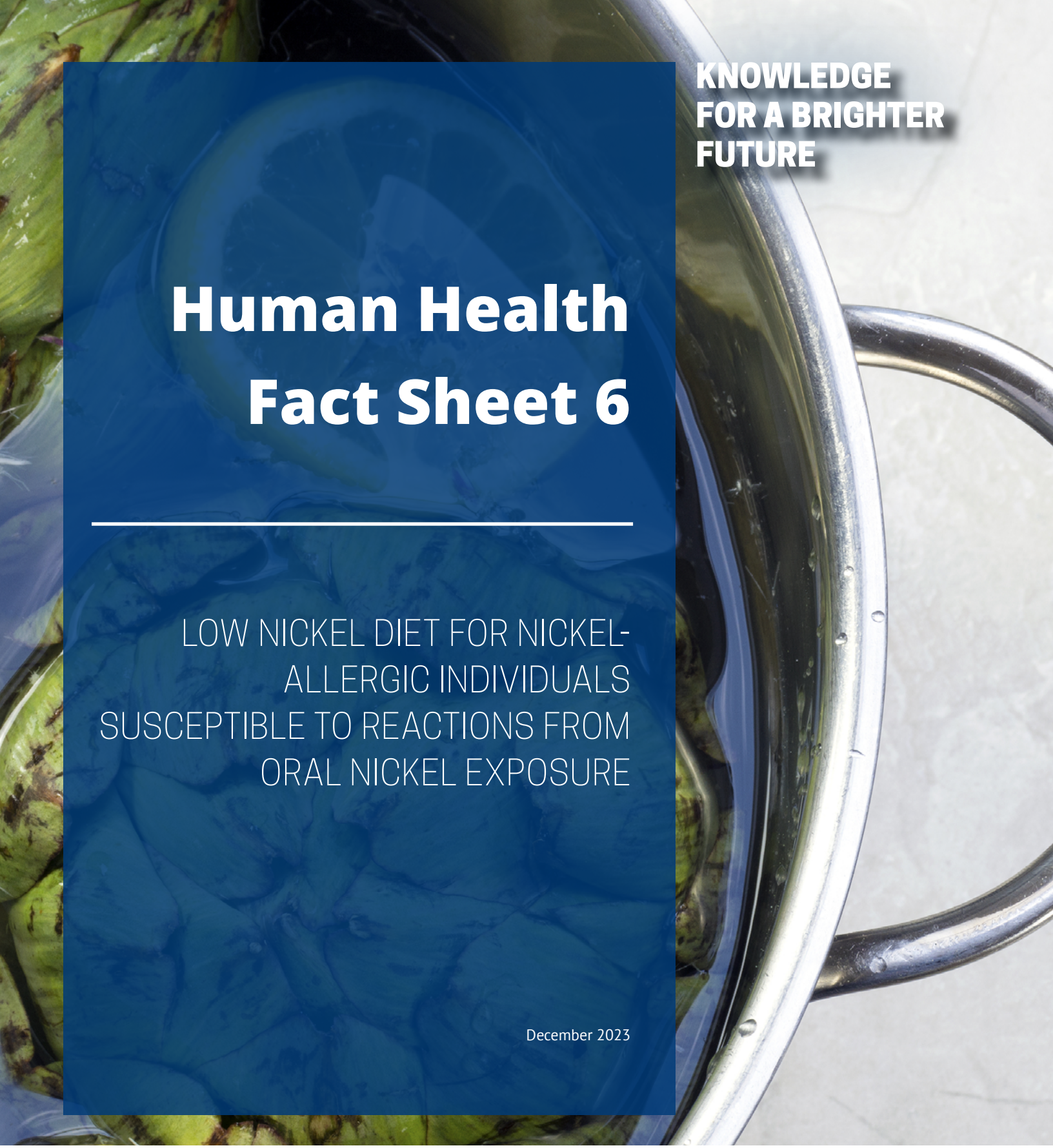

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Human Health Fact Sheet 6

LOW NICKEL DIET FOR NICKEL-ALLERGIC INDIVIDUALS SUSCEPTIBLE TO REACTIONS FROM ORAL NICKEL EXPOSURE

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A small portion of the nickel allergic population are susceptible to allergic reactions from oral exposure to nickel substances, most commonly through food and beverages. These individuals may benefit from a low nickel diet, which should only be undertaken when advised by a dermatologist or other qualified medical doctor.

This fact sheet discusses some of the existing low nickel diets made available by clinics, dermatologists, medical doctors, and on the internet. This fact sheet also briefly explains the origins of nickel in food and examines some of the other potential sources of nickel. In particular, sources that are sometimes highlighted by dermatologists and medical doctors but for which data does not conclusively support substantial contribution to nickel intake (e.g., bottled water versus tap water, canned foods, and the use of stainless steel cookware) are addressed. Recommendations are made with regard to these sources.

Many delicious foods are included in a low nickel diet

Annex I to this fact sheet provides an extensive, non-exhaustive list of foodstuffs that are categorized as high, medium, and low in nickel and expressed in terms of micrograms per kilogram (µg/kg) of food. In order to assist users with compliance with a low nickel diet, each foodstuff within the relevant category is also listed with its nickel content in terms of micrograms per serving (µg/serving).

Low nickel diet for nickel-allergic individuals susceptible to reactions from oral nickel exposure

1. Introduction

Nickel metal and its compounds, as well as some nickel-containing alloys, are skin sensitizers. These materials can sensitize (i.e., make allergic) people to nickel or elicit a dermal allergic reaction in nickel-sensitized individuals when in close and prolonged contact with the skin if a sufficient amount of nickel ions is released (above the threshold for a nickel allergic reaction). A study conducted by the Danish Environmental Protection Agency on nickel allergy has shown prevalence, in the general population, to be between 8 – 18% depending on the European country.[1] Alinaghi et al. (2019)[2] reviewed numerous studies of prevalence of allergens in the general population over may years and around the world, estimating nickel allergy to be 11.4%. The percentage of females sensitized to nickel is higher than the figure for males.

Important considerations regarding nickel allergy are listed below.

- There is no indication that nickel sensitization can be acquired (i.e., become allergic to nickel) via oral exposure to nickel.
- An allergic reaction from oral exposure to nickel substances is referred to as systemic nickel allergy syndrome (SNAS), which is characterized by an outbreak of contact dermatitis associated with systemic symptoms after ingestion of foods containing relatively high amounts of nickel.
- Two approaches have been used to address SNAS. Only the first approach is described in this fact sheet.
    1. Lower the amount of nickel intake through a low nickel diet, for which this fact sheet is designed to provide additional information.
    2. Provide low amounts of nickel orally to induce hyposensitization (or immunotolerance) to nickel. This approach ultimately allows for digestion of moderate amounts of nickel without an allergic reaction.[3][4][5]
- A small portion of the nickel-allergic population are susceptible to nickel dermatitis through oral exposure. Several studies have indicated that some individuals that are hypersensitized to nickel benefit from a reduction in contact dermatitis outbreaks by adopting a nickel restricted diet.[6][7][8][9]
- Not all nickel-sensitized individuals adhering to a low nickel diet will experience a reduction in outbreaks of dermatitis.[8]

Numerous versions of low nickel diets exist, which are provided by dermatologists and other doctors directly to patients or are published on the internet.[10][11][12][13][14][15][16][17][18][19] While many of the same food items are included in these lists, not all of the recommendations and background information provided on SNAS are consistent or correct (e.g., foods cooked in stainless steel pans, canned goods). Hence, it is possible that the users of such diets may not receive the anticipated reduction of their nickel dermatitis outbreaks and/or that the recommendations result only in unnecessary and costly changes in habits and purchases that could affect their health in other ways. Furthermore, following a low nickel diet may lead to the unwarranted avoidance of nickel-containing food contact materials that are common, economical, and already regulated (under separate legislation) to ensure their safe use, even if they contain nickel.

Penn State Hershey Medical Center recommends that after following their diet for one to three months without any improvement the diet should be discontinued.[10] Similarly, Drs. M. Mislankar and M. J. Zirwas indicate that it may take up to two months to reap the benefits from following their low nickel diet.[12] Rebelytics Research and Development Inc. warns that their diet is intended for individuals diagnosed with systemic nickel allergy and that the diet must not be entered into lightly.[14]

With the publication of the European Food Safety Agency's (EFSA) recent update of its Scientific Opinion on Nickel in Food and Drinking Water,[20][21] there is a renewed interest on the topic of nickel in the diet and in drinking water and an opportunity to

better inform the general public, regulators, and other stakeholders. Although the numbers of those affected by SNAS is low, these individuals need access to accurate and reliable information as there is the potential for and evidence of unwarranted health concerns being raised about the oral intake of nickel in food and beverages.

