheese,
8 5 concentrations (10%) exceeded 50 mg kg⁻¹ but the mean concentration was below 50 mg kg⁻¹,
9 except for processed cheeses and other types of cheese (120 and 60 mg kg⁻¹ respectively).
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16 *Water.* Mean concentrations of nitrate obtained in water (Table 1), were, for the lower and upper
17 bound respectively, 17.4 mg L⁻¹ for tap water and boiled water, 1.6 and 2.2 mg L⁻¹ for water of
18 source origin, 2.7 and 3.0 mg L⁻¹ for mineral and sparkling mineral water.
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22 23 *Mean nitrite concentrations*

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25 *Food items.* Nitrite monitoring data concerns 109 food items (Table 2). Only some of these are
26 concerned by the food additive uses regulation (Directive 2006/52/EC). 9 meat product
27 concentrations (0.2%) and 2 industrial prepared meat product concentrations (0.4%) exceeded
28 100 mg kg⁻¹ but mean concentrations in these food items were below 50 mg kg⁻¹, except in
29 Rosette (94 mg kg⁻¹).
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35 *Water.* Mean concentrations of nitrite obtained in water (Table 2) were, for the lower and upper
36 bound estimates respectively, 0.0 and 0.1 mg L⁻¹ for tap water and boiled water, 0.0 and 0.03
37 mg L⁻¹ for water of source origin and 0.00 and 0.04 mg L⁻¹ for mineral and sparkling mineral
38 water.
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42 43 *Nitrate dietary exposure assessment*

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45 Nitrate dietary exposure levels were almost the same with the lower and the upper bound
46 estimates (Table 3). For adults, dietary exposure was on average 1.5 mg kg⁻¹ bw day⁻¹ (40%
47 ADI) and the 97.5th percentile was 3.3 mg kg⁻¹ bw day⁻¹ (89% ADI). For children, dietary
48 exposure was on average between 1.9 and 2.0 mg kg⁻¹ bw day⁻¹ (51 and 54% ADI) and the
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3 97.5th percentile was between 4.8 and 4.9 mg kg⁻¹ bw day⁻¹ (130 and 132% ADI). Nitrate dietary
4 exposure levels for adults and children were on average below the nitrate ADI (3.7 mg kg⁻¹ bw
5 day⁻¹). However, Table 4 shows that 1.4% (CI_{95th} [0.8; 2.0]) to 1.5% (CI_{95th} [0.9; 2.1]) of adults
6 and 7.9% (CI_{95th} [6.2; 9.6]) to 8.4% (CI_{95th} [6.7; 10.1]) of children have an individual dietary
7 exposure exceeding the ADI.
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11 With dietary intakes exceeding 5% of the ADI for adults and children respectively (Table
12 3), vegetables other than potatoes (24 and 27% ADI), potatoes (5 and 11% ADI) and water
13 including boiled water (5 and 5% ADI) were major contributors to total nitrate intake. Food items
14 contributing to more than 5% of the ADI and considered as major contributors to nitrate dietary
15 intakes were, for adults and children respectively (Table 5), green salads other than lettuce and
16 corn salad (5 and 5% ADI), spinach (3 and 5% ADI) and potatoes (5 and 11% ADI). Other
17 vegetables usually considered to be major contributors (DGS 1992), such as lettuce ,corn salad
18 , radish , green beans or celery , were estimated to contribute to less than 5% of the ADI. Water
19 including boiled water was a major contributor but no individual item contributed to more than
20 5% of the ADI.
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30 *Nitrite dietary exposure assessment*

31 Nitrite dietary exposure levels depended largely on the lower or upper bound estimates chosen
32 (Table 6). For adults, dietary exposure was on average between 0.02 and 0.04 mg kg⁻¹ bw day⁻¹
33 (33 and 67% of the ADI) and the 97.5th percentile was between 0.05 and 0.08 mg kg⁻¹ bw day⁻¹
34 (83 and 133% ADI). For children, dietary exposure was on average between 0.04 and 0.08 mg
35 kg⁻¹ bw day⁻¹ (67 and 133% ADI) and the 97.5th percentile was between 0.09 and 0.17 mg kg⁻¹
36 bw day⁻¹ (150 and 283% ADI). Additive food-vectors contributed on average 0.02 mg kg⁻¹ bw
37 day⁻¹ (33% ADI) for adults and between 0.03 and 0.04 mg kg⁻¹ bw day⁻¹ (50 - 67% ADI) for
38 children. The nitrite dietary intake means for adults and children were almost the same as or
39 higher than the ADI (0.06 mg kg⁻¹ bw day⁻¹). Table 7 shows that between 0.7% (CI_{95th} [0.3; 1.1])
40 and 16.4% (CI_{95th} [14.5; 18.3]) of adults and between 10.5% (CI_{95th} [8.6; 12.4]) and 66.2% (CI_{95th}
41 [63.3; 69.1]) of children have an individual nitrite dietary intake exceeding the ADI.
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3 Industrial prepared meat products and meat products with intakes at 17 and 17% of the
4 ADI for adults and 33 and 17% of the ADI for children (Table 6) were major contributors (i.e. >
5 5% of the ADI). Dietary intakes due to vegetables and potatoes exceeded 5% of the ADI, only
6 for upper bound estimation, with contributions equal to 17 and 33% of the ADI for vegetables
7 and 17 and 33% of the ADI for potatoes for adults and children respectively. Major contributors
8 to dietary intake of nitrite, i.e. food contributing to more than 5% of the ADI were, for adults and
9 children respectively (Table 8), industrial prepared meat products made from chicken , beef ,.

