The Director General

Maisons-Alfort, 3 February 2025

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

on the establishment of dietary guidelines for people following a diet that excludes some or all foods of animal origin

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It also contributes to the protection of the health and welfare of animals, the protection of plant health, the evaluation of the nutritional characteristics of food and the protection of the environment by assessing the impact of regulated products.
It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).
Its opinions are published on its website. This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 3 February 2025 shall prevail.

On 28 June 2019, ANSES issued an internal request to conduct the following expert appraisal: "establishment of dietary guidelines for people following a diet that excludes some or all foods of animal origin".

1. BACKGROUND AND PURPOSE OF THE REQUEST

The National Nutrition and Health Programme (PNNS) guidelines for the general adult population were updated by ANSES in 2016 on the basis of dietary reference values and consumption data for the general population, as well as data on the composition and contamination of foods consumed by this population. To carry out this update, ANSES used a "constrained linear optimisation method" for establishing specific guidelines that incorporated food composition and consumption data and satisfied a set of nutritional, epidemiological and toxicological constraints and objectives (ANSES 2016a).

By its nature, this general population study did not cover certain specific populations with particular physiological characteristics or atypical dietary practices. This was particularly the case for people following a diet excluding some or all foods of animal origin. For these "vegetarian" populations, the guidelines established for the general population need to be adapted, on the basis of dietary reference values and different consumption patterns specific to these populations.

The general objective here was therefore to establish consumption guidelines that can meet the nutritional needs of these populations, while considering the association of certain food groups with the risk of chronic non-communicable diseases (cardioneurovascular diseases, type 2 diabetes, obesity, certain types of cancer and diseases linked to bone health were selected) and exposure to contaminants. To achieve this objective, the methodological approach to diet optimisation developed for the general adult population was adapted to the characteristics of vegetarian populations.

2. ORGANISATION OF THE EXPERT APPRAISAL

The expert appraisal was carried out in accordance with French standard NF X 50-110 "Quality in Expert Appraisals – General Requirements of Competence for Expert Appraisals (January 2024)".

This expert appraisal falls within the scope of the Expert Committee (CES) on Human Nutrition. ANSES entrusted the expert appraisal to the Working Group (WG) on Vegetarians. The methodological and scientific aspects of the work were presented to the CES regularly between January 2018 and October 2024. It was adopted by the CES on Human Nutrition at its meeting of 10 October 2024. The WG's task was divided into two parts: firstly, a systematic review of the literature on the links between vegetarian diets and health (expert appraisal report) and secondly, modelling of dietary intakes and optimisation of diets under a set of nutritional and epidemiological constraints (documented in the expert appraisal report) and toxicological constraints (the subject of this opinion).

ANSES analyses interests declared by experts before they are appointed and throughout their work, in order to prevent risks of conflicts of interest in relation to the points addressed in expert appraisals.

The experts' declarations of interests are made public via the website: https://dpi.sante.gouv.fr/.

3. ANALYSIS AND CONCLUSIONS OF THE CES ON HUMAN NUTRITION AND THE WG ON VEGETARIANS

3.1. Optimisation method

Optimisation is a branch of mathematics that involves modelling, analysing and solving a problem by identifying the best solution based on predefined criteria. These criteria are translated into a mathematical function known as the "objective" function.

The optimal solution, obtained using the simplex algorithm (an algorithm for solving linear optimisation problems), corresponds to an extreme value of this "objective" function. Adaptations of this algorithm have been developed to address nonlinear problems.

This approach calls on a specific vocabulary presented below.

Constraint: a constraint is a condition that must be satisfied by the solution to the optimisation problem. The set of solutions satisfying all the constraints is called the set of possibilities. In the method used by ANSES, the constraints corresponded to meeting dietary reference values, not exceeding upper intake levels for nutrients and maximum exposure values for contaminants, as well as complying with lower and upper consumption bounds.

"Objective" function: the "objective" function is the variable (incorporating the criteria) to be minimised. In the method used by ANSES, this was an equally weighted sum of terms corresponding to the following criteria: minimisation of deviations from average consumption, variables of deviation from the constraint made flexible (see definition of flexibility below), minimisation of exposure to certain contaminants, and minimisation or maximisation of dietary intakes to be limited or promoted.

Criteria: criteria are the terms that define the "objective" function, and therefore translate the objectives whose achievement must be optimised. While the constraints enable a set of solutions to be defined, the criteria make it possible to identify a single optimal solution in terms of these criteria, which are combined in the "objective" function. In the approach used by ANSES, the criteria reflected the minimisation of deviations from current consumption, the minimisation (or maximisation) of consumption of certain food groups in order to prevent chronic non-communicable diseases, the minimisation of exposure to certain contaminants, and the minimisation of deviations from the constraints made flexible.

Flexibility: flexibility allows an unsatisfied constraint to be "relaxed". For example, relaxing a nutritional constraint that cannot be fully satisfied helps to get as close to it as possible. The introduction of flexibility corresponds to the addition of an optimisation criterion in the form of a term in the "objective" function, known as the "goal variable" or variable of deviation from the constraint.

Solution: the solution corresponds to the vector $\{x_1, x_2...x_n\}$ that satisfies all the constraints and for which the value of the "objective" function is minimal. In the method used by ANSES, the x_i (or state variables) corresponded to the optimal amounts of each food group.

3.2. Dietary optimisation method used by ANSES

The method used by ANSES sought to identify combinations of food groups (state variables) enabling the set objectives to be met, i.e. to reduce nutritional and toxicological risks, while deviating as little as possible from current consumption habits. All the nutritional and toxicological constraints and the criteria (minimisations or maximisations) made it possible to take account of the risks associated with nutrient intakes or exposure to contaminants, as well as the expected nutritional benefits.

3.2.1. Constraints applied to the optimisation method

3.2.1.1. Ensure adequate nutrient intake

The general term "dietary reference values" encompasses a set of dietary nutrient intake values used to reduce the risk of inadequate or excessive intake of vitamins, minerals and macronutrients by a healthy person. These values vary according to age and gender, and also according to physical activity levels, physiological status (e.g. pregnancy) and dietary habits. The dietary reference values for vitamins and minerals were updated by ANSES in 2021 (ANSES 2021).

These values constitute a set of input data considered as "nutritional constraints" that have to be satisfied in order to establish an optimised diet solution. In other words, the addition of these constraints ensures that the diets identified by the optimisation method provide amounts of nutrients in line with the dietary reference values.

3.2.1.2. Prevent the risk of chronic non-communicable diseases

The consumption of certain food groups is associated with a reduction or, on the contrary, an increase in the risk of developing different chronic non-communicable diseases. Numerous publications – in particular those of the Dietary Guidelines Advisory Committee (DGAC) – have characterised, from an epidemiological point of view, the relationships between certain food groups and the risk of developing these diseases, including cardioneurovascular diseases, type 2 diabetes, obesity, certain types of cancer and diseases associated with bone health (DGAC 2020; ANSES 2016a).

Since the prevention of these diseases is one of the challenges of food consumption guidelines, the parameters of the optimisation method can be set to maximise or minimise the food groups for which epidemiological links with a reduction or increase in the risk of these diseases have been observed.

3.2.1.3. Limit exposure to contaminants

Since exposure to chemical contaminants found in food can have an impact on health, it is also necessary to take this into account when drawing up food consumption guidelines. The substances to be considered (see Annex 3) were selected in line with the previous work on updating the PNNS guidelines for the general adult population, based on the available concentration data and health-based guidance values (HBGVs), and on the list of chemical hazards selected for ANSES's ongoing expert appraisal in response to Request No. 2016-SA-0153 on the ranking of food-related biological and chemical risks (PrioR).

Assessment of health risks incurred by the population is based on the comparison of dietary exposure estimates with reference values, established for each compound: acceptable daily intake (ADI) or tolerable daily intake (TDI), provisional tolerable weekly intake (PTWI) or benchmark dose lower bound (BMDL), etc. The list of reference values was updated with the support of ANSES's Food Risk Assessment Unit (UERALIM) and Methodology and Studies Unit (UME), considering the values validated by the Data-Tox WG[1] (whose work is in progress, in support of ANSES's third Total Diet Study (TDS3)) as of 13 December 2023. For substances without a value validated by the Data-Tox WG, the most recent reference value was considered or, failing that, the value used in the latest available assessment (ANSES 2016a, 2016b).

Food additives and pesticide residues (excluding those identified as persistent organic pollutants at the time of data collection), are subject to European authorisation, they were not included in the optimisation parameters, as was the case for the general population. Indeed, the EU process to assess and authorise additives and pesticides, as well as the establishment

[1] In order to select health-based guidance values (HBGVs, or other guideline values) for the chemicals not subject to an authorisation for use analysed in the TDS3, ANSES issued an internal request (Request No. 2021-AUTO-0154) and mandated the Data-Tox Working Group, reporting to the CES on Assessment of Physical-Chemical Risks in Food (CES ERCA), to carry out this work. The Data-Tox WG was set up in June 2022.

of maximum residue limits for pesticides and authorised uses, take dietary habits into account, as well as agricultural practices for pesticides.

3.2.1.4. Take dietary habits into account

To facilitate acceptance and implementation of the food consumption guidelines, it is important to take the dietary habits of the population into account and try to deviate from them as little as possible. Consumption habits were therefore taken into account at two levels of the optimisation parameters, to ensure that the amounts of food groups proposed were: 1) between the upper and lower consumption bounds observed in the population, and 2) as close as possible to the average daily consumption levels observed.

The latter parameter was not applied to food groups whose consumption is associated with an increase or decrease in the risk of chronic non-communicable diseases, and should therefore be minimised or maximised.

3.2.2. Setting the method parameters

3.2.2.1. Input data

Initially, it was necessary to adapt the optimisation method to the consumption characteristics of vegetarian populations. For the remainder of this analysis, the WG adopted the following definitions:

- lacto-ovo-vegetarian (LOVG) diet: diet excluding animal products with the exception of eggs and egg products, milk and dairy products and honey;
- vegan diet: diet excluding all foods of animal origin.

■ Consumption data

The consumption data used came from the NutriNet-Santé study, a prospective French cohort launched online in May 2009 (Hercberg *et al.* 2010). The study was carried out by Inserm's Nutritional Epidemiology Research Team (EREN).

Participants in the NutriNet-Santé study were classified into subgroups according to the type of vegetarian diet they followed, using the diets they reported and food consumption data (zero intake of meat and fish for LOVGs and zero intake of meat, fish, eggs, milk and dairy products for vegans). This "hybrid" identification method (reported diets and consumption data) was adapted to the optimisation work carried out by the WG.

Indeed, in line with the inclusion criteria used for its systematic review (ANSES 2024), a tolerance threshold for meat or fish consumption of once a month or 10 g per week was adopted by the WG. This threshold, which is widely used in the literature, is due to the meat consumption artefacts that can be observed in the consumption data collected, because vegetarian equivalents of standard meat-based recipes (lasagne, cottage pie, etc.) are not always available.