2. Nickel in food

Nickel occurs extensively in the earth's crust and core.[22] Nickel in adequate quantities has a vital role in a wide range of physiological processes.[23] It is an essential trace element for all plants and microbes, as well as certain animal species.[22][24] Nickel deficiency in these animals has been noted to have an adverse effect on the concentration of other essential metals including iron, copper, and zinc.[24] As its presence in soil varies, it is not surprising that the level of nickel in foods also varies in different plant species with the nickel content of the soil and with the seasons. In addition, different species require and use different amounts of nickel, resulting in some foods having higher nickel content than others.[22][24] Animals absorb nickel from food, water, and their environment (especially aquatic species). As most foods contain some measurable level of nickel, an entirely nickel-free diet is not possible.

As nickel is usually measured in food as total nickel and there is limited information on the different chemical species of nickel in food, this fact sheet refers to "nickel" in all its forms in food. Limited information is available on the content or dietary intake of different chemical species of nickel in food. Generally, it is assumed that nickel occurs as complex bound organic nickel molecules in the divalent state (Ni II) with different physico-chemical properties than inorganic nickel[25] and has been demonstrated for some beverages and plants.[26][27][28][29]

While data from numerous studies on nickel in food can disagree markedly on their recommendations for items with low nickel levels, most studies indicate that the sources of highest potential dietary nickel are found in nuts, dried peas and beans, whole grains, and chocolate. Annex I provides a non-exhaustive list of nickel-containing foodstuffs extracted from the updated EFSA Scientific Opinion on nickel in food and drinking water,[20] the INNIBEL report on nickel in foodstuffs on the Belgian market,[30] and the global listing from the Rebelytics Low-Nickel Global Diet Scoring System.[14] Annex I categorizes foodstuffs as high (more than 500 µg/kg), medium (100 – 500 µg/kg), and low (less than 100 µg/kg) in nickel. The information is presented in terms of the average and typical ranges of nickel content per serving. Serving sizes are based on the Rebelytics global listing,[14] which uses Health Canada's serving sizes[31] to generate its micrograms of nickel per serving data. This approach is taken because the nickel content of foodstuffs is usually reported in milligrams of nickel per kilogram of food (mg/kg), which is not easily related to micrograms per serving (µg/serving) as more useful numbers for people following a low nickel diet. This is especially true for diets that aim to limit nickel intake to 150 micrograms per day or 15 points per day (according to the point systems discussed in more detail below).

3. Existing low nickel diets

Low nickel diets tend to fall into two distinct categories. One type is based on categorization of high, medium, and low nickel-containing foods, drinks, and beverages, where avoidance of high nickel-containing foods is recommended, and low nickel-containing foods are permitted.[10][11] Some diets also permit medium nickel-containing foods that are managed by limiting their intake.[11] Such information is usually provided in the form of lists,[10] which may also be accompanied by an indication of the nickel content of each food or by recommendations regarding the quantity and frequency of consumption. For example, bananas (in moderation), apples (up to 3 – 4 times a week), and citrus fruits (up to 3 – 4 times a week) may be permitted.[11] However, this approach to reducing nickel in the diet can be quite challenging due to adherence difficulties and management of the overall nickel intake[13] (e.g., where those following low nickel diet can find it difficult to relate the nickel content of foods to the amount of nickel contained per serving as noted above).

Another approach is that originally designed by Drs. M. Mislankar and M. J. Zirwas[12] which uses a simple "Low-Nickel Diet Scoring System" where the overall objective is a low-nickel diet that does not exceed 150 µg of nickel per day or equivalent to 15 "points" per day. The serving sizes are based on the US Food and Drug Administration (US FDA) approved serving sizes.[1] Thus, the authors arrived at a system of micrograms (µg) nickel per serving (e.g., yogurt 5.34 µg Ni/175 g). Table 1 is based on the publication by Mislankar and Zirwas[12] in which each food listed was assigned a score from 0 to 10.

In the Mislankar and Zirwas Low-Nickel Diet Scoring System,[12] foods with more than 100 µg nickel per serving are to be avoided entirely. For children under the age of 12 years, no more than 10

1 While based on the US Food and Drug Administration (US FDA) approved serving sizes in 2012, the Mislankar and Zirwas[12] low nickel diet scoring system used double the standard serving sizes because Americans frequently consume larger portions. The US FDA updated their serving sizes in 2016 (last amended in 2022)[32] to reflect increased consumption, though the values are still lower than twice the previous values used by Mislankar and Zirwas[12] in 2013 for their low nickel diet.

Table 1 Overview of scoring system for Mislankar and Zirwas approach

Score	Micrograms (µg) Nickel per Serving
0	For food with less than 1 µg/serving
1	For food with 1 to 10 µg/serving
2	For food with 11 to 20 µg/serving
and on up to	
10	For food with 91 to 100 µg/serving

points per day should be consumed. In very rare cases, individuals that are particularly sensitive to nickel may need to limit their intake to 5 points per day if directed by their doctor.

One example of an adaptation to Mislankar and Zirwas approach is the low nickel diet system provided by Rebelytics,[14] which is based on nickel content data from multiple sources (including data from national health organizations and research papers) to compute a weighted average that reflects the potential local variations in food sources, manufacturing, and food preparation methods. Rebelytics used Health Canada's serving sizes[31] to generate its micrograms of nickel per serving data. As with the Mislankar and Zirwas scoring system, Rebelytics assigned points to their food lists and the objective is to limit nickel intake to 15 points per day. Unlike the Mislankar and Zirwas approach, Rebelytics provides global and regional lists of nickel values on their website.[14] Other low nickel diet plans are also available online, each prescribing their own schedule.[15][16][17][18][19]

While the food values in all of these diets are helpful, it should be noted that the recommendations regarding use of stainless steel cookware and utensils, as well as consumption of canned foods and drinking water, may not be accurate. These topics are specifically addressed later in this fact sheet.

4. Comparing nickel levels in foods

In order to facilitate comparison, the data on selected dairy products in Table 2 is presented in terms of micrograms of nickel per serving. The EFSA[20] and INNIBEL[30] data is presented using the Rebelytics serving portions (from Health Canada),[14] while Mislankar and Zirwas data is presented in terms of the serving portions derived by the US Food and Drug Administration (multiplied by 2).[12] The factors influencing the variation in nickel content of foodstuffs are as follows:

- The number of items of a particular food sampled and their origin has an impact on the range of values reported.
- The level of nickel substances in the soil varies from country to country as well as from region to region within a country.
- Different types of plants vary in their uptake of nickel, which is essential for plants.
- As nickel is present in both soil and plants, it follows that there is nickel uptake in animals since they eat plants or eat animals that eat plants.

Thus, the quantity of nickel found in animals and plants will vary according to both the level of nickel compounds in soil in their locality and the amount of uptake.

The range of nickel content of foodstuffs shown by dairy products in Table 2 illustrates these influences. The larger the number of samples of food from different areas of the globe, the greater the range of nickel contents that are likely to be reported, with the Rebelytics Global diet having the highest range.

Therefore, regional information on nickel content is relevant when considering a low nickel diet, if available. For example, the Rebelytics diet[14] provides regional dietary information (as well as global).

Stainless steel cookware and utensils do not need to be avoided on a low nickel diet

Table 2 Comparison of example average values and ranges of nickel in dairy products with color coding for low (green), medium (yellow), and high (red) nickel content[2]

Dairy Products	Level of Nickel[1]	Mean Nickel Content (µg/serving)[2]	Nickel Content Range (µg/serving)[3]	Data Source
Butter	Low	0.8 µg/10 g	0 – 10 µg/10 g	EFSA[20]
	Low	<1 µg/10 g	–	Mislankar and Zirwas[12]
	Low	0.5 µg/10 g	0 – 10 µg/10 g	Rebelytics[14]
Eggs	Low	2.5 µg/100 g	0.5 – 8.8 µg/100 g	EFSA[20]
	Low	<1.6 µg/100 g	–	INNIBEL[30]
	Low	<1 µg/50 g	–	Mislankar and Zirwas[12]
	Low	5 µg/100 g	0 – 10 µg/100 g	Rebelytics[14]
Milk	Low	4.8 µg/250 g	0 – 20 µg/250 g	EFSA[20]
	Low	0.6 µg/250 g	0.2 – 0.9 µg/250 g	INNIBEL[30]
	Low	5 µg/250 g	1 – 30 µg/250 g	Rebelytics[14]
Tofu	Medium	32.6 µg/85 g	8.9 – 77.3 µg/85 g	EFSA[20]
	High	105 µg/85 g	10 – 370 µg/85 g	Rebelytics[14]
Yogurt	Low	1.8 µg/175 g	0 – 5 µg/175 g	EFSA[20]
	Low	0.7 µg/175 g	0 – 1.8 µg/175 g	INNIBEL[30]
	Low	15.5 µg/170 g	–	Mislankar and Zirwas[12]
	Low	5 µg/175 g	0 – 30* µg/175 g	Rebelytics[14]

1. Low = less than 100 µg/kg; Medium = 100–500 µg/kg; High = more than 500 µg/kg. Values are for content per kg of food. Nickel content per serving is shown in columns 3-4.