16 Discussion

17 *Nitrate dietary exposure*

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20 The nitrate dietary exposure level estimated in this study (40% ADI for adults and 51 - 54% ADI
21 for children) is twice as low as the results obtained in the "Diagonale des nitrates" (1.5 versus
22 2.5 mg kg⁻¹ bw day⁻¹ and 2.0 vs. 4.2 mg kg⁻¹ bw day⁻¹ for adults and children respectively) but is
23 greater than in the Netherlands Duplicate Diet Survey (Vaessen and Schothorst 1999) and in
24 the New Zealand foods and drinking water survey results (Thomson et al. 2007), where nitrate
25 intakes for adults are 30% and 16 % of the ADI respectively. This could be explained by the fact
26 that the Duplicate Diet Survey and the New Zealand foods and drinking water survey are
27 exposure assessment methods which focus less on contributor items than this study method,
28 which is based on monitoring data more or less targeted on food suspected to represent a risk.
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32 The percentage of individual nitrate exposure exceeding the ADI in this study (1.4%
33 Cl_{95th} [0.8; 2.0] to 1.5 Cl_{95th} [0.9; 2.1] of adults and 7.9% Cl_{95th} [6.2; 9.6] to 8.4% Cl_{95th} [6.7; 10.1]
34 of children) is similar to the New Zealand foods and drinking water survey (Thomson et al.
35 2007). The levels exceeding the ADI are explained by high consumption of the major
36 contributors to total dietary intake, which are vegetables (green salads other than lettuce and
37 corn salad and spinach) and potatoes, consumed in large quantity by the French population.
38 High consumers of vegetables, or vegetarians, have already been identified as subjects more
39 exposed to nitrate (Ministry of Agriculture 1998a; FAO/WHO 2002). These contributors were
40 already identified in France by the "Diagonale des nitrates" (DGS 1992) and other studies
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3 (Thomson et al. 2007). Although lettuce, corn salad, radish, celery stalk, beetroot, Swiss chard
4 and turnip, due to high contamination, and green beans, carrots, cabbage, courgette and leeks,
5 due to high consumption, were previously identified as major contributors in the "Diagonale des
6 nitrates", they are not included as such in this study. Identification of green salads other than
7 lettuce and corn salad as major contributors and not corn salad or lettuce, which are already
8 known to contribute to nitrate dietary intake (Thomson et al. 2007), could be explained by the
9 fact that some participants in the French INCA1 survey did not know exactly which kind of salad
10 they ate. That is why this study does not show lettuce or corn salad as major contributors of
11 nitrate exposure. The contributions of water (5.4 % ADI for adults and children) were obtained
12 with an estimation of the data mean from several French monitoring databases. This nitrate
13 concentration mean in water is considered to be representative of the expected concentration at
14 the national level but not at the regional level. In fact, in each French region, nitrate
15 concentrations in soil and water depend on the scale of agriculture. In French regions, some
16 nitrate concentrations in tap water even exceed the ML. As a result, these water contributions
17 do not take account of the local consumption of water that could contain a higher concentration
18 of nitrate than the means used in this study. This survey may therefore give an underestimated
19 dietary exposure for the local populations consuming and cooking with this tap water.
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33 *Nitrite dietary exposure*

34 The nitrite dietary exposure level estimated in this study (33 - 67% ADI for adults and 67 - 133%
35 ADI for children) is higher than in the Netherlands Duplicate Diet Survey results (Vaessen and
36 Schothorst 1999), where the majority of studied subjects had an intake of less than 10% of the
37 ADI, and in the New Zealand foods and drinking water survey ones (Thomson et al. 2007),
38 where nitrite intakes were approximately 13% of the ADI.
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43 The percentage of individuals with a nitrite exposure exceeding the ADI in this study
44 (0.7% CI_{95th} [0.3; 1.1] to 16.4% CI_{95th} [14.5; 18.3] of adults and 10.5% CI_{95th} [8.6; 12.4] to 66.2%
45 CI_{95th} [63.3; 69.1] of children) is also higher than the results of the New Zealand study where
46 only 1% of the exposure scenarios exceeded the ADI, but this New Zealand study included the
47 major contributors only and did not take account of the whole diet. Several points could explain
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3 these exceedances of the ADI. Firstly, additive food-vectors, for which the use of nitrites as
4 additives is allowed, are the major contributors (33% ADI for adults and 50 - 67% ADI for
5 children). These additive food-vectors contributed on average 1 to 19 times more than the other
6 food items. So, subjects whose nitrite intakes exceed the ADI are high consumers of meat
7 products and industrial meat products. But the additive food-vector contributions, calculated in
8 this study and based on concentrations measured in food, are lower than the results obtained in
9 the first AFSSA study (Bemrah-Aouachria et al. 2007) based on nitrite uses declared by
10 industries, where adult results were 1.2 to 2 times higher (mean at 0.034 - 0.050 mg kg⁻¹ bw
11 day⁻¹ and P97.5th at 0.093 - 0.134 mg kg⁻¹ bw day⁻¹) and children results were 2 to 3 times
12 higher (mean 0.058 - 0.088 mg kg⁻¹ bw day⁻¹ and P97.5th at 0.165 - 0.250 mg kg⁻¹ bw day⁻¹).
13 The higher contributions of additive food-vectors compared to the rest of the diet could be
14 explained by the fact that industrial meat products, items not well identified in the INCA survey
15 and for which no consumption data was available, were assumed to be consumed in the
16 amount equivalent to the consumption data of the corresponding meat, which was consumed in
17 greater quantity. This assumption can overestimate the nitrite dietary exposure.
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28 Moreover, the differences between results of nitrite exposure obtained with the lower
29 and the upper bound estimates are considerable, in particular for vegetables and potatoes. This
30 is due to the fact that analytical limits of the different French laboratories for non-additive food-
31 vectors were higher than for food regulated for the use of nitrites as additives. As a result,
32 although vegetables and potatoes were not quantified, their concentrations, depending on the
33 lower and the upper bound estimates, have an impact on total dietary intake. Indeed vegetables
34 without potatoes and potatoes contributions were 33.4 and 66.6% ADI for adults and children
35 respectively with the upper bound estimate. But only, 4% of lettuce, 23% of others green salads
36 and 8% of spinaches had detected concentration values. These food items, for which at least
37 one concentration value was detected, contributed to nitrate dietary intake at 4.8 and 5.2% of
38 the ADI for adults and children respectively with the high scenario. So, except lettuce, others
39 green salads and spinach, the others vegetables and potatoes, for which 100% of
40 concentrations values are not detected and assumed to be equal to the corresponding LOD,
41 contributed at 28.5 and 61.4% ADI for adults and children respectively. So, the upper bound
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3 estimate, using LODs for vegetables and potatoes concentration values, generally not detected,
4 could overestimate the nitrite the dietary intake. This significant difference between analytical
5 limits for some foods has already been identified in the Netherlands Duplicate Diet Survey
6 (Vaessen and Schothorst 1999). Furthermore, vegetables and potatoes are consumed in large
7 quantities by the French population (110 and 63 g day⁻¹ and 67 and 59 g day⁻¹ for adults and
8 children respectively). So the more a food item is consumed, the greater the impact of high
9 analytical limits for this food item is. This can explain the higher exposure of nitrite in this current
10 assessment compared to those in the New Zealand and the Netherlands surveys, where the
11 LOQ can be 10 times smaller than the LOQ reported in this study (Vaessen and Schothorst
12 1999, Thomson et al. 2007).