This classification yielded the following participant numbers for the optimisation work:

– lacto-ovo-vegetarian men: n = 78
– lacto-ovo-vegetarian women n = 347
– vegan men: n = 47
– vegan women: n = 103

- **Nutritional composition data**
- *Classification of foods*

In 2016, when updating the PNNS guidelines for the general adult population, ANSES carried out a categorisation of foods based on considerations of use and nutritional composition (ANSES 2016a). The WG drew on this classification and adapted it to the dietary intakes of LOVGs and vegans by:

- eliminating the food groups excluded from these diets;
- adapting the scope of certain groups by eliminating the foods excluded from these diets (Table 1a). For example, for LOVG diets, the "meat, fish, eggs" group became the "eggs" group;
- adapting recipes for certain products containing ingredients of animal origin. For example, for vegan diets, recipes for food products containing milk or butter were adapted with ingredients of plant origin;
- adding groups that reflected the consumption habits observed in these diets, and concerning foods consumed more rarely by populations following diets containing animal flesh. This was particularly true of animal product alternatives, such as meat alternatives (Table 1b).

Following this categorisation, 40 food groups and subgroups were considered for the LOVG population, and 33 groups and subgroups for the vegan population (Table 1).

Table 1: food groups and subgroups used in the optimisation method

Table 1a: groups and subgroups already present in the modelling for the general population and reused for vegetarian populations

Groups	Subgroups	Examples
Vegetables		Fresh and processed vegetables (lettuce, cucumber, carrots, corn, peas) Uncooked mixed vegetables (*jardinière*, *macédoine*)
Pulses		Pulses (dried beans, lentils)
Fruit	Fresh fruit	Fresh fruit (apples, bananas, watermelon)
	Processed fruit	Fruit compotes and fruits in syrup
	Dried fruit	Dried fruit (prunes, dates, sultanas, goji berries)
Starchy foods and cereals[1]	Starchy foods and cereals that are a source of fibre (fibre ≥ 3 g/100 g or "wholegrain")	Wheat berries, buckwheat, quinoa, wholegrain semolina, oat flakes, brown rice
	Other starchy foods and cereals[1]	Wheat, pasta, white rice
Bread and bakery products[1]	Bread and bakery products that are a source of fibre (fibre ≥ 3 g/100 g or "wholegrain")	Wholegrain bread, multigrain bread, wholegrain rusks, country-style bread
	Other bread and bakery products	Baguette, white sandwich bread
Eggs[2]		Eggs used as ingredients and eggs eaten "as is" (hard-boiled eggs, poached eggs, soft-boiled eggs, fried eggs)
Butter and other animal fats[2]		Butter (unsalted, salted, etc.), duck fat
Vegetable oils	Vegetable oils rich in ALA	Rapeseed oil, walnut oil, soybean oil, linseed oil
	Other vegetable oils and margarines	Olive oil, sunflower oil, groundnut oil, etc., and all margarines and vegetable fats
Oilseeds		Pistachios, almonds, hazelnuts, etc. salted or unsalted, olives, almond butter, peanut butter
Milk[2]		Plain skimmed or whole milk
Dairy products[2]	Sweetened fresh dairy products and sweetened milk beverages	Flavoured milks, sweetened yoghurts and sweetened fromage blanc, flavoured petit-suisse or those containing fruit
	Plain fresh dairy products	Plain yoghurts, plain fromage blanc, plain petit-suisse
	Sweetened dairy desserts	Chocolate mousse, dessert creams, caramel flan, tiramisu
	Cheeses	Cheeses, cheese spreads, processed cheeses
Sweet or sweet and fatty products[1]		Pana cotta, crème brûlée, sugar and sweeteners, chocolate or sweet confectionery, squashes and cordials, cakes
Starch-based savoury products[1]		Cooked or processed potatoes, snack biscuits, pastry dough
Starch-based sweet products[1]	Non-fortified starch-based sweet products	Breakfast cereals, dry biscuits
	Fortified starch-based sweet products[3]	Fortified breakfast cereals, fortified dry biscuits
Drinking water		Still water, spring water, tap water, sparkling water

Groups	Subgroups	Examples
Beverages with added sugar		Still fruit-based beverages, soft drinks, lemonades
Fruit juices, smoothies and nectars[1]		Fruit juices (100% and from concentrate), vegetable juices, smoothies, fruit nectars, coconut water, fruit juice- and milk-based beverages
Salts		Sea salt, iodised salt, flavoured salts, gomasio
Sauces and condiments[1]		Fresh creams, hot and cold sauces, spreads (aubergine caviar, hummus, etc.)

[1] The foods in this group vary according to the diet (presence or absence of foods containing eggs or dairy products)

[2] Group excluded from modelling of the vegan diet [3] Subgroup created for modelling vegetarian diets

Table 1b: Groups and subgroups created for modelling for vegetarian populations

Groups	Subgroups	Examples
Plant-based meat alternatives[1]	Plant-based meat alternatives containing protein (≥ 14 g/100 g)	Gluten, textured soy protein, tofu, soy-based "steak" or "sausage"
	Plant-based meat alternatives not containing protein (< 14 g/100 g)	Cereal cakes, "mince" made from soy
Plant-based beverages	Unsweetened non-calcium-fortified plant-based beverages	Non-fortified almond beverages, non-fortified soy beverages
	Unsweetened calcium-fortified plant-based beverages	Calcium-fortified almond beverages, calcium-fortified soy beverages
	Sweetened non-calcium-fortified plant-based beverages	Non-fortified rice beverages, non-fortified oat beverages, non-fortified chestnut beverages
	Sweetened calcium-fortified plant-based beverages	Calcium-fortified rice beverages
Plant-based alternatives of fresh dairy products (FDPs)	Unsweetened non-calcium-fortified FDP alternatives	Plain soy yoghurts, plant-based dessert creams, flavoured soy dessert creams, fruit soy yoghurts, plant-based milk yoghurts, plant-based dessert creams (without soy)
	Unsweetened calcium-fortified FDP alternatives	
	Sweetened non-calcium-fortified FDP alternatives	
	Sweetened calcium-fortified FDP alternatives	
Plant-based "cheese" alternatives		Vegetarian cheese spreads
Nutritional yeast and others		Wheat germ, nutritional yeast flakes, yeast extract spread (such as Marmite®)

[1] The foods in this group vary according to the diet (presence or absence of foods containing eggs or dairy products)

- *Average nutritional compositions of food groups*

Optimisation was carried out on the basis of the food groups and subgroups thus defined, whose average compositions were calculated taking into account consumption habits. For each of the four populations studied – lacto-ovo-vegetarian men, lacto-ovo-vegetarian women, vegan men and vegan women – the nutritional composition of each food making up the group was therefore weighted by the proportion represented by its consumption as observed in the NutriNet-Santé study. This method ensured that the foods in each group were more representative, thereby optimising the applicability of the public health messages.

Certain compound foods were not included in the groups listed above because they were broken down into ingredients, which were then assigned to the associated food groups. Therefore, all egg-based dishes (omelette, soufflé, flan, etc.), cooked vegetable dishes (slow-cooked leeks, creamed spinach, ratatouille, vegetable sauté, etc.), soups and broths, vegetable-, starch-, potato- and cereal-based dishes (rice, pasta, wheat, etc.), sandwiches, pizzas and other savoury pastries were broken down into simple ingredients. Separate recipes were sometimes chosen for the same food, depending on whether it was eaten by vegetarians or vegans, to ensure that the recipe considered for vegans contained plant-based alternatives rather than ingredients of animal origin.

For each ingredient in the foods to be broken down and for each food that was not broken down, its nutritional composition was assigned using the CALNUT 2020 table[2] produced by Ciqual, a table with no missing values made available by ANSES for calculating nutrient intakes. Middle bound (MB) values were used in this table. An assumption was therefore made that led to data below the limit of detection (LOD) being replaced with the ½ LOD value. In addition, to avoid incorrectly overestimating the levels of certain nutrients known to be absent from given food groups, zeros were assigned for EPA, DHA, vitamin B12 and vitamin D in the following groups: vegetables (except mushrooms for vitamin D), pulses, fresh fruit, processed fruit, dried fruit, starchy foods and cereals that are a source of fibre, other starchy foods and cereals (except gnocchi and egg pasta), oilseeds, other vegetable oils and margarines (except margarines, which are formulated foods that can therefore be fortified) and beverages with added sugar.

- **Contaminant concentration data**

For the majority of foods, data from ANSES's second Total Diet Study (TDS2) were used. In the course of this study, 1319 samples representing 212 different types of food covering around 90% of the French diet were collected between 2007 and 2009. Each sample was made up of 15 subsamples representative of consumption in France for the food in question (concerning the mode of consumption, culinary preparation, brands purchased where applicable, place of purchase, etc.). The samples were taken in different regions of France (8 inter-regions), most of them during two different seasons (spring-summer and autumn-winter), to take account of any geographical or seasonal disparities.

For nine foods more specific to lacto-ovo-vegetarian and vegan diets, data from German monitoring plans were used. Some concentrations were supplemented with data from the German total diet study (MEAL study) available in open data format (Fechner *et al.* 2022;

[2] ANSES. 2020. Ciqual's CALNUT nutritional composition table for calculating nutritional intakes

Hackethal *et al.* 2021). Lastly, data on isoflavones, generated under a research and development agreement conducted by ANSES in 2019-2020, were used for two foods.

In the same way as with the updating of the PNNS guidelines for the general population, and as with the nutritional composition data, the MB assumption was considered for processing censored data[3]: concentrations below the LOD were replaced by a concentration of ½ LOD, and concentrations below the limit of quantification (LOQ) but above the LOD were replaced by a concentration equivalent to ½ (LOD+LOQ).

Where the new HBGVs concerned a sum of several substances, the concentration data were recalculated accordingly.

In addition, for inorganic arsenic and chromium, the speciation assumptions (proportions of the different chemical forms of the compound in foods) validated when updating the PNNS guidelines for the general population were applied (ANSES 2016a).

A correspondence table was first drawn up between the foods consumed by lacto-ovo-vegetarians and vegans in the NutriNet-Santé cohort and the nomenclature of the data mentioned above. This table took into account the same breakdown of foods into ingredients as that used to determine the nutritional composition. Then, for each previously defined population, the concentration of each substance was calculated for each food group, by weighting the average concentration of each food in the group by the proportion it represented in consumption of that group within the population in question.

3.2.2.2. Choice of optimisation parameters

In order to be consistent with the approach followed for the general adult population, the WG decided, as far as possible, to keep the same parameter choices as when the PNNS dietary guidelines for the general population were updated. These choices and the necessary adaptations for vegetarians are presented below.

- **Parameters related to dietary intakes**
  - *Upper and lower bounds*

In the work carried out in 2016 for adults in the general population, the food group consumption bounds were the 5th and 95th percentiles (p5 and p95). Because the NutriNet-Santé sample of vegetarian consumers stratified by gender and diet (lacto-ovo-vegetarian or vegan) was not large enough to provide a reliable estimate of the p95, the p90 was used as the upper bound (Kroes *et al.* 2002). For reasons of consistency, therefore, the lower bound chosen was p10.

For vegan men, the sample size was too small to take the p90 into account. The WG therefore decided to use the p90 from lacto-ovo-vegetarian men for vegan men, considering that these two populations most likely had similar consumption habits regarding the food groups consumed by both populations.