2. EFSA range values were the P25 LB and P95 UB values from EFSA Annex C (Table C.6). Mislankar and Zirwas[12] only provided mean scores. Rebelytics range values were calculated using the minimum value and maximum values of the score (e.g., score of 2 = 10-20 µg/serving) or of the range of scores (e.g,. range 2-4; score of 2 = 10-20 µg/serving, score of 4 = 30-40 µg/serving; range = 10-40 µg/serving). INNIBEL range values were calculated using the minimum and maximum values provided in the INNIBEL report. EFSA and INNIBEL range values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]

3. EFSA mean values were calculated using the average values of the mean LB and the mean UB from the EFSA document, Annex C (Table C.6). Mislankar and Zirwas[12] used the mean values for each food from the Total Diet Study published by the Food and Drug Administration (FDA) and the FDA-approved metric serving sizes (times 2 for large portion sizes) to calculate the mean value of nickel per serving, which was assigned a score based (see Table 1). Rebelytics mean values were calculated for each food using the mean score provided for each entry and finding the median value (e.g., mean score of 2 = 10-20 µg/serving, median of 15 µg/serving used as mean in table above). INNIBEL mean values were calculated using the mean values cited in the INNIBEL report. EFSA and INNIBEL mean values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]

2 The information provided in Table 2 is extracted from the following sources and adjusted for serving size as described above:

i. Annex C of the November 2020 EFSA Scientific Opinion on nickel in food,[20] which included data from 26 European countries on a large number of individual food items aggregated into food groups and broader food categories and descriptions in a hierarchical parent-child relationship based of the format used in European Union FoodEx2 system. The information provided in Annex C of the EFSA Scientific Opinion is presented in terms of milligrams of nickel per kilogram of food.

ii. The 2019 INNIBEL report[30] titled *Intake Estimation of Nickel via Food for the Belgian Population and Identification of Potential Sources of Nickel Contamination* conducted by the Belgian Federal Public Service, Health, Food Chain and Environment. The information provided in INNIBEL report is presented in terms of milligrams of nickel per kilogram of food.

iii. The *Low-Nickel Diet Scoring System for Systemic Nickel Allergy* derived by Drs. M. Mislankar and M. J. Zirwas.[12] The information presented by Mislander and Zirwas is presented in terms of micrograms per serving based on serving portions derived by the US Food and Drug Administration.

iv. The Rebelytics' *Low Nickel Diet Scoring System*.[14] The information presented by Rebelytics in their global listing in terms of micrograms per serving based on serving portions derived by Health Canada.

5. Stainless steel cookware/utensils data

Nickel-containing stainless steels are one of the most widely used food contact materials; applications range from domestic utensils and kitchen equipment, through commercial catering equipment to mass food production equipment. Stainless steels are selected for these applications because of their cleanability, durability, hygienic properties, inertness, and their excellent mechanical/physical properties such as corrosion resistance which result in very low, if any, nickel release.

In these food contact applications, stainless steels fulfill the key regulatory requirements that constituents are not transferred to food in quantities sufficient to bring about unacceptable changes in its composition, color, odor, taste, or texture.[33] They satisfy, too, the explicit requirement that substances in food contact materials and articles (FCM&As) should not be released in quantities that endanger human health. Studies[34][35] have shown that stainless steels used in FCM&As release low amounts of nickel and other alloying ingredients that are within regulatory limits or guidelines. The European Directorate for the Quality of Medicines & Healthcare (EDQM) Technical Guide on Metals and Alloys Used in Food Contact Materials and Articles[36] includes an appropriate protocol for metal release testing. Provided that the manufacturers' recommendations for care and cleaning are followed, even scratched and scoured stainless steel saucepans should not present a problem for individuals suffering from SNAS.

Several studies have demonstrated low nickel release from stainless steels used in food contact materials.[34][36][37] Nickel release from nickel-containing stainless steel grades tested in food simulants decreased with each successive use. [35][37]

Higher nickel release values were reported for stainless steels by other researchers.[38][39][40] However, two of these studies used test methods that were not in accordance with accepted national or international protocols,[38][39] with one study testing non-relevant stainless steel granules using excessive cooking times.[39]

6. Canned foods data

Many low nickel diets, irrespective of whether they originate from dermatologists, clinics, or online articles/blogs, advise individuals displaying symptoms of SNAS to avoid eating canned food altogether or, at the very least, to eat it only in moderation. The explanation most often given is that some cans are made with materials (alloys) that contain nickel and nickel can dissociate from the alloy of the can and thus increases the total nickel content of the canned food.[8]

Food cans are made of three different materials: aluminium (does not contain nickel), electrolytic tinplate steel (ETP, contains 0.08% maximum nickel), and electrolytic chromium coated steel (ECCS, contains 0.08% maximum nickel). In addition, food cans are typically coated with an additional organic layer that protects the integrity of the can from effects of the food and prevents chemical reactions between the metal coating of the can and the food.[41] The type of can selected for food applications depends on the food type (e.g., aluminium cans are not used for highly acidic fruits). In a limited number of applications, unlacquered ETP cans are used (e.g., tomato-based products)[42] and, in these sealed cans, the presence of a bare tin surface inside the can leads to protection of the natural flavor and appearance of the food.[42]

In a study of the level of metals in fresh and canned foods (typically packaged in coated steel or aluminum cans) consumed in North Central Nigeria,[43] Dallatu et al. found that there was no significant difference in the levels of nickel and other metals in fresh and canned foods. In addition, the nickel concentrations were below the specific release limit for nickel recommended by the EDQM Technical Guide on Metals and Alloys Used in Food Contact Materials and Articles.[36]

This lack of contribution of nickel in canned foods to the diet is supported by comparing the values of nickel in foodstuffs reported the Rebelytics Low Nickel Diet Scoring System[14] and the results reported by Noureddine El Moussawi et al.[44] for fresh and canned fava beans, chickpeas, and okra. The nickel release patterns may be linked to the low nickel composition (less than 0.8% weight^3)[41] in the steel alloy used to construct the cans, resulting in a slow release over time.[45]

A number of other published studies have measured nickel content in canned foods, but without a comparison to nickel content in foods prior to canning, storage time, and conditions of storage.[46][47][48][49][50][51][52][53][54][55][56][57][58][59][60][61] While these studies demonstrate, generally, greater nickel contents in canned food, it is not possible to determine whether the additional nickel content of canned foods occurs because of natural variations in soil, from the canning materials, the canning process, or the storage time and storage conditions.

7. Drinking water data

Nickel and other metal ions can accumulate in tap water supply systems such as taps/faucets during times of stagnation (i.e., when the faucet/tap is unused overnight or during holiday periods). Hence, some diets that list high, medium, and low nickel-containing foods, drinks, and beverages advise that water taken from the tap (faucet) after periods of stagnation should be discarded and should not be used in food preparation.[10][11][13]

The Rebelytics Global Low Nickel Diet Scoring System[14] provides a score of 1 per serving for both bottled water average <10 µg/serving (375 g) [range 0 – 190 µg/serving (375 g)] and tap water average <10 µg/serving (375 g) [range 0 – 20 µg/ serving (375 g)]. Similar data reported by EFSA[20] for bottled and tap water, shown in Annex I, indicates the same range of nickel values apply to both sources of water. According to the EFSA data, bottled water has a mean nickel ion content of 2.6 µg/serving (375 g) compared with 0.4 µg/serving (375 g) for tap water.

8. General recommendations for a low nickel diet

It is important to emphasize that a low nickel diet should only be followed by individuals who are susceptible to SNAS, and only when advised by a dermatologist or their medical doctor. Regional information for nickel levels should be considered when available.