21 *Study limits*

22 Contamination data from the national monitoring programs might have been focused on food
23 items which are known to be major contributors to dietary intakes of nitrate and nitrite. This
24 explains why it might not cover the whole diet, because some foods are not taken into account
25 such as cereals products, milk, butter and eggs. Therefore, according to some studies
26 (Kammerer et al. 1992), nitrate concentrations in milk can reach 2 mg L⁻¹, with a milk
27 consumption at 0.4 L day⁻¹ (with a body weight at 60 kg for adults and 30 kg for children), the
28 contribution of milk can reach 0.3 and 0.7% ADI, for adults and children respectively.

29 Besides, the food nomenclature correspondences between contamination and
30 consumption data were not perfect due to some foods which were analyzed but not declared to
31 be consumed, the INCA 1 survey being not precise enough for the some foods. Moreover,
32 monitoring programs are essentially based on food items for which nitrate and nitrite uses are
33 allowed. So the number of samples varies considerably from one food item to another and the
34 concentration obtained depends on the food items. This could be because some food items like
35 additive food-vectors for nitrite and vegetables for nitrate are analyzed more frequently than
36 other items in the diet. This important heterogeneity in the analysis number can also have an
37 impact on the results of the dietary exposure levels obtained in this study. It is therefore
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3 necessary to make the national monitoring program more homogeneous in terms of number of
4 analyses and more representative in terms of food items consumed at the national level.
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6 Another point to mention is the fact that concentrations measured are reported if the
7 concentration is above the LOQ. But if no result is quantified it does not imply that no nitrate and
8 / or nitrite are present in the food items. This is why two mean estimates are calculated, an
9 upper and a lower one, using analytical limits values. But as it has been shown in this study,
10 there were great differences between analytical limit values. Analytical limits were generally
11 higher for food items for which nitrate or nitrite uses are not allowed. The level of the analytical
12 limits may have a major impact on the exposure estimates that is why upper estimates could be
13 very higher than the lower ones. Improving the sensitivity of these analytical limits, in
14 decreasing analytical limits could refine these upper estimates obtained in this study and
15 decrease the uncertainties on the dietary exposure assessment.
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23 Another point to emphasize is the fact that this study does not take account of the
24 variability of food contamination across regions and seasons. For example, some studies
25 (Ministry of Agriculture 1998a; Vaessen and Schothorst 1999) showed dietary exposure
26 variations according to the season, the nitrate intake mean was 73 mg day⁻¹ in spring vs. 87 mg
27 day⁻¹ in autumn and the nitrite intake mean was 0.6 mg day⁻¹ in spring and below 0.2 mg day⁻¹
28 in autumn. Cooking vegetables has also been shown to reduce nitrate concentrations by up to
29 75% (Ministry of Agriculture 1998b). Taking seasons and cooking habits into account would
30 consequently improve this dietary exposure assessment.
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36 Taking account of the endogenous synthesis of nitrate and the proportion of nitrate
37 converted to nitrite in humans, being taken as 5% (mol mol⁻¹) for normally responding
38 individuals and 20% for those showing a high level of conversion, the endogenous synthesis of
39 nitrite would also improve the nitrate and nitrite exposure assessment. But before this,
40 knowledge of the nitrate and nitrite metabolisms must be improved. It would be foreseen to
41 create a new exposure model of dietary exposure, integrating nitrate with a transformed into
42 nitrite part and the excretion urinal rate, and nitrite with the endogenous synthesis part.
43 Nevertheless, based on present toxicological studies, the nitrate and nitrite effects on human
44 health are still not agreed upon, it is therefore important to keep conducting toxicological studies
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3 to establish more accurate ADIs and because nitrite causes methemoglobinemia, it would also
4 be appropriate to establish an acute reference dose (FAO/WHO 2002).
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7 Lastly, with nitrate and nitrite intakes exceeding the ADIs, the lists and the levels of the
8 respective MLs and MrLs, essentially lower than the residue levels used in this study, might be
9 reconsidered, as recommended by the Joint FAO/WHO Expert Committee on Food Additives
10 (FAO/WHO 2002) and as it was confirmed by the last intake assessment of the WHO
11 (FAO/WHO 2003).
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15 16 17 **Conclusion**

18 This study is the first French estimate of the dietary exposure of nitrate and nitrite based on
19 concentrations analysed in foods (13 657 analyses in foods and 6870 analyses in water).
20 Nitrate dietary exposure is on average lower than the ADI (40% ADI for adults and 51 - 54%
21 ADI for children) but this exposure is not only due to foods for which MLs and MrLs are fixed
22 (lettuce and spinach). Nitrite dietary exposure is on average fairly similar to the ADI (33 - 67%
23 ADI for adults and 67 - 133% ADI for children) and largely depends on the lower or the upper
24 estimate of the exposure chosen to treat the non-detected and non-quantified analysis results.
25 The major contributors to nitrite dietary exposure are only foods for which nitrite use is
26 authorized. Nitrite dietary exposure, obtained with this approach, is 1 to 3 times lower than the
27 theoretical nitrite dietary exposure previously obtained in France. This is why work on the
28 methodology of dietary exposure assessment must be continued. Analytical limits for non-
29 additive food-vectors would need to be improved in order to refine the exposure assessment.
30 Consumption data must also be refined to take account of all contaminated food items, even
31 those that are rarely consumed, as has been done in the second French individual consumption
32 survey (INCA2), not yet available. Knowledge of the nitrate and nitrite metabolisms and
33 toxicological effects must also be improved to better characterize the risk of dietary exposure of
34 nitrate and nitrite present in food
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49 **Acknowledgements**

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3 Contamination data has been provided by the French Ministry of consumer Affairs « Direction
4 Générale de la concurrence, de la consommation et de la Répression des Fraudes ».