  - *Coupling bounds*

"Coupling" bounds involved combining subgroups characterised by similar food practices (consumption occasions and food preparations) that could therefore be considered as substitutable. A common consumption bound was therefore defined for the sum of dietary intakes of these subgroups. As a result, these subgroups no longer had their own consumption bounds.

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[3] The censoring rate is the proportion of unquantified data (below the analytical limit).

These bounds were set up to help meet requirements for fibre and alpha-linolenic acid. This enabled refined starchy foods or bread to be replaced by wholegrain starchy foods or bread or those that are a source of fibre, and vegetable oils low in alpha-linolenic acid (e.g. sunflower oil) to be substituted by oils rich in this fatty acid (e.g. rapeseed or walnut oil). These substitutions could therefore lead to consumption levels for these subgroups that were only actually observed for the sum of the subgroups.

"Coupling" bounds were also used to optimise the lacto-ovo-vegetarian diet between plant-based beverages and milk, between cheese alternatives and cheese, and between fresh dairy product alternatives and fresh dairy products.

Furthermore, to ensure that consumption of sweetened beverages[4] remained below one glass a day (see next paragraph), a "coupling" bound combined the "Fruit juices, smoothies and nectars" and "Beverages with added sugar" groups.

- *Epidemiological criteria*

To set consumption objectives based on epidemiological knowledge, the WG decided to apply the same criteria as those used when modelling for the general population (ANSES 2016a), for food groups compatible with vegetarian diets. For sweetened beverages[3], the maximum limit of one glass a day defined on the basis of epidemiological studies replaced the p90 consumption bound. Moreover, for this group, the objective was not to minimise deviations from observed consumption, but to minimise consumption.

The WG decided to update these criteria on the basis of the Dietary Guidelines Advisory Committee's scientific report (DGAC 2020) (see Annex 5).

The food groups compatible with vegetarian diets for which the DGAC report established a favourable link with health in the general population, with a high weight of evidence, were fruits, vegetables, legumes (pulses), wholegrain cereals, low-fat dairy products, nuts and unsaturated vegetable oils.

The WG therefore decided to maximise consumption of the following groups and subgroups: fresh fruit, processed fruit, dried fruit, vegetables, pulses, starchy foods that are a source of fibre, cereals that are a source of fibre, bread that is a source of fibre, milk, plain fresh dairy products, oilseeds and vegetable oils rich in alpha-linolenic acid.

- **Parameters related to nutrient and energy intakes**
  - *Constraints associated with nutrient intakes*

The dietary reference values (DRVs) for the French population were updated in 2021 (ANSES 2021). Among these, the values taken into account for the optimisation were the population reference intakes (PRIs), the acceptable intakes (AIs) when they were not based on average intakes in the French population, and the tolerable upper intake levels (ULs), including those recently reviewed by EFSA (for iron, manganese, folic acid, vitamin D, selenium). For AIs based on average intakes (mean of the observed intakes, excluding food supplements, in the INCA 3 study), the WG decided to use the 5p intakes in the general population from INCA 3 as the lower bound, as it considered that 95% of the population had adequate intakes and

[4] These sweetened beverages include soft drinks, nectars, fruit juices made from concentrate, fresh fruit juices, smoothies, etc.

arbitrarily placed the risk of inadequate intake at p5. This concerned magnesium, copper and vitamins B5, E and K1 (Table 2: list of constraints relating to energy and nutrient intakes).

For iron, an absorption rate adapted to the dietary intake of vegetarians was taken into account. According to the data observed in the INCA 3 study, the absorption rate was estimated to be 13% in the diets observed in the general population and 9% based on models including high consumption of plant-based foods (Fouillet *et al.* 2023). The WG therefore believed that the dietary reference value for vegetarians (men and women) considered in this work should be raised to 16 mg/d[5]. For zinc, the WG used the PRI established for high phytate consumption (i.e. 900 mg/d).

For protein, the WG used as the dietary reference value the PRI of 0.83 g/kg/d, as well as the upper bound of 20% of TEI. The WG decided not to use the reference intake ranges for fats and carbohydrates, because for fats, these percentages were set to ensure that requirements are met for essential fatty acids, which are already subject to constraints. For carbohydrates, the percentages were derived from the references established for the other two macronutrients and are therefore not justified on their own.

For nutrients with a UL, this value was used as the maximum intake constraint.

For energy, the WG used the same references as for the updating of the guidelines for the general adult population with a low to moderate level of physical activity (ANSES 2016a), which were themselves based on the values established by EFSA (EFSA 2013).

- *Criteria associated with nutrient intakes*

Given the large number of nutritional constraints to be taken into account, it was possible that no single solution would meet them all. In this case, the method used by ANSES introduced flexibility for certain selected constraints. The constraint was thus removed, but the deviation from this target value was minimised thanks to a criterion incorporated into the "objective" function.

[5] PRI of 11 mg x (13/9) = 16 mg/d

Table 2: list of constraints relating to energy and nutrient intakes

	Men		Women	
Nutrient (unit)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Total energy intake (TEI) (kcal/d)	2470	2730	1995	2205
Sodium (mg/d)		2300		2300
Calcium (mg/d)	1000	2500	1000	2500
Iron (mg/d)	16		16	
Iodine (µg/d)	150	600	150	600
Magnesium (mg/d)[2]	225.25		156.10	
Sodium/potassium ratio	1.69		1.69	
Zinc (mg/d)	14	25	11	25
Selenium (µg/d)	70	255	70	255
Phosphorus (mg/d)	550		550	
Manganese (mg/d)		8		8
Copper (mg/d)[2]	0.88	5	0.67	5
Water (g/d)	2500		2000	
Vitamin A (µg/d)	750	3000	650	3000
Vitamin B1 (mg/kcal/d)	0.000418		0.000418	
Vitamin B2 (mg/d)	1.6		1.6	
Vitamin B3 (mg/kcal/d)	0.0067		0.0067	
Vitamin B5 (mg/d)[2]	3.27		2.62	
Vitamin B6 (mg/d)	1.7	25	1.6	25
Vitamin B9 (µg/d)	330		330	
Vitamin B12 (µg/d)	4		4	
Vitamin C (mg/d)	110		110	
Vitamin D (µg/d)	15	100	15	100
Vitamin E (mg/d)[2]	4.25		3.73	
Vitamin K1 (µg/d)[2]	19.70		16.36	
α-linolenic acid (% TEI)	1		1	
Linoleic acid (% TEI)	4		4	
EPA+DHA (mg/d)	500		500	
SFAs C12+C14+C16 (% TEI)		8		8
SFAs (% TEI)		12		12
Total sugars excluding lactose (g/d)		100		100
Fibre (g/d)	30		30	
Protein (% TEI)		20		20
Protein (g/d)[1]	58		46.5	

[1] Values based on a median weight of 70 kg for men and 56 kg for women (NutriNet-Santé individuals included in this optimisation work)

[2] Lower limit based on the p5 of the intake distribution in the INCA 3 population

- **Parameters related to contaminant exposure**
  - *Maximum exposure constraints*

For substances for which a threshold HBGV (such as the acceptable daily intake) was selected, this reference value was used as the maximum constraint in the optimisation method. The exposure from optimised diets can be compared directly with the reference value.

For substances for which a BMDL was selected, the median exposure of the general population estimated from TDS2 data was used by default as the maximum value not to be exceeded. Since no threshold can be set for these substances, the decision was taken to ensure that exposure from the optimised diets remained below the median exposure of the general population.

Lastly, for a few contaminants, no maximum value was chosen as a constraint for the optimisation method: this concerned contaminants for which no organisation has proposed a reference value, or for which the available reference value(s) were not deemed sufficiently robust. This is particularly true of certain polycyclic aromatic hydrocarbons (PAHs).

The constraints associated with contaminant exposure are presented in Annex 3.

  - *Criteria associated with exposure*

A first optimisation criterion was minimisation of total exposure to the contaminants in question, induced by optimised dietary intakes.

Furthermore, given the large number of maximum exposure constraints to be taken into account, it was possible that no single solution would meet them all. In this case, the method used by ANSES introduced flexibility for the selected constraints. The constraint was thus removed, but the deviation from this target value was minimised thanks to a second criterion in the "objective" function.

- **Summary of the optimisation parameters**

With these parameters, the method could therefore be used to identify optimised diets described by the foods consumed (state variables) by vegetarians and divided into 40 groups for lacto-ovo-vegetarians and 33 groups for vegans, while satisfying the defined constraints and optimally meeting the criteria summarised in the table below.

Table 3: summarised optimisation parameters

Parameters	Constraints	Criteria
Nutrient intakes	Minimum intake (27 constraints) Maximum intake (15 constraints)	Minimise deviation from the nutritional constraints made flexible
Dietary intakes	Lower bounds (26 constraints for LOVGs, 23 for vegans) Upper bounds (26 constraints for LOVGs, 23 for vegans)	Minimise deviation from the observed consumption: 28 (for LOVGs) or 21 (for vegans) groups and subgroups Maximise consumption (11 groups and subgroups) Minimise consumption (1 group)
Exposure to contaminants	Maximum exposure (56 constraints)	Minimise exceeding the maximum exposure to contaminants for which the constraint was made flexible Minimise total exposure to contaminants

3.3. Results of the optimisation

3.3.1. Lacto-ovo-vegetarian diets

As with the study for the general population, the WG tested two scenarios, one taking account of dietary habits, constraints and criteria associated with nutrients and epidemiological criteria ("nut" scenario), and the other additionally incorporating constraints and criteria associated with contaminants ("conta-nut" scenario).

3.3.1.1. Parameters for the "nut" scenario

It was not possible to find any solution that did not involve relaxing a constraint. The WG therefore looked for nutrients for which the constraint required flexibility in order to obtain a solution. As a reminder, in the general population, no solution had been found without removing the nutritional constraint on vitamin D. In addition, vegetarian diets exclude fish, the main contributor to intakes of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The WG therefore first added flexibility to the constraints associated with the lower intake limits for EPA+DHA and vitamin D. No solution was obtained by relaxing only one or other of the constraints for these nutrients, so a solution was found by adding flexibility to both parameters simultaneously. This was selected as the basis for continuing, i.e. with the other scenarios and other populations.

3.3.1.2. Parameters for the "conta-nut" scenario

With the same parameters as for the "nut" scenario (flexibility for the constraints associated with EPA+DHA and vitamin D intakes), no solution was obtained for the "conta-nut" scenario. The WG therefore looked for contaminants for which the constraint needed to be relaxed. The WG carried out a test adding flexibility to all the toxicological constraints. This test identified the contaminants exceeding the constraints by the highest percentages. The WG then added flexibility to these contaminants, one by one in descending order of percentage of maximum values exceeded.

The first solution was obtained, for both men and women, by relaxing the constraints on the following contaminants: dieldrin, heptachlor, lindane, chromium VI, the sum of four polycyclic aromatic hydrocarbons (PAH4), isoflavones, ochratoxin A, polybrominated compounds (nine constraints), perfluorodecanoic acid, lead, aflatoxins, the mycotoxins T2, HT2 and diacetoxyscirpenol, and zearalenone and its metabolites.

Table 4 shows the results obtained for these two scenarios, "nut" and "conta-nut", for lacto-ovo-vegetarian men and women. Table 5 shows the nutrient intake levels made flexible in each of the scenarios. Annex 4 shows the variations in exposure to contaminants for which the constraint was made flexible between the "nut" and "conta-nut" scenarios.