8.1. Stainless steel cookware recommendations

Low nickel diets often recommend that individuals with SNAS should avoid cooking acidic foods in stainless steel cookware. Unfortunately, though well-intended, this advice is not entirely accurate. These recommendations are frequently based on conclusions drawn from poorly designed/poorly executed studies and not on well-conducted, relevant studies. Food contact materials, such as cookware and utensils, are subject to release limits for certain substances, including nickel, but it is important to follow the manufacturers' instructions for care and cleaning (including pre-treatment before first use). If these recommendations are followed, stainless steel saucepans should not present a problem for individuals suffering from SNAS.[34]

8.2. Canned food recommendations

While nickel release from nickel-containing food contact material into the foods are subject to nickel migration limits, a comparison of the ranges of values reported for nickel in fresh and canned foods revealed that these values can vary widely. Thus, it is not possible to determine, with any degree of certainty, whether a canning material, the canning process, and/or long-term storage in a can have a significant impact on the level of nickel in canned foods. Therefore, as a precautionary measure, it is recommended that individuals with SNAS consider the avoidance of canned food or consider canned foods to contain nickel in the medium to high values reported for each foodstuff category, especially as some studies[46][47][48][49][50][51][52][53][54][55][56][57][58][59][60][61] have reported outliers that are significantly higher than the nickel content values reported by EFSA.[20]

8.3. Drinking water recommendations

According to the World Health Organization background document for development of World Health Organization Guidelines for Drinking Water Quality, Nickel in Drinking Water (2021)[62] consumers should flush chromium- or nickel-plated taps/faucets before using the water. Thus, the avoidance of tap water should not be necessary for individuals with SNAS if they follow this recommendation. The EFSA Update of the Risk Assessment of Nickel in Food and Drinking Water (2020)[20] indicates that the contribution to the mean dietary exposure to nickel from 'bottled water' is slightly higher than other types of water (e.g., tap water, ice, well water), but it does not raise a health concern. Therefore, the consumption of bottled water should not be a concern for individuals with SNAS.

3 EN 10202 grade TH 550 (1.0384) used for can bodies.

9. Conclusions

- Systemic nickel allergy syndrome is characterized by an outbreak of dermal contact dermatitis associated with systemic exposure after ingestion of foods containing nickel.
- Individuals with systemic nickel allergy syndrome should only embark on a low nickel diet if advised by and under the supervision of a dermatologist or other medical doctor.
- Not all nickel-sensitized individuals adhering to a low nickel diet will experience a reduction in outbreaks of dermatitis.
- Nickel naturally occurs in plants and animals; a nickel-free diet is therefore not achievable. Low nickel diets can be achieved by following the recommendations offered above.
- Provided that the manufacturer's recommendations for care and cleaning are followed, even scratched and scoured stainless steel cookware should not present a problem for, and do not need to be avoided by, individuals suffering from systemic nickel allergy syndrome.
- As a precautionary measure, individuals with systemic nickel allergy syndrome should consider avoiding canned food, or assume that canned foods contain nickel in the medium to high values reported for each foodstuff category.
- Provided that faucets/taps are flushed after periods of stagnation, avoiding faucet/tap water should not be necessary for individuals with systemic nickel allergy syndrome.
- Consuming bottled water should not be a concern for individuals with systemic nickel allergy syndrome.

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ANNEX I

Nickel amounts of common foods

This Annex should be used in the context of the NiPERA Human Health Fact Sheet 6 *Low Nickel Diet For Nickel-Allergic Individuals Susceptible To Reactions From Oral Nickel Exposure* and is not meant to be a stand-alone document.

The footnotes to the annex table are listed below, and source details are located under References (Section 10) of the fact sheet.

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1. Low = less than 100 µg/kg; Medium = 100–500 µg/kg; High = more than 500 µg/kg. Values are for content per kg of food. Nickel content per serving is shown in columns 3-4.
2. EFSA range values were the P25 LB and P95 UB values from EFSA Annex C (Table C.6). INNIBEL range values were calculated using the minimum and maximum values provided in the INNIBEL report. EFSA and INNIBEL range values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]
3. EFSA mean values were calculated using the average values of the mean LB and the mean UB from the EFSA document, Annex C (Table C.6). Rebelytics mean values were calculated for each food using the mean score provided for each entry and finding the median value (e.g., mean score of 2 = 10-20 µg/serving, median of 15 µg/serving used as mean in table above). INNIBEL mean values were calculated using the mean values cited in the INNIBEL report. EFSA and INNIBEL mean values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]
4. EFSA Panel on Contaminants in the Food Chain (CONTAM), data of 26 European countries (EFSA, Annex C, 2020).[20]
5. INNIBEL Final Scientific Report; data for Belgian foodstuffs (June 2019).[30]
6. Rebelytics values taken from global score sheet by Rebelytics Low-Nickel Global Diet Scoring System (July 2023).[14]

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
BEVERAGE/DRINKS				
Alcoholic spirits (brandy, rum, vodka, whiskey)	Low	0 – 2.2 µg/30 g	0.3 µg/30 g	EFSA[20] European Countries
Beer (Pilsner)	Low	0.5 – 2.7 µg/333 g	1.5 µg/333 g	INNIBEL[30] Belgium
Beer (strong, regular, light)	Low	0 – 23 µg/333 g	4.4 µg/333 g	EFSA[20] European Countries
Chocolate milk	Low	1 – 50 µg/250 g	15 µg/250 g	Rebelytics[14] Global
Coconut water	Low	0 – 170 µg/375 g	25 µg/375 g	Rebelytics[14] Global
Coffee (latte, au lait)	Low	1 – 9.5 µg/250 g	3.6 µg/250 g	EFSA[20] European Countries
Soft drinks (cola, caffeinated, flavored, fruity)	Low	0 – 67.5 µg/375 g	9.4 µg/375 g	EFSA[20] European Countries
Tea (iced with and without lemon)	Low	3.3 – 14.5 µg/250 g	9 µg/250 g	INNIBEL[30] Belgium
Tea (infusion)	Low	9.4 – 77.6 µg/375 g	25.1 µg/375 g	INNIBEL[30] Belgium
Water (bottled)	Low	0 – 1.9 µg/375 g	2.6 µg/375 g	EFSA[20] European Countries
Water (drinking/tap)	Low	0 – 1.9 µg/375 g	0.4 µg/375 g	EFSA[20] European Countries
Wine (all types)	Low	0 – 18.8 µg/188 g	6.4 µg/188 g	EFSA[20] European Countries
Chocolate milkshake	Medium	10 – 310 µg/250 g	45 µg/250 g	Rebelytics[14] Global
Tea (green, domestic protocol)	Medium	28 – 63 µg/250 g	48.5 µg/250 g	INNIBEL[30] Belgium
Liqueur	High	0 – 6.6 µg/30 g	3.3 µg/30 g	EFSA[20] European Countries
CEREALS AND GRAINS				
Breakfast cereals, porridge	Low	0 – 20 µg/140 g	6 µg/140 g	EFSA[20] European Countries
Noodles (rice)	Low	0 – 18 µg/140 g	7.6 µg/140 g	EFSA[20] European Countries
Bagel	Low	1 – 20 µg/85 g	5 µg/85 g	Rebelytics[14] Global
Barley (cooked)	Low	1 – 30 µg/140 g	5 µg/140 g	Rebelytics[14] Global
Bread (white)	Low	1 – 20 µg/75 g	5 µg/75 g	Rebelytics[14] Global
English muffins	Low	–	5 µg/55 g	Rebelytics[14] Global
Noodles (wheat flour with and without eggs)	Low	0 – 20 µg /140 g	5 µg/140 g	EFSA[20] European Countries
Rice (white, cooked)	Low	1 – 60 µg/140 g	5 µg/140 g	Rebelytics[14] Global
Bread (multigrain)	Medium	1 – 110 µg/75 g	15 µg/75 g	Rebelytics[14] Global
Bread (whole wheat)	Medium	1 – 50 µg/75 g	15 µg/75 g	Rebelytics[14] Global
Bread, oat	Medium	1 – 50 µg/75 g	35 µg/75 g	Rebelytics[14] Global
Cereal bars	Medium	6.2 – 14.8 µg/35 g	10 µg/35 g	EFSA[20] European Countries
Crispbread	Medium	1 – 20 µg/30 g	5 µg/30 g	Rebelytics[14] Global
Oat cereal (hot)	Medium	10 – 190 µg/194 g	75 µg/194 g	Rebelytics[14] Global
Pasta (whole wheat, cooked)	Medium	0 – 30 µg/215 g	15 µg/215 g	Rebelytics[14] Global
Quinoa (cooked)	Medium	0-30 µg/140 g	15 µg/140 g	Rebelytics[14] Global
Rice (brown, cooked)	Medium	1 – 30 µg/140 g	15 µg/140 g	Rebelytics[14] Global
Rolls (multigrain)	Medium	1 – 40 µg/55 g	15 µg/55 g	Rebelytics[14] Global
Wheat bran (cold cereal)	Medium	1 – 40 µg/30 g	5 µg/30 g	Rebelytics[14] Global