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Table 1: Nitrate concentration data

Nitrate concentrations in food expressed in mg kg ⁻¹											
Food item	Number of analyses	% of results < LOD	Estimate of the average concentration		Maximum concentration value	Food item	Number of analyses	% of results < LOD	Estimate of the average concentration		Maximum concentration value
			Lower bound	Upper bound					Lower bound	Upper bound	
Meat products						Vegetables other than potatoes					
Andouille	36	2.8	29.8	29.8	91	Artichoke	1	0.0	16.0	16.0	16
Andouillette	35	11.4	53.3	53.3	294	Asparagus	32	12.5	111.6	111.6	1245
Bacon	10	10.0	114.9	114.9	287	Avocado	2	0.0	1256.0	1256.0	2483
Bacon bits	24	0.0	67.6	67.6	270	Beetroot	3	0.0	644.3	644.3	1141
Black pudding (blood sausage)	41	48.8	17.2	17.2	128	Broccoli	7	14.3	442.4	442.4	1131
Chipolata sausage	231	28.6	69.3	69.3	683	Brussels sprout	4	25.0	24.1	24.1	78
Chorizo dry sausage	116	4.3	164.1	164.1	685	Cabbage, green	16	6.3	498.3	498.3	1855
Cocktail sausage	14	14.3	101.6	101.6	510	Carrot	185	16.2	120.7	120.7	861
Coppa	5	0.0	394.2	394.2	860	Cauliflower	29	10.3	214.2	214.2	910
Dried sausage	142	10.6	85.3	85.3	642	Celeriac	20	10.0	612.7	612.7	1861
Dried sausage (sliced)	438	10.1	95.7	95.7	1248	Celery stalk	17	5.9	1240.8	1240.8	2500
Foie gras, canned	65	13.9	196.6	196.6	11100	Chicory (Belgian endive)	35	2.9	135.1	135.1	414
Frankfurter sausage	45	4.4	67.7	67.7	464	Corn salad	28	0.0	1975.2	1975.2	3600
French saveloy	27	22.2	69.3	69.3	342	Courgette (zucchini)	43	2.3	559.3	559.3	1198
Galantine	66	6.1	65.8	65.8	300	Cucumber	33	3.0	191.6	191.6	1800
Garlic sausage	78	5.1	80.9	80.9	550	Eggplant	23	0.0	284.4	284.4	777
Ham, raw	58	19.0	240.2	240.2	3270	Endive (US chicory)	35	0.0	534.2	534.2	2100
Ham, cooked	346	15.9	71.5	71.5	3000	Fennel	9	0.0	1042.7	1042.7	3345
Head-cheese (Brawn)	39	7.7	133.1	133.1	866	Garlic	4	25.0	120.5	120.5	286
Merguez sausage	382	8.4	160.2	160.2	9500	Green bean	40	2.5	449.0	449.0	922
Montbeliard sausage	6	0.0	199.8	199.8	345	Leek	59	8.5	409.5	409.5	2960
Mortadella	19	21.1	75.0	75.0	341	Lettuce	579	1.9	1973.9	1973.9	5600
Morteaux sausage	22	9.1	52.5	52.5	250	Mushroom	3	33.3	116.5	116.5	341
Pâté	340	16.2	62.3	62.3	2962	Mushroom, canned	6	16.7	24.2	24.2	78
Pâté in pastry.	28	14.3	88.4	88.4	213	Onion	4	75.0	52.5	77.7	210
Pâté, duck	74	25.7	22.0	22.0	412	Other green salads	403	2.7	1783.3	1783.3	6100
Pâté, fish and shellfish	5	20.0	27.0	27.0	42	Parsley	16	6.3	1980.1	1980.1	4300
Pâté, pork liver	45	17.8	91.4	91.4	773	Pea	10	60.0	21.1	21.1	79
Pâté, poultry liver	254	14.6	65.5	65.5	2236	Pepper	34	14.7	158.8	158.8	2870
Rillettes	102	41.2	10.5	10.5	88	Radish	19	0.0	1860.7	1860.7	5000
Rosette dry sausage	24	25.0	101.2	101.2	296	Sorrel	1	100.0	0.0	5.0	
Salami	16	25.0	94.0	94.0	458	Spinach	266	3.4	1681.7	1681.7	8700