Table 4: amounts of foods as consumed (g/d) in optimised lacto-ovo-vegetarian diets

	Men		Women	
Food groups and subgroups	**nut scenario**	**conta-nut scenario**	**nut scenario**	**conta-nut scenario**
Vegetables	1017	403	867	257
Pulses	288	120	133	68
Fresh fruit	146	228	60	60
Processed fruit	79	0	0	0
Dried fruit	16	0	31	0
Starchy foods and cereals that are a source of fibre	42	171	0	55
Other starchy foods and cereals	202	70	36	36
Bread that is a source of fibre	21	21	21	21
Other bread	0	0	0	0
Eggs	12	32	12	36
Butter	6	0	0	0
Vegetable oils rich in ALA	13	20	16	17
Other vegetable oils and margarines	11	11	8	8
Oilseeds	0	0	0	0
Milk	623	384	628	511
Sweetened FDPs and sweetened milk beverages	24	0	10	0
Plain FDPs	256	0	232	0
Sweetened dairy desserts	12	0	13	2
Cheeses	32	64	0	25
Sweet or sweet and fatty products	33	33	29	29
Starch-based savoury products	0	0	0	0
Water	1367	2182	1357	2098
Beverages with added sugar	0	0	0	0
Fruit juices, smoothies and nectars	0	14	56	157
Salts	0.9	0.3	1.2	0.8
Sauces and condiments	13	13	12	12
Meat alternatives containing protein	42	110	127	93

	Men		Women	
Food groups and subgroups	**nut scenario**	**conta-nut scenario**	**nut scenario**	**conta-nut scenario**
Meat alternatives not containing protein	14	0	18	0
Unsweetened non-Ca-fortified plant-based beverages	0	0	8	0
Unsweetened Ca-fortified plant-based beverages	0	0	82	0
Sweetened non-Ca-fortified plant-based beverages	0	0	0	0
Sweetened Ca-fortified plant-based beverages	0	0	0	0
Unsweetened non-Ca-fortified FDP alternatives	25	25	28	0
Unsweetened Ca-fortified FDP alternatives	58	350	52	327
Sweetened non-Ca-fortified FDP alternatives	6	0	4.9	0
Sweetened Ca-fortified FDP alternatives	6	0	5	5
Cheese alternatives	6	0	4	0
Brewer's yeast and others	2.5	7.2	2.7	9
Starch-based sweet products (non-fortified)	35	26	31	83
Starch-based sweet products (fortified)	32	138	52	90

In yellow: decreases >10% between the "nut" scenario and the "conta-nut" scenario

In blue: increases >10% between the "nut" scenario and the "conta-nut" scenario

Table 5: intakes of vitamin D and EPA+DHA in optimised LOVG diets

	Men		Women	
	"Nut" scenario	**"Conta-nut" scenario**	**"Nut" scenario**	**"Conta-nut" scenario**
Vitamin D, µg (% PRI[1])	3.7 (25%)	2.8 (18%)	2.9 (26%)	2.7 (18%)
EPA+DHA, mg (% PRI[1])	108 (22%)	124 (25%)	118 (24%)	129 (26%)

[1] Population reference intakes

When the contaminants were taken into account, the amounts of food proposed varied, some increasing (particularly starchy foods and cereals that are a source of fibre, unsweetened calcium-fortified fresh dairy product alternatives, eggs and cheese, as well as for men, meat alternatives containing protein), and others decreasing (particularly vegetables, pulses, plain fresh dairy products).

When the constraints and criteria associated with contaminants were taken into account, in the "conta-nut" scenario, as expected, exposure decreased. Compared with the "nut" scenario, the "conta-nut" scenario satisfied five additional exposure constraints for men, and seven for women (Annex 4).

For the 21 substances for which the constraint was made flexible, exposure was reduced overall compared with the "nut" scenario, with the exception of isoflavones for men. The increase in exposure to isoflavones for men can be explained by the increase in the amount of meat alternatives containing protein.

It should be noted that regardless of the scenario, the optimal amounts of milk were fairly high (384 g/d for men, 511 g/d for women), due to the fact that the upper bound for milk was coupled with that for all plant-based beverages. Since these amounts were far removed from the consumption levels observed in the NutriNet-Santé study (on average), the WG also wished to consider a vegetarian profile limiting consumption of milk and dairy products, without however equating it to an ovo-vegetarian diet.

3.3.2. Lacto-ovo-vegetarian diets limiting the consumption of milk and dairy products

To model the dietary intakes of this consumer profile, the WG modified the parameters in such a way that the consumption of milk and dairy products was limited to p90 of the dietary intakes observed for each of these groups, while maintaining the "coupling" bounds for the other groups in the "coupling" bound.

As before, the WG also tested two scenarios, one taking account of dietary habits and constraints and criteria associated with nutrients ("nut" scenario), and the other additionally incorporating constraints and criteria associated with contaminants ("conta-nut" scenario).

3.3.2.1. Parameters for the "nut" scenario

Adding flexibility to the constraints associated with the lower bounds for EPA+DHA and vitamin D did not lead to a solution. The WG therefore searched for the "blocking" nutrients by relaxing the constraints on all the nutrients and identifying nutrients whose intakes were furthest from the dietary reference values. By adding flexibility to the vitamin B12 constraint, a solution was found.

3.3.2.2. Parameters for the "conta-nut" scenario

With the parameters for the "nut" scenario (flexibility for the constraints associated with the lower bounds for EPA+DHA and vitamins D and B12), no solution was obtained for the "conta-nut" scenario. The same approach as for the lacto-ovo-vegetarian diet was used to identify the contaminants that needed to be relaxed in order to find a solution. The first solution was obtained, for both men and women, by relaxing the same contaminant constraints as for LOVG men and women: dieldrin, heptachlor, lindane, chromium VI, the sum of four polycyclic aromatic hydrocarbons (PAH4), isoflavones, ochratoxin A, polybrominated compounds, perfluorodecanoic acid, lead, aflatoxins, the mycotoxins T2, HT2 and diacetoxyscirpenol, and zearalenone and its metabolites.

Table 6 shows the results obtained for these two scenarios, for lacto-ovo-vegetarian men and women wishing to limit their consumption of milk and dairy products. Table 7 shows the nutrient intake levels for which the lower constraint was made flexible in each of the scenarios. Annex 4 shows the variations in exposure to contaminants for which the constraint was made flexible between the "nut" and "conta-nut" scenarios.

Table 6: amounts of foods as consumed (g/d) on diets optimised for LOVGs limiting their consumption of milk and dairy products

Food groups and subgroups	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Vegetables	1181	855	867	807
Pulses	288	82	133	36
Fresh fruit	146	146	60	60
Processed fruit	0	0	0	0
Dried fruit	0	0	31	0
Starchy foods and cereals that are a source of fibre	89	103	188	92
Other starchy foods and cereals	123	50	36	36
Bread that is a source of fibre	21	21	21	21
Other bread	0	0	0	0
Eggs	12	32	12	36
Butter	6	0	6	0
ALA vegetable oils	27	39	13	26
Other vegetable oils and margarines	11	11	8	8
Oilseeds	55	77	0	57
Milk	21	0	26	0
Sweetened FDPs and sweetened milk beverages	24	0	10	0
Plain FDPs	32	0	91	0
Sweetened dairy desserts	12	0	13	0
Cheeses	55	73	31	51
Sweet or sweet and fatty products	33	33	29	29
Starch-based savoury products	0	0	0	0
Water	1367	2422	1357	2299
Beverages with added sugar	0	0	0	0
Fruit juices, smoothies and nectars	0	0	132	29
Salts	1.3	1.1	1.2	1.1
Sauces and condiments	13	13	34	12
Meat alternatives containing protein	42	110	43	0
Meat alternatives not containing protein	14	0	18	0
Unsweetened non-Ca-fortified plant-based beverages	49	0	61	0
Unsweetened Ca-fortified plant-based beverages	84	0	82	0
Sweetened non-Ca-fortified plant-based beverages	36	0	0	0
Sweetened Ca-fortified plant-based beverages	36	0	0	0
Unsweetened non-Ca-fortified FDP alternatives	25	25	28	0
Unsweetened Ca-fortified FDP alternatives	58	350	52	332
Sweetened non-Ca-fortified FDP alternatives	6	0	5	0

Food groups and subgroups	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Sweetened Ca-fortified FDP alternatives	6	0	5	0
Cheese alternatives	6	0	4	0
Brewer's yeast and others	7.2	7.2	9	9
Starch-based sweet products (non-fortified)	30	0	31	16
Starch-based sweet products (fortified)	0	66	37	90

In yellow: decreases >10% between the "nut" scenario and the "conta-nut" scenario

In blue: increases >10% between the "nut" scenario and the "conta-nut" scenario

Table 7: intakes of vitamin D, vitamin B12 and EPA+DHA in diets optimised for LOVGs limiting their consumption of milk and dairy products

	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Vitamin D, µg (% PRI)	1.8 (12%)	1.76 (12%)	2.12 (14%)	1.67 (11%)
Vitamin B12, µg (% PRI)	1.5 (38%)	2 (50%)	1.6 (40%)	1.9 (47%)
EPA+DHA, mg (% PRI)	57 (11%)	84 (17%)	19 (12%)	71.8 (14%)

When the contaminants were taken into account, the amounts of foods proposed varied, some increasing (particularly unsweetened calcium-fortified fresh dairy product alternatives, cheese, eggs and water), and others decreasing (particularly milk, plain fresh dairy products and pulses).

When the constraints and criteria associated with contaminants were taken into account, in the "conta-nut" scenario, as expected, exposure decreased. Compared with the "nut" scenario, the "conta-nut" scenario satisfied three additional exposure constraints for both men and women (Annex 4).

For the 21 substances for which the constraint was removed, exposure was reduced overall, with the exception of isoflavones for men. The increase in exposure to isoflavones for men can be explained by the increase in the amount of meat alternatives containing protein.

3.3.3. Vegan diet

The WG also tested two scenarios, one taking account of dietary habits and nutrient constraints ("nut" scenario), and the other additionally incorporating constraints and criteria associated with contaminants ("conta-nut" scenario).

3.3.3.1. Parameters for the "nut" scenario

Adding flexibility to the constraints associated with the lower bounds for EPA+DHA and vitamins D and B12 led to a solution for women, but not for men. The WG therefore searched for the "blocking" nutrients by relaxing the lower constraints on all the nutrients and identifying nutrients whose intakes were furthest from the dietary reference values. By adding flexibility to the lower bound of zinc, a solution was found for men.

3.3.3.2. Parameters for the "conta-nut" scenario

No solution was found for the "conta-nut" scenario using the "nut" scenario settings. The same approach as above was used to identify the contaminants whose constraints needed to be relaxed in order to find a solution. The first solution was obtained, for both men and women, by relaxing the same contaminant constraints as for LOVGs: dieldrin heptachlor, lindane, chromium VI, the sum of four polycyclic aromatic hydrocarbons (PAH4), isoflavones, ochratoxin A, polybrominated compounds (nine constraints), perfluorodecanoic acid, lead, aflatoxins, the mycotoxins T2, HT2 and diacetoxyscirpenol, and zearalenone and its metabolites.