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Breakfast cereals (not containing nuts, raisins)	High	9.1 – 124 µg/55 g	49.9 µg/55 g	INNIBEL[30] Belgium
Buckwheat cereal (hot)	High	30 – 220 µg/140 g	155 µg/140 g	Rebelytics[14] Global
Cereal flakes	High	15.8 – 149 µg/55 g	60 µg/55 g	EFSA[20] European Countries
Granola/muesli (cold)	High	1 – 130 µg/55 g	55 µg/55 g	Rebelytics[14] Global
Millet cereal (hot)	High	70 – 100 µg/194 g	105 µg/194 g	Rebelytics[14] Global
Muesli	High	20.9 – 99.9 µg/55 g	41.2 µg/55 g	EFSA[20] European Countries
DAIRY PRODUCTS AND SUBSTITUTES				
Butter	Low	0 – 10 µg/10 g	0.8 µg/10 g	EFSA[20] European Countries
Buttermilk	Low	0 – 12.8 µg/250 g	5 µg/250 g	EFSA[20] European Countries
Cheese (plain, processed, Edam, Camembert, Emmental, mozzarella, ricotta, Roquefort)	Low	0 – 5 µg/30 g	1.4 µg/30 g	EFSA[20] European Countries
Cream, sour cream	Low	0 – 1.5 µg/15 g	0.3 µg/15 g	EFSA[20] European Countries
Eggs (fresh and whole chicken eggs)	Low	0.5 – 8.8 µg/100 g	2.5 µg/100 g	EFSA[20] European Countries
Milk (cow's, condensed, goat's)	Low	0 – 20 µg/250 g	4.8 µg/250 g	EFSA[20] European Countries
Milk (dried)	Low	0 – 2.5 µg/25 g	1.3 µg/25 g	EFSA[20] European Countries
Milk (flavored beverages)	Low	0 – 44 µg/250 g	22 µg/250 g	EFSA[20] European Countries
Yogurt (milk, plain), yogurt (sheep milk)	Low	0 – 5 µg/175 g	1.8 µg/175 g	EFSA[20] European Countries
Ice cream (milk-based)	Low	0 – 12.9 µg/129 g	2 µg/129 g	EFSA[20] European Countries
Ice cream (vanilla)	Low	0 – 40 µg/129 g	5 µg/129 g	Rebelytics[14] Global
Yogurt substitute (coconut)	Low	0 – 130 µg/175 g	15 µg/175 g	Rebelytics[14] Global
Cheese (feta)	Medium	2.2 – 11.1 µg/30 g	4.9 µg/30 g	EFSA[20] European Countries
Cheese (gouda)	Medium	0.3 – 7.4 µg/30 g	3.8 µg/30 g	EFSA[20] European Countries
Cheese (processed, sliceable)	Medium	0 – 6.9 µg/30 g	1.3 µg/30 g	EFSA[20] European Countries
Custard	Medium	0 – 81.3 µg/129 g	16.7 µg/129 g	EFSA[20] European Countries
Ice cream (not milk-based)	Medium	14.7 – 30.8 µg/129 g	18.7 µg/129 g	EFSA[20] European Countries
Ice cream desserts (non-dairy)	Medium	10 – 90 µg/129 g	45 µg/129 g	Rebelytics[14] Global
Oat beverage	Medium	10 – 50 µg/250 g	35 µg/250 g	Rebelytics[14] Global
Paneer, khoa, halloumi	Medium	1 – 30 µg/80 g	15 µg/80 g	Rebelytics[14] Global
Soy beverage	Medium	1 – 130 µg/250 g	55 µg/250 g	Rebelytics[14] Global
Tofu	Medium	8.9 – 77.3 µg/85 g	32.6 µg/85 g	EFSA[20] European Countries
Tofu	High	10 – 370 µg/85 g	105 µg/85 g	Rebelytics[14] Global
FATS AND OILS				
Coconut oil	Low	0 – 1 µg/10 g	0.4 µg/10 g	EFSA[20] European Countries
Corn oil	Low	0 – 0.6 µg/10 g	0.3 µg/10 g	EFSA[20] European Countries
Margarine (normal and low fat)	Low	0 – 0.4 µg/10 g	0.1 µg/10 g	EFSA[20] European Countries
Walnut oil	Low	0 – 1.6 µg/10 g	0.4 µg/10 g	EFSA[20] European Countries

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Coconut fat	Medium	2.5 – 5 µg/10 g	2.5 µg/10 g	EFSA[20] European Countries
Pork lard	Medium	–	3.2 µg/10 g	EFSA[20] European Countries
Rapeseed oil	Medium	0 – 10 µg/10 g	1.1 µg/10 g	EFSA[20] European Countries
Sunflower oil	Medium	0.3 – 2 µg/10 g	1.5 µg/10 g	EFSA[20] European Countries
Peanut butter	High	10.4 – 112 µg/15 g	26.6 µg/15 g	EFSA[20] European Countries
Shortening	High	1 – 30 µg/10 g	15 µg/10 g	Rebelytics[14] Global
FISH AND SEAFOOD				
Anchovy (cooked)	Low	0 – 20 µg/100 g	4 µg/100 g	EFSA[20] European Countries
Bass (cooked)	Low	0 – 23 µg/100 g	0.4 µg/100 g	EFSA[20] European Countries
Cod, whiting (cooked)	Low	0 – 9.8 µg/100 g	4.4 µg/100 g	EFSA[20] European Countries
Fish (canned)	Low	0 – 20 µg/55 g	5 µg/55 g	Rebelytics[14] Global
Fish (salted or smoked)	Low	0 – 100 µg/55 g	5 µg/55 g	Rebelytics[14] Global
Herring (cooked)	Low	0 – 10 µg/100 g	3.2 µg/100 g	EFSA[20] European Countries
Lobster	Low	0 – 50 µg/100 g	9 µg/100 g	EFSA[20] European Countries
Mackerel (cooked)	Low	0 – 7.1 µg/100 g	2.5 µg/100 g	EFSA[20] European Countries
Mussels	Low	1.2 – 23 µg/100 g	7 µg/100 g	INNIBEL[30] Belgium
Oysters (cooked)	Low	0 – 24 µg/100 g	8 µg/100 g	EFSA[20] European Countries
Plaice (cooked)	Low	0 – 5 µg/100 g	2.5 µg/100 g	EFSA[20] European Countries
Prawns (cooked)	Low	0 – 50 µg/100 g	5 µg/100 g	EFSA[20] European Countries
Shrimps	Low	–	<4 µg/100 g	INNIBEL[30] Belgium
Swordfish (cooked)	Low	0 – 20 µg/100 g	7.9 µg/100 g	EFSA[20] European Countries
Tuna	Low	0 – 17 µg/100 g	5.6 µg/100 g	EFSA[20] European Countries
Carp	Medium	0 – 33.9 µg/100 g	13.7 µg/100 g	EFSA[20] European Countries
Grey mullet	Medium	3 – 110 µg/100 g	15.8 µg/100 g	EFSA[20] European Countries
Mussels	Medium	9 – 50 µg/100 g	23.7 µg/100 g	EFSA[20] European Countries
Roach	Medium	0 – 56.8 µg/100 g	20.5 µg/100 g	EFSA[20] European Countries
Sole	Medium	14 – 64 µg/100 g	39 µg/100 g	EFSA[20] European Countries
Whelks	Medium	7.6 – 38 µg/100 g	13 µg/100 g	EFSA[20] European Countries
Bivalves (canned)	High	20 – 50 µg/55 g	35 µg/55 g	Rebelytics[14] Global
Clams	High	24 – 155 µg/100 g	66.1 µg/100 g	EFSA[20] European Countries
Cockles	High	110 – 941 µg/100 g	559 µg/100 g	EFSA[20] European Countries
Mussels (cooked)	High	1 – 470 µg/100 g	55 µg/100 g	Rebelytics[14] Global
FRUIT AND BERRIES				
Apples	Low	0 – 35 µg/140 g	4.6 µg/140 g	EFSA[20] European Countries
Bananas	Low	0 – 28 µg/140 g	7.8 µg/140 g	EFSA[20] European Countries
Blueberries	Low	1 – 12 µg/80 g	4.5 µg/80 g	EFSA[20] European Countries
Canned fruit	Low	2.4 – 35 µg/140 g	11 µg/140 g	EFSA[20] European Countries
Cranberries	Low	–	1.7 µg/55 g	EFSA[20] European Countries
Currants (black, red, etc.)	Low	3.4 – 7.8 µg/80 g	4.9 µg/80 g	EFSA[20] European Countries