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3	Sausage meat	55	34.6	91.7	91.7	2128	Swiss chard	7	14.3	1353.7	1353.7	3500
4	Snack	15	13.3	64.9	64.9	267	Turnip	42	0.0	656.6	656.6	2128
5	Strasbourg sausage	21	9.5	87.2	87.2	363	Watercress	21	0.0	1876.6	1876.6	2655
6	Toulouse sausage	379	24.0	88.7	88.7	941	Fruits					
7	Tripes à la mode de Caen	15	0.0	16.8	16.8	53	Apple	2	50.0	22.5	22.5	35
8	White pudding (white sausage)	59	37.3	12.5	12.5	43	Fig	1	0.0	72.0	72.0	72
9	Other meat products	17	5.9	168.3	168.3	1242	Strawberry	2	0.0	77.5	77.5	110
10	Industrial prepared meat products						Dried fruit and nuts					
11	Cassoulet, canned	1	0.0	33.0	33.0	33	Dried apricot	1	100.0	0.0	50.0	
12	Confit of duck	2	0.0	7.0	7.0	7	Dry vegetables					
13	Hare, stewed	5	20.0	32.4	32.4	78	Tofu	3	0.0	73.7	73.7	198
14	Other processed game	20	30.0	16.3	16.3	54	Mixed dishes					
15	Pigeon, roasted	4	25.0	50.0	50.0	134	Lasagna	1	0.0	41.0	41.0	41
16	Processed beef	27	11.1	37.4	37.4	164	Paella	2	50.0	5.5	5.5	6
17	Processed boar	37	18.9	29.4	29.4	458	Tomato	120	30.8	17.6	17.6	157
18	Processed chicken	34	26.5	21.3	21.3	110	Tomato	1	0.0	19.0	19.0	19
19	Processed duck	48	31.3	21.2	21.2	224	Pastas					
20	Processed hare	6	16.7	27.8	27.8	82	Pasta	3	100.0	0.0	70.0	
21	Processed pork	155	12.9	105.0	105.0	757	Potatoes					
22	Processed poultry	1	100.0	0.0	10.0		Potato	167	4.2	191.8	191.8	730
23	Processed quail	7	28.6	27.7	27.7	124	Sweet potato	1	0.0	717.0	717.0	717
24	Processed rabbit	42	11.9	53.1	53.1	280	Quiches					
25	Processed turkey	54	31.5	56.1	56.1	471	Quiche Lorraine	2	50.0	19.5	19.5	4
26	Processed veal	21	57.1	41.8	41.8	288	Vegetable quiche	8	12.5	309.9	309.9	650
27	Processed lamb	4	50.0	14.5	14.5	32	Shellfish and mollusks					
28	Ravioli with tomato sauce, canned	1	100.0	0.0	10.0		Snails	6	16.7	43.2	43.2	115
29	Roasted pheasant	3	0.0	21.7	21.7	54	Starter					
30	Sauerkraut with meat, canned	1	0.0	206.0	206.0	206	Small spring roll	2	0.0	56.5	56.5	108
31	Stuffed escalope of poultry	3	0.0	137.7	137.7	187	Alcoholic beverages					
32	Stuffed escalope of veal	2	100.0	0.0	10.0		Beer, brown ale	3	0.0	45.5	45.5	72
33	Offal						Bee, ordinary	45	4.4	42.1	42.1	137
34	Liver, poultry	7	28.6	8.9	8.9	18	Cider	1	100.0	0.0	1.0	
35	Tongue, beef	3	33.3	12.0	12.0	27	Soft drinks					
36	Rapeseed oil	1	0.0	55.0	55.0	55	Apple juice	1	0.0	0.0	0.0	0
37	Cheese						Fruit syrup	3	0.0	27.3	27.3	42
38	Bonbel-Babybel ® type cheese	3	100.0	0.0	10.0		Lemonade	2	0.0	10.8	10.8	17
39	Edam cheese	4	0.0	13.0	13.0	18	Bread					
40	Emmental cheese	1	100.0	0.0	50.0		Bread	1	0.0	34.0	34.0	34
41	Ewe's cheese	2	0.0	2.5	2.5	4	Water					
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3	Gouda cheese	2	0.0	21.5	21.5	33	Mineral water	957	32.5	2.7	3.0	/
4	Maasdam® type cheese	1	0.0	12.0	12.0	12	Sparkling mineral water	/	/	2.7	3.0	/
5	Mimolette ® type cheese	22	40.9	14.9	14.9	55	Tap water	/	/	17.4	17.4	/
6	Other cheeses	5	20.0	120.0	120.0	225	Water of source origin	2732	55,6	1.6	2.2	/
7	Port Salut® type cheeses	2	100.0	0.0	10.0		Boiled Water					
8	Processed cheese	5	0.0	60.0	60.0	280	Coffee	/	/	17.4	17.4	/
9	Saint-Paulin® type cheese	1	100.0	0.0	10.0		Tea	/	/	17.4	17.4	/
10	Appetizer cheese	1	0.0	12.0	12.0	12	Soup	/	/	17.4	17.4	/

Wen less 60 % of results < LOD, upper and lower bound estimates of concentration means correspond to middle bound estimates.
Censored results correspond to analyses for which contamination levels were non-detected or non-quantified

Table 2 : Nitrite concentration data

Nitrite concentrations in food expressed in mg kg ⁻¹											
Food item	Number of analyses	% of results < LOD	Estimate of the average concentrations		Maximum concentration value	Commodities	Number of analyses	% of results < LOD	Estimate of the average concentrations		Maximum concentration value
			Lower bound	Upper bound					Lower bound	Upper bound	
Meat products						Cheese					
Andouille	39	5.1	13.54	13.54	76	Bonbel-Babybel ® type cheese	3	66.7	0.33	1.00	1
Andouillette	48	22.9	11.68	11.68	67	Edam cheese	4	75.0	0.75	1.50	3
Bacon	19	26.3	10.09	10.09	45	Ewe's cheese	2	100.0	0.00	0.10	
Bacon bits	40	5.0	16.65	16.65	59	Gouda cheese	1	100.0	0.00	1.00	
Black pudding (blood sausage)	49	79.6	1.04	2.49	19	Maasdam® type cheese	1	100.0	0.00	1.00	
Chipolata sausage	298	78.9	2.05	3.00	71	Mimolette ® type cheese	17	94.1	0.06	0.84	1
Chorizo dry sausage	139	35.3	3.30	3.30	16	Other cheeses	6	100.0	0.00	1.00	
Cocktail sausage	16	31.3	9.41	9.41	26	Port Salut® type cheese	2	50.0	1.25	1.25	2
Coppa	6	0.0	25.50	25.50	51	Processed cheese	5	60.0	0.70	0.70	1
Dried sausage	176	22.7	8.54	8.54	75	Saint-Paulin® type cheese	1	100.0	0.00	1.00	
Dried sausage (slices)	567	17.1	11.60	11.60	79	Small cheese for aperitif	1	100.0	0.00	1.00	
Foie gras, canned	75	26.7	4.36	4.36	12	Vegetables other than potatoes					
Frankfurter sausage	44	2.3	30.00	30.00	71	Artichoke	1	100.0	0.00	2.00	
French savoloy	45	2.2	34.01	34.01	77	Avocado	1	100.0	0.00	20.00	
Galantine	79	29.1	10.20	10.20	54	Broccoli	2	100.0	0.00	2.00	
Garlic sausage	107	2.8	29.67	29.67	76	Brussels sprout	1	100.0	0.00	2.00	
Ham, raw	73	32.9	8.77	8.77	118	Cabbage, green	7	100.0	0.00	18.57	
Ham, cooked	470	12.1	11.22	11.22	190	Carrot	84	100.0	0.00	4.15	
Head-cheese (Brawn)	51	19.6	12.29	12.29	71	Cauliflower	4	100.0	0.00	2.00	
Merguez sausage	469	72.3	3.04	3.99	220	Celeriac	3	100.0	0.00	2.00	
Montbeliard sausage	6	0.0	19.00	19.00	42	Celery stalk	7	100.0	0.00	2.00	
Mortadella	25	4.0	17.02	17.02	54	Chicory (Belgian endive)	3	100.0	0.00	2.00	
Mortaux sausage	23	4.4	5.89	5.89	40	Corn salad	23	100.0	0.00	2.00	
Pâté	428	53.7	3.44	3.44	36	Courgette (zucchini)	3	100.0	0.00	2.00	
Pâté in pastry	36	19.4	9.93	9.93	34	Cucumber	4	100.0	0.00	2.00	
Pâté, duck	101	64.4	2.70	3.43	43	Endive (US chicory)	10	100.0	0.00	7.40	
Pâté, fish and shellfish	11	90.9	0.09	1.36	1	Garlic	1	100.0	0.00	2.00	
Pâté, pork liver	67	58.2	7.65	7.65	352	Green bean	2	100.0	0.00	15.00	
Pâté, poultry liver	335	49.0	6.01	6.01	500	Leek	15	100.0	0.00	2.53	
Rillettes	136	74.3	1.65	2.60	42	Lettuce	259	99.6	0.10	6.25	25