Table 8 shows the results obtained for these two scenarios, for vegan men and women. Table 9 shows the nutrient intake levels made flexible in each of the scenarios. Annex 4 shows the variations in exposure to contaminants for which the constraint was made flexible between the "nut" and "conta-nut" scenarios.

Table 8: amounts of foods (g/d) in optimised vegan diets

Food groups and subgroups	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Vegetables	547	547	1192	483
Pulses	210	43	197	197
Fresh fruit	263	263	90	90
Processed fruit	0	0	76	0
Dried fruit	0	0	0	0
Starchy foods and cereals that are a source of fibre	71	71	0	117
Other starchy foods and cereals	98	98	51	154
Breads that are a source of fibre	43	43	0	0
Other bread	0	0	0	0
ALA vegetable oils	43	16	27	10
Other vegetable oils and margarines	15	15	15	15
Oilseeds	21	62	13	46
Sweet or sweet and fatty products	55	55	14	14
Starch-based savoury products	0	0	0	0
Water	1363	1283	1407	886
Beverages with added sugar	0	0	0	0
Fruit juices, smoothies and nectars	0.7	0.7	156	53
Salts	0.9	1.4	1.4	2.5
Sauces and condiments	51	51	46	22
Meat alternatives containing protein	19	19	68	0
Meat alternatives not containing protein	22	0	18	0

Food groups and subgroups	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Unsweetened non-Ca-fortified plant-based beverages	121	0	53	0
Unsweetened Ca-fortified plant-based beverages	55	0	105	0
Sweetened non-Ca-fortified plant-based beverages	0	0	55	0
Sweetened Ca-fortified plant-based beverages	0	0	55	0
Unsweetened non-Ca-fortified FDP alternatives	31	106	45	0
Unsweetened Ca-fortified FDP alternatives	82	170	71	0
Sweetened non-Ca-fortified FDP alternatives	3.8	11	5.2	5.2
Sweetened Ca-fortified FDP alternatives	3.8	3.8	5.2	248
Cheese alternatives	17	0	11	0
Brewer's yeast and others	7.2	7.2	26	26
Starch-based sweet products (non-fortified)	34	21	25	76
Starch-based sweet products (fortified)	120	138	46	47

In yellow: decreases >10% between the "nut" scenario and the "conta-nut" scenario

In blue: increases >10% between the "nut" scenario and the "conta-nut" scenario

Table 9: intakes of vitamin D, vitamin B12, zinc and EPA+DHA in diets optimised for vegans

	Men		Women	
	"Nut" scenario	"Conta-nut" scenario	"Nut" scenario	"Conta-nut" scenario
Vitamin D, µg (% AI)	1.5 (10%)	1.2 (9%)	1.5 (10%)	0.74 (5%)
Vitamin B12, µg (% AI)	1.3 (33%)	1.32 (33%)	0.9 (22%)	1.3 (32%)
EPA+DHA, mg (% AI)	46 (9%)	50 (10%)	53 (11%)	38.6 (8%)
Zinc, mg (% PRI)	10.5 (75%)	10.2 (73%)	11 (100%)	11 (100%)

When the contaminants were taken into account, the amounts of foods proposed varied differently for men and women, and more so for women. For men, the amounts of fresh dairy product alternatives and oilseeds increased, while the amounts of pulses and plant-based beverages decreased. For women, the amounts of starchy foods, oilseeds and sweetened calcium-fortified fresh dairy product alternatives increased, while the amounts of fruit and vegetables, plant-based beverages and meat alternatives decreased. It should be noted that the contamination levels of sweetened calcium-fortified fresh dairy product alternatives were not taken into account due to a lack of data.

When the constraints and criteria associated with contaminants were taken into account, in the "conta-nut" scenario, as expected, exposure decreased. Compared with the "nut" scenario, the "conta-nut" scenario satisfied seven additional exposure constraints for women, but none for men (Annex 4).

For the 21 substances for which the constraint was removed, exposure was reduced overall.

3.4. Summary of results

The WG decided to base the dietary guidelines for vegetarians on the results of the "conta-nut" scenario, as this scenario reduced exposure to contaminants. The WG summarised the results for men and women for each of the lacto-ovo-vegetarian (by averaging the optimal amounts obtained and indicating the specific features due to reduced consumption of milk and fresh dairy products) and vegan diets.

3.4.1. Lacto-ovo-vegetarian diets

The optimal amounts of vegetables and fruits are around 700 g/d on average. Vegetables provide fibre, vitamins A, C, K1 and B9, and potassium. Lacto-ovo-vegetarians who limit their consumption of milk and fresh dairy products have lower vitamin B2 intakes, so vegetables are all the more important as they are major contributors to vitamin B2 intakes (20%).

The optimal amounts of pulses are around 75 g/d on average. Pulses are major contributors to fibre, protein and vitamin B9 intakes.

The optimal amounts of starchy foods and bread are around 170 g/d on average, including at least 120 g that are wholegrain or "a source of fibre". They contribute to intakes of magnesium, manganese, zinc and vitamin B1.

The group of oilseeds is important for lacto-ovo-vegetarians who limit their consumption of milk and fresh dairy products, as they contribute to intakes of vitamin B2 and calcium, with an optimal amount of 65 g/d.

The optimal amounts of oils are 35 g/d, with an average of at least 25 g/d of oils rich in alpha-linolenic acid (rapeseed, walnut, soy, linseed). As well as providing alpha-linolenic acid, these oils make a major contribution to vitamin E intakes.

The optimal amount of milk is 450 ml/d on average. Milk contributes to intakes of calcium and phosphorus, EPA+DHA, iodine, vitamins B12, B2 and D, and zinc.

In addition to meeting the dietary reference values, these amounts of fruit, vegetables, pulses, fresh dairy products, wholegrain cereal products, oils rich in alpha-linolenic acid and oilseeds help meet the objectives of reducing the risk of chronic non-communicable diseases.

The optimal amount of eggs is 30 g/d on average. These foods provide EPA+DHA and vitamin D for all lacto-ovo-vegetarians, even if the dietary reference values are not met.

The amount of cheese in the optimised diets is 50 g/d on average. The cheese group is a major contributor to calcium, iodine, vitamin B12, B2 and zinc intakes. However, it is also a major contributor to intakes of saturated fatty acids and salt.

The optimal amounts of fresh dairy product alternatives are 350 g/d on average, giving preference to unsweetened and calcium-fortified versions. They contribute to calcium, iodine and selenium intakes.

The optimal amount of meat alternatives containing protein is 100 g/d on average. This group contributes to protein, iron and zinc intakes.

The optimal amount for the group containing wheat germ, nutritional yeast flakes and yeast extract spreads such as Marmite® is around 10 g/d. This nutritionally dense group is a major contributor to intakes of vitamins B1, B3 and B9, and zinc.

It should be noted that in the group of starch-based sweet products, fortified products are major contributors to intakes of iron and vitamins B1, B2, B3, B5, B6, B9, B12, D and E. However, this group is also a high contributor to sodium and total sugar intakes.

3.4.2. Vegan diet

The optimal amounts of vegetables and fruits are around 700 g/d on average. This food group contributes to intakes of fibre, calcium, magnesium, potassium and beta-carotene, and vitamins B2, B5, B6, B9, C and K1.

The optimal amounts of pulses are around 120 g/d on average. Pulses are major contributors to intakes of fibre, protein, phosphorus, iron, zinc and vitamin B9.

The optimal amounts of starchy foods and bread are around 250 g/d on average, including at least 120 g that are wholegrain or "a source of fibre". They contribute to magnesium and zinc intakes.

The optimum amounts of oilseeds are around 50 g/d on average. They contribute to intakes of magnesium, protein, vitamins B1 and E, and zinc.

The optimal amounts of oils are 30 g/d, at least half of which should be oils rich in alpha-linolenic acid (rapeseed, walnut, soy, linseed). As well as providing alpha-linolenic acid, these oils make a major contribution to vitamin E intakes.

The optimal amounts of fresh dairy product alternatives are 270 g/d on average, giving preference to calcium-fortified versions. They are major contributors to calcium, iodine and selenium intakes.

The optimal amount for the "yeast and others" group is around 15 g/d on average. This group is a major contributor to intakes of vitamins B1, B2, B12, B3 and B9, and zinc.

It should be noted that in the group of starch-based sweet products, fortified products contribute to intakes of calcium, iron, vitamins B1, B2, B3, B5, B6, B9, B12, D and E, and zinc. However, this group is also a major contributor to sodium and total sugar intakes.

Table 10: summary of dietary guidelines for lacto-ovo-vegetarian and vegan diets

Food groups	**Lacto-ovo-vegetarians**	**Vegans**
Vegetables and fruit	700 g/d	700 g/d
Pulses	75 g/d	120 g/d
Starchy foods and bread	170 g/d of which at least 120 g/d is wholegrain and a source of fibre	250 g/d of which at least 120 g/d is wholegrain or a source of fibre
Oilseeds	65 g/d	50 g/d
Oils	35 g/d, including at least 25 g/d of oils rich in alpha-linolenic acid	30 g/d, at least half of which should be oils rich in alpha-linolenic acid
Milk	450 ml/d (or 0 ml/d for those wishing to limit this consumption)	
Eggs	30 g/d	
Cheese	50 g/d	
Fresh dairy product alternatives	350 g/d	270 g/d
Meat alternatives containing protein	100 g/d	0 g/d
Brewer's yeast and others	10 g/d	15 g/d

3.5. Analyses of uncertainty

Table 11: analysis of identified uncertainties

Sources of uncertainty					
Part of the expert appraisal	**Origin (level 1)**	**Origin (level 2)**	**Description**	**How it was taken into account**	**Consequences on the expert appraisal results**
Planning	Background (questions asked)	Revision of the scope of the expert appraisal	No data on consumption by children, vegetarians, pregnant or breastfeeding women, the elderly, or very physically active populations	Restriction of the scope of the expert appraisal to adults	The guidelines cannot be applied to children, pregnant or breastfeeding women, the elderly, or very physically active populations
Hazard characterisation	Method	Selection of input data	No specific dietary reference values for vegetarian populations	Absorption rates taken into account and a dietary reference value calculated for iron, tailored to plant-based diets Use of a dietary reference value for zinc tailored to plant-based diets	The optimised diets are tailored to meet the specific needs of vegetarians

Hazard characterisation	Method	Selection of input data	No data on variations in the bioavailability of certain nutrients in foods; for example, vitamin B12 is likely to have poor bioavailability in eggs, and the bioavailability of calcium is lower in the presence of phytates and oxalates	Not taken into account	Overestimation of the diet's contribution to meeting the dietary reference values for vitamin B12 and calcium
Characterisation of exposure	Method	Selection of input data	Only one study available in France has sufficient numbers of vegetarians	Not taken into account	It was not possible to compare the dietary intake data used with those from another study
Characterisation of exposure	Method	Quantity and quality of input data	Data from a cohort of volunteers, dating from 2009-2010	Not taken into account	Guidelines quantified on the basis of the consumption habits of a proportion of French vegetarians, whose representativeness is not guaranteed, particularly given the age of the data
Characterisation of exposure	Method	Quantity and quality of input data	Occurrence data on substances subject to authorisations for use have not been updated since the TDS2	Not taken into account	No characterisation of exposure to these substances in the optimised diets