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Dried dates	Low	0 – 19.2 µg/40 g	3.4 µg/40 g	EFSA[20] European Countries
Figs	Low	–	3.5 µg/140 g	EFSA[20] European Countries
Grapes (table)	Low	0 – 28 µg/140 g	4.6 µg/140 g	EFSA[20] European Countries
Kiwi	Low	0 – 17 µg/140 g	6.1 µg/140 g	EFSA[20] European Countries
Lemon, limes	Low	0 – 3.9 µg/55 g	1.5 µg/55 g	EFSA[20] European Countries
Lingonberries	Low	0 – 19 µg/80 g	7 µg/80 g	EFSA[20] European Countries
Lychee	Low	0 – 8.8 µg/140 g	5.3 µg/140 g	EFSA[20] European Countries
Mandarins	Low	1.7 – 36 µg/140 g	8.5 µg/140 g	EFSA[20] European Countries
Mangos	Low	0 – 34 µg/140 g	6.7 µg/140 g	EFSA[20] European Countries
Melons	Low	1.7 – 11 µg/150 g	6.9 µg/150 g	EFSA[20] European Countries
Oranges	Low	1.7 – 10 µg/140 g	5.6 µg/140 g	EFSA[20] European Countries
Peaches	Low	0 – 34 µg/140 g	11.3 µg/140 g	EFSA[20] European Countries
Plums	Low	1.3 – 18 µg/140 g	6.4 µg/140 g	EFSA[20] European Countries
Strawberries	Low	1.5 – 14 µg/140 g	5.6 µg/140 g	EFSA[20] European Countries
Strawberries	Low	0 – 50 µg/140 g	5 µg/140 g	Rebelytics[14] Global
Watermelon	Low	3.6 – 14 µg/150 g	6.3 µg/150 g	EFSA[20] European Countries
Apricot	Medium	-	25 µg/140 g	Rebelytics[14] Global
Apricots (canned)	Medium	1 – 220 µg/140 g	15 µg/140 g	Rebelytics[14] Global
Avocado	Medium	18 – 96 µg/140 g	44.2 µg/140 g	EFSA[20] European Countries
Blackberries	Medium	2.2 – 35 µg/80 g	11 µg/80 g	EFSA[20] European Countries
Blackberries	Medium	10 – 30 µg/80 g	15 µg/80 g	Rebelytics[14] Global
Dates	Medium	9.5 – 48 µg/140 g	16.8 µg/140 g	EFSA[20] European Countries
Dried apricots (Prunus armeniaca)	Medium	8 – 35.6 µg/40 g	19.7 µg/40 g	EFSA[20] European Countries
Dried prunes (Prunus domestica)	Medium	2.1 – 29 µg/40 g	6 µg/40 g	EFSA[20] European Countries
Dried vine fruits (currants, raisins, sultanas)	Medium	0 – 34 µg/40 g	4.8 µg/40 g	EFSA[20] European Countries
Grapefruit	Medium	2 – 35 µg/140 g	14.1 µg/140 g	EFSA[20] European Countries
Lychee	Medium	1 – 40 µg/140 g	15 µg/140 g	Rebelytics[14] Global
Passionfruit	Medium	–	35 µg/140 g	Rebelytics[14] Global
Pineapple	Medium	0 – 148 µg/140 g	26.5 µg/140 g	EFSA[20] European Countries
Plums	Medium	1 – 80 µg/140 g	25 µg/140 g	Rebelytics[14] Global
Pomegranate	Medium	0 – 16 µg/80 g	8.8 µg/80 g	EFSA[20] European Countries
Raisins	Medium	2.9 – 10 µg/40 g	5 µg/40 g	INNIBEL[30] Belgium
Raspberries	Medium	4.2 – 24 µg/80 g	9.3 µg/80 g	EFSA[20] European Countries
Table olives (Olea europaea)	Medium	0.6 – 3 µg/15 g	1.8 µg/15 g	EFSA[20] European Countries
Cocoa (powder)	High	20 – 90 µg/5 g	55 µg/5 g	Rebelytics[14] Global
Coconut (dried)	High	1 – 50 µg/15 g	25 µg/15 g	Rebelytics[14] Global
Coconut (fresh)	High	30 – 190 µg/140 g	105 µg/140 g	Rebelytics[14] Global
Dried apricots	High	10 – 50 µg/40 g	35 µg/40 g	Rebelytics[14] Global
Dried figs	High	34.4 – 147 µg/40 g	62.6 µg/40 g	INNIBEL[30] Belgium

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Dried figs	High	40 – 60 µg/40 g	45 µg/40 g	Rebelytics[14] Global
Prunes	High	10 – 30 µg/40 g	25 µg/40 g	Rebelytics[14] Global
HERBS AND SPICES AND CONDIMENTS				
Dill (fresh)	Low	0.07 – 0.3 µg/1.5 g	0.13 µg/1.5 g	EFSA[20] European Countries
Gelatine	Low	0 – 1.2 µg/15 g	0.18 µg/15 g	EFSA[20] European Countries
Mayonnaise	Low	0 – 1.1 µg/15 g	0.4 µg/15 g	EFSA[20] European Countries
Salad dressing	Low	1.9 – 3.2 µg/30 g	2.6 µg/30 g	EFSA[20] European Countries
Salsa	Low	3.2 – 9.3 µg/60 g	4.7 µg/60 g	EFSA[20] European Countries
Vinegar (wine)	Low	0 – 0.9 µg/15 g	0.5 µg/15 g	EFSA[20] European Countries
Chives	Medium	0.03 – 0.6 µg/1.5 g	0.15 µg/1.5 g	EFSA[20] European Countries
Chives	Medium	–	0.5 µg/1.5 g	Rebelytics[14] Global
Cinnamon	Medium	0.07 – 0.4 µg/0.5 g	0.17 µg/0.5 g	EFSA[20] European Countries
Dressings	Medium	0 – 220 µg/30 g	5 µg/30 g	Rebelytics[14] Global
Fruit jams	Medium	0 – 20 µg/15 g	5 µg/15 g	Rebelytics[14] Global
Garlic	Medium	0 – 10 µg/4 g	0.5 µg/4 g	Rebelytics[14] Global
Ginger (fresh)	Medium	0.19 – 2.6 µg/1.5 g	0.68 µg/1.5 g	EFSA[20] European Countries
Gravy granules (instant)	Medium	0 – 7.5 µg/15 g	1.5 µg/15 g	EFSA[20] European Countries
Ketchup	Medium	0 – 10 µg/15 g	5 µg/15 g	Rebelytics[14] Global
Mustard (mild)	Medium	0.72 – 1.7 µg/5 g	1.2 µg/5 g	EFSA[20] European Countries
Parsley (fresh)	Medium	0.09 – 1.7 µg/1.5 g	0.6 µg/1.5 g	EFSA[20] European Countries
Rosemary	Medium	0.05 – 1.3 µg/1.5 g	0.3 µg/1.5 g	EFSA[20] European Countries
Salt (common)	Medium	0 – 4 µg/1 g	0.48 µg/1 g	EFSA[20] European Countries
Soy sauce	Medium	0 – 40 µg/15 g	5 µg/15 g	Rebelytics[14] Global
Vinegar (apple)	Medium	0 – 2.7 µg/15 g	1.5 µg/15 g	EFSA[20] European Countries
Basil (fresh)	High	0.14 – 6.4 µg/1.5 g	2 µg/1.5 g	EFSA[20] European Countries
Cardamom	High	–	0.3 µg/0.5 g	EFSA[20] European Countries
Nutmeg	High	0.33 – 041 µg/0.5 g	0.37 µg/0.5 g	EFSA[20] European Countries
Oregano (dry)	High	–	5 µg/0.5 g	Rebelytics[14] Global
Paprika powder	High	0.5 – 2.6 µg/0.5 g	1.2 µg/0.5 g	EFSA[20] European Countries
Pepper (black and white)	High	0.6 – 2.9 µg/0.5 g	1.3 µg/0.5 g	EFSA[20] European Countries
Sage	High	0.08 – 0.9 µg/0.5 g	0.3 µg/0.5 g	EFSA[20] European Countries
Tartar sauce	High	0 – 50 µg/30 g	15 µg/30 g	Rebelytics[14] Global
Thyme	High	0.4 – 1.6 µg/0.5 g	0.8 µg/0.5 g	EFSA[20] European Countries
Turmeric	High	0.3 – 0.45 µg/0.5 g	0.37 µg/0.5 g	EFSA[20] European Countries
JUICES				
Apple juice	Low	0 – 25 µg/250 g	5.8 µg/250 g	EFSA[20] European Countries
Apple juice (canned or bottled)	Low	0 – 40 µg/250 g	5 µg/250 g	Rebelytics[14] Global
Blackcurrant juice	Low	8 – 37.5 µg/250 g	17.8 µg/250 g	EFSA[20] European Countries
Carrot juice	Low	9 – 21.8 µg/250 g	13.5 µg/250 g	EFSA[20] European Countries
Citrus juice	Low	0 – 10 µg/250 g	5 µg/250 g	Rebelytics[14] Global