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3	Rosette dry sausage	28	28.6	93.79	93.79	883	Onion	2	100.0	0.00	11.00		
4	Salami	22	36.4	4.36	4.36	36	Other green salads	128	97.7	0.65	10.48	55	
5	Sausage meat	66	75.8	3.35	4.53	77	Parsley	7	100.0	0.00	2.00		
6	Snack	20	15.0	18.23	18.23	164	Pea	2	100.0	0.00	10.00		
7	Strasbourg sausage	33	9.1	23.53	23.53	68	Pepper	2	100.0	0.00	2.00		
8	Toulouse sausage	459	74.1	2.45	3.49	76	Radish	13	100.0	0.00	3.39		
9	Tripes à la mode de Caen	18	77.8	1.17	1.94	14	Sorrel	1	100.0	0.00	2.00		
10	Vegetable terrines and mousses	1	0.0	4.00	4.00	4	Spinach	112	92.0	10.17	18.88	220	
11	White pudding (white sausage)	72	88.9	0.15	1.10	3	Swiss chard	3	100.0	0.00	2.00		
12	Other meat products	23	17.4	18.00	18.00	78	Turnip	13	100.0	0.00	2.00		
13	Offal						Watercress	6	100.0	0.00	11.00		
14	Liver, poultry	12	75.0	1.08	1.83	6	Potatoes						
15	Tongue, beef	3	0.0	8.00	8.00	11	Potato	2	100.0	0.00	10.50		
16	Industrial prepared meat products						Oils						
17	Hare, stewed	5	60.0	3.30	3.30	11	Rapeseed oil	1	0.0	29.00	29.00	29	
18	Other processed games	28	67.9	3.86	4.68	27	Pastas						
19	Other processed meat products	4	75.0	1.75	2.50	7	Pasta	4	100.0	0.00	4.00		
20	Pigeon, roasted	4	75.0	2.25	4.00	9	Quiches						
21	Processed beef	18	61.1	7.33	8.17	46	Quiche lorraine	1	100.0	0.00	5.00		
22	Processed boar	44	77.3	2.39	3.25	43	Shellfish and mollusks						
23	Processed chicken	41	29.3	15.12	15.12	43	Mussels	1	100.0	0.00	1.00		
24	Processed duck	45	60.0	3.77	3.77	32	Snails	6	66.7	0.67	1.33	3	
25	Processed hare	6	33.3	7.50	7.50	20	Mixed dishes						
26	Processed lamb	5	20.0	5.70	5.70	15	Tomato	2	100.0	0.00	2.00		
27	Processed pork	171	32.8	9.75	9.75	155	Water						
28	Processed quail	7	85.7	0.29	1.71	2	Mineral water	460	92.6	0.00	0.04	/	
29	Processed rabbit	63	46.0	6.15	6.15	44	Sparkling mineral water			0.00	0.04	/	
30	Processed turkey	80	40.0	17.66	17.66	154	Tap water	/	/	0.00	0.10	/	
31	Processed veal	27	81.5	2.22	3.04	23	Water of source origin	2721	95.1	0.00	0.03	/	
32	Roasted pheasant	4	75.0	5.50	6.25	22	Boiled water						
33							Coffee	/	/	0.00	0.10	/	
34							Tea	/	/	0.00	0.10	/	
35							Soup	/	/	0.00	0.10	/	

Wen less 60 % of results < LOD, upper and lower bound estimates of concentration means correspond to middle bound estimates.
Censored results correspond to analyses for which contamination levels were non-detected or non-quantified

Table 3: Consumption and dietary exposure of nitrate

Food groups consumption (g day ⁻¹) and dietary exposure of nitrate (mg kg ⁻¹ bw day ⁻¹)										
Food Groups	Number of consumers	Consumption Mean	Lower bound estimate				Upper bound estimate			
			Mean	Mean in % ADI	P 97.5	P 97.5 % ADI	Mean	Mean in % ADI	P 97.5	P 97.5 % ADI
For Adults > 15 years (n= 1474)										
Alcoholic beverages	338	31.5	<0.05	<0.05	0.2	5.4	<0.05	<0.05	0.2	5.4
Bread	1404	117.7	0.1	2.7	0.2	5.4	0.1	2.7	0.2	5.4
Cheese	494	3.7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dried fruit and nuts	6	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dry vegetables	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fruit	813	47.3	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
Industrial prepared meat products	1450	112.0	0.1	2.7	0.3	8.1	0.1	2.7	0.3	8.1
Meat products	1362	37.0	0.1	2.7	0.2	5.4	0.1	2.7	0.2	5.4
Mixed dishes	1373	11.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Soft drinks	216	7.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Offal	104	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Oil	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pasta	407	35.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	5.4
Potatoes	1132	62.6	0.2	5.4	0.5	13.5	0.2	5.4	0.5	13.5
Quiches	287	8.0	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
Shellfish and mollusks	17	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Starters	88	1.7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Vegetables excluding potatoes	1437	110.8	0.9	24.3	2.6	70.3	0.9	24.3	2.6	70.3
Water	1389	556.9	0.1	2.7	0.3	8.1	0.1	2.7	0.3	8.1
Boiled Water	1363	324.6	0.1	2.7	0.3	8.1	0.1	2.7	0.3	8.1
Total		1470.1	1.5	40.5	3.3	89.2	1.5	40.5	3.3	89.2
Children between 3 and 14 years of age (n=1018)										
Alcoholic beverages	20	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bread	921	58.9	0.1	2.7	0.3	8.1	0.1	2.7	0.3	8.1
Cheese	398	3.4	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
Dried fruit and nuts	1	0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dry vegetables		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fruits	494	22.3	<0.05	<0.05	0.2	5.4	<0.05	<0.05	0.2	5.4