Characterisation of exposure	Method	Quantity and quality of input data	TDS2 contamination data are old	Not taken into account	Risk of error in estimating exposure to certain contaminants
Characterisation of exposure	Method	Quantity and quality of input data	No data on food composition and contamination according to production methods and changes in consumption trends (high consumption of organically produced food among vegetarians)	Not taken into account	Risk of error in estimating exposure to certain contaminants
Characterisation of exposure	Method	Quantity and quality of input data	No contamination data for sweetened fresh dairy product alternatives and "yeast and others"	Not taken into account	Optimum amounts proposed by the optimisation tool for these foods not influenced by their contamination
Characterisation of exposure	Method	Quantity and quality of input data	No composition data for choline	Not taken into account	The proposed guidelines do not guarantee an adequate intake of choline
Characterisation of exposure	Method	Quantity and quality of input data	No "seaweed" food group due to insufficient composition data (unreliable data for vitamin B12 and variability in iodine content) and consumption data No "spices and herbs" food group	Not taken into account	Possible nutrient intakes from these food groups not taken into account and underestimation of exposure to certain chemical contaminants
Characterisation of exposure	Method	Exploitation of input data	Limited number of vegan men in the study population used	Extrapolation of the consumption habits of lacto-ovo-vegetarian men – whose	Cannot be estimated

				numbers were higher – to the vegan population	
Characterisation of exposure	Method	Exploitation of input data	For nutritional composition data where the censored data are below a limit of quantification, the actual level is between 0 and the limit of quantification	The middle bound nutritional composition values (limit of quantification/2) were used	For nutrients for which there was a high censoring rate (particularly copper, selenium and iodine), levels may be over- or underestimated

3.6. Conclusions of the CES on Human Nutrition

This work enabled the first food consumption guidelines for adult vegetarians living in France to be established. These guidelines incorporate all the data on nutrition (nutrients and food groups), contamination and dietary habits currently available in France. The optimised diets are used to describe broad trends in optimal consumption levels in order to maintain adequate nutritional intakes and adult health. By their nature, these guidelines are intended for populations already following a vegetarian diet[6]. However, they are also suitable for those wishing to adopt this type of diet.

For vegetables and fruits, the guideline is around 700 g/d for lacto-ovo-vegetarians and vegans. For pulses, the guidelines are 75 g/d for lacto-ovo-vegetarians and 120 g/d for vegans. For starchy foods and bread, the guidelines are 170 g/d for lacto-ovo-vegetarians and 250 g/d for vegans, more than half of which should come from wholegrain foods or those that are a source of fibre. Oilseeds should be present at a level of 50 g/d in vegetarian diets that contain little milk and fresh dairy products and in vegan diets. The guideline for oils is around 30 g/d, half of which should be oils rich in alpha-linolenic acid (rapeseed, walnut, soy, linseed). The guidelines for fresh dairy product alternatives are around 300 g/d, giving preference to versions fortified with vitamins and minerals. The guidelines for the group containing wheat germ, nutritional yeast flakes and yeast extract spreads are 10-15 g/d.

For lacto-ovo-vegetarians, the guidelines are 30 g/d for eggs, 50 g/d for cheese and 100 g/d for meat alternatives containing protein. For milk, the guidelines are 450 ml/d, or zero for people wishing to minimise this consumption.

In addition, the optimisation work showed that products fortified with vitamins and minerals provide numerous nutrients, particularly those that are limiting in these diets. Expanding the available foods could make it easier to achieve diets that are sufficiently rich in potentially limiting nutrients.

The systematic review carried out by the WG revealed the lower status in iron, iodine and vitamins D, B2, B6 and B12 in vegetarians, compared with people who eat animal flesh. Nevertheless, the diets optimised for vegetarians enable the dietary reference values to be met, with the exception of a few nutrients. For all populations, this concerned vitamin D (as with the general population) and eicosapentaenoic and docosahexaenoic acids. It also concerned vitamin B12 for lacto-ovo-vegetarians wishing to limit their consumption of milk and dairy products, and for vegans. Lastly, for vegan men, the optimised diet does not cover zinc requirements. These nutrients therefore require special attention. On an individual level, this could involve supplementation. At the level of the food supply or, more generally, the production systems, this may mean having more fortified foods available, particularly for vegetarians.

Regarding exposure to contaminants, the optimisation work highlighted the impossibility of finding solutions that enable all the dietary reference values to be met while limiting the risk of exposure to contaminants, and remaining within the range of dietary intakes observed in vegetarians. Thus, the proposed optimised diets were unable to keep below the maximum exposure limits for 21 contaminants or groups of contaminants. Most of these were man-made

[6] With a low to moderate level of physical activity and no special dietary requirements

contaminants (e.g. lindane or certain polybrominated compounds) or natural substances (e.g. mycotoxins), for which management measures are more appropriate than trade-offs at consumer level. In other cases, they were intrinsic substances, such as isoflavones mainly found in soy-based products. The guidelines set for pulses, plant-based beverages and meat and dairy alternatives should therefore be accompanied by recommendations to vary the sources of plant-based foods.

The method used to establish these guidelines may be updated to take account of changes in consumption trends in vegetarian populations and in the food supply, as well as advances in knowledge of food composition and contamination.

Due to the absence of sufficient data, these guidelines only apply to the adult population. Consumption data need to be acquired for other vegetarian populations in order to establish appropriate guidelines (e.g. for children, adolescents, pregnant or breastfeeding women, the elderly, or very physically active populations).

4. AGENCY CONCLUSIONS AND RECOMMENDATIONS

The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) endorses the conclusions of the CES on Human Nutrition.

This opinion is the culmination of expert appraisal work that began with a systematic review of the epidemiological links between vegetarian diets and health. These first French dietary guidelines aim to enable vegetarians to achieve adequate nutritional intakes while reducing their exposure to the contaminants studied.

The systematic review and establishment of dietary guidelines using an optimisation tool show that the lacto-ovo-vegetarian diet requires particular attention regarding certain nutrients for which requirements in terms of vitamin D and eicosapentaenoic and docosahexaenoic fatty acids may not be met. The risk of requirements not being met by the lacto-ovo-vegetarian diet is greater than that associated with the diet of non-vegetarian populations. In addition, lacto-ovo-vegetarians wishing to reduce their intake of milk and fresh dairy products may not be able to cover their vitamin B12 requirements. Furthermore, with the vegan diet, which excludes all foods of animal origin, it is difficult to meet the dietary reference value for zinc in men.

Work on vitamin and mineral fortification is currently under way at European level. The dietary guidelines proposed in this opinion will be brought to the attention of the European Working Group on Food Supplements, Addition of Vitamins and Minerals and of Certain Other Substances to Foods, to help with the implementation of management measures at EU level.

ANSES stresses that the guidelines drawn up in this expert appraisal apply only to the general adult population excluding pregnant or breastfeeding women, the elderly, or very physically active populations, who have particular needs. Therefore, regarding children and the adult populations not taken into account in these guidelines, specific work will need to be carried out to determine whether the adoption of exclusion diets is compatible with meeting their specific needs. This requires identifying, where appropriate, food combinations that enable them to meet the nutritional guidelines specific to them.

This work identified difficulties in meeting the nutritional needs of vegetarian populations in general and vegans in particular, compounded by the environmental contaminants in food.

The method used by the experts is designed to be protective, meeting nutritional needs as far as possible while limiting exposure to major contaminants. Given the widespread distribution in the environment of these man-made contaminants, the findings underline the need to reduce exposure and strengthen the ongoing collective actions that have been encouraged by the public authorities. ANSES stresses that these actions should focus as much as possible on the source of the risks, particularly in product formulation. These actions concern all products and environmental pollutants, whether man-made or not, with particular attention paid to substances that are very stable, such as heavy metals, or very persistent in the environment. The ambition should be for these exposures to have as little impact as possible on the definition of nutritional guidelines.

Besides diets excluding foods of animal origin, the guidelines presented in this opinion do not take account of any additional exclusions concerning foodstuffs of plant origin, which could make it even more difficult to meet the dietary reference values. Vegetarians should therefore ensure that they eat a varied diet.

Pr Benoit Vallet

KEY WORDS

Végétarien, végétalien, lacto-ovovégétarien, optimisation, régime, Plan national nutrition santé

Vegetarian, vegan, lacto-ovo-vegetarian, optimisation, diet, French National Nutrition and Health Programme

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ANNEX 1

Presentation of the participants

PREAMBLE: The expert members of the Expert Committees (CESs) and Working Groups (WGs) or designated rapporteurs are all appointed in a personal capacity, *intuitu personae*, and do not represent their parent organisation.

WORKING GROUP

Chair

Ms Emmanuelle KESSE-GUYOT – Research Director (INRAE, UMR Inserm U1153/INRAE U1125/CNAM/Sorbonne Paris Nord University) – Epidemiology, nutrition and pathologies, nutrition and public health, food sustainability

Members

Mr Benjamin ALLÈS – Researcher (INRAE, CRESS) – Nutrition, epidemiology, public health, vegetarian diets, food profiles

Ms Blandine de LAUZON-GUILLAIN – Research Director (INRAE, CRESS) – Epidemiology, infant nutrition, nutrition of pregnant or breastfeeding women, public health, food behaviour

Ms Christine FEILLET-COUDRAY – Research Director (INRAE, Montpellier) – Micronutrients, lipids, oxidative stress, nutrition, physiology

Mr Nathanael LAPIDUS – University Lecturer-Hospital Practitioner (AP-HP Saint-Antoine Hospital, Inserm-Sorbonne University, UMR-S1136) – Biostatistics, epidemiology, clinical research, methodology, meta-analyses, public health

Mr François MARIOTTI – Professor (AgroParisTech) – Protein nutrition, nutritional needs, nutritional status, epidemiological approaches, cardiometabolic risk

Mr Olivier STEICHEN – University Professor-Hospital Practitioner (AP-HP Tenon Hospital; Inserm/Sorbonne University UMR-S1136) – Nutrition and non-communicable diseases, biological functions, cardiology, endocrinology, systematic reviews and meta-analyses, clinical intervention studies

EXPERT COMMITTEE

The work that is the subject of this report was monitored and adopted by the following Expert Committee (CES):

- CES on Human Nutrition – 2022-2026

Chair

Ms Clara BENZI-SCHMID – Federal Food Safety and Veterinary Office (FSVO), Switzerland – Specialities: revision and updating of legal bases of foodstuffs

Members

Ms Karine ADEL-PATIENT – Research Director (Paris-Saclay University, CEA, INRAE) – Specialities: food allergy, immunology, perinatal care, metabolomic analyses, allergic risk management

Ms Charlotte BEAUDART – Research Manager (University of Namur) – Specialities: epidemiology, public health, meta-analyses, sarcopenia

Ms Annabelle BEDARD – Research Manager (Inserm UMR 1018, CESP) – Specialities: nutritional epidemiology, nutrition in adults, pregnant women and children, chronic non-communicable diseases, environment, exposure estimation and assessment

Ms Cécile BETRY – University Lecturer-Hospital Practitioner (Grenoble Alpes University, Grenoble Alpes University Hospital) – Specialities: clinical nutrition, artificial nutrition, malnutrition, nutrition and diabetes, nutrition and obesity