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Cranberry juice	Low	0 – 5 µg/250 g	1.6 µg/250 g	EFSA[20] European Countries
Elderberry juice	Low	12.5 – 17.8 µg/250 g	14.3 µg/250 g	EFSA[20] European Countries
Grape juice	Low	0 – 20 µg/250 g	5 µg/250 g	Rebelytics[14] Global
Grape juice	Low	0 – 25 µg/250 g	8.3 µg/250 g	EFSA[20] European Countries
Grapefruit juice	Low	0 – 12.5 µg/250 g	6.3 µg/250 g	EFSA[20] European Countries
Lemonade	Low	0 – 10 µg/250 g	15 µg/250 g	Rebelytics[14] Global
Mango juice	Low	0 - 10 µg/250 g	5 µg/250 g	Rebelytics[14] Global
Peach juice	Low	–	5 µg/250 g	Rebelytics[14] Global
Pear juice	Low	1 – 30 µg/250 g	15 µg/250 g	Rebelytics[14] Global
Pineapple juice	Low	1 – 20 µg/250 g	15 µg/250 g	Rebelytics[14] Global
Tomato juice	Low	10 – 25.3 µg/250 g	15.3 µg/250 g	EFSA[20] European Countries
Tomato juice	Low	–	15 µg/250 g	Rebelytics[14] Global
Vegetable juice	Low	1 – 30 µg/250 g	15 µg/250 g	Rebelytics[14] Global
Blackberry juice	Medium	0 – 50 µg/250 g	25 µg/250 g	EFSA[20] European Countries
Prune juice	Medium	20 – 80 µg/250 g	35 µg/250 g	Rebelytics[14] Global
MEAT AND POULTRY				
Bacon (cooked)	Low	0 – 7.5 µg/15 g	0.6 µg/15 g	EFSA[20] European Countries
Chicken	Low	0 – 12 µg/100 g	8.1 µg/100 g	EFSA[20] European Countries
Duck	Low	0 – 15 µg/100 g	3.6 µg/100 g	EFSA[20] European Countries
Goose	Low	0 – 5 µg/100 g	1.8 µg/100 g	EFSA[20] European Countries
Ham	Low	0.9 – 3.5 µg/55 g	1.7 µg/55 g	EFSA[20] European Countries
Kidney (beef)	Low	0 – 9.5 µg/100 g	3.1 µg/100 g	EFSA[20] European Countries
Lamb (mutton)	Low	0 – 36.6 µg/100 g	6.6 µg/100 g	EFSA[20] European Countries
Pheasant	Low	0 – 5 µg/100 g	2.2 µg/100 g	EFSA[20] European Countries
Pork	Low	0 – 12.7 µg/100 g	8.9 µg/100 g	EFSA[20] European Countries
Poultry	Low	5.1 – 11 µg/100 g	8.1 µg/100 g	EFSA[20] European Countries
Quail	Low	0 – 1.5 µg/100 g	0.8 µg/100 g	EFSA[20] European Countries
Sausage (cooked)	Low	0 – 10.6 µg/55 g	4.2 µg/55 g	EFSA[20] European Countries
Turkey	Low	0 – 6 µg/100 g	2.4 µg/100 g	EFSA[20] European Countries
Veal	Low	0 – 5 µg/100 g	2 µg/100 g	EFSA[20] European Countries
Beef	Medium	0 – 30.3 µg/100 g	10.4 µg/100 g	EFSA[20] European Countries
Beef or pork (ground, cooked)	Medium	0 – 310 µg/100 g	15 µg/100 g	Rebelytics[14] Global
Mutton (cooked)	Medium	1 – 60 µg/100 g	15 µg/100 g	Rebelytics[14] Global
Pork (cured, cooked)	Medium	0 – 390 µg/55 g	15 µg/55 g	Rebelytics[14] Global
Venison	Medium	0 – 123 µg/100 g	31.3 µg/100 g	EFSA[20] European Countries
NUTS AND SEEDS				
Almonds	High	21.3 – 59.4 µg/30 g	30.9 µg/30 g	EFSA[20] European Countries
Brazil nuts	High	107 – 183 µg/30 g	124 µg/30 g	EFSA[20] European Countries
Cashew nuts	High	152 – 202 µg/30 g	168 µg/30 g	EFSA[20] European Countries

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Chestnuts	High	3 – 2250 µg/30 g	171 µg/30 g	EFSA[20] European Countries
Flax seeds	High	30 – 70 µg/30 g	55 µg/30 g	Rebelytics[14] Global
Hazelnuts	High	35.9 – 115 µg/30 g	71.5 µg/30 g	INNIBEL[30] Belgium
Peanuts	High	17.8 – 341 µg/30 g	96.5 µg/30 g	EFSA[20] European Countries
Pistachios	High	12.2 – 52.2 µg/30 g	28.5 µg/30 g	INNIBEL[30] Belgium
Poppy seeds	High	0 – 42 µg/30 g	23.4 µg/30 g	EFSA[20] European Countries
Pumpkin seeds	High	32.7 – 77.4 µg/30 g	47.4 µg/30 g	EFSA[20] European Countries
Sesame seeds	High	21.5 – 49.50 µg/30 g	28 µg/30 g	EFSA[20] European Countries
Sunflower seeds	High	42.6 – 193 µg/30 g	84.5 µg/30 g	EFSA[20] European Countries
Walnuts	High	21.6 – 138.7 µg/30 g	72.3 µg/30 g	INNIBEL[30] Belgium
SUGAR AND CONFECTIONARY				
Fudge	Low	0 – 4 µg/40 g	2 µg/40 g	EFSA[20] European Countries
Sugar (brown)	Low	–	0.5 µg/4 g	Rebelytics[14] Global
Sugar (cane)	Low	0 – 0.5 µg/4 g	0.14 µg/4 g	EFSA[20] European Countries
Sugar (white)	Low	0 – 0. 6 µg/4 g	0.25 µg/4 g	EFSA[20] European Countries
Candy	Medium	0 – 30 µg/40 g	5 µg/40 g	Rebelytics[14] Global
Chocolate (white)	Medium	0 – 20 µg/15 g	5 µg/15 g	Rebelytics[14] Global
Chocolate pudding	Medium	10 – 40 µg/130 g	25 µg/130 g	Rebelytics[14] Global
Honey	Medium	0 – 10 µg/20 g	5.2 µg/20 g	EFSA[20] European Countries
Marzipan	Medium	–	5 µg/30 g	Rebelytics[14] Global
Molasses	Medium	9.5 – 15.8 µg/20 g	9.9 µg/20 g	EFSA[20] European Countries
Toffee	Medium	10.2 – 22 µg/40 g	14.3 µg/40 g	EFSA[20] European Countries
Treacle	Medium	0 – 20 µg/20 g	2.7 µg/20 g	EFSA[20] European Countries
White chocolate	Medium	0 – 12.4 µg/15 g	1.5 µg/15 g	EFSA[20] European Countries
Bitter chocolate	High	97 – 240 µg/40 g	131 µg/40 g	EFSA[20] European Countries
Chocolate confections	High	1 – 130 µg/40 g	35 µg/40 g	Rebelytics[14] Global
Chocolate confections (with nuts)	High	0 – 120 µg/40 g	25 µg/40 g	Rebelytics[14] Global
Cooking chocolate	High	76 – 180 µg/40 g	101 µg/40 g	EFSA[20] European Countries
Maple syrup	High	0 – 60 µg/60 g	30 µg/60 g	EFSA[20] European Countries
Milk chocolate	High	22 – 36.4 µg/40 g	25.4 µg/40 g	EFSA[20] European Countries
Nougat	High	–	27.7 µg/40 g	EFSA[20] European Countries
VEGETABLES AND LEGUMES				
Aubergines (eggplant)	Low	0 – 5.2 µg/85 g	1.5 µg/85 g	EFSA[20] European Countries
Beetroot	Low	0 – 23.8 µg/85 g	8.4 µg/85 g	EFSA[20] European Countries
Brussel sprouts	Low	2 – 4.3 µg/85 g	3.1 µg/85 g	EFSA[20] European Countries
Cabbage	Low	0 – 14.5 µg/85 g	4.8 µg/85 g	EFSA[20] European Countries
Carrots	Low	0 – 8.2 µg/85 g	2.7 µg/85 g	INNIBEL[30] Belgium
Cauliflower	Low	0.77 – 6.8 µg/85 g	2.7 µg/85 g	EFSA[20] European Countries
Cucumber	Low	0 – 6 µg/85 g	1.8 µg/85 g	EFSA[20] European Countries