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3	Industrial prepared meat products	1011	90.9	0.1	2.7	0.5	13.5	0.2	5.4	0.5	13.5
4	Meat products	932	27.2	0.1	2.7	0.3	8.1	0.1	2.7	0.3	8.1
5	Mixed dishes	989	9.3	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
6	Soft drinks	437	22.7	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
7	Offal	44	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
8	Oil		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9	Pasta	246	36.7	<0.05	<0.05	<0.05	<0.05	0.1	2.7	0.3	8.1
10	Potatoes	881	59.1	0.4	10.8	1.2	32.4	0.4	10.8	1.2	32.4
11	Quiches	216	4.8	<0.05	<0.05	0.2	5.4	<0.05	<0.05	0.2	5.4
12	Shellfish and mollusks	10	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
13	Starters	50	1.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
14	Vegetables without potatoes	983	67.1	1.0	27.0	3.7	100.0	1.0	27.0	3.7	100.0
15	Water	990	477.7	0.2	5.4	0.7	18.9	0.2	5.4	0.7	18.9
16	Boiled Water	577	45.2	<0.05	<0.05	0.1	2.7	<0.05	<0.05	0.1	2.7
17	Total		927.3	1.9	51.4	4.8	129.7	2.0	54.1	4.9	132.4
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Table 4 : Individual exposure of nitrate exceeding the ADI

Individual exposure exceeding the ADI				
	Low estimation		High estimation	
	% of people over the ADI	[95% CI]	% of people over the ADI	[95% CI]
Adults > 15 years (n=1474)	1.4	[0.8; 2.0]	1.5	[0.9; 2.1]
Children between 3 and 14 years of age (n=1018)	7.9	[6.2; 9.6]	8.4	[6.7; 10.1]

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Table 5: Major food contributors to nitrate exposure

Food consumption (g day ⁻¹) and dietary exposure of nitrate (mg kg ⁻¹ bw day ⁻¹)										
	Consumption		Lower bound estimate				Upper bound estimate			
	Adults > 15 years	Children between 3 and 14 years of age	Adults > 15 years		Children between 3 and 14 years of age		Adults > 15 years		Children between 3 and 14 years of age	
	Mean	Mean	Mean	Mean % ADI	Mean	Mean % ADI	Mean	Mean % ADI	Mean	Mean % ADI
Vegetables										
Artichoke	4.3	2.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Asparagus	2.2	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Avocado	2.8	1.6	0.1	2.7	0.1	2.7	0.1	2.7	0.1	2.7
Beetroot	2.4	1.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Broccoli	1.9	1.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Brussels sprout	1.0	0.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Carrot	9.8	8.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cabbage, green	0.3	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cauliflower	5.5	3.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Celeriac	0.5	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Celery stalk	1.3	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chicory (Belgian endive)	5.2	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn salad	1.2	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Courgette (zucchini)	3.5	1.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cucumber	3.8	3.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Eggplant	0.6	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Endive (US chicory)	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fennel	0.4	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Garlic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Green bean	14.9	9.7	0.1	2.7	0.2	5.4	0.1	2.7	0.2	5.4
Leek	2.0	0.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lettuce	0.7	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mushroom	3.5	1.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mushroom, canned	0.2	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Onion	0.4	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Other green salads	8.9	3.0	0.2	5.4	0.2	5.4	0.2	5.4	0.2	5.4

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3	Parsley	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
4	Pea	6.1	7.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
5	Pepper	0.5	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6	Radish	2.2	1.1	0.1	2.7	0.1	2.7	0.1	2.7	0.1	2.7
7	Spinach	4.1	3.2	0.1	2.7	0.2	5.4	0.1	2.7	0.2	5.4
8	Sorrel	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9	Swiss chard	0.6	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
10	Tomato	19.1	11.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
11	Turnip	0.5	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
12	Watercress	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
13	Total	110.8	67.1	0.9	24.3	1.0	27.0	0.9	24.3	1.0	27.0
14	Potatoes										
15	Potato	62.5	59.1	0.2	5.4	0.4	10.8	0.2	5.4	0.4	10.8
16	Sweet potato	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
17	Total	62.6	59.1	0.2	5.4	0.4	10.8	0.2	5.4	0.4	10.8
18	Water										
19	Mineral water	249.8	196.7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Sparkling mineral water	17.8	15.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
21	Tap water	270.6	261.0	0.1	2.7	0.2	5.4	0.1	2.7	0.2	5.4
22	Water of source origin	18.6	4.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Coffee	200.7	10.5	0.1	2.7	<0.05	<0.05	0.1	2.7	<0.05	<0.05
24	Tea	69.3	8.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
25	Soup	54.5	26.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
26	Total	881.4	522.9	0.2	5.4	0.2	5.4	0.2	5.4	0.2	5.4
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Table 6: Consumption and dietary exposure of nitrite