Mr Patrick BOREL – Research Director (INRAE, UMR C2VN) – Specialities: bioavailability, fat-soluble vitamins, micro-constituents, metabolism of micronutrients, edible insects, nutrigenetics

Ms Blandine de LAUZON-GUILLAIN – Research Director (INRAE, CRESS) – Specialities: epidemiology, infant nutrition, nutrition of pregnant or breastfeeding women, public health

Ms Christine FEILLET-COUDRAY – Research Director (INRAE, UMR DMEM, Montpellier) – Specialities: micronutrients, lipids, oxidative stress, nutrition, physiology

Mr Jérôme GAY-QUEHEILLARD – University Lecturer (University of Picardy Jules Verne, Ineris UMR I-01 INERIS) – Specialities: gastroenterology, nutrition, obesogenic diet, immune system, pesticides, endocrine disruptors

Ms Aurélie GONCALVES – University Lecturer (University of Nîmes, UPR APSY-v) – Specialities: physical activity for health, sedentary behaviour, nutrition, obesity, bioavailability

Ms Tao JIANG – University Lecturer (University of Burgundy, Inserm U1028 – CNRS UMR5292) – Specialities: methodologies of consumer studies, methodologies of clinical studies, food behaviour and dietary intakes, biostatistics

Ms Emmanuelle KESSE-GUYOT – Research Director (Sorbonne Paris Nord University, INRAE, UMR Inserm U1153/INRA U1125/CNAM) – Specialities: epidemiology, nutrition and pathologies, nutrition and public health, food sustainability

Mr Nathanaël LAPIDUS – University Lecturer-Hospital Practitioner (AP-HP Saint-Antoine, Inserm-UPMC, UMR-S1136) – Specialities: epidemiology, clinical research, methodology, meta-analyses, public health, biostatistics

Ms Corinne MALPUECH-BRUGERE – University Professor (University of Clermont Auvergne) – Specialities: human nutrition, metabolism of macro- and micronutrients

Ms Christine MORAND – Research Director (INRAE Clermont-Ferrand) – Specialities: prevention of vascular dysfunctions and related diseases, micro-constituents of plants

Mr Thomas MOUILLOT – University Lecturer-Hospital Practitioner (University of Burgundy, François Mitterrand University Hospital) – Specialities: nutrition, hepatology, gastroenterology, physiology, food behaviour

Mr Ruddy RICHARD – University Professor-Hospital Practitioner (Clermont-Ferrand University Hospital) – Specialities: clinical research, sports medicine, nutrition, chronic disease, bioenergetics, exercise

Ms Anne-Sophie ROUSSEAU – University Lecturer (University of Côte d'Azur, iBV, UMR 7277 CNRS, UMR 1091 Inserm) – Specialities: nutrition and physical activity, oxidative stress, immunometabolism

Mr Olivier STEICHEN – Hospital Practitioner (Sorbonne University Faculty, Tenon Hospital) – Specialities: nutrition and non-communicable diseases, biological functions, cardiology, endocrinology, systematic reviews and meta-analyses, clinical intervention studies

Mr Stéphane WALRAND – University Professor-Hospital Practitioner (University of Clermont Auvergne and Gabriel Montpied University Hospital in Clermont-Ferrand) – Specialities: pathophysiology, protein metabolism, vitamin D, amino acids

ANSES PARTICIPATION

Scientific coordination

Ms Sabine HOUDART – Head of the nutritional risk assessment project – ANSES

Ms Perrine NADAUD – Deputy Head of the Nutritional Risk Assessment Unit (UERN) – ANSES

Scientific contribution

Ms Sabine HOUDART – Head of the nutritional risk assessment project – ANSES

Ms Perrine NADAUD – Deputy Head of the UERN – ANSES

Ms Véronique SIROT – Methodology and Studies Project Manager – ANSES

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Ms Marine OSEREDCZUK – Food Observatory Project Manager – ANSES

Mr Aymeric DOPTER – Head of the UERN – ANSES

Ms Irène MARGARITIS – Deputy Director of Risk Assessment – ANSES

Administrative secretariat

Ms Chakila MOUHAMED – ANSES

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ANNEX 2

Internal request letter

anses
agence nationale de sécurité sanitaire
alimentation, environnement, travail
Connaître, évaluer, protéger

2019-SA-0118

Décision N° 2019-05-141

AUTOSAISINE

Le directeur général de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Anses),

Vu le code de la santé publique, et notamment son article L. 1313-3 conférant à l'Anses la prérogative de se saisir de toute question en vue de l'accomplissement de ses missions,

Décide :

Article 1er.- L'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail se saisit afin de réaliser une expertise dont les caractéristiques sont listées ci-dessous.

1.1 Thématiques et objectifs de l'expertise
Etablissement de repères alimentaires destinés aux personnes suivant un régime d'exclusion de tout ou partie des aliments d'origine animale

1.2 Contexte de l'autosaisine
Les repères du Programme National Nutrition Santé (PNNS) ont été actualisés par l'Anses en 2016 pour la population générale adulte sur la base des nouvelles références nutritionnelles et des données de consommation, de composition et de contamination des aliments.
A l'issue de ce travail, plusieurs populations spécifiques ont été identifiées, dont différents types de végétariens. Pour ces populations, une déclinaison des repères établis pour la population générale omnivore nécessite d'être réalisée, sur la base des références nutritionnelles et des différents modes de consommation propres à ces populations.
Ce travail s'inscrit dans un contexte sociétal d'une évolution des comportements alimentaires se situant au carrefour de multiples enjeux (politiques, identitaires, culturels, agroalimentaires, économiques, sanitaires, environnementaux, éthiques…) eux-mêmes traversés de valeurs diverses (bien-être animal et rapports humains-animaux, religion, santé, écologie…), conduisant à la progression de modes de consommation avec peu voire sans produits animaux. Cette évolution est relayée par des demandes exprimées par des associations végétariennes (Association des Végétariens France et Fédération Végane) portant sur l'adaptation des repères nutritionnels généraux aux différents types de végétarismes.
De plus, la littérature épidémiologique récente montre des liens entre les types de végétarisme et des effets sur la santé.
Dans le but de réduire les risque sanitaires liés à ces modes de consommation, ce travail vise à établir des repères de consommation permettant de couvrir les besoins nutritionnels de ces populations, tout en réduisant l'incidence de pathologies chroniques non transmissibles et l'exposition aux contaminants.

ANSES/PR1/9/02-01 [version c] – code Ennov : ANSES/FGE/0039 1 / 2

1.3 Questions sur lesquelles portent les travaux d'expertise à mener

L'établissement de repères alimentaires implique l'utilisation d'un outil d'optimisation nécessitant dans un premier temps une phase préparatoire, prévue en 2019, visant à :

- identifier et évaluer la prévalence des différents types de végétarisme ;
- établir les éventuels liens épidémiologiques entre consommations alimentaires spécifiques aux différents types de végétariens et santé, à l'aide d'une revue systématique de la littérature ;
- acquérir des données de consommation de différents types de végétariens en France ;
- acquérir des données de composition nutritionnelle des aliments consommés par les différents types de végétariens ;
- recueillir des données de contamination des aliments consommés par les différents types de végétariens.

Ces données seront utilisées par le groupe de travail dans un second temps (de fin 2019 à 2021) pour :

- paramétrer l'outil pour différents types de végétarisme qui seront définis durant la phase préparatoire ;
- établir les repères alimentaires à destination des types de végétariens identifiés.

1.4 Durée prévisionnelle de l'expertise

La date prévisionnelle de fin d'instruction et signature de l'avis associé est fixée à juin 2021 sous réserve du flux de saisines prioritaires à traiter qui pourraient être transmises à l'Anses d'ici là.
Calendrier prévisionnel : restitution des travaux mi-2021

Article 2.- Un avis sera émis et publié par l'Agence à l'issue des travaux.

Fait à Maisons-Alfort, le 28 JUIN 2019

Dr Roger Genet
Directeur général

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ANNEX 3

List of toxicological constraints

Substance class	Substance	Women	Men	Unit
Bisphenols	Bisphenol A (BPA)	0.2	0.2	µg/kg bw/d
Newly-formed compound	Acrylamide	314	395	ng/kg bw/d
Polybrominated compounds	BDE-100	0.009	0.009	ng/kg bw/d
	BDE-153	0.010	0.011	ng/kg bw/d
	BDE-154	0.006	0.007	ng/kg bw/d
	BDE-183	0.015	0.016	ng/kg bw/d
	BDE-209	0.286	0.291	ng/kg bw/d
	BDE-28	0.002	0.002	ng/kg bw/d
	BDE-47	0.050	0.053	ng/kg bw/d
	BDE-99	0.034	0.037	ng/kg bw/d
	Hexabromocyclododecane (HBCDD)	0.133	0.151	ng/kg bw/d
	Polybrominated biphenyls (PBBs)	0.008	0.008	ng/kg bw/d
Dioxins, furans and PCBs	Dioxins, furans and DL-PCBs	0.286	0.286	pg TEQ_{WHO05}/kg bw/d
	NDL-PCBs	10000	10000	pg/kg bw/d
Trace metal elements	Aluminium (Al)	286	286	µg/kg bw/d
	Antimony (Sb)*			
	Organic arsenic (As)*			
	Inorganic arsenic (As)	0.50	0.43	µg/kg bw/d
	Barium (Ba)	200	200	µg/kg bw/d
	Cadmium (Cd)	0.35	0.35	µg/kg bw/d
	Chromium III (CrIII)	300	300	µg/kg bw/d
	Chromium VI (CrVI)	0.51	0.49	µg/kg bw/d
	Cobalt (Co)	1.6	1.6	µg/kg bw/d
	Tin (Sn)*			
	Germanium (Ge)*			
	Inorganic mercury (Hg)	0.57	0.57	µg/kg bw/d
	Methylmercury (MeHg)	0.1	0.1	µg/kg bw/d
	Nickel (Ni)	13	13	µg/kg bw/d
	Lead (Pb)	0.18	0.20	µg/kg bw/d
	Strontium (Sr)	600	600	µg/kg bw/d
	Vanadium (V)*			
Polycyclic aromatic hydrocarbons (PAHs)	5-methylchrysene (MCH)*			
	Anthracene (AN)*			
	Benzo(c)fluorene (BcFL)*			
	Benzo(g,h,i)perylene (BghiP)*			
	Benzo(j)fluoranthene (BjF)*			
	Benzo(k)fluoranthene (BkF)*			
	Benzo[a]pyrene (BaP) + chrysene (CHR) + benz[a]anthracene (BaA) + benzo[b]fluoranthene (BbF) (PAH4)	1.29	1.33	ng/kg bw/d
	Cyclopenta[cd]pyrene (CPP)*			