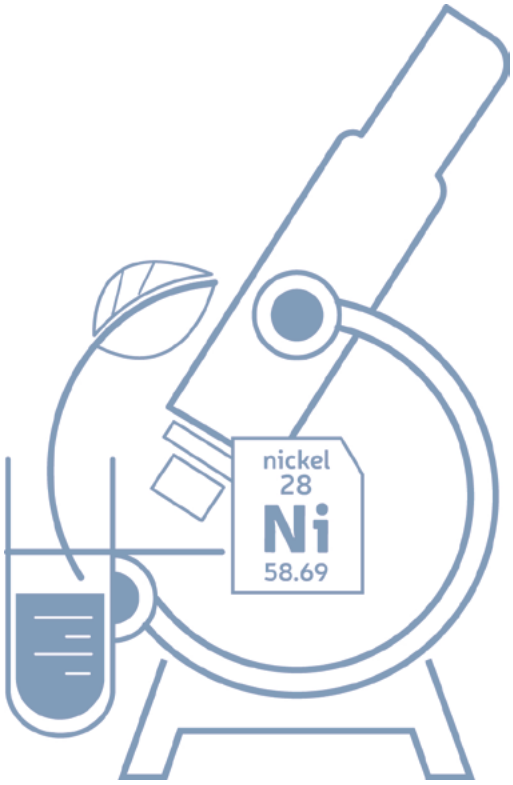
Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5,6]
Fennel	Low	3.2 – 6.5 µg/85 g	4.5 µg/85 g	EFSA[20] European Countries
Leek	Low	0 – 8.5 µg/85 g	3.3 µg/85 g	EFSA[20] European Countries
Lettuce	Low	0 – 12.8 µg/85 g	4.3 µg/85 g	EFSA[20] European Countries
Mushrooms (cultivated)	Low	0 – 6.7 µg/85 g	2.5 µg/85 g	EFSA[20] European Countries
Onions (spring)	Low	0.4 – 5.2 µg/40 g	1.7 µg/40 g	EFSA[20] European Countries
Peppers (paprika)	Low	0.3 – 15.3 µg/85 g	6.2 µg/85 g	EFSA[20] European Countries
Potatoes (boiled)	Low	3 – 6.8 µg/167 g	5.4 µg/167 g	EFSA[20] European Countries
Potatoes (fried)	Low	0 – 4.2 µg/70 g	2.8 µg/70 g	EFSA[20] European Countries
Potatoes (new)	Low	2 – 19.8 µg/110 g	5.9 µg/110 g	EFSA[20] European Countries
Radishes	Low	0 – 17 µg/85 g	2.9 µg/85 g	EFSA[20] European Countries
Rhubarb	Low	6.6 – 20.3 µg/140 g	9.7 µg/140 g	EFSA[20] European Countries
Rocket (rucola)	Low	1.1 – 17 µg/85 g	5.6 µg/85 g	EFSA[20] European Countries
Sauerkraut	Low	5.2 – 9.9 µg/85 g	5.8 µg/85 g	EFSA[20] European Countries
Shallots	Low	1.3 – 7.7 µg/85 g	3.6 µg/85 g	EFSA[20] European Countries
Swedes	Low	3.1 – 17.3 µg/85 g	7.7 µg/85 g	EFSA[20] European Countries
Sweet corn	Low	1.4 – 35 µg/85 g	8 µg/85 g	EFSA[20] European Countries
Sweet potato (cooked)	Low	0 – 60 µg/167 g	15 µg/167 g	Rebelytics[14] Global
Turnips	Low	0 – 36.6 µg/85 g	4.1 µg/85 g	EFSA[20] European Countries
Yams (cooked)	Low	–	15 µg/167 g	Rebelytics[14] Global
Artichokes	Medium	7.9 – 111 µg/85 g	30.9 µg/85 g	EFSA[20] European Countries
Asparagus	Medium	3.5 – 34 µg/85 g	11.6 µg/85 g	EFSA[20] European Countries
Broccoli	Medium	2.9 – 37.4 µg/85 g	14.7 µg/85 g	EFSA[20] European Countries
Celery	Medium	3.8 – 26.4 µg/85 g	8.5 µg/85 g	EFSA[20] European Countries
Kale	Medium	1.7 – 425 µg/85 g	28.1 µg/85 g	EFSA[20] European Countries
Mushrooms (canned)	Medium	1 – 30 µg/130 g	15 µg/130 g	Rebelytics[14] Global
Okra	Medium	-	20.1 µg/85 g	EFSA[20] European Countries
Onions	Medium	0.77 – 57.8 µg/85 g	15.9 µg/85 g	EFSA[20] European Countries
Parsnips	Medium	5.7 – 19.3 µg/85 g	9.7µg/85 g	EFSA[20] European Countries
Parsnips	Medium	1 – 40 µg/85 g	15µg/85 g	Rebelytics[14] Global
Pumpkin (cooked)	Medium	1 – 20 µg/130 g	15 µg/130 g	Rebelytics[14] Global
Snow peas	Medium	–	15 µg/85 g	Rebelytics[14] Global
Spinach	Medium	0 – 38.3 µg/85 g	11.1 µg/85 g	EFSA[20] European Countries
Sweet potato	Medium	1.4 – 28.6 µg/110 g	12.7 µg/110 g	EFSA[20] European Countries
Tomatoes	Medium	0 – 26.6 µg/85 g	8.8 µg/85 g	EFSA[20] European Countries
Yams	Medium	10 – 30 µg/110 g	15 µg/110 g	Rebelytics[14] Global
Beans	High	69.4 – 804 µg/80 g	231 µg/80 g	INNIBEL[30] Belgium
Leguminous vegetables	High	55.6 – 374 µg/80 g	174 µg/80 g	INNIBEL[30] Belgium
Lentils	High	58.7 – 296 µg/80 g	151 µg/80 g	INNIBEL[30] Belgium
Lentils (cooked)	High	50 – 80 µg/80 g	65 µg/80 g	Rebelytics[14] Global

Food	Level of Nickel[1]	Nickel Content Range (µg/serving)[2]	Mean Nickel Content (µg/serving)[3]	Data Source (Reference and Region Included) [4, 5, 6]
Peas	High	46.9 – 354 µg/85 g	120 µg/85 g	INNIBEL[30] Belgium
Sea weeds	High	4 – 93.7 µg/15 g	30.7 µg/15 g	EFSA[20] European Countries
MISCELLANEOUS				
Pretzels	Low	0 – 8.5 µg/50 g	3.6 µg/50 g	EFSA[20] European Countries
Potato crisps/potato chips	Medium	5.2 – 60 µg/50 g	15.6 µg/50 g	EFSA[20] European Countries
Pretzels	Medium	0 – 10 µg/50 g	5 µg/50 g	Rebelytics[14] Global
Yeast	Medium	0.09 – 0.16 µg/0.6 g	0.12 µg/0.6 g	EFSA[20] European Countries
Baking powder	High	0 – 1.35 µg/0.6 g	0.68 µg/0.6 g	EFSA[20] European Countries
Baking powder	High	0 – 1 µg/0.6 g	0.5 µg/0.6 g	Rebelytics[14] Global
Yeast	High	–	0.5 µg/0.6 g	Rebelytics[14] Global

This Annex should be used in the context of the NiPERA Human Health Fact Sheet 6 *Low Nickel Diet For Nickel-Allergic Individuals Susceptible To Reactions From Oral Nickel Exposure* and is not meant to be a stand-alone document.

The footnotes to the annex table are listed below, and source details are located under References (Section 10) of the fact sheet.

1. Low = less than 100 µg/kg; Medium = 100–500 µg/kg; High = more than 500 µg/kg. Values are for content per kg of food. Nickel content per serving is shown in columns 3-4.
2. EFSA range values were the P25 LB and P95 UB values from EFSA Annex C (Table C.6). INNIBEL range values were calculated using the minimum and maximum values provided in the INNIBEL report. EFSA and INNIBEL range values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]
3. EFSA mean values were calculated using the average values of the mean LB and the mean UB from the EFSA document, Annex C (Table C.6). Rebelytics mean values were calculated for each food using the mean score provided for each entry and finding the median value (e.g., mean score of 2 = 10-20 µg/serving, median of 15 µg/serving used as mean in table above). INNIBEL mean values were calculated using the mean values cited in the INNIBEL report. EFSA and INNIBEL mean values were adjusted from µg/kg food to µg/g serving size using the Rebelytics serving sizes for each food,[14] derived from the Health Canada "Table of Reference Amounts for Food" as the basis for serving sizes.[31]
4. EFSA Panel on Contaminants in the Food Chain (CONTAM), data of 26 European countries (EFSA, Annex C, 2020).[20]
5. INNIBEL Final Scientific Report; data for Belgian foodstuffs (June 2019).[30]
6. Rebelytics values taken from global score sheet by Rebelytics Low-Nickel Global Diet Scoring System (July 2023).[14]



Fact Sheet on Nickel and Human Health

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This is the sixth in a series of fact sheets addressing issues specific to the evaluation of risks to humans associated with nickel-containing substances and materials. The fact sheets are intended to assist the reader in understanding the complex issues and concepts associated with assessment of human health hazards, dose-response relationships, and exposure by summarizing key technical information and providing guidance for implementation.

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