Food groups consumption (g day ⁻¹) and dietary exposure of nitrite (mg kg ⁻¹ bw day ⁻¹)										
Food Groups	Number of consumers	Consumption	Lower bound estimate				Upper bound estimate			
		Mean	Mean	Mean in % ADI	P 97.5	P 97.5 % ADI	Mean	Mean in % ADI	P 97.5	P97.5 % ADI
For Adults > 15 years (n= 1474)										
Cheese	475	3.51	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Industrial prepared meat products *	1450	99.15	0.01	16.7	0.04	66.7	0.02	33.3	0.04	66.7
Meat products *	1363	37.11	0.01	16.7	0.02	33.3	0.01	16.7	0.02	33.3
Mixed dishes	83	2.36	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Offal	104	1.12	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Oil	1	0.00	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Pasta	1132	35.80	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	0.01	16.7
Potatoes	1372	62.52	<0.005	<0.05	<0.005	<0.05	0.01	16.7	0.03	50.0
Quiches	337	6.00	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Shellfish and mollusks	160	0.99	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Vegetables excluding potatoes	1432	99.34	<0.005	<0.05	0.01	16.7	0.01	16.7	0.03	50.0
Water	1389	556.85	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Boiled Water	1363	324.55	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Total		1229.29	0.02	33.3	0.05	83.3	0.04	66.7	0.08	133.3
* Share of additive food-vectors	1474	136.25	0.02	33.3	0.04	66.7	0.02	33.3	0.05	83.3
Share of non-additive food-vectors	1474	1093.04	<0.005	<0.05	0.01	16.7	0.02	33.3	0.05	83.3
Children between 3 and 14 years of age (n=1018)										
Cheese	386	3.31	<0.005	<0.05	<0.005	<0.05	0.00	<0.05	<0.005	<0.05
Industrial prepared meat products *	1006	74.80	0.02	33.3	0.07	116.7	0.03	50.0	0.07	116.7
Meat products *	932	27.21	0.01	16.7	0.03	50.0	0.01	16.7	0.03	50.0
Mixed dishes	30	0.70	<0.005	<0.05	<0.005	<0.05	0.00	<0.05	<0.005	<0.05
Offal	44	0.46	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Oil	/	/	/	/	/	/	/	/	/	/
Pasta	881	36.69	<0.005	<0.05	<0.005	<0.05	0.01	16.7	0.02	33.3
Potatoes	988	59.10	<0.005	<0.05	<0.005	<0.05	0.02	33.3	0.06	100.0
Quiches	206	3.98	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	0.01	16.7
Shellfish and mollusks	72	0.59	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Vegetables excluding potatoes	980	61.90	<0.005	<0.05	0.01	16.7	0.02	33.3	0.05	83.3
Water	990	477.71	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Boiled Water	577	45.23	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05

Total		791.66	0.04	66.7	0.09	150.0	0.08	133.3	0.17	283.3
* Share of additive food-vectors	1018	102.01	0.03	50.0	0.08	133.3	0.04	66.7	0.09	150.0
Share of non-additive food-vectors	1018	689.65	<0.005	<0.05	0.01	16.7	0.05	83.3	0.10	166.7

For Peer Review Only

Table 7: Individual exposure of nitrite exceeding the ADI

Individual exposure exceeding the ADI				
	Low estimation		High estimation	
	% of people over the ADI	[95% CI]	% of people over the ADI	[95% CI]
Adults > 15 years (n=1474)	0.7	[0.3; 1.1]	16.4	[14.5; 18.3]
Children between 3 and 14 years of age (n=1018)	10.5	[8.6; 12.4]	66.2	[63.3; 69.1]

For Peer Review Only

Table 8: Major food contributors to nitrite exposure

Food consumption (g day⁻¹) and dietary exposure of nitrite (mg kg⁻¹ bw day⁻¹)

	Consumption		Lower bound estimate				Upper bound estimation			
	Adults > 15 years	Children between 3 and 14 years of age	Adults > 15 years	Children between 3 and 14 years of age	Adults > 15 years	Children between 3 and 14 years of age	Adults > 15 years	Children between 3 and 14 years of age		
	Mean	Mean	Mean	Mean in % ADI	Mean	Mean in % ADI	Mean	Mean in % ADI		
Meat products										
Andouille	0.52	0.12	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Andouillette	0.06	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Bacon	0.02	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Bacon bits	4.57	3.83	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Black pudding (blood sausage)	0.17	0.03	<0.005	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Chipolata sausage	0.33	0.44	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Chorizo dry sausage	0.59	0.12	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Cocktail sausage	0.69	0.72	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Coppa	0.38	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Dried sausage (slices)	6.30	4.52	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Dried sausage	2.89	1.65	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Foie gras, canned	0.06	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Frankfurter sausage	0.07	0.10	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
French saveloy	1.18	0.82	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Galantine	<0.005	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Garlic sausage	2.45	1.69	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Ham, cooked.	4.91	2.97	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Ham, raw.	0.39	0.10	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Head-cheese (Brawn)	0.08	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Merguez sausage	2.08	0.95	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Montbeliard sausage	0.09	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Mortadella	0.29	0.26	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Mortaux sausage	0.22	0.21	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Others meat products	0.94	0.42	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Pâté	0.09	0.09	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Pâté, duck	0.01	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Pâté, fish and selffish	0.09	0.02	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05

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3	Pâté in pastry.	0.10	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
4	Pâté, poultry liver	0.02	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
5	Pâté, pork liver	0.02	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
6	Pigeon, roasted	0.39	0.03	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
7	Rillettes	0.03	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
8	Roasted pheasant	1.06	0.39	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
9	Rosette dry sausage	0.10	0.27	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
10	Salami	1.71	1.58	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
11	Sausage meat	0.03	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
12	Snack	0.02	0.06	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
13	Strasbourg sausage	2.54	3.11	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
14	Toulouse sausage	2.89	3.08	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
15	Tripes à la mode de Caen	0.16	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
16	Vegetable terrines and mousses	0.04	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
17	White pudding (white sausage)	0.00	0.01	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
18	Total	37.11	27.21	0.01	16.7	0.01	16.7	0.01	16.7	0.01	16.7
19	Industrial prepared meat products										
20	Processed beef	31.50	29.31	<0.005	<0.05	0.01	16.7	<0.005	<0.05	0.01	16.7
21	Processed boar	0.07	0.03	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
22	Processed chicken	22.42	15.52	0.01	16.7	0.01	16.7	0.01	16.7	0.01	16.7
23	Processed duck	2.35	1.51	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
24	Processed hare	0.20	0.03	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
25	Processed lamb	5.28	2.84	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
26	Processed pork	16.82	10.28	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
27	Processed quail	0.27	0.25	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
28	Processed rabbit	4.67	2.24	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
29	Processed turkey	5.98	5.89	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
30	Processed veal	5.23	3.69	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
31	Other processed game	0.14	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
32	Other processed meat products	2.79	2.79	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
33	Total	99.15	74.80	0.01	16.7	0.02	33.3	0.02	33.3	0.03	50.0
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