	Dibenzo[a,e]pyrene (DbaeP)*			
	Dibenzo[a,h]anthracene (DBahA)*			
	Dibenzo[a,h]pyrene (DbahP)*			
	Dibenzo[a,i]pyrene (DbaiP)*			
	Dibenzo[a,l]pyrene (DbalP)*			
	Fluoranthene (FA)*			
	Indeno[1,2,3-c,d]pyrene (IP)*			
	Phenanthrene (PHE)*			
	Pyrene (PY)*			
Isoflavones	Isoflavones	10000	20000	ng/kg bw/d
Mycotoxins	Aflatoxins	0.39	0.45	ng/kg bw/d
	Deoxynivalenol (DON) and its acetylated derivatives (DON-3-Ac and DON-15-Ac)	1000	1000	ng/kg bw/d
	Fumonisins B1 and B2 (FB1 and FB2)	1000	1000	ng/kg bw/d
	Nivalenol	1200	1200	ng/kg bw/d
	Ochratoxin A (OTA)	0.90	1.01	ng/kg bw/d
	Patulin	400	400	ng/kg bw/d
	Toxins T2, HT2 and Diacetoxyscirpenol (DAS)	25	25	ng/kg bw/d
	Zearalenone and its metabolites	250	250	ng/kg bw/d
Residues of plant protection products	Camphechlor (toxaphene)	0.033	0.033	µg/kg bw/d
	Chlordane	0.5	0.5	µg/kg bw/d
	DDT	0.5	0.5	µg/kg bw/d
	Dieldrin	0.05	0.05	µg/kg bw/d
	Endrin	0.2	0.2	µg/kg bw/d
	HCH	0.6	0.6	µg/kg bw/d
	Heptachlor	0.1	0.1	µg/kg bw/d
	Hexachlorobenzene (HCB)	0.07	0.07	µg/kg bw/d
	Lindane (HCH-gamma)	0.0008	0.0008	µg/kg bw/d
Per- and polyfluoroalkyl substances (PFAS)	Perfluorobutanoic acid (PFBA)	1000	1000	ng/kg bw/d
	Perfluorodecanoic acid (PFDA)	4.00E-04	4.00E-04	ng/kg bw/d
	Perfluorododecanoic acid (PFDoA)	12	12	ng/kg bw/d
	Perfluoroheptanesulfonic acid (PFHpS)*			
	Perfluoroheptanoic acid (PFHpA)	23	23	ng/kg bw/d
	Perfluorohexanoic acid (PFHxA)	500	500	ng/kg bw/d
	Perfluoro-n-undecanoic acid (PFUnA)	12	12	ng/kg bw/d
	Perfluorooctanesulfonic acid (PFOS), Pentadecafluorooctanoic acid (PFOA), Perfluorohexane sulfonate (PFHxS) and Perfluorononanoic acid (PFNA)	4.4	4.4	ng/kg bw/d
	Perfluoropentanoic acid (PFPeA)	500	500	ng/kg bw/d
	Perfluorotetradecanoic acid (PFTeDA)*			
	Perfluorotridecanoic acid (PFTrDA)	12	12	ng/kg bw/d
	Perfluorodecane sulfonate (PFDS)	12	12	ng/kg bw/d
	Perfluorobutane sulfonate (PFBS)	300	300	ng/kg bw/d

* Contaminants for which no maximum value was chosen as a constraint in the optimisation tool

ANNEX 4

Maximum exposure percentages for contaminants whose constraints were relaxed in the "conta-nut" scenario

<100 indicates that the constraint was satisfied, i.e. the maximum exposure value was not exceeded

Contaminant	Lacto-ovo-vegetarian men		Lacto-ovo-vegetarian women	
	"nut"	"conta-nut"	"nut"	"conta-nut"
PFDA	142,357	79,066	153,212	100,320
Lindane (HCH-gamma)	17,996	14,814	16,875	13,583
Isoflavones	2,137	4,718	13,843	10,100
BDE-183	1,452	588	1,572	485
Zearalenone and its metabolites	1,041	934	994	804
Aflatoxins	740	435	745	416
BDE-153	592	258	666	231
BDE-209	488	222	516	206
Heptachlor (sum)	484	231	510	202
T2, HT2 and DAS	462	425	450	379
BDE-154	314	155	355	146
Dieldrin (sum)	312	201	328	213
OTA	317	270	326	255
PBB	254	161	268	156
BDE-99	226	113	251	108
BDE-100	210	106	224	*<100*
BDE-47	205	*<100*	218	*<100*
Pb	186	144	214	171
BDE-28	195	105	195	*<100*
CrVI	189	209	194	220
PAH4	152	183	171	175

Contaminant	Lacto-ovo-vegetarian men limiting milk and FDPs		Lacto-ovo-vegetarian women limiting milk and FDPs	
	"nut"	"conta-nut"	"nut"	"conta-nut"
PFDA	60,337	36,703	70,323	39,860
Lindane (HCH-gamma)	18,585	14,562	18,830	14,455
Isoflavones	3,559	4,729	9188	3383
BDE-183	1,610	1,165	1538	1377
Zearalenone and its metabolites	1,089	1,039	1069	1104
Aflatoxins	851	572	793	662
BDE-153	654	492	647	591
Heptachlor (sum)	537	387	508	443
BDE-209	485	357	485	417
T2, HT2 and DAS	478	449	483	447

OTA	340	293	355	343
Dieldrin (sum)	326	223	344	239
BDE-154	349	281	343	327
BDE-99	240	186	259	236
PBB	265	237	251	253
BDE-100	221	172	227	207
BDE-47	207	158	220	193
PAH4	201	223	216	238
CrVI	174	211	183	225
Pb	173	155	181	171
BDE-28	181	147	171	157
Dioxins, furans and DL-PCBs	115	100	128	100
DDT (sum)	121	*<100*	114	100

Contaminant	Vegan men		Vegan women	
	"nut"	"conta-nut"	"nut"	"conta-nut"
PFDA	46,126	31,452	47,727	38,695
Lindane (HCH-gamma)	14,539	13,157	21,097	14,998
Isoflavones	3,894	1,811	12,003	184
BDE-183	778	735	1,927	777
Zearalenone and its metabolites	843	920	1,249	689
Aflatoxins	616	504	1,020	748
BDE-153	344	307	806	328
BDE-209	187	179	464	187
Heptachlor (sum)	306	283	654	289
T2, HT2 and DAS	365	380	512	394
BDE-154	212	171	427	178
Dieldrin (sum)	255	197	408	217
OTA	287	284	424	274
PBB	174	130	278	129
BDE-99	115	110	285	117
BDE-100	110	102	249	104
BDE-47	*<100*	*<100*	231	*<100*
Pb	146	122	216	118
BDE-28	*<100*	*<100*	184	*<100*
CrVI	166	154	182	124
PAH4	255	180	212	176

ANNEX 5

Extract of the relationships between food groups and health outcomes of interest from the Dietary Guidelines Advisory Committee's scientific report (DGAC 2020)

Table D8.1. Dietary pattern components in the Committee's Conclusion Statements that are associated with the health outcomes of interest.**

Health Outcome of Interest:	All-cause mortality	Cardiovascular disease[a]	Growth, size, body composition and risk of overweight and obesity[a]	Type 2 diabetes[a]	Bone health[a]	Colorectal Cancer[b]	Breast Cancer (Post-menopausal)[b]	Lung Cancer[b]	Neurocognitive health
Grade:	*Strong (adults)*	*Strong (adults); Limited (children)*	*Moderate (adults); Limited (children)*	*Moderate (adults)*	*Moderate (adults)*	*Moderate (adults)*	*Moderate (adults)*	*Limited (adults)*	*Limited (adults)*
Dietary patterns associated with lower risk of disease consistently included the following components.									
Components									
Fruits	X	X	X	X	X	X	X	X	X
Vegetables	X	X	X	X	X	X	X	X	X
Whole grains/cereal	X	X	X	X	X	X	X	X	
Legumes	X	X	X (adults)		X	X		X	X
Nuts	X	X (adults)			X				X
Low-fat dairy	X	X	X		X	X		X	
Fish and/or seafood	X	X	X (adults)		X	X		X	X
Unsaturated vegetable oils	X	X	X (adults)						X
Lean meat	X					X		X	
Poultry	X								
Dietary patterns associated with higher risk of disease consistently included the following components.									
Red meat	X	X (adults)	X (adults)	X		X			
Processed meat	X	X	X	X	X	X			
High-fat meat								X	
High-fat dairy	X			X					
Animal-source foods							X		
Saturated fats		X (adults)	X (adults)			X			

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ANNEX 6

Objectives and methods of the NutriNet-Santé study

The main objectives of the NutriNet-Santé cohort study are to:

- assess the relationship between nutrition (food and nutrient intake, physical activity and nutritional status) and health (including major health problems such as obesity, hypertension, diabetes, cardiovascular disease, cancer, digestive disorders, as well as healthy ageing and quality of life);
- understand the determinants (sociological, economic, cultural, psychological, cognitive, sensory, biological, genetic, etc.) of eating behaviour, nutritional status and health status.

Participants in the NutriNet-Santé study are French volunteers, aged 15 or over, with an Internet connection and recruited from the general population.

On enrolment, all participants are asked to complete a baseline dossier comprising five questionnaires about their diet, health, physical activity, anthropometric data and whether they follow any specific diets such as vegetarian and vegan, as well as their socio-economic data and lifestyles. Inclusion in the study is effective once participants have completed all the questionnaires in this baseline dossier. As part of their follow-up, participants are then invited to complete these five questionnaires on an annual basis. In addition, further cross-cutting questionnaires on specific research topics are sent to participants on a regular basis.

Dietary intake is assessed at inclusion and then every six months (to take account of the seasonal nature of food), using a series of three non-consecutive 24-hour records, randomly distributed over a two-week period (two weekdays and one weekend day). Participants report all the food and drink (type and amount) consumed over a 24-hour period: three main meals (breakfast, lunch, dinner) as well as snacks. Information about the time, place, conditions and environment (whether alone or with others; reading, in front of a screen, etc.) in which the food was consumed is also requested.

Dietary intakes are entered on a dedicated platform, using a search engine, a classification tree or by manual entry if the food is not found. Portion sizes are estimated using a validated photograph manual (Le Moullec *et al.* 1996), or in grams or millilitres depending on the food. Participants also indicate the type of food (home-cooked or industrial, and the brand if applicable). For each 24-hour record, participants are also asked whether the dietary intake reported is consistent with their usual diet. This protocol is validated against an interview conducted by a qualified nutrition professional and against urine and blood biomarkers (Lassale *et al.* 2015; Lassale *et al.* 2016; Touvier *et al.* 2011).

Under-reporting individuals are identified with Black's energy intake assessment method (Black 2000a, 2000b) using Goldberg cut-offs (Goldberg *et al.*). This method, which has been validated in nutritional epidemiology, can distinguish under-reporting and amounts of food consumed by comparing, for each individual, the average energy intake and the energy requirement at constant weight. The energy requirement is calculated by considering the level of physical activity and the basal metabolic rate, which itself is calculated according to the gender, age, weight and height of the individual at inclusion, based on Schofield's equations (Schofield 1985). The respective coefficients of variability for the basal metabolic rate and level of physical activity are 8.5% and 15% (Schofield 1985). For the level of physical activity, two thresholds are considered: 0.88 to identify extreme under-reporters and 1.55 to identify other under-reporters (Goldberg *et al.* 1991; Black 2000a). These under-reporters and extreme under-reporters are systematically excluded. Under-reporters who report weight-loss diets, recent weight loss of more than 5 kg or food consumption that differs from normal are not considered as under-reporters and remain in the study.